



IALA S-247 Product Specification

Working Draft 1.0.0 – March 2021

IALA Differential eLoran Reference Station Almanac Product Specification

Document Revisions

Revisions to the IALA Document are to be noted in the table prior to the issue of a revised document.

Date	Page / Section Revised	Requirement for Revision
Oct. 2019	Various	Draft the product specification
Mar. 2021	Various	Updated various sections and figures

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1 Overview

1.1 Introduction

Enhanced Loran is an internationally standardized positioning, navigation, and timing (PNT) service for use by many modes of transport and in other applications. It is the latest in the long-standing and proven series of low-frequency, Long-Range Navigation (LORAN) systems, one that takes full advantage of 21st century technology.

eLoran meets the accuracy, availability, integrity, and continuity performance requirements for aviation non-precision instrument approaches, maritime harbor entrance and approach maneuvers, land-mobile vehicle navigation, and location-based services, and is a precise source of time and frequency for applications such as telecommunications.

eLoran is an independent, dissimilar, complement to Global Navigation Satellite Systems (GNSS). It allows GNSS users to retain the safety, security, and economic benefits of GNSS, even when their satellite services are disrupted.

The Product Specification can be used to exchange Differential eLoran Reference Station in a consistent form between stakeholders.

1.2 References

1.2.1 Normative References

IHO S.100 IHO Universal Hydrographic Data Model, Edition 4.0.0, December 2018

IHO S.63 Data Protection Scheme, Edition 1.2.0, January 2015

ISO 8601:2004 Data elements and interchange formats _ Information interchange _ Representation of dates and times

ISO/TS 19103:2005 Geographic information - Conceptual schema language

ISO 19111:2003 Geographic information - Spatial referencing by coordinates

ISO 19115:2006 Geographic information – Metadata (Tech Corr. 1, 2006)

ISO 19115-2:2009 Geographic information - Metadata: Extensions for imagery and gridded data

ISO 19131:2007 Geographic information - Data product specifications

ISO/IEC 19505-1:2012, Information technology — Open Distributed Processing - Unified Modelling Language Version 2.4.1

International Loran Association: 2007 Enhanced Loran (eLoran) Definition Document

RTCM SC 127 Minimum Performance Standards for Marine eLoran Receiving Equipment

1.2.2 Informative References

ISO, 2006. ISO 19109 Geographic Information - Rules for Application Schema.

ISO, 2007. ISO 19135 Geographic Information – Procedures for Item Registration.

ISO, 2009. ISO 19136 Geographic Information - Geography Markup Language (GML).

IMO, 2008. Safety of Navigation Circular SN/Circ.243

1.3 Terms, Definitions and abbreviations

1.3.1 Terms and definitions

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

application

manipulation and processing of data in support of user requirements (ISO 19101)

application schema

conceptual schema for data required by one or more **applications** (ISO 19101)

conceptual model

model that defines concepts of a **universe of discourse** (ISO 19101)

conceptual schema

formal description of a **conceptual model** (ISO 19101)

coverage

feature that acts as a function to return values from its range for any direct position within its spatial, temporal or spatiotemporal **domain** (ISO 19123)

EXAMPLE Raster image, polygon overlay, digital elevation matrix.

data product

dataset or **dataset series** that conforms to a **data product specification**

data product specification

detailed description of a **dataset** or **dataset series** together with additional information that will enable it to be created, supplied to and used by another party

NOTE: A data product specification provides a description of the universe of discourse and a specification for mapping the universe of discourse to a dataset. It may be used for production, sales, end-use or other purpose.

dataset

identifiable collection of data (ISO 19115)

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

dataset series

collection of **datasets** sharing the same product specification (ISO 19115)

domain

well-defined set (ISO/TS 19103)

NOTE: Well-defined means that the definition is both necessary and sufficient, as everything that satisfies the definition is in the set and everything that does not satisfy the definition is necessarily outside the set.

feature

abstraction of real world phenomena (ISO 19101)

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

feature association

relationship that links instances of one **feature** type with instances of the same or a different **feature** type (ISO19110)

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

NOTE 2: Feature associations include aggregation of features.

feature attribute

characteristic of a **feature** (ISO 19101)

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 for a feature instance has an attribute value taken from the domain.

geographic data

data with implicit or explicit reference to a location relative to the Earth (ISO 19109)

NOTE: Geographic information is also used as a term for information concerning phenomena implicitly or explicitly associated with a location relative to the Earth.

metadata

data about data (ISO 19115)

model

abstraction of some aspects of reality (ISO 19109)

portrayal

presentation of information to humans (ISO 19117)

quality

totality of characteristics of a product that bear on its ability to satisfy stated and implied needs (ISO 19101)

universe of discourse

view of the real or hypothetical world that includes everything of interest (ISO 19101)

1.3.2 Acronyms

This product specification adopts the following convention for symbols and abbreviated terms:

AtoN	Aid to navigation
CRS	Coordinate Reference System
ECDIS	Electronic Chart Display and Information System
eLoran	Enhanced Loran
e-Navigation	Enhanced Navigation (maritime)
EPSG	European Petroleum Survey Group
ENC	Electronic Navigational Chart
FTA	Finnish Transport Administration
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICAO	International Civil Aviation Organization
IHO	International Hydrographic Organization
IMO	International Maritime Organization
ISO	International Organization for Standardization
Loran	Long-Range Navigation
PNT	Positioning, Navigation, and Timing
WWRNS	World Wide Radionavigation System
XML	Extensible Markup Language

1.4 Product Specification metadata

Title	Differential eLoran Reference Station Almanac
Identifier	1.0.0
S-100 version	4.0.0
Date	March 2021
Language	English
Classification:	001 - unclassified
Contact:	IALA-AISM 10, rue des Gaudines 78100 Saint Germain en Laye, France Telephone: +33 1 34 51 70 01 Fax: +33 1 34 51 82 05
URL:	iala-aism.org

Maintenance:

The product specification is maintained by IALA-AISM and amendments are performed on a needs base, up to maximum one new release per calendar year.

1.4.1 IALA Product Specification Maintenance

This chapter is for clarification only on PS Maintenance.

1.4.1.1 Introduction

Changes to a product specification will be released by IALA-AISM as a new edition, revision, or clarification.

1.4.1.2 New Edition

New editions of a product specification 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.

1.4.1.3 Revisions

Revisions are defined as substantive semantic changes to a product specification. Typically, revisions will change a product specification 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 a product specification. All cumulative *clarifications* must be included with the release of approved corrections.

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 data product of one version could always be processed with a later version of the feature and portrayal catalogues.

1.4.1.4 Clarification

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

Changes in a clarification are minor and ensure backward compatibility with the previous versions within the same edition. Within the same edition, a data product 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.

1.4.1.5 Version Numbers

The associated version control numbering to identify changes (n) to a product specification must be as follows:

New editions denoted as **n**.0.0

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

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

2 Specification Scope

This product specification describes one data product and therefore requires only one scope which is described below:

Scope ID: Differential eLoran Reference Station Almanac datasets.

Hierarchical level: MD_ScopeCode - 005

Hierarchical level name: dataset.

Level description: information applies to the dataset

Extent: EX_Extent.description: Global coverage of maritime areas

3 Data Product Identification

This clause describes how to identify data sets that conform to the specification. A dataset that conforms to this Product Specification may be identified by its discovery metadata as defined in clause 13 of this specification. The information identifying the data product may include the following items from S-100 4.0.0 clause 11-6 (adapted from ISO 19115-1).

Title	Differential eLoran Reference Station Almanac
Alternate Title	S-247
Abstract	An Differential eLoran Reference Station is a vector dataset containing all relevant information regarding the eLoran Reference Station within a defined geographical area.
Topic Category	

Geographic Description	EX_GeographicDescription: E.g., official name of region
Spatial Extent	Description: Global East Bounding Longitude: -180 West Bounding Longitude: 180 North Bounding Latitude: 90 South Bounding Latitude: -90
Description	
Spatial Resolution	
Purpose	Differential eLoran Reference Station Almanac are produced to allow the producer to exchange Differential eLoran Reference Station information with interested stakeholders
Language	English
Spatial Representation Type	
Point of Contact	IALA-AISM 10, rue des Gaudines 78100 Saint Germain en Laye, France Telephone: +33 1 34 51 70 01 Fax: +33 1 34 51 82 05
Use Limitation	None

4 Data Content and structure

4.1 Introduction

An Differential eLoran Reference Station dataset is a feature-based product. The following sub-sections contain the product application schema expressed in UML and an associated feature catalogue. The feature catalogue provides a full description of each feature type including its attributes and attribute values in the data product.

4.2 Application Schema

The application schema conforms to the modelling conventions of UML as constrained in S-100 Part 1, and conforms to the General Feature Model described in Part 3.

An overview of the application schema is provided in the following figure (Figure 1). The subsequent figures provide details for feature types and their relationships.

- The feature type DLoranStation is a type which is used to indicate DLoran station.

- Reference-referenceby associations are modelled by the association labelled ReferenceReferenceby, between classes DLoranStation and DLoranStationAlmanac in Figure 1 below.
- The information type DLoranStationAlmanac is a type which is used to indicate a characteristics in the DLoran Reference station.

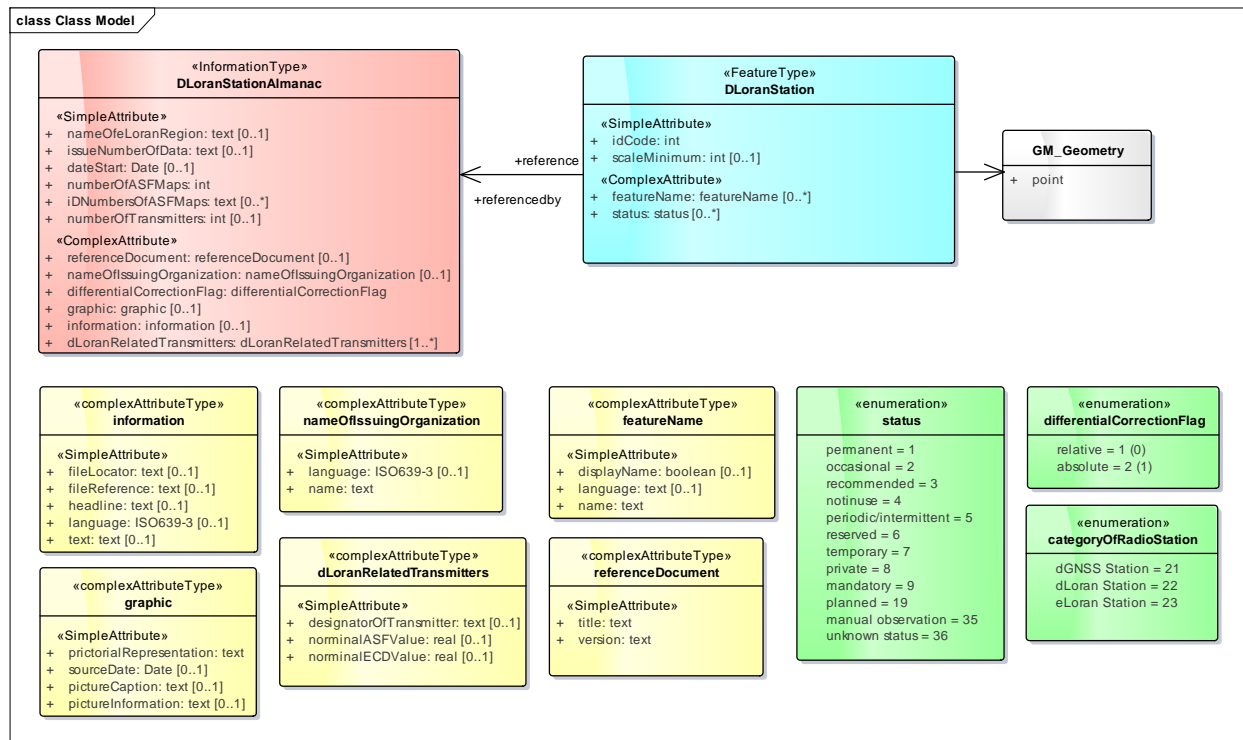


Figure 4.1 - Application schema of Differential eLoran Reference Station Almanac

4.3 Feature Catalogue

The Feature Catalogue describes the feature types, information types, attributes, attribute values, associations and roles which may be used in the product. It also assigns the geometric primitives. The S-247 Feature Catalogue is available in an XML document which conforms to the S-100 XML Feature Catalogue Schema and can be downloaded from the IALA website (iala-aism.org). A printed version of the feature catalogue is provided in Annex X.

Name: Differential eLoran Reference Station Almanac

Scope: Ocean, Coastal, Ports, Harbors and Inland waters

Version Number: 1.0.0

Version Date: 2021-03

Producer:

IALA-AISM

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78100 Saint Germain en Laye, France
Telephone: +33 1 34 51 70 01 Fax: +33 1 34 51 82 05
URL : <https://iala-aism.org>

Language: English

4.4 Feature Types

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

4.4.1 Geographic

Geographic (Geo) feature types carries the descriptive characteristics of a real-world entity.

4.4.2 Meta

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

4.4.3 Feature Relationship

A feature relationship links instances of one feature type with instances of the same or a different feature type.

4.4.4 Information Types

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

4.4.5 Attributes

S-247 defines attributes as either simple or complex.

S-247 uses several types of simple attributes; they are listed in the following table:

Type	Definition
Enumeration	A fixed list of valid identifiers of named literal values
Boolean	A value representing binary logic. The value can be either True or False.

	The default state for Boolean type attributes (i.e. where the attribute is not populated for the feature) is False.
Real	A signed Real (floating point) number consisting of a mantissa and an exponent
Integer	A signed integer number. The representation of an integer is encapsulation and usage dependent.
CharacterString	An arbitrary-length sequence of characters including accents and special characters from a repertoire of one of the adopted character sets
Date	A date provides values for year, month and day according to the Gregorian Calendar. Character encoding of a date is a string which must follow the calendar date format (complete representation, basic format) for date specified by ISO 8601. EXAMPLE 19980918 (YYYY-MM-DD)
Time	A time is given by an hour, minute and second. Character encoding of a time is a string that follows the local time (complete representation, basic format) format defined in ISO 8601. EXAMPLE 183059 or 183059+0100 or 183059Z
Date and Time	A DateTime is a combination of a date and a time type. Character encoding of a DateTime shall follow ISO 8601 EXAMPLE 19850412T101530
Codelist	A type of flexible enumeration. A code list type is a list of literals which may be extended only in conformance with specified rules.
Truncated date	One or more components of the Date type are omitted.

Table 4.1 - Simple feature attributes

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

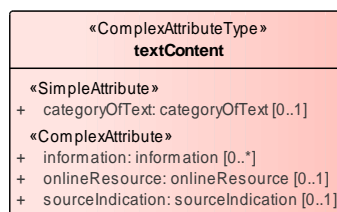


Figure 4.2 - textContent - a complex attribute

4.5 Units of Measure

The following units of measure is used in Marine Traffic Management datasets;

- Orientation is given in decimal degrees
- Radio frequency is given in hertz
- Uncertainty is given in metres
- Distances are given in metres or nautical miles

4.6 Geometry

The specifications for S-247 geometry are the same as for S-101 geometry except that 3-D geometry is not permitted even for sounding features since these features are not part of the S-247 application schema. The relevant (modified) extract from the S-101 product specification is reproduced below.

The underlying geometry of an S-247 dataset is constrained to level 3a which supports 0, 1 and 2 dimensional features (points, curves and surfaces) as defined by S-100 Part 7 – Spatial Schema.

Level 3a is described by the following constraints:

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

S-247 further constrains Level 3a with the following:

- Coincident linear geometry must be avoided when there is a dependency between features.
- The interpolation of GM_CurveSegment must be loxodromic.
- Linear geometry is defined by curves which are made of curve segments. Each curve segments contains the geographic coordinates as control points and defines an interpolation method between them. The distance between two consecutive control points must not exceed 0.3 mm at a display scale of 1:10000.

The following exception applies to S-247:

- The use of coordinates is restricted to two dimensions.
- Soundings features which use GM_Point or GM_Multipoint with three dimensional coordinates are not currently included in S-247.

Geometric representation is the digital description of the spatial component of an object as described in S-100 and ISO 19107. This product specification uses three types of geometries: GM_Point, GM_OrientableCurve, and GM_OrientableSurface.

5 Co-ordinate reference systems (CRS)

5.1.1 Introduction

The location of an object in the S-100 standard is defined by means of coordinates which relate a feature to a position. The coordinate reference system used for this product specification is World Geodetic System 1984 (WGS 84) which is defined by the European Petroleum Survey Group (EPSG) code 4326, (or similar - North American Datum 1983 / Canadian Spatial Reference System).

Spatial data are expressed as latitude (ϕ) and longitude (λ) geographic coordinates. Latitude values are stored as a negative number to represent a position south of the Equator. Longitude values are stored as a negative number to represent a position west of the Prime Meridian. Coordinates are expressed as real value, degree / degree decimal format. Datasets conforming to this product specification are not projected.

Horizontal coordinate reference system: WGS 84

Projection: None

Vertical coordinate reference system: Although all coordinates in a dataset must refer to the same horizontal CRS different Vertical Datums can be used for the depth component of a coordinate tuple. Therefore the vertical CRS can be repeated. For each Vertical CRS a unique identifier is defined. Those identifiers will be used to indicate which Vertical CRS is used. Units must be in metres. (From S-101 Draft).

Temporal reference system: Gregorian calendar

Coordinate reference system registry: [EPSG Geodetic Parameter Registry](#)

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

5.1.2 Horizontal reference system

Positional data is expressed in latitude and longitude geographic coordinates to one of the reference horizontal reference systems defined in the HORDAT attribute. Unless otherwise defined, the World Geodetic System 84 (WGS 84) will be used for S-247 data products.

5.1.3 Projection

Marine Traffic Management data products are un-projected.

5.1.4 Vertical coordinate reference system

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

5.1.5 Temporal reference system

Time is measured by reference to Calendar dates and Clock time in accordance with ISO 19108:2002 Temporal Schema clause 5.4.4.

6 Data Quality

6.1 Introduction

Data quality allows users and user systems to assess fitness for use of the provided data. Data quality measures and the associated evaluation are reported as metadata of a data product. This metadata improves interoperability with other data products and provides usage by user groups that the data product was not originally intended for. The secondary users can make assessments of the data product usefulness in their application based on the reported data quality measures.

For S-247 the following data quality elements have been included:

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

6.2 Quality measure elements

The recommended data quality measures and their applicability in S-247 are indicated in the table below. NA indicated the measure is not applicable. This table reproduces the first 4 columns of the data quality checklist recommended elements and replaces the final column with descriptions of the scope of the element in the context of S-247 datasets.

Data quality element and sub element	Definition	DQ measure / description	Evaluation scope	Scope in S-247
Completeness / Commission	Excess data present in a dataset, as described by the scope.	numberOfExcessItems / This data quality measure indicates the number of items in the dataset, that should not have been present in the dataset.	dataset/dataset series	All features and info types
Completeness / Commission	Excess data present in a dataset, as described by the scope.	numberOfDuplicateFeatureInstances / This data quality measure indicates the total number of exact duplications of feature instances within the data.	dataset/dataset series	All features and info types
Completeness / Omission	Data absent from the dataset, as described by the scope.	numberOfMissingItems / This data quality measure is an indicator that shows that a specific item is missing in the data.	dataset/dataset series/spatial object type	All features and info types
Logical Consistency / Conceptual Consistency	Adherence to the rules of a conceptual schema.	numberOfInvalidSurfaceOverlaps / This data quality measure is a count of the total number of erroneous overlaps within the data. Which surfaces may overlap and which must not is application dependent. Not all overlapping surfaces are necessarily erroneous.	spatial object / spatial object type	Features with surface geometry; spatial objects of type surface
Logical Consistency / Domain Consistency	Adherence of the values to the value domains.	numberOfNonconformantItems / This data quality measure is a count of all items in the dataset that are not in conformance with their value domain.	spatial object / spatial object type	All features and info types
Logical Consistency / Format Consistency	Degree to which data is stored in accordance with the physical structure of the data set, as described by the scope	physicalStructureConflictsNumber / This data quality measure is a count of all items in the dataset that are stored in conflict with the physical structure of the dataset.	dataset/dataset series	All features and info types
Logical Consistency / Topological Consistency	Correctness of the explicitly encoded topological characteristics of the dataset, as described by the scope.	rateOfFaultyPointCurveConnections / This data quality measure indicates the number of faulty link-node connections in relation to the number of supposed link-node connections. This data quality measure gives the erroneous point-curve connections in relation to the total number of point-curve connections.	spatial object / spatial object type	Features with curve geometry; spatial objects of curve types
Logical Consistency / Topological Consistency	Correctness of the explicitly encoded topological characteristics of the dataset, as described by the scope.	numberOfMissingConnectionsUndershoots / This data quality measure is a count of items in the dataset within the parameter tolerance that are mismatched due to undershoots.	spatial object / spatial object type	Features with curve geometry; spatial objects of curve types

Data quality element and sub element	Definition	DQ measure / description	Evaluation scope	Scope in S-247
Logical Consistency / Topological Consistency	Correctness of the explicitly encoded topological characteristics of the dataset, as described by the scope.	numberOfMissingConnectionsOvershoots / This data quality measure is a count of items in the dataset within the parameter tolerance that are mismatched due to overshoots.	spatial object / spatial object type	Features with curve geometry; spatial objects of curve types
Logical Consistency / Topological Consistency	Correctness of the explicitly encoded topological characteristics of the dataset, as described by the scope.	numberOfInvalidSlivers / This data quality measure is a count of all items in the dataset that are invalid sliver surfaces. A sliver is an unintended area that occurs when adjacent surfaces are not digitized properly. The borders of the adjacent surfaces may unintentionally gap or overlap to cause a topological error.	dataset / dataset series	Features with surface geometry; spatial objects of type surface
Logical Consistency / Topological Consistency	Correctness of the explicitly encoded topological characteristics of the dataset, as described by the scope.	numberOfInvalidSelfIntersects / This data quality measure is a count of all items in the dataset that illegally intersect with themselves.	spatial object / spatial object type	Features with surface geometry; spatial objects of type surface or curve
Logical Consistency / Topological Consistency	Correctness of the explicitly encoded topological characteristics of the dataset, as described by the scope.	numberOfInvalidSelfOverlap / This data quality measure is a count of all items in the dataset that illegally self-overlap.	spatial object / spatial object type	Features with surface geometry; spatial objects of type surface or curve
Positional Accuracy / Absolute or External Accuracy	Closeness of reported coordinative values to values accepted as or being true.	Root Mean Square Error / Standard deviation, where the true value is not estimated from the observations but known a priori.	spatial object / spatial object type	objects that have coordinative values associated.
Positional Accuracy / Vertical Position Accuracy	Closeness of reported coordinative values to values accepted as or being true.	linearMapAccuracy2Sigma / Half length of the interval defined by an upper and lower limit in which the true value lies with probability 95%.	spatial object / spatial object type	objects that have a vertical coordinate values associated.
Positional Accuracy / Horizontal Position Accuracy	Closeness of reported coordinative values to values accepted as or being true.	linearMapAccuracy2Sigma / Half length of the interval defined by an upper and lower limit in which the true value lies with probability 95%.	spatial object / spatial object type	objects that have a horizontal coordinate values associated.
Positional Accuracy / Gridded Data Position Accuracy	Closeness of reported coordinative values to values accepted as or being true.	Root mean square error of planimetry / Radius of a circle around the given point, in which the true value lies with probability P.	spatial object / spatial object type	NA. S-247 does not have features with gridded geometry

Data quality element and sub element	Definition	DQ measure / description	Evaluation scope	Scope in S-247
Temporal Quality / Temporal Consistency	Consistency with time.	Correctness of ordered events or sequences, if reported.	dataset/dataset series/spatial object type	Features with time intervals, fixed/periodic date ranges, schedules.
Thematic Accuracy / ThematicClassificationCorrectness	Comparison of the classes assigned to features or their attributes to a universe of discourse.	miscalculationRate / This data quality measure indicates the number of incorrectly classified features in relation to the number of features that are supposed to be there. [Adapted from ISO 19157] This is a RATE which is a ratio, and is expressed as a REAL number representing the rational fraction corresponding to the numerator and denominator of the ratio. For example, if there are 1 items that are classified incorrectly and there are 100 of the items in the dataset then the ratio is 1/100 and the reported rate = 0.01.	dataset/dataset series/spatial object type	All features and info types
Aggregation Measures / AggregationMeasures	In a data product specification, several requirements are set up for a product to conform to the specification.	DataProductSpecificationPassed / This data quality measure is a boolean indicating that all requirements in the referred data product specification are fulfilled.	dataset/dataset series/spatial object type	Dataset as a whole
Aggregation Measures / AggregationMeasures	In a data product specification, several requirements are set up for a product to conform to the specification.	DataProductSpecificationFailRate / This data quality measure is a number indicating the number of data product specification requirements that are not fulfilled by the current product/dataset in relation to the total number of data product specification requirements.	dataset/dataset series/spatial object type	Dataset as a whole

Table 6.1 - Recommended quality element relevance to S-247

6.3 Data quality testing and reporting

S-247 products must be tested with the S-247 specific checks prior to release by the data producer. The data producer must review the check results and address any issues to ensure sufficient quality of the data products. The checks are a mix of data format validation checks, conformance to standard checks and logical consistency checks. The checks are listed in Annex E.

Production and certification processes for S-247 data should include a standalone quality report which provides full information on the original results (with evaluation procedures and measures applied).

The dataset or exchange set metadata that is distributed with the exchange set may describe only the aggregated result with a reference to the original results described in the standalone quality report. The aggregated Data Quality result provides an indication if the dataset has passed conformance to the Data Product Specification.

Data Quality Measure Aggregation results should be included to indicate if the dataset/dataset series have passed the Product Specifications. The elements which must be included are described in the table below.

Data quality element and sub element	Definition	DQ measure / description	Evaluation scope	Applicable to spatial representation types
Aggregation Measures / AggregationMeasures	In a data product specification, several requirements are set up for a product to conform to the specification.	DataProductSpecificationPassed / This data quality measure is a boolean indicating that all requirements in the referred data product specification are fulfilled.	dataset	All features and information types of the dataset
Aggregation Measures / AggregationMeasures	In a data product specification, several requirements are set up for a product to conform to the specification.	DataProductSpecificationFailRate / This data quality measure is a number indicating the number of data product specification requirements that are not fulfilled by the current product/dataset in relation to the total number of data product specification requirements.	dataset	All features and information types of the dataset

Table 6.2 - Elements of data quality aggregated report (extract from DQWG checklist)

7 Data Capture and classification

S-247 products must be based on data sources released by an appropriate Differential eLoran Reference Station defining authority. Data source must be described in each data product.

The production process used to generate S-247 products may be described in the dataset metadata.

Item Name	Description	Multiplicity	Type
dataSource	Identification of the kinds of data sources usable to product datasets compliant with the considering specification	0..*	CharacterString
productionProcess	Link to a textual description of the production process (including encoding guide) applicable to the datasets compliant with the considering specification	0..*	CharacterString (URL)

Table 7.1 Data capture information

7.1 Data Encoding and Product Delivery

7.1.1 Data Encoding

The principal encoding will be the Open Geospatial Consortium (OGC), Geography Markup Language (GML) format. GML is an XML grammar designed to express geographical features. It serves as a modelling language for geographic systems as well as an open interchange format for geographic transactions.

7.1.2 Types of Datasets

Datasets are distributed as files which are part of exchange sets structured as described in this specification. The distribution media are left to the discretion of the producer and distributor.

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

- New dataset and new edition of a dataset (base dataset): Each new edition of a dataset must have the same name as the dataset that it replaces. A new edition can also be S-247 data that has previously been produced for this area.
- Cancellation: The dataset is cancelled and is deleted from the SYSTEM.

7.2 Encoding of Latitude and Longitude

Values of latitude and longitude must be accurate to 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 dataset identification record.

7.2.1 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, i.e., 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 (e.g., 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, i.e., {1} for coordinates encoded in decimal degrees.

EXAMPLE 1 A longitude = 42.0000 is converted into $X = \text{longitude} * \text{coordMultFactorX}$
 $= 42.0000 * 1 = 42.0000000$.

7.3 Numeric Attribute Encoding

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

7.4 Text Attribute Values

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

7.5 Mandatory Attribute Values

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

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

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

7.6 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”.

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

7.7 Structure of dataset files

7.7.1 Sequence of objects

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

Dataset Identification Information

Dataset structure information

Spatial records for by-reference geometries

Point

Multi point

Curve

Composite Curve

Surface

Information objects

Feature objects (Geometry may be encoded inline or by reference.)

Meta features

Geo features

7.8 Object identifiers

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

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

7.9 Data coverage

All areas of a dataset must be covered by a DataCoverage meta feature.

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

7.10 Data overlap

S-247 datasets shall not overlap other S-247 datasets.

7.11 Data extent

Datasets must not cross the 180° meridian of longitude

8 Data Maintenance

8.1 Introduction

Datasets are maintained as needed and must include mechanisms for S-247 updating. Data updates will be made by new editions. The maintenance and update frequency of S-247 datasets should be defined by the producers (official national authority) implementing this specification.

Data Producers must use applicable sources to maintain and update data and provide a brief description of the sources that were used to produce the dataset in the appropriate metadata field.

The data product shall provide information on how the data is maintained and should describe the principles and criteria applied in maintenance regime. This should specify the expected frequency of updates.

Item Name	Description	Multiplicity	Type
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maintenanceAndUpdateFrequency	Frequency with which changes and additions are made to the data product (per update scope)	1..*	MD_MaintenanceInformation (ISO 19115)
dataSource	Identification of the kinds of data sources usable to produce datasets	1..*	LI_Source (ISO 19115)
productionProcess	Textual description of the production process applicable to the datasets (per scope or data source)	1..*	LI_ProcessStep (ISO 19115)

Table 8.1 Maintenance and update frequency

8.2 Production process for base and update datasets

Data Producers should follow their established production processes for maintaining and updating datasets. Data is produced against the DCEG and checked against the appropriate set of validation rules in Appendix E.

8.3 Dataset updates and cancellation

The purpose of issue of the dataset is indicated in the “purpose” field of the dataset discovery metadata. In order to terminate a dataset, an update dataset file is created for which the edition number must be set to 0. This convention is only used to cancel a base dataset file.

Where a dataset is cancelled and its name is reused at a later date, the issue date must be greater than the issue date of the cancelled dataset.

When the dataset is cancelled it must be removed from the system.

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

8.4 Support file updates

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

Updates or deletions of a support file may require concurrent updates to feature or information type instance attributes that depend on the file, e.g., pictorialRepresentation, fileReference and fileLocator attributes.

8.5 Feature and portrayal catalogues

For each new version of the S-247 Product Specification a new feature and portrayal catalogue will be released. The system must be able to manage datasets and their catalogues that are created on different versions of the S-247 product specification.

9 Portrayal

Portrayal is not defined in this version of S-247 Differential eLoran Reference Station Almanac Product Specifications. Users are free to choose the means and methodology of portrayal as they see best suited for their needs. It should be noted that future versions of S-247 may include a portrayal catalogue, and any implementer should therefore anticipate this, and make sufficient provisions in any system supporting S-247.

10 Data Product format (Encoding)

The principal encoding will be the Open Geospatial Consortium (OGC), Geography Markup Language (GML) format. GML is an XML grammar designed to express geographical features. It serves as a modelling language for geographic systems as well as an open interchange format for geographic transactions.

11 Data Product delivery

11.1 Data Product Delivery Information

This data product specification defines GML as the primary format in which S-247 data products are delivered. The delivery format is described by the following items (from ISO 19131:2005): format name, version, specification, language, character set.

Name	ISO 19131 Elements	Value
Format name	DPS_DeliveryInformation.deliveryFormat > DPS_DeliveryFormat.formatName	GML*
Version	DPS_DeliveryInformation.deliveryFormat > DPS_DeliveryFormat.version	3.2.1
Specification description	DPS_DeliveryInformation.deliveryFormat > DPS_DeliveryFormat.specification	GML*
Language	DPS_DeliveryInformation.deliveryFormat > DPS_DeliveryFormat.language	English

Character set	DPS_DeliveryInformation.deliveryFormat > DPS_DeliveryFormat.characterSet > MD_CharacterSetCode	004 – utf8
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Table 11.1 Data product delivery

* GML is an XML encoding for the transport and storage of geographic information, including both the geometry and the properties of geographic features, between distributed systems. The XML Schema for the GML application schema is provided in a schema document S247.xsd which imports other schema(s) defining common types. Feature instance shall validate against S247.xsd and conform to all other requirements specified in this data product specification including all constraints not captured in the XML Schema document.

11.2 Exchange Set

Data which conforms to this product specification must be delivered by means of an exchange set.

An exchange set will consist of one or more S-247 datasets. An exchange set may also include one or more support files containing supplementary information encoded in separate files. These are linked to the S-247 dataset features, using the attributes described below. Each exchange set will include a single (XML) catalogue file, S-247 exchange set catalogues conform to S-100 4.0.0 Figure 4a-D-2 without modification, containing discovery metadata for each S-247 dataset as well as support files. S-247 Exchange set structure conforms to S-100 4.0.0 Figure 4a-D-3 without modification.

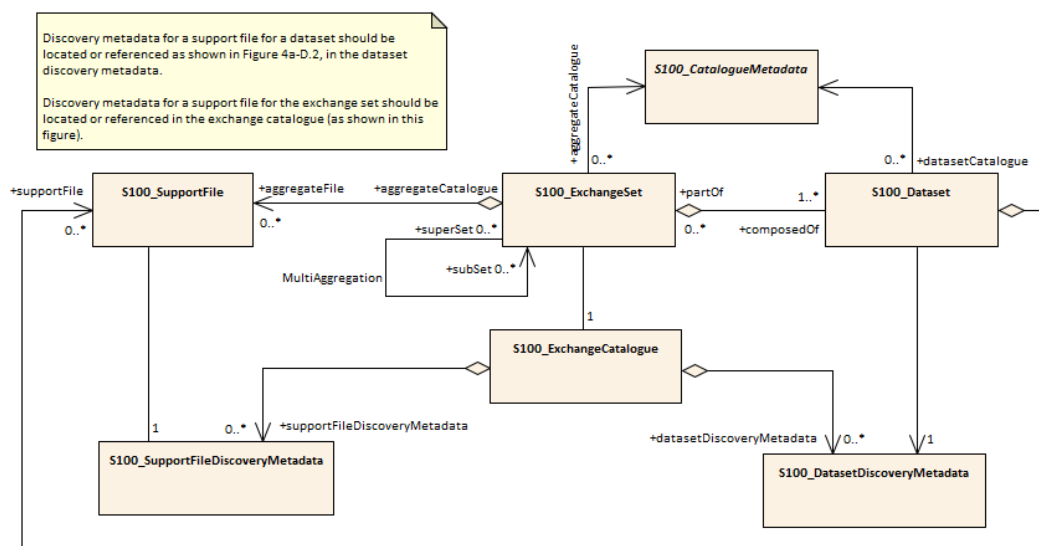


Figure 11.1 - Exchange set structure

11.3 Support Files

Support files contain ancillary textual or graphic information in separate (linked in dataset) files. Information should be encoded in a structured format as defined by W3C. The following formats would be suitable for graphics:

- Portable Network Graphics (PNG) [Edition 2.0]
- Scalable Vector Graphics (SVG) [Edition 1.1]
- Tagged Image File Format (TIFF) [Edition 6.0]
- Joint Photographic Experts Group (JPEG) [Edition 1.02]

Note: PNG is an extensible file format designed for lossless, portable storage of raster images. It provides a patent-free replacement for the GIF format and also replicates many common uses of TIFF. The PNG edition 2 format has been adopted as an ISO standard, (ISO/IEC 15948:2003). SVG is a language for describing two-dimensional graphics in XML [XML10]. SVG allows for three types of graphic objects: vector graphic shapes (e.g., paths consisting of straight lines and curves), images and text. The JPEG standard specifies the codec, which defines how an image is compressed into a stream of bytes and decompressed back into an image, but not the file format used to contain that stream. (The term "JPEG" is an acronym for the Joint Photographic Experts Group, which is the body that created the standard).

11.4 Support File Naming Convention

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

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

247CCCC00000000000.EEE

The file name forms a unique S-247 identifier where:

- 247 - the first 3 characters identify the dataset as an S-247 dataset (mandatory).
 - CCCC - the fourth to seventh characters identify the producer code of the issuing agency (mandatory for S-247). Where the producer code is derived from a 2 or 3 character format, the missing characters of the producer code must be populated with zeros ("00" or "0" respectively) for the sixth and seventh characters of the dataset file name, as required.
 - 000000000000 - the eighth to the maximum seventeenth characters are optional and may be used in any way by the producer to provide the unique file name. The following characters are allowed in the dataset name: A to Z, 0 to 9 and the special character _ (underscore).
- .EEE – support file extension. (TXT, HTM, XML or TIF)

11.5 Dataset Naming Convention

All dataset files will have unique world-wide file identifiers. The file identifier of the dataset should not be used to describe the physical content of the file. The dataset file metadata that accompanies the file will inform the user of the name and purpose of the file (new, replacement and deletion).

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

247CCCC0000000000.EEE

The file name forms a unique S-247 identifier where:

- 247 - the first 3 characters identify the dataset as an S-247 dataset (mandatory).
- CCCC - the fourth to seventh characters identify the producer code of the issuing agency (mandatory for S-247). Where the producer code is derived from a 2 or 3 character format, the missing characters of the producer code must be populated with zeros ("00" or "0" respectively) for the sixth and seventh characters of the dataset file name, as required.
- ØØØØØØØØØØØØØØØØ - the eighth to the maximum seventeenth characters are optional and may be used in any way by the producer to provide the unique file name. The following characters are allowed in the dataset name: A to Z, 0 to 9 and the special character _ (underscore).

.EEE – new datasets, new editions and cancellations use gml.

11.6 Catalogue File Naming Convention

The exchange catalogue acts as the table of contents for the exchange set. The catalogue file of the exchange set must be named CATALOG.XML. No other file in the exchange set may be named CATALOG.XML. The content of the exchange catalogue file is described in Section 14.

12 Metadata

12.1 Introduction

The S-247 metadata description is based on the S-100 metadata document section, which is a profile of the ISO 19115 standard. These documents provide a structure for describing digital geographic data and define metadata elements, a common set of metadata terminology, definitions and extension procedures.

Two metadata packages are described in this product specification: dataset metadata and exchange set metadata.

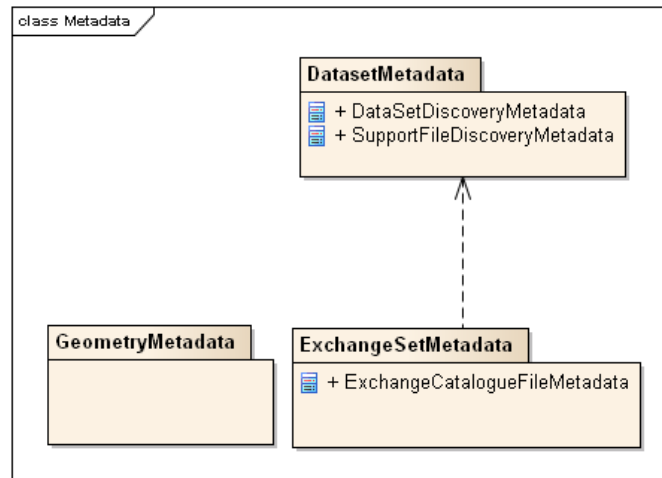


Figure 12.1 - Metadata packages

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.

12.2 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.

Name	Cardinality	Value	Type	Remarks
S-100_DataSetDiscoveryMetadata				
fileName	1		CharacterString	Dataset file name
filePath	1		CharacterString	Full path from the exchange set root directory
description	1		CharacterString	
copyright	0..1		MD_LegalConstraints >MD_RestrictionCode <copyright> (ISO 19115)	
classification	0..1		Class MD_SecurityConstraints>MD_ClassificationCode (codelist)	1. unclassified 2. restricted 3. confidential 4. secret 5. top secret
purpose	1	{1}, {2}	CharacterString	1. New dataset 2. New edition
specificUsage	1		MD_USAGE>specificUsage (character string) MD_USAGE>userContactInfo (CI_ResponsibleParty)	brief description of the resource and/or resource series usage
editionNumber	1	{1}	Integer	When a dataset is initially created, the edition number "1" is assigned to it. The edition number is increased by one with each new edition.
issueDate	1		Date	Date on which the dataset was generated.
productSpecification	1	S-247 version N.n	CharacterString	This must be encoded as S247.N.n
producingAgency	1		CI_ResponsibleParty	Party responsible for generating the dataset.
horizontalDatumReference	1	WGS84	CharacterString	EPSG
horizontalDatumValue	1	WGS84	Integer	4326
dataType	1	GML	CharacterString	
dataTypeVersion	1	3.2.1	CharacterString	
dataCoverage	1..*		S100_DataCoverage	
comment	0..1		CharacterString	Any additional Information
layerID	1..*	S-101	CharacterString	Dataset must be used with ENC in an ECDIS

Table 12.1 - Dataset metadata

12.3 Support file Metadata

Support file metadata is intended to describe information about a data resource. It facilitates the management and exploitation of data and is an important requirement for understanding the characteristics of a data resource.

Name	Cardinality	Value	Type	Remarks
S100_SupportFileDiscoveryMetadata				
fileName	1		CharacterString	
fileLocation	1		CharacterString	Path relative to the root directory of the exchange set. The location of the file after the exchange set is unpacked into directory <EXCH_ROOT> will be <EXCH_ROOT>/<filePath>/<filename>
purpose	1		S100_SupportFilePurpose	new, replacement, or deletion.
editionNumber	1		CharacterString	When a dataset is initially created, the edition number 1 is assigned to it. The edition number is increased by 1 at each new edition. Edition number remains the same for a re-issue
issueDate	1		Date	
supportFileSpecification	1		S100_SupportFileSpecification	
dataType	1		S100_SupportFileFormat	
otherDataTypeDescription	0..1		CharacterString	
dataTypeVersion	1		CharacterString	
comment	0..1		CharacterString	

Table 122.2 - Support file metadata

12.4 Exchange Set Metadata

Frequently datasets are packaged and distributed as composite exchange sets by third party vendors. An exchange set could contain many different types of datasets, sourced from different data producers. For example an exchange set may contain numerous dataset files, ancillary data files, discovery metadata files and others. Exchange set metadata contains metadata about the contents of the exchange set and metadata about the data distributor.

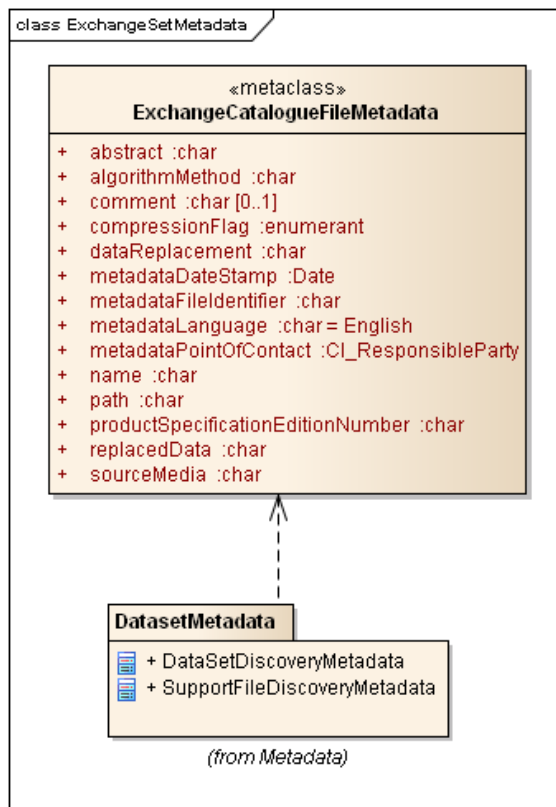


Figure 12.2 - Exchange set metadata

12.5 Catalogue File Metadata.

All S-247 Catalogue metadata files must contain at least the following metadata elements.

Name	Cardinality	Value	Type	Remarks
S100_ExchangeCatalogue				
identifier	1		S100_CatalogueIdentifier	
contact	1		S100_CataloguePointOfContact	
productSpecification	0..1		S100_ProductSpecification	Conditional on all the datasets using the same product specification
metadataLanguage	1..2	English, French	CharacterString	All datasets conforming to this PS must use English language. The catalogue file must be in English with the optional addition of French.
exchangeCatalogueName	1	CATALOG.247.XML	CharacterString	Catalogue filename
exchangeCatalogueDescription	1		CharacterString	

exchangeCatalogueComment	0..1		CharacterString	Any additional Information
compressionFlag	0..1		Boolean	Yes or No
algorithmMethod	0..1		CharacterString	For example. RAR or ZIP
sourceMedia	0..1		CharacterString	
replacedData	0..1		Boolean	
dataReplacement	0..1		CharacterString	

Table 12.2 - Catalogue file metadata