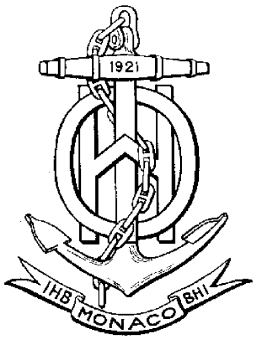
INTERNATIONAL HYDROGRAPHIC ORGANIZATION



S-104 Water Level Information for Surface Navigation Product Specification

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IHO S-104 Water Level Information For Surface Navigation

Version Number	Date	Editor	Purpose
0.0.0	11-Feb-15	Z Jayaswal	Initial Draft
0.0.1	1-May-16	Z Jayaswal	TWCWG 1 – Working group input incorporated from Brazil meeting
0.0.2	Aug-16	Z. Jayaswal	TWCWG – incorporate feedback on Portrayal and Attributes
0.0.3	Mar-17	Z.Jayaswal	Extract commonality from S-111 v0.1.10 to ensure consistency between standards.
0.0.4	May 17	Z Jayaswal	As edited during IHO TWCWG 2
0.0.5	Nov 17	Z Jayaswal	Feedback from TWCWG and S100 WG
0.0.6	Sep 18	Z Jayaswal	Feedback from TWCWG3 and S-129 WG
0.0.7	Mar 19	Z Jayaswal	Feedback from S100 Test Strategy Working Group Sep 2018

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IHO S-104 Water Level Information For Surface Navigation

1 Overview

S-104 is the Water Level Information for Surface Navigation Product Specification, produced by the IHO.

The development of electronic navigation with high resolution bathymetric data, and the drive to increase safety of navigation are now demanding time-sensitive data. IHO has identified the requirement for a product specification for dynamic tidal and water level data.

Tidal height information has traditionally been provided as high/low predictions however with increasing drafts and technology, there has been a move to hourly predictions with major ports providing real-time height information to their pilots and web-sites.

There is now a requirement to supply tidal and water level data as a single point time-series and as a surface time series to manage critical depths and provide tidal windows.

1.1 Introduction

This document describes an S-100 compliant product specification for the encapsulation and data transfer of tidal and water level data for use in an ECDIS or any proposed dynamic tide application Tidal and water level predictions have been fundamental in route planning and entry to ports (SOLAS Chapter V Reg 8 and 20). These have traditionally been supplied as a physical hard copy publication and recently as a separate software installation that may not be integrated with the Electronic Display and Information System. To improve safety of navigation, this product specification will ensure that tidal and water level data supplied for dynamic capability is consistent by all approved authorities.

There are three different dataset sets that can be delivered to an ECDIS with this standard.

1.2 References

S-44 *IHO Standards for Hydrographic Surveys,* 5th Edition February 2008

S-100 *IHO Universal Hydrographic Data Model*, version 3.0.0 (June 2017)

S-101 *IHO Electronic Navigational Chart Product Specification*, July 2014

S-102 *IHO Bathymetric Surface Product Specification*, April 2012

S-111 *IHO Surface Currents Product Specification, MM YYYY*

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

ISO 3166-1:1997 Country Codes

ISO/TS 19103:2005 *Geographic information – Conceptual schema language*

ISO 19111:2003 *Geographic information – Spatial referencing by coordinates*

ISO 19115:2003 *Geographic information – Metadata updated by Corr1 (2006)*

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

ISO 19123:2005 *Geographic information – Schema for coverage geometry and functions*

ISO 19129:2009 *Geographic information – Imagery gridded and coverage data framework*

ISO 19131:2007 *Geographic information – Data product specifications*

ISO/IEC 19501-1 and 19505-2, *Information technology — Open Distributed Processing – Unified Modelling Language Version 2.4.1*

netCDF – *Network Commo Data Form Unidata - www.unidata.ucar.edu/software/netcdf*

HDF5 – *Hierarchical Data Format version 5 – www.hdfgroup.org*

1.3 Terms, definitions and abbreviations

1.3.1 Use of Language

Within this document:

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

1.3.2 Terms and Definitions

Terms and definitions have been taken from the normative references cited in clause 1.3. Only those which are specific to this document have been included and modified where necessary. Additional terms are defined in this document.

1.3.2.1 Coordinate

one of a sequence of numbers designating the position of a point in N-dimensional space [ISO 19111]

1.3.2.2 coordinate reference system

coordinate system which is related to the real world by a datum [ISO 19111]

1.3.2.3 coverage

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

EXAMPLE: Examples include a raster **image**, polygon overlay, or digital elevation matrix

NOTE: In other words, a **coverage** is a **feature** that has multiple values for each **attribute** type, where each **direct position** within the geometric representation of the **feature** has a single value for each **attribute** type

[ISO 19123]

1.3.2.4 coverage geometry

configuration of the **domain** of a **coverage** described in terms of **coordinates**

[ISO 19123]

1.3.2.5 data product

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

NOTE: The S-111 data product consists of metadata and one or more sets of speed and direction values
[ISO 19131]

1.3.2.6 direct position

position described by a single set of coordinates within a coordinate reference system [ISO 19107]

1.3.2.7 domain

well-defined set [ISO 19103]

NOTE Domains are used to define the domain set and range set of operators and functions.

1.3.2.8 Elevation

the altitude of the ground level of an object, measured from a specified vertical datum. [IHO S100 GFM]

1.3.2.9 Feature

abstraction of real world phenomena [ISO 19101]

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

1.3.2.10 **feature attribute**

characteristic of a **feature**
EXAMPLE 1: A **feature attribute** named *colour* may have an **attribute** value *green* which belongs to the **data type** *text*
EXAMPLE 2: A **feature attribute** named *length* may have an **attribute** value *82.4* which belongs to the **data type** *real*
NOTE 1: A **feature attribute** may occur as a **type** or an **instance**. **Feature attribute** type or **feature attribute** instance is used when only one is meant
NOTE 2: A **feature attribute** type has a name, a **data type**, and a **domain** associated to it. A **feature attribute** instance has an **attribute** value taken from the **domain** of the **feature attribute** type
NOTE 3: In a **feature catalog**, a **feature attribute** may include a value **domain** but does not specify **attribute** values for **feature** instances
[ISO 19101, ISO 19109, ISO 19110, ISO 19117]

1.3.2.11 Height

distance of a point from a chosen reference surface measured upward along a line perpendicular to that surface. [ISO 19111:2006]

NOTE Height is distinguished from elevation in that is a directional measurement.

1.3.2.12 **georeferenced grid**

grid for which cells can be located by the use of specific algorithms. See **ungeorferenced grid**.

1.3.2.13 **grid**

network composed of a set of elements, or cells, whose vertices, or nodes, have defined positions within a coordinate system. See also **georeferenced grid, regular grid, rectangular grid, ungeorectified grid, node,** and **grid point**.

[ISO 19123]

NOTE 1: A rectangular grid has axes perpendicular to each other

NOTE 2: A uniform rectangular grid has constant spacing in the X-direction and constant spacing in the Y-direction, although the two spacing values are not necessarily equal

1.3.2.14 **grid cell**

element of a grid defined by its vertices, or **nodes**

1.3.2.15 **grid point**

point located at the intersection of two or more **grid cells** in a **grid.** Also called a **node**. [ISO 19123]

1.3.2.16 Record

Finite, named collection of related items (objects or values) [ISO 19107]
NOTE Logically, a record is a set of pairs <name,item>

1.3.2.17 Uncertainty

The interval (about a given value) that will contain the true value of the measurement at a specific confidence level [IHO S44]
NOTE Errors exists and are the differences between the measured value and the true value. Since the true value is never known it follows that the error itself cannot be known. Uncertainty is a statistical assessment of the likely magnitude of this error.

1.3.2.18 Water level Trend

When the average rate of change of the water level observations over a one hour period is less than 0.20m it is considered “steady”.
In areas of small water level range e.g. Baltic Sea, use of “not available” is optional.

1.3.2.19 **ungeorectified grid**

grid with non-uniform point spacing in any coordinate system. Includes triangular irregular networks (TINs) and those curvilinear coordinate grids whose node positions cannot be calculated analytically.

1.3.3 Abbreviations

CRS	Coordinate Reference System
ECDIS	Electronic Chart Display Information System
EPSG	European Petroleum Survey Group
ENC	Electronic Navigational Chart
IHO	International Hydrographic Organization
IMO	International Maritime Organization
ISO	International Organization for Standardization

1.3.3.1 Notation

In this document conceptual schemas are presented in the Unified Modelling Language (UML). Several model elements used in this schema are defined in ISO standards developed by ISO TC 211, or in IHO S-100. In order to ensure that class names in the model are unique ISO TC/211

has adopted a convention of establishing a prefix to the names of classes that define the TC/211 defined UML package in which the UML class is defined. Since the IHO standards and this product specification make use of classes derived directly from the ISO standards this convention is also followed here. In the IHO standards the class names are identified by the name of the standard, such as "S100" as the prefix optionally followed by the bialpha prefix derived from ISO. For the classes defined in this product specification the prefix is *"S104"*. In order to avoid having multiple classes instantiating the same root classes, the ISO classes and S-100 classes have been used where possible; however, a new instantiated class is required if there is a need to alter a class or relationship to prevent a reverse coupling between the model elements introduced in this document and those defined in S-100 or the ISO model.

Table 1.3.3-1 – Sources of externally defined UML classes

Prefix	Standard	Package
CI	ISO 19115	Citation and Responsible Party
CV	ISO 19123	Coverage Core & Discrete Coverages
DQ	ISO 19115	Data Quality Information
DS	ISO 19115	Metadata Application Information
EX	ISO 19115	Metadata Extent information
IF	ISO 19129	Imagery Gridded and Coverage Data Framework
LI	ISO 19115	Linage Information
MD	ISO 19115	Metadata entity set information
MI	ISO 19115-2	Metadata entity set imagery
S100	IHO S-100	IHO Standard for Hydrographic Data
SC	ISO 19111	Spatial Referencing by Coordinates
SD	ISO 19130	Sensor Data
S101	IHO S-101	IHO Electronic Navigational Chart Product Specification
S102	IHO S-102	IHO Bathymetric Surface Product Specification
S111	IHO S-111	IHO Surface Currents Product Specification

1.4 General Data Product Description

Title: Water Level Information for Surface Navigation Product Specification

Abstract: Encodes information and parameters for use in making a tidal and water level product.

Content: Describes the Tidal and water level data contained in the product. The specific content is defined by the feature catalogue and schema.

Spatial Extent:

Description: Areas where Tidal Information is available

East Bounding Longitude: 180

West Bounding Longitude: -180

North Bounding Latitude: 90

South Bounding Latitude: -90

IHO S-104 Water Level Information For Surface Navigation

Purpose: The data shall be used to produce a dataset to be used for dynamic water level applications, including an ECDIS.

1.5 Data product specification metadata

Title: **IHO S-104** Water Level

S-100 Version: 3.0.0

S-104 Version: 0.0.6

Date: September 2018

Language: English

Classification: Unclassified (TBC)

Contact: International Hydrographic Bureau.
4 quai Antoine 1er
B.P. 445 MC 98011 MONACO CEDEX
Telephone: +377 93 10 81 00
Telefax: + 377 93 10 81 40

URL: www.iho.int\

Commented [JZM1]: Need to point to final version of specification once published

Identifier: S-104

Maintenance: Changes to the Product Specification S-104 are coordinated by Tides, Water Level and Currents Working Group (TWCWG) of the IHO and made available via the IHO Publications website. Maintenance of the Product Specification must conform to IHO Technical Resolution 2/2007 (revised 2010). This specification will be a standing agenda item for TWCWG meeting with clarifications, revisions and new editions released as required. A new edition will be released every 5-10 years depending on technological advances.

1.5.1 IHO Product Specification Maintenance

1.5.1.1 Introduction

Changes to S-104 will be released by the IHO as a new edition, revision, or clarification.

1.5.1.2 New Edition

New Editions of S-104 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-104.

1.5.1.3 Revisions

Revisions are defined as substantive semantic changes to S-104. Typically, revisions will change S-104 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 S-10s. 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 S-104.

1.5.1.4 Clarification

Clarifications are non-substantive changes to S-104. 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 change to S-104.

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

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

1.5.1.5 Version Numbers

The associated version control numbering to identify changes (n) to S-104 must be as follows:

New Editions denoted as **n**.0.0

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

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

2 Specification Scopes

This product specification outlines the types of water level products from the national Hydrographic Office (HO) or authorised producer, to the end user. The data may be Historical observation, Real-time observation, Astronomical prediction, analysis or hybrid method, hindcast or forecast models. Requirements for data and metadata are provided. This document does not include product delivery mechanisms. The three data products are:

a) Single point product– provision of water level information for a single point in the traditional graphic display mariners are familiar with from hard copy publications and digital tide tables.

b) Gridded data product– provision of water level information for a defined region as a surface. Allowing any grid point to be queried as per a traditional single point.

c) Gridded Hydroid product – this product will provided the mariner the separation surface between the Ellipsoid and chart datum for a defined region.

Scope ID: Global

IHO S-104 Water Level Information For Surface Navigation

Level: 006- series

Level name: Water Level Dataset

3 Dataset Identification

Title: Water Level Data Product

Alternate Title: None

Abstract: This data product is a file containing water level data for a particular geographic region and set of times, along with the accompanying metadata describing the content, variables, applicable times, locations and structure of the data product. Water level data is the height of the water observed or mathematically-predicted values. The data may consist of water level at a small set of points where observations/or predictions are available or may consist of numerous points organized in a grid as from a hydrodynamic model forecast.

Topic Category: Producing authority to choose the most appropriate from the list below:

Name	ISO 19115 Domain Code	Definition
Elevation	006	Height above or below mean sea level Examples: altitude, bathymetry, digital elevation models, slope, derived products
Inland Waters	012	Inland water features, drainage systems and their characteristics Examples: rivers and glaciers, salt lakes, water utilization plans, dams, currents, floods, water quality, Hydrographic charts
Oceans	014	Features and characteristics of salt water bodies(excluding inland waters) Examples: tides, tidal waves, coastal information, reefs

Geographic Description: Areas specific to water navigation

Spatial Resolution: The spatial resolution, or the spatial dimension of the earth covered by the size of a grid matrix cell (nominal ground sample distance), varies according to the model adopted by the producer.

Purpose: Water level data is intended to be used as a stand-along data or as a layer in an ENC.

Language: English

Classification:	Data can be classified as one of the following: Unclassified Restricted Confidential Secret Top Secret
Spatial Representation Type:	Coverage
Point of Contact:	Producing Authority.
Use Limitation:	Invalid over land

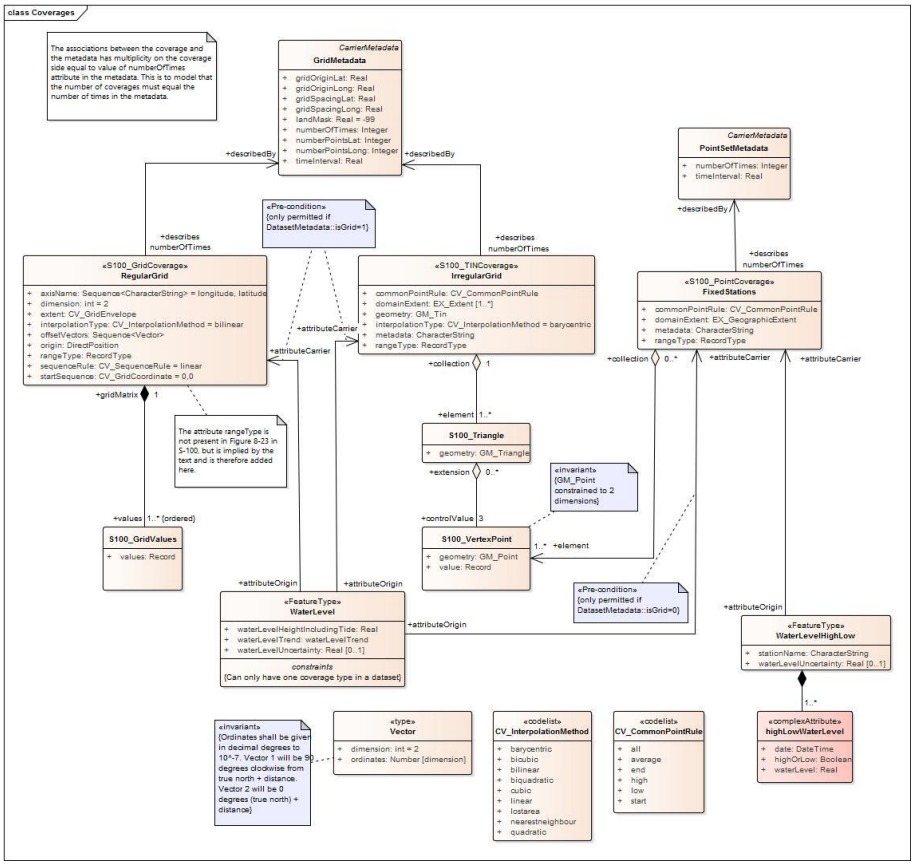
4 Data Content and structure

4.1 Introduction

This section discusses the application schema, which is described in UML; the feature catalogue; dataset types, in which there is an extensive discussion of the water level data; dataset loading and unloading; and geometry.

Water level data consist of the water level at a point of time relative to a vertical datum. The data can be represented as a time series of values for either a single point (i.e. one geographic location) or for an array of points contained in a grid.

The gridded Hydroid product provides the chart datum relative to a defined ellipsoid that matches what is used for the chart created by the same product producer**.**



4.2 Application Schema

This application scheme is expressed in UML. The details of the application schema are given in ANNEX C.

4.3 Feature Catalogue

4.3.1 Introduction

The S-104 Feature Catalogue describes the feature types, information types, attributes, attribute values, associations and roles which may be used in the product. See ANNEX D – Feature Catalogue

The S-104 Feature Catalogue is available in an XML document which conforms to the S-100 XML Feature Catalogue Schema and can be downloaded from the IHO website.

4.3.2 Feature Types

4.3.2.1 Geographic

Geographic (geo) feature types form the principle content of S-104 and fully defined by their associated attributes.

4.3.2.2 Meta

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

4.3.3 Feature Relationship

A feature relationship links instances of one feature type with instances of the same or a different feature type. There are three common types of feature relationship: Association, Aggregation and Composition. In S-104 there are no relationship used.

4.3.4 Attributes

S-100 defines attribute as either simple or complex. S-104 uses eight simple attributes; listed in Table 4.1. There are no complex attributes

Table 4-1 - Simple feature attribute types.

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 8601:1988. EXAMPLE 19980918 (YYYYMMDD)
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 8601:1988. 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 8601:1988 EXAMPLE 19850412T101530

4.3.5 Spatial Quality

Spatial quality attribute (Figures 4.1) are carried in an information class called **spatial quality**. Only points, multipoint and curves can be associated with spatial quality. .

Water levels are usually defined at one or more individual locations, so spatial quality applies to these locations. The spatial quality will list the following:

For Single station data product : 1) Port Type- a) Standard/Major or b)Secondary /minor

2) 2 Sigma confidence of predictions/models or

3) Instrument measuring accuracy for observed

For Gridded data product: 2 Sigma confidence of predictions/model

Figure 4.1 - Spatial Quality Information Type

4.4 Dataset Types

4.4.1 Introduction

<There is the capability to have different types of datasets, typically they are classified as complete, scale dependent and scale independent. Most products that are designed to be used with an ENC will be of a complete nature – where it contains the information needed to form a complete picture.>

4.5 Dataset Loading and Unloading

< This section is only needed if the intended product specification has datasets that have multiple scales and would require a loading strategy>

4.6 Geometry <S-100 Part 7>

<Geometric representation is the digital description of the spatial component of an object as described in S-100 and ISO 19107. Specify which S-100 Level of Geometry is to be used in the product specification.>

Commented [JZM2]: S100 Review: Describe how quality is handled by the data created in S-104 and create specific examples that relates to S-104 including diagram

Commented [JZM3]: List data options here in detail.

Commented [JZM4]: S100 Review: use this section if intended to restrict data loading e.g. gridded data to certain scale of ENC.

Commented [JZM5]: S100 Review: Expand section to provide sufficient details on geometry structures used in S-104.

5 Coordinate Reference Systems (CRS)

The location of a feature in the S-100 standard is defined by means of coordinates, which relate a feature to a position. The S-104 CRS is a compound system, with a two-dimensional ellipsoidal horizontal component and a one-dimensional datum-related vertical component (cf. S-100, Part 6 – Coordinate Reference Systems).

5.1 Horizontal Reference System

For S-104 products, the horizontal CRS must be the ellipsoidal (geodetic) system EPSG:4326 (WGS 84). The full reference to EPSG: 4326 can be found at www.epsg-registry.org.

Horizontal coordinate reference system:	EPSG: 4326 (WGS 84)
Projection:	None

Coordinate reference system registry:	EPSG Geodetic Parameter Registry
Date type (according to ISO 19115):	002 - publication
Responsible party:	International Organisation of Oil and Gas Producers (IOGP)

5.2 Vertical Reference System

The vertical coordinate is directed upwards (i.e. away from the Earth's centre) from its origin, the vertical datum is expressed in units of metres. That is, a positive value for the level of the water level relative to the vertical datum means that the level is above the vertical datum. The vertical datum is not an ellipsoid but is the defined chart datum for the area of interest. The vertical datum must be consistent with the bathymetric CRS in S-102.

5.3 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. 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*

6 Data Quality

6.1 Introduction

Quality of water level data for navigation consists of quality of the observed/predicted/forecast data, quality of the positional data, and quality of the time stamp. Quality of the observed data depends on the accuracy of the water level gauges and their processing techniques, and is normally available in field survey reports or quality controlled analyses. Quality of predicted/forecast data depends on quality, timeliness, and spatial coverage of the input data as well as the mathematical techniques. Temporal accuracy for observational data is normally available in field survey reports or quality controlled analyses. Temporal accuracy for predicted/forecast data is normally described in technical reports.

Commented [JZM6]: S-100 Review: Add explanation of how data quality is captured and move how data quality is calculated to the Data Classification and Encoding Guide (DCEG) section.

6.2 Completeness

A water level coverage data set is complete when the grid coverage value matrix contains height value or null (missing) value for every vertex point defined in the grid, and when all of the mandatory associated metadata is provided. See ANNEX E – TEST OF COMPLETENESS (NORMATIVE)

What are the requirements for point data sets? No treatment of null (missing) values for real-time observations (no data sent for that reading). Manufacturers to default to predicted/modelled information on ECDIS.

NLD propose the use of "NaN" – not a Number to indicate missing data.

7 Data Capture and Classification

The water level product contains data processed from sensors or derived from the output from mathematical models. In most cases, the data collected by the producing authority must be translated, sub-setted, reorganized, or otherwise processed to restructure into a usable data format.

Commented [JZM7]: S100 Review: Expand or remove Annex A

7.1 Data Sources

Water level data comes primarily from a few specific sources: observations, astronomical predictions, analyses, and forecast models. When such data are produced and quality-controlled by an approved producing authority (IHO Resolution A6.3 & A6.9, S-62), they are suitable for inclusion in the Water level data product. See ANNEX F – WATER LEVEL DATA

Observational Data: Observational water level data comes initially from *in situ* sensors in the field (.e.g. tide gauges deployed along channel) and are monitored by the data collecting authority. After reception, the data are quality controlled and stored by the producing authority. Some of the observed data may be available for distribution within minutes of being collected and are this described as being 'in real time. Other data may be days or years old, and are called historical data.

Astronomical Predictions: Astronomical predictions are produced when a sufficiently long time series of observed water level has been obtained and the data has been harmonically analyzed by the producing authority to produce a set of amplitude and phase constants. The harmonic values can then be used to predict the astronomical component of the water level as a time series covering any desired time interval. Data available for single stations or numerous, may be arranged by the producing authority into a gridded field.

Analyzed Values: Analyzed water level values may be produced from sea-surface topography, data assimilation, statistical correlations or other means. A hybrid method combines two of or more approaches.

Hindcast and Forecast Data: Hydrodynamic models numerically solve a set of fluid dynamic equations in two or three dimensions, and rely on observational data, including water levels and winds, to supply boundary conditions. Model grids may be either regular or irregular. Such models are often run several times per day, and in each run there is usually a hindcast and a forecast. The hindcast is a model simulation that attempts to recreate present conditions by using the most recent observational data, while a forecast is a simulation made for many hours in to the future using predicted winds, water levels, etc. The results are saved for a limited number of times, and are stored as arrays that derive from the model's grid. These models and methods are developed, run and monitored by the HO.

These descriptions are summarized in Tables 7.1.

Table 7.1 – Types of water level data, based on the source of the data.

Type	Name	Description
1	Historical observation	Observation made hours, days, etc., in the past
2	Real-time observation	Observation no more than a few minutes old
3	Astronomical prediction	Value computed using harmonic constants only
4	Analysis or hybrid method	Calculation by statistical or other indirect methods, or a combination of methods
5	hindcast	Gridded data from a two- or three-dimensional dynamic simulation of past conditions using only observed data for boundary forcing, via statistical method or combination
6	forecast	Gridded data from a two- or three-dimensional dynamic simulation of future conditions using predicted data for boundary

		forcing, via statistical method or combination

7.2 The Production Process

Nearly all available information on water level from the Producer must be reformatted to meet the standards of this Product Specification (Figure 10.1 - the S-104 format). This means (a) populating the carrier metadata block (Section 12.3) with the relevant data and (b) reorganizing the water level data when using the encoding rules (see ANNEX G – HDF5 Encoding for gridded data). Need encoding rules for non gridded data.

Commented [JZM8]: S100- Review: add production process for point set datasets as its own chapter.

7.2.1 Metadata

Commented [JZM9]: S100 Review: Add a section on production metadata; such as when the data is valid, when the data was issued, who compiled the data, datums etc.

Metadata is derivable from the information available from the approved authority. The following variables will require additional processing:

- The bounding rectangle is computable from either the distribution of stations or nodes, or from grid parameters
- Position uncertainties may be available from the approved authority's metadata;
- Water level uncertainty may be available from the prediction model, specification of the water level gauge or calculated from observations;

Commented [JZM10]: S100 review: add text to state the bounding rectangle is encoded using the E_GeographicBoundingBox type in the bounding box attributes of S100_dataCoverage field in S100_datasetDiscoveryMetadata.

7.2.2 Water Level Data

Observational water level and astronomical water level predictions at a single location and gridded forecast data must normally be reformatted to fit the S-104 standard. The following may require additional calculations:

- For gridded data. If a land mask array is included, the mask value (-9999) is substituted into the gridded values as appropriate.
- Time stamps must be encoded as UTC.

8 Maintenance

Maintenance and Update Frequency: Water level is always moving, so more-or-less- continual revision or updating of the data is essential. For real-time observations, new values are periodically collected (e.g. every 6 minutes). For a forecast, the entire field of water levels is created one or more times per day. New issues of real-time observations or forecasts should be considered new editions.

Commented [JZM11]: S100 Review: Reconsider the use of editions for describing new water level datasets. The issue is highlighted is consider the example of a new edition issued fro every real-time observation at 6 minute interval will be ~ 600 edition per day.

Water level harmonic constant data are updated much less often, typically on an annual basis.

Table 8.1 summarizes this information.

Table 8.1 – Typical update/revision intervals and related information

For S-104 products produced by a single Producer.

Data Types	Interval	Number Of Spatial Locations	Number Of Time Values Per Location

Harmonic Constant Tidal Predictions	1 year	100 to 1,000	52560 (10 minute data) or 8,760 (hourly data)
Model Forecasts	6 hr	100,000 to 1,000,000	1 to 24
Real-time Observations	0.1 hr	1 to 10	1 to 240

Data Source: Data is produced by the producing authority through the collection of observed values, predicting astronomical tides, or running analysis or hindcast/forecast. This data is typically quality-controlled and reformatted to conform to file size limitations and the S-104 standard encoding.

Production Process: S-104 datasets, including the metadata and the coverages for water level, are updated by replacement of the entire data product. Producers routinely collect observational data and maintain an analysis and/or forecast capability. When new data becomes available (often several times per day), the data is reformatted and made available for dissemination.

9 Portrayal

Commented [JZM12]: S100 Review: Create a portrayal catalogue, the different product formats need to be considered.

9.1 Introduction

This section describes means of displaying water level data to support navigation, route planning and route monitoring. Three types of data are discussed in depth. The first is point data, which would apply to historical data, astronomical predictions, forecast/hindcast, and real-time data. The second is regularly gridded data, which would apply to analyses, hindcasts and forecasts. For gridded or point set data, the water level portrayal characteristics used for single-point data can be adapted to displaying data at multiple points.

For example, a point portrayal may be provided to display water level at significant locations such as where real-time observations are available. A gridded portrayal may be provided for voyage planning where a mariner's selection of routes may be influenced by water level at certain way points. Note that not all portrayal categories (point and gridded) may be available for all types of water level data (historical observations, real-time observations, astronomical predictions, and forecast total water level).

All recommended sizes are given assuming a minimum size ECDIS display of 270 by 270 mm or 864 by 864 pixels per S-52(5.1) and IEC61174 (7).

Three portrayal options are provided because of the different types of information that could be supplied. *The options listed below are to allow Members State cater for the information that they have available for their countries. Intent is that the mariner will want to use the data for route planning and real-time navigation.*

9.2 Display of Water level at a single point

Portrayal of water level using single point data should be used in instances where the data source is a water level (e.g. a historical or real-time water level measuring device) at a single geographic location. All text and line colour will be in black unless stated otherwise.

9.2.1 Symbol

9.2.2 The water level point will be represented by the S-100 GI Registry:

"TIDEHT01". Information Displayed

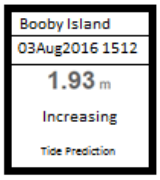
The information displayed within a window (minimum of 100x 100 pixels, example 1 demonstrates this minimum size) will be dependent on water level information type. See Table 9.2.2-1 and 9.2.2-2 for a break down of **information**

Commented [JZM13]: S100 Review: insert picture as an example

Table 9-1 Numerical information displayed at the location of a water level

Water Level Type	Information Displayed
All types	UniqueName, date and time stamp (Ship time zone), water level, trend, water level type, additional information (link to create pic report)

Commented [JZM14]: Define what a Unique name is and how it first within the Maritime Resource Name concept



Example 1:

If available, "Additional information" will be supplied on a priority level or possible via "pic report" (S-100 WG on working on this option via statistical method or combination).

Table 9-2 Priority for additional information

Priority Level	Additional Information
1	Only that listed in Table 9.2.2-1
2	Data Source, Latitude, Longitude, Graphic plot display
3	Uncertainty in water level, uncertainty in horizontal position, uncertainty in vertical position, uncertainty in time

The numerical value of the water level is a number in metres in black text on white background (or the inverse for night vision). This display should be made available when the cursor is held over the data point.

9.2.3 Graphic Plot

The availability of the graphic plot display (605x650 pixels), should be a link in the window mentioned in 9.2.1 that create another window/tab displaying up to 7 days of water level. The mariner will have the option to change between 3hours, 6 hours, 12 hours, 1 day, 3, 5 or 7 day display. The display will

have the option to display two plots within the one window; a primary plot and a secondary plot. The number of plots shown will depend on dataset availability for the area in question.

Transparency must be adjusted according to ECDIS standard (S-57, S-101), see S-111 section 9.3 for guidance.

Title of plot will include Unique Name and the water level type legend.

Table 9.2.3 Data Type Colours for Graphic Plot window

Data Type	Plot Colour
Primary plot	
Observed	Magenta
Predicted	Black
Forecast	Blue
Secondary plot	
Observed minus Predicted	Black
Observed minus Forecast	Blue

Maximum limit of three line in total to be plotted: 1) Observed, Forecast, Observed minus Forecast or 2) Observed, Predicted, Observed minus Predicted.

NB Multiple lines can be plotted on the graphic plot window at the same time and the colours are used to differentiate the data type. Data types with the same colours are plotted on different plots. Note that other ECDIS standards will define when this graphic plot can be displayed, due to the size of the window covering the screen size.

Commented [JZM15]: Note the dashed lines was considered but discounted by the WG members who indicated difficulty following lines on a small plot window.

9.3 Display of single point location from Regularly Gridded data

The display of gridded data depicts a water level surface with each individual point having the qualities described in section 9.2. As with single point water level data, mouse click in the chart area will display the information at that point at the nearest node. There is no adjustment of bathymetry data and no gridded water level surface will be portrayed Because both of these options are outside the scope of this specification.

9.4 Display of ~~water level at point locations with zones of influence~~gridded hydroid

~~This can be used where gridded data is not available. Portrayal of this data layer will not be required. This data is intended to be used by other S-100s specifications that required water level measurements. An example is S-129, where the tidal model used to produce an ENC is required for UKC.~~

~~This section is about showing how far "real-time" observation defines an area where the water level is assumed to be constant.~~

~~Single point features – plot (layer) on top of chart showing location of tide station(s) and a water level value with zones of influence for each station~~

~~1 Is this a mini-map or a layer?~~

~~2 If a mini-map, what size is the window to be useful? Should these settings be the same as defined in Option A for consistency?~~

~~3 Use same setting for display between standard/major stations and secondary/minor stations per Option A.~~

~~4 If treated as a separate layer – how will the water level zones of influence be used? Will the soundings that fall within in each zone be adjusted by the value of the water level for the identified water level station to fall in the zone? Defer all adjustment of soundings for Option C and D or IHO UKMCPT~~

~~5 Will zones without a water level station have a ratio relationship to one or more water level stations?~~

~~6 Will require documenting the methodology for selecting the zones and for displaying them.~~

~~7 How is relationship to areas managed?~~

~~7.1 Single station: single polygon area~~

~~7.2 Single station: multiple areas with ratio of influence (like a co-tidal chart)~~

~~7.3 Multiple stations: multiple area (but each area has a station)~~

~~7.4~~7.1 ~~Multiple stations: single area (method of interpolation)~~ not yet considered

9.5 Temporal Considerations

The time selected for display (i.e. past, present or future) of the water level by the system will typically not correspond exactly to the timestamp of the input data. For data with only a single record (i.e. the timestamp of the earliest values equals that of the latest value) such as real-time data, the water level values are displayed only if the absolute difference between the display time and the data timestamp is less that a discrimination interval (e.g. 5 minutes). For a single record, the variable *timeRecordInterval* (see Clause 12.3) can be used to set the discrimination interval.

Commented [JZM16]: S100 Review: What happened to data outside of the discrimination interval? Consquences?

For data with multiple times, if selected display time is later than the first timestamp and earlier than the last timestamp, then the closest two timestamps (i.e. one earlier and one later) in the data are found and the water level values are linearly interpolated. However, if the selected display time is earlier than the first timestamp or later than the last timestamp, the water level values at the closest time are displayed only if the absolute time difference between the display time and the data time stamp is less than a discrimination interval (e.g. half the value of the variable *timeRecordInterval*).

9.6 Interoperability

Interoperability principles determine priority in display of elements so that important image elements, such as depth numerals, are not obscured by water level values. Water level portrayal will conform to interoperability rules when they are established.

10 Data Product format (encoding)

10.1 Introduction

Commented [JZM17]: S100 Review: need to complete the list of formats for each data type

The Water level Data Product must be encoded using one of the listed formats. The structure of the data product is discusses in the next section. There will be a minimum of two formats to handle data:

a) Real-time water level data via AIS –

b) All water level data types for other dissemination methods.

Character Set: MD_CharacterSetCode (ISO19115) should be set to utf8

Specification: S-100 profile of HDF-5

10.2 Product Structure

10.2.1 Real-time water level data via AIS

The information that can be delivered through the AIS system is limited to information that can be delivered as part of the AIS FI-32 Tidal Window.

The AIS FI-32 allows the following fixed order of feature types:

Name: Meteorological and Hydrographic Data AIS Application-Specific Message Dynamic Water Level Data Feature Catalogue

Scope: Catalogue containing features associated with making Dynamic Water Level Data available for transmission in Meteorological and Hydrographic Data AIS Application-Specific Messages

Field of application: Marine navigation (as shown in S-100 Part 11, B-1 Example Product Specification – tbc)

Version Number: 1.0

Version Date: November 2014

Producer: International Hydrographic Organization

Functional Language: English

Spatial Use: Each AIS station will be limited to ENC NAV 5 and NAV6 boundaries. S-129 services to take precedence.

Feature Type

Name: Meteorological and Hydrographic Data AIS Application-Specific Message

Definition: This message allows the distribution of meteorological and hydrographic information via AIS

camelCase: MetHydroDataAISMessage

Remarks: - This message must not be transmitted when positional information or time of measurement are not available.

Alias: -

Feature Attributes

Name: Message ID

Attribute Type: Simple

Definition: Identifier for Message 8; always 8. Message ID 8 - Binary broadcast message (provides a structure which can accommodate data suited for a specific application (e.g. meteorological and hydrographic data))
camelCase: messageID
Cardinality: 1
Data Type: text

Name: Repeat Indicator
Attribute Type: Simple
Definition: Used by the repeater to indicate how many times a message has been repeated. 0 - 3, 0 = default, 3 = do not repeat anymore.
camelCase: repeatIndicator
Cardinality: 0..1 (tbc)
Data Type: real (tbc)
Name: Source ID
Attribute Type: Simple
Definition: MMSI number of source station.
camelCase: sourceID
Cardinality: 1
Data Type: text

Name: Spare
Attribute Type: Simple
Definition: Not used. Set to zero.
camelCase: spare
Cardinality: 0..1 (tbc)
Data Type: text (tbc)

Name: IAI (tbc)
Attribute type: Complex
Definition: International Application Identifier, DAC = 001; FI = 31
camelCase: IAI (tbc)
Cardinality: 1..* (tbc)

Sub Attributes

Name: DAC
Definition: Designated Area Code
Attribute Type: Simple
Data Type: text

Name: FI
Definition: Function Identifier
Attribute Type: Simple
Data Type: text

Feature Attributes

Name: Longitude

Attribute Type: Simple
Definition: Longitude in 1/1,000 min, ±180 degrees as per 2's complement (East = positive, West = negative). 181 = not available = default
camelCase: longitude
Cardinality: 1
Data Type: (tbc)

Name: Latitude
Attribute Type: Simple
Definition: Latitude in 1/1,000 min, ±90 degrees as per 2's complement (North = positive, South = negative). 91 = not available = default
camelCase: latitude
Cardinality: 1
Data Type: (tbc)
Name: Positional Accuracy
Attribute Type: Simple
Definition: 1 = high (<10 m; Differential Mode of, e.g., DGNSS receiver) 0 = low (>10 m; Autonomous Mode of, e.g., GNSS receiver or of other electronic position fixing device) default = 0
camelCase: positionalAccuracy
Cardinality: 1
Data Type: real (tbc)

Name: Time Stamp
Attribute type: Complex
Definition: UTC date and time of the data
camelCase: timeStamp
Cardinality: 1 (tbc)

Sub Attributes

Name: UTC Day
Definition: 1 - 31, 0 = not available = default
Attribute Type: Simple
Data Type: real (tbc)

Name: UTC Hour
Definition: 0 - 23, 24 = not available = default
Attribute Type: Simple
Data Type: real (tbc)

Name: UTC Minute
Definition: 0 - 59, 60 = not available = default
Attribute Type: Simple
Data Type: real (tbc)

Feature Attributes

Name: Average Wind Speed

Attribute Type: Simple
Definition: Average of wind speed values for the last 10 minutes, in 1 knot steps. 0 - 125 knots, 126 = wind 126 knots or greater, 127 = not available = default.
camelCase: averageWindSpeed
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Wind Gust
Attribute Type: Simple
Definition: Maximum wind speed reading during the last 10 minutes, in 1 knot steps. 0 - 125 knots, 126 = wind 126 knots or greater, 127 = not available = default.
camelCase: windGust
Cardinality: 0..1 (tbc)
Data Type: real (tbc)
Name: Wind Direction
Attribute Type: Simple
Definition: Direction of the average wind during the last 10 minutes, in 1 degree steps. 0 - 359 degrees, 360 = not available = default, 361 - 511 (reserved for future use).
camelCase: windDirection
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Wind Gust Direction
Attribute Type: Simple
Definition: Direction of the maximum wind during the last 10 minutes, in 1 degree steps. 0 - 359 degrees, 360 = not available = default, 361 - 511 (not for use).
camelCase: windGustDirection
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Air Temperature
Attribute Type: Simple
Definition: Dry bulb temperature in degrees Celsius (as per 2's complement), in 0.1 degree steps. -60 to +60 degrees Celsius, 601 - 1,023 (reserved for future use), -1,024 = data not available = default, -1,023 to -601 (reserved for future use).
camelCase: airTemperature
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Relative Humidity
Attribute Type: Simple
Definition: Relative Humidity, in 1% steps. 0 - 100%, 101 = not available = default, 102 -127 (reserved for future use).
camelCase: relativeHumidity
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Dew point

Attribute Type: Simple
Definition: Dew point temperature in degrees Celsius (as per 2's complement), in 0.1 degree steps. -20.0 to +50.0 degrees, 501 = not available = default, 502 - 511 (reserved for future use), -511 to -201 (reserved for future use).
camelCase: dewPoint
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Air Pressure
Attribute Type: Simple
Definition: Air pressure, defined as pressure reduced to sea level, in 1 hPa steps. 0 = pressure 799 hPa or less, 1 - 401 = 800 - 1200 hPa, 402 = pressure 1201 hPa or greater, 403 - 510 (reserved for future use), 511 = not available = default.
camelCase: airPressure
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Air Pressure Tendency
Attribute Type: Simple
Definition:
camelCase: airPressureTendency
Cardinality: 0..1 (tbc)
Data Type: Enumeration
Values:
1: steady
2: decreasing
3: increasing
4: not available = default

Name: Horizontal Visibilty
Attribute Type: Simple
Definition: Horizontal visibility, in 0.1 Nautical Miles steps (00000000 to 01111111). 0.0 - 12.6 Nautical Miles. The most significant bit (MSB) indicates that the maximum range of the visibility equipment was reached and the reading shall be regarded as > x.x NM. (e.g., if 10110010, then visibility is 5.0 NM or greater), 127 = data not available = default.
camelCase: horizontalVisibility
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Water Level (including tide)
Attribute Type: Simple
Definition: Deviation from local chart datum, in 0.01 metre steps. -10.00 to +30.00 metres.
A value representing 0 - 4,000 is sent by the 12 binary bits. The water level is achieved by adding -10.0 to the sent value. Water level = (Integer value /100) – 10 for Integer = 0-4,000. 4,001 = not available = default 4,002 – 4,095 (reserved for future use).
camelCase: waterLevelIncTide
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Water Level Trend
Attribute Type: Simple
Definition:
camelCase: waterLevelTrend
Cardinality: 0..1 (tbc)
Data Type: Enumeration
Values:
1: steady
2: decreasing
3: increasing
4: not available = default

Name: Surface Current Speed (including tide)
Attribute Type: Simple
Definition: Speed of Current measured at the sea surface, in 0.1 knot steps. 0.0 - 25.0 knots, 251 = speed 25.1 knots or greater, 255 = not available = default, 252-254 (reserved for future use).
camelCase: surfaceCurrentSpeedIncTide
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Surface Current Direction
Attribute Type: Simple
Definition: Direction of Current at the sea surface, in 1 degree steps. 0 - 359 degrees, 360 = not available = default, 361 - 511 (reserved for future use).
camelCase: surfaceCurrentDirection
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Formatted: French (France)

Name: Current Speed, #2
Attribute Type: Simple
Definition: Speed of Current 2 measured at a chosen level below the sea surface, in 0.1 knot steps. (Same as Surface Current Speed)
camelCase: currentSpeed2
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Current Direction, #2
Attribute Type: Simple
Definition: Direction of Current 2, in 1 degree steps. (Same as Surface Current Direction)
camelCase: currentDirection2
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Current Measuring Level, #2
Attribute Type: Simple
Definition: Measuring level below sea surface, in 1 metre increment. 0 - 30 metres, 31 = not available = default.

camelCase: currentMeasuringLevel2
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Current Speed, #3
Attribute Type: Simple
Definition: Speed of Current 3 measured at a chosen level below the sea surface, in 0.1 knot steps. (Same as Surface Current Speed)
camelCase: currentSpeed3
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Current Direction, #3
Attribute Type: Simple
Definition: Direction of Current 3, in 1 degree steps. (Same as Surface Current Direction)
camelCase: currentDirection3
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Current Measuring Level, #3
Attribute Type: Simple
Definition: Measuring level below sea surface, in 1 metre increment. 0 - 30 metres, 31 = not available = default.
camelCase: currentMeasuringLevel3
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Significant Wave Height
Attribute Type: Simple
Definition: Height of the waves, in 0.1 metre steps. 0.0 - 25.0 metres, 251 = height 25.1 metres or greater, 255 = data not available = default, 252 - 254 (reserved for future use).
camelCase: significantWaveHeight
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Wave Period
Attribute Type: Simple
Definition: Wave period, in 1 second steps. 0 - 60 seconds, 61 - 62 (reserved for future use), 63 = not available = default.
camelCase: wavePeriod
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Wave Direction
Attribute Type: Simple
Definition: Direction of waves, in 1 degree steps. 0 - 359 degrees, 360 = data not available = default 361 - 511 (reserved for future use).

camelCase: waveDirection
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Swell Height
Attribute Type: Simple
Definition: Height of the swell, in 0.1 metre steps. 0.0 - 25.0 metres, 251 = height 25.1 metres or greater, 255 = data not available = default, 252 - 254 (reserved for future use).
camelCase: swellHeight
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Swell Period
Attribute Type: Simple
Definition: Swell period, in 1 second steps. 0 - 60 seconds, 61 - 62 (reserved for future use), 63 = not available = default.
camelCase: swellPeriod
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Swell Direction
Attribute Type: Simple
Definition: Direction of swells, in 1 degree steps. 0 - 359 degrees, 360 = not available = default, 361 - 511 (reserved for future use).
camelCase: swellDirection
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Sea State
Attribute Type: Simple
Definition: Beaufort Scale
camelCase: seaState
Cardinality: 0..1 (tbc)
Data Type: Enumeration
Values:

1: calm
2: light air
3: light breeze
4: gentle breeze
5: moderate breeze
6: fresh breeze
7: strong breeze
8: near gale
9: gale
10: strong gale
11: storm
12: violent storm
13: hurricane

14: not available
15: reserved
16: reserved for future use

Name: Water Temperature
Attribute Type: Simple
Definition: Temperature of the water in degrees Celsius (as per 2's complement), in 0.1 degree steps. -10.0 to +50.0 degrees, 501 = data not available = default, 502 - 511 (reserved for future use), -511 to -101 (reserved for future use).
camelCase: waterTemperature
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Precipitation type
Attribute Type: Simple
Definition:
camelCase: precipitationType
Cardinality: 0..1 (tbc)
Data Type: Enumeration
Values:
1: reserved
2: rain
3: thunderstorm
4: freezing rain
5: mixed/ice
6: snow
7: reserved for future use
8: not available

Name: Salinity
Attribute Type: Simple
Definition: Salinity, in 0.1‰ (ppt) steps. 0.0 - 50.0 ‰, 50.1 = salinity 50.1 ‰ or greater, 510 = not available = default, 511 = sensor not available, 502 - 509 (reserved for future use).
camelCase: salinity
Cardinality: 0..1 (tbc)
Data Type: real (tbc)

Name: Ice
Attribute Type: Simple
Definition:
camelCase: ice
Cardinality: 0..1 (tbc)
Data Type: Enumeration
Values:
1: no
2: yes
3: reserved for future use
4: not available

Name: Spare End of Message
Attribute Type: Simple
Definition: Not used. Set to zero.
camelCase: spareEndOfMessage
Cardinality: 0..1 (tbc)
Data Type: text (tbc)

10.2.2 The rest of the water level data types

The key idea at the core of the structure is this: the organization of the information is substantially the same for each of the various types of data, but the information itself will be interpreted differently.

10.2.2.1 Data Type Definition

HDF5 will be used for product format is designed to be flexible enough to apply for (a) time series data for one or more individual, fixed stations, (b) regularly-gridded data for multiple times, and (c) irregularly-gridded data for multiple times. This approach contains, for each type, data in a similar format but which is interpreted differently. Since each type of data will be interpreted differently, the type of data must be identified by the variable *dataCodingFormat,* as shown in Table 10.1.

Table 10.1 – Values of the variable *dataCodingFormat.*

dataCodingFormat	Type of Data
1	Time series data at one or more fixed stations
2	Regularly-gridded data at one or more times
3	Irregularly-gridded data at one or more times
4	Fixed stations with associated areas

For all data types, the product structure in HDF5 (can this format be used for fixed station with zones????) includes (a) a metadata block, which is followed by (b) one or more Groups which contain the actual water level data. The water level information is saved in arrays that hold either gridded data or a time series.

Commented [JZM18]: S100 Review: in theory HDF5 can support fixed station with zones, e.g. all cells have the same value and where there is no data a null or land mask must be encoded.

10.2.2.2 Sample Types

For regularly gridded data, the water level array is two dimensional, with dimensions *numPointsLongitudinal* and *numPointsLatitudinal*. By knowing the grid origin and the grid spacings, the position of every point in the grid can be computed by simple formulae.

However, for time series data and irregularly gridded data (i.e., when *dataCodingFormat* is 1, or 3), the location of each point must be specified individually. This is accomplished by the data in Group XY, which gives the individual longitude (X) and latitude (Y) for each location. For time series data, the X and Y values are the positions of the stations; the number of

stations is *numberOfStations.* For irregularly-gridded data, the X and Y values are the positions of each point in the grid; the number of grid points is *numberOfNodes*.

NOTE: If *dataCodingFormat* is 2, Group XY is not present.

The remaining Groups each contain a title, a date-time value, and the water level array. The title can be used to identify each individual station with time-series data. For *dataCodingFormat* = 2 or 3, the date-time is for the entire grid. The water level array is a two dimensional, with a number of columns (*numCOL*) and rows (*numROW*). For a time series, the water level value will be for each time in the series. For a grid, the water value will be for each point in the grid.

The Groups are numbered 1, 2, etc., up to the maximum number of Groups, *numGRP*. For fixed station data, the number of Groups is the number of stations. For regular and irregular grids, the number of Groups is the number of time records

10.2.2.3 Generalized Dimensions

To summarize, for non-regularly gridded data only, there is an initial Group with X and Y position, stored in one-dimensional arrays of size *numPOS*. Following that, there are data Groups containing water level data, which are stored in two-dimensional arrays of size *numROWS* by *numCOLS*. The total number of data Groups is *numGRPS*.

The four variables that determine the array sizes (*numROWS*, *numCOLS*. *numPOS,* and *numGRPS)* are different, depending upon which coding format is used. Their descriptions are given in Table 10.2.

Table 10.2 – The array dimensions used in the data product.

Coding Format	Data Type	numPOS	numCOL	numROW	numGRP
1	Fixed Stations	numberOfStations	numberOfTimes	1	numberOfStations
2	Regular Grid	(not used)	numPointsLongitudinal	numPointsLatitudinal	numberOfTimes
3	Irregular Grid	numberOfNodes	numberOfNodes	1	numberOfTimes

The overall structure of the water level data product is created by assembling the data and metadata. The product structure is compliant with the HDF5 data architecture, which allows multi-dimensional arrays of data to be grouped with metadata. The format of the data product (cf. Figure F.5) described above is portrayed in Figure 10.1. The Carrier Metadata is discussed in Clause 12.3.

NOTE: The name of each Group is the ‘Group n‘, where n is numbered from 1 to *numGRP*. The length of the name is six plus the number of digits in n.

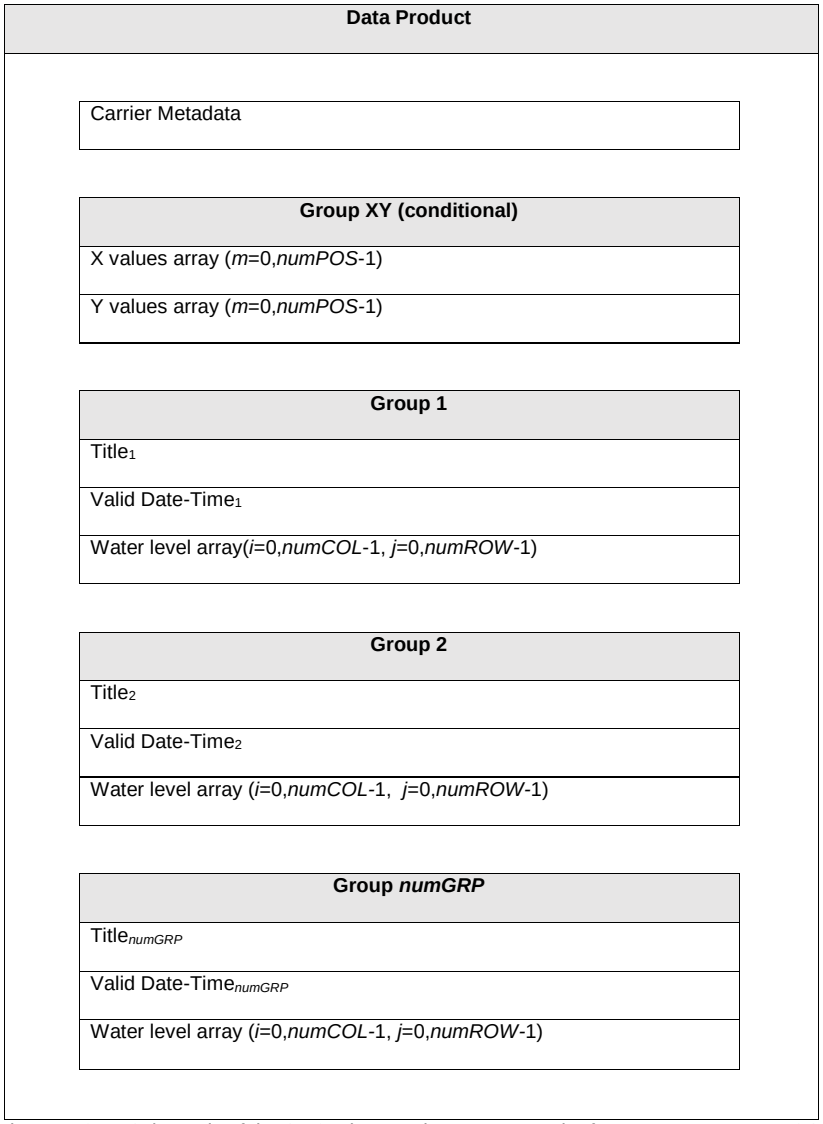


Figure 110.1 - Schematic of the S-104 data product structure. The four parameters *numPOS, numCOL, numROW*, and *numGRP* are explained in Table 10.2.
Group XY appears only for *dataCodingFormat* = 1 or 3 (Table 10.1).

10.2.2.4 ~~10.3~~ Digital Certification Block

Information here is used to certify the validity or integrity of the data.

10.4 HDF5 Encoding

The HDF-5 encoding of the data set is discussed in ANNEX G – HDF5 ENCODING.

11 Data Product Delivery

11.1 Introduction

This section describes how the water level data product is to be packaged by the Producer.

Due to the cost of transmitting data via the internet, it is desirable to limit file size and updating frequency whenever possible. The exchange data file size, as created by the Producer and before compression, is limited to 10 MB.

Updating of files typically means issuing a new forecast, or disseminating the latest observed water level for a specific geographic region. All datasets must therefore contain the issue date and time.

11.2 Exchange Datasets

Datasets, or data products, produced by the Producer consist of files containing both the exchange catalogue and one or more data products (of possibly different S-100 types), with each product covering a specific geographic region and specific period of time (Figure 11.1). The Exchange Catalogue lists the products and contains the discovery metadata.

The name of the exchange set will have the character string 'S104' somewhere in it (e.g., 'S104_ExchangeSet'), and this will identify the data as containing water level.

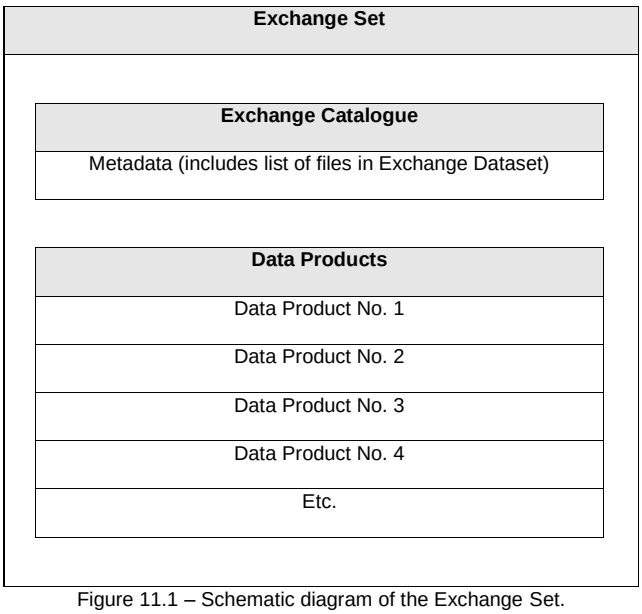


Figure 11.1 – Schematic diagram of the Exchange Set.

The dataset size is limited to 10 MB. The size of each file can vary widely, depending on the data. Using the sample HDF5 file (see Figure F.3), a file containing, along with metadata, a single speed array and a single direction array, each with 100,000 grid points would have a size of approximately 0.21 Mbytes. Exchange files may be compressed using zip methodology. Doing so can reduce file size by 80% or more.

Commented [JZM19]: S100 Review: need to update text to suit water level data in HDF5 format.

11.3 Exchange Catalogue

The exchange catalogue normally in XML format acts as the table of contents for the exchange set. The catalogue file of the exchange set must be named S104ed01CAT.XML; no other file in the exchange set may have the same name. The contents of the exchange catalogue are described in Clause 12.

11.4 Data Product File Naming

The data product file contains both a metadata block and one or more sets of water level arrays. The file naming convention described here must be used for all water level files from all sources. The file naming convention consists of 20 to 22 characters. The first two characters are used to identify the producing country code (two characters, ref S-62), followed by Producer specific characters to uniquely define the dataset (must be 15 characters). The filename extension (e.g., .hdf5) denotes the file format. Characters may be lower or upper case. This is summarized in Table 11.1.

***Table 11.11-1 - Characters used in the file naming convention*.**

N	DESCRIPTION	LENGTH	EXAMPLE
1	Country Code	2	CA
2	Unrestricted	15	Gulf20141106ABC
3	Extension	3 to 5	.h5, .hdf5
	Total =	20 to 22	

The unrestricted characters may be used to denote geographical region, valid time, source of the data, version numbers, and/or any other relevant information.

11.5 Support Files

This Data Product requires no support files.

12 Metadata <S-100 Part 4>

12.1 Introduction

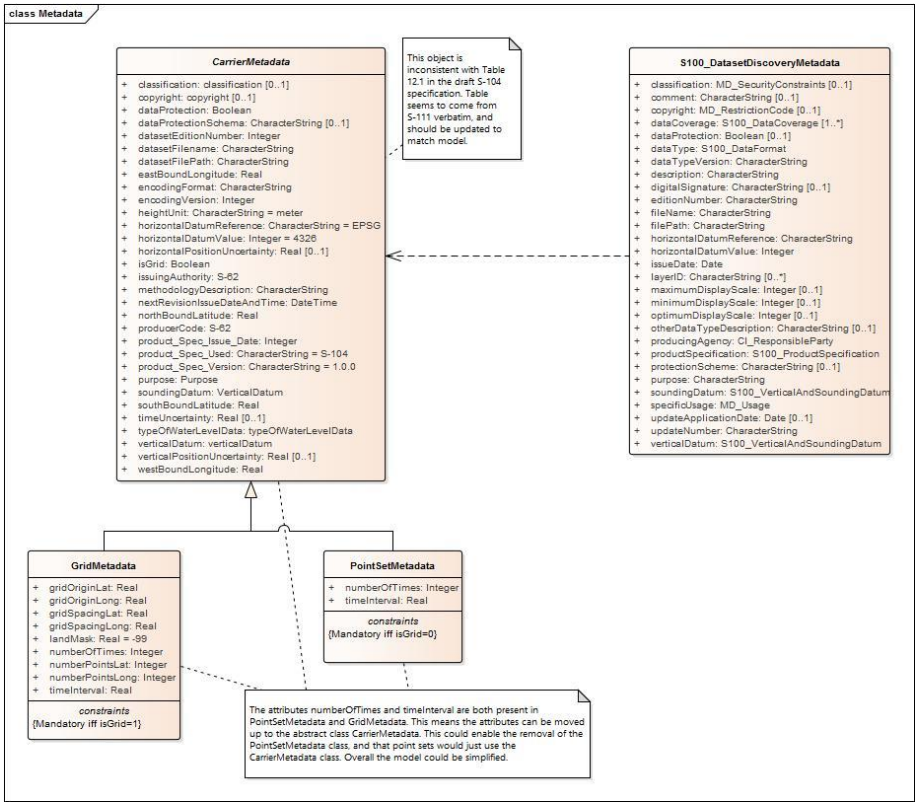
For information exchange, there are several categories of metadata required: metadata about the overall exchange catalogue, metadata about each of the datasets contained in the catalogue. The discovery metadata classes have numerous attributes which enable important information about the datasets and accompanying support files to be examined without the need to process the data, e.g. decrypt, decompress, load etc. Other catalogues can be included in the exchange set in support of the datasets such as feature, portrayal, coordinate reference systems, codelists etc. The attribute "purpose" of the support file metadata provides a mechanism to update support files more easily.

This clause defines the mandatory and optional metadata needed for S-104. For information exchange, there are several categories of metadata required: metadata about the overall exchange catalogue, metadata about each of the datasets contained in the catalogue, and metadata about the support files, if any, that make up the package. In some cases the metadata may be repeated in a national language.

12.2 Discovery Metadata

An outline the overall concept of an S-104 exchange set for the interchange of geospatial data and its relevant metadata is explained in the following figures. Figure 12.1 depicts the realization of the ISO 19139 classes which form the foundation of the exchange set. The overall structure of the S-104 metadata for exchange sets is modelled in shown in ANNEX C.. More detailed information about the various classes and a textual description in the tables at Clause 12.3.

Figure 12.1 - Realization of the exchange set classes. Note that there are no support files.



The discovery metadata classes have numerous attributes which enable important information about the datasets to be examined without the need to process the data, e.g. decrypt, decompress, load etc. Other catalogues can be included in the exchange set in support of the datasets such as feature and portrayal..

The language used for the metadata is English.

Time reference for all **data will be UTC.**

All water level values to be given in metres (up to three decimal places for real values).

12.2.1 S100_ExchangeCatalogue

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

Name	Description	Mult	Value	Type	Remarks
S100_ExchangeCatalogue	An exchange catalogue contains the discovery metadata about the exchange datasets and support files	-		-	-
Identifier	Uniquely identifies this exchange catalogue	1		S100_CatalogueIdentifier	
Contact	Details about the issuer of this exchange catalogue	1		S100_CataloguePointOfContact	
productSpecification	Details about the product specifications used for the datasets contained in the exchange catalogue	0..1		S100_ProductSpecification	Conditional on all the datasets using the same product specification
exchangeCatalogueName	Catalogue filename	1		CharacterString	In S-104 it would be CATLOG.104
exchangeCatalogueDescription	Description of what the exchange catalogue contains	1		CharacterString	
exchangeCatalogueComment	Any additional Information	0..1		CharacterString	
compressionFlag	Is the data compressed	0..1		Boolean	Yes or No
algorithmMethod	Type of compression algorithm	0..1		CharacterString	Eg. RAR or ZIP
sourceMedia	Distribution media	0..1		CharacterString	
replacedData	If a data file is cancelled	0..1		Boolean	

Name	Description	Mult	Value	Type	Remarks
	is it replaced by another data file				
dataReplacement	Cell name	0..1		CharacterString	

12.2.2 S100_CatalogueIdentifier

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_CatalogueIdentifier	An exchange catalogue contains the discovery metadata about the exchange datasets and support files	-	-	-
Attribute	identifier	Uniquely identifies this exchange catalogue	1	CharacterString	
Attribute	editionNumber	The edition number of this exchange catalogue	1	CharacterString	
Attribute	date	Creation date of the exchange catalogue	1	Date	

12.2.3 S100_CataloguePointofContact

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

12.2.4 S100_DatasetDiscoveryMetaData

Data in the Discovery Metadata are used to identify the relevance of the dataset to the particular application.

Name	Description	Mult	Value	Type	Remarks
S100_DatasetDiscoveryMetadata	Metadata about the individual datasets in the exchange catalogue	-		-	-
fileName	Dataset file name	1		CharacterString	
filePath	Full path from the exchange set root directory	1		CharacterString	Path relative to the root directory of the exchange set. The location of the file after the exchange set is unpacked into directory <EXCH_ROOT> will be <EXCH_ROOT>/<filePath>/<filename>
description	Short description giving the area or location covered by the dataset	1		CharacterString	E.g. a harbour or port name, between two named locations etc.
dataProtection	Indicates if the data is encrypted	0..1		Boolean	0 indicates an unencrypted dataset 1 indicates an encrypted dataset
protectionScheme	specification or method used for data protection	0..1		CharacterString	Eg S-63
digitalSignature	Indicates if the data has a digital signature	0..1		Boolean	0: unsigned 1: datafile is digitally signed [to be reconciled when S-100 finalizes digital signature elements]
digitalSignatureValue	Digital signature	0..1		CharacterString	This contains a base64 encoding of the hexadecimal numbers comprising the digital signature itself. The content of these fields are defined, along with the algorithms for their calculation, in S-63 ed2.0 Part (C). [to be reconciled when S-100 finalizes digital signature elements]
classification	Indicates the security classification of the dataset	0..1		Enumeration	One of the following from ISO 19115 MD_SecurityConstraints> MD_ClassificationCode (codelist) 1. unclassified 2. restricted 3. confidential 4. secret 5. top secret
purpose	The purpose for which the dataset has been issued	1		MD_Identification>purpose CharacterString	E.g. new, re-issue, new edition, update etc.
specificUsage	The use for which the dataset is	1		CharacterString	E.g. in the case of ENCs this would be

Commented [JZM20]: S100 Review: Review remarks against text in section 11.1 for consistency.

Name	Description	Mult	Value	Type	Remarks
	intended				a navigation purpose classification.
editionNumber	The edition number of the dataset	1		CharacterString	When a data set is initially created, the edition number 1 is assigned to it. The edition number is increased by 1 at each new edition. Edition number remains the same for a re-issue.
issueDate	date on which the data was made available by the data producer	1		Date	
productSpecification	The product specification used to create this dataset	1		S100_ProductSpecification	
producingAgency	Agency responsible for producing the data	1		CI_ResponsibleParty	
horizontalDatumReference	Reference to the register from which the horizontal datum value is taken	1		characterString	EPSG
horizontalDatumValue	Horizontal Datum of the entire dataset	1		Integer	4326
verticalDatum	Vertical Datum of the entire dataset	1		S100_VerticalAndSoundingDatum	
~~soundingDatum~~	~~Sounding Datum of the entire dataset~~	~~1~~		~~Enumeration S100_VerticalAndSoundingDatum~~	~~Not relevant to S-104. Fixed value corresponding to literal localDatum from S100_VerticalAndSoundingDatum.~~
dataType	The encoding format of the dataset	1		S100_DataFormat	
otherDataTypeDescription	Encoding format other than those listed.	0..1		CharacterString	
dataTypeVersion	The version number of the dataType.	1		CharacterString	
dataCoverage	Area covered by the dataset	1		S100_DataCoverage	
comment	Any additional information	0..1		CharacterString	

Commented [JZM20]: S100 Review: Review remarks against text in section 11.1 for consistency.

Commented [JZM21]: S100 Review: suggest adding clarification about water level datum elsewhere and reference that here or add comment that this attribute is the datum the water level data is referenced to.

12.2.5 S100_DataCoverage

Name	Description	Mult	Value	Type	Remarks
S100_DataCoverage		-		-	-
ID	Uniquely identifies the coverage	1		Integer	-
boundingBox	The extent of the dataset	1		EX_GeographicBoundingBox	-

	limits				
boundingPolygon	A polygon which defines the actual data limit	1..*		EX_BoundingPolygon	-
optimumDisplayScale	The scale with which the data is optimally displayed	0..1		Integer	
maximumDisplayScale	The maximum scale with which the data is displayed	0..1		Integer	
minimumDisplayScale	The minimum scale with which the data is displayed	0..1		Integer	

12.2.6 EX_GeographicBoundingBox

From ISO 19115:2003 Corr. 1 (2006).

Name	Description	Mult	Type	Remarks
EX_GeographicBoundingBox	geographic position of the dataset	-	-	Defined in ISO 19115
westBoundLongitude	western-most coordinate of the limit of the dataset extent, expressed in longitude in decimal degrees (positive east)	1	Real	Arc degrees
eastBoundLongitude	eastern-most coordinate of the limit of the dataset extent, expressed in longitude in decimal degrees (positive east)	1	Real	Arc degrees
southBoundLatitude	southern-most coordinate of the limit of the dataset extent, expressed in latitude in decimal degrees (positive north)	1	Real	Arc degrees
northBoundLatitude	northern-most, coordinate of the limit of the dataset extent expressed in latitude in decimal degrees (positive north)	1	Real	Arc degrees

12.2.7 EX_BoundingPolygon

From ISO 19115:2003 Corr. 1 (2006).

Name	Description	Mult	Type	Remarks
EX_BoundingPolygon	boundary enclosing the dataset, expressed as the closed set of (x,y) coordinates of the polygon (last point replicates first point)	-	-	Defined in ISO 19115

Name	Description	Mult	Type	Remarks
polygon	sets of points defining the bounding polygon	1	GM_Object	Must be a GM_Polygon (See S-100 Part 7, ISO 19107, ISO 19136)

12.2.8 S100_VerticalAndSoundingDatum

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_VerticalAndSoundingDatum	Allowable vertical and sounding datums	-	-	-
Value	meanLowWaterSprings		-	-	1
Value	meanSeaLevel		-	-	2
Value	meanLowerLowWaterSprings		-	-	3
Value	lowestLowWater		-	-	4
Value	meanLowWater		-	-	5
Value	lowestLowWaterSprings		-	-	6
Value	approximateMeanLowWaterSprings		-	-	7
Value	indianSpringLowWater		-	-	8
Value	lowWaterSprings		-	-	9
Value	approximateLowestAstronomicalTide		-	-	10
Value	nearlyLowestLowWater		-	-	11
Value	meanLowerLowWater		-	-	12
Value	lowWater		-	-	13
Value	approximateMeanLowWater		-	-	14
Value	approximateMeanLowerLowWater		-	-	15
Value	meanHighWater		-	-	16
Value	meanHighWaterSprings		-	-	17
Value	highWater		-	-	18
Value	approximateMeanSeaLevel		-	-	19
Value	highWaterSprings		-	-	20
Value	meanHigherHighWater		-	-	21
Value	equinoctialSpringLowWater		-	-	22
Value	lowestAstronomicalTide		-	-	23
Value	localDatum		-	-	24
Value	internationalGreatLakesDatum1985		-	-	25
Value	meanWaterLevel		-	-	26
Value	lowerLowWaterLargeTide		-	-	27

Value	higherHighWaterLargeTide		-	-	28
Value	nearlyHighestHighWater		-		29
Value	highestAstronomicalTide		-		30(HAT)
Value	Ellipsoidal Height	Not in S100!			31

Commented [JZM22]: S100 Review: Ask for an extension to the S-100 list

12.2.9 S100_DataFormat

Commented [JZM23]: S100 Review: ask for extension to list for new data formats

Role Name	Name	Description	Mult	Type	Remarks
Class	S100_DataFormat	Encoding format	-	-	
Value	HDF5	Format	1	Character	
Value	BAG	Format			S102 Bathymetric Attributed Grid

12.2.10 S100_ProductSpecification

Name	Description	Mult	Type	Remarks
S100_ProductSpecification	The Product Specification contains the information needed to build the specified product	-	-	-
name	The name of the product specification used to create the datasets	1	CharacterString	S-104 Surface Current Product Specification
version	The version number of the product specification	1	CharacterString	1.0.0
date	The version date of the product specification	1	Date	

12.2.11 S100_CatalogueMetadata

Commented [JZM24]: S100 Review: add explanation for class. This class is used to provide metadata about feature and portrayal catalogues.

Name	Description	Mult	Value	Type	Remarks
S100_CatalogueMetadata		-		-	-
filename	The name for the catalogue	1..*		CharacterString	
fileLocation	Full location from the exchange set root directory	1..*		CharacterString	Path relative to the root directory of the exchange set. The location of the file after the exchange set is unpacked into directory <EXCH_ROOT> will be <EXCH_ROOT>/<filePath>/<file name>

scope	Subject domain of the catalogue	1..*		S100_CatalogueScope	
versionNumber	The version number of the product specification	1..*		CharacterString	
issueDate	The version date of the product specification	1..*		Date	
productSpecification	The product specification used to create this file	1..*		S100_ProductSpecification	
digitalSignatureReference	Digital Signature of the file	1		CharacterString	Reference to the appropriate digital signature algorithm
digitalSignatureValue	Value derived from the digital signature	1		CharacterString	

12.2.12 S100_CatalogueScope

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

12.3 Carrier Metadata

The carrier metadata consists of the data and parameters needed to read and interpret the information in the Water Level product even if the other S-104 MetaData files are unavailable.

Table 12.1 – S-104 Carrier metadata with Latitude and longitude values precise to 10^{-7} deg.

N	Name	Camel Case	Data Type	Remarks and/or Units
1	Product Spec and version	productSpecification	Character	This must be encoded as 'S-104.X.X.X', with Xs representing the version number
2	Date-Time of data product issue	dateTimeOfIssue	Character	DateTime. Must be consistent with issueDate in discovery metadata.
3	Name of geographic region	nameRegion	Character	
4	Name of geographic sub-region	nameSubregion	Character	
5	Horizontal datum	horizontalDatumReference	Character	EPSG
6	Horizontal datum number	horizontalDatumValue	Integer	4326 (for WGS84)
7	Indicates if the data is encrypted	dataProtection	Enumeration	0: unencrypted dataset 1: encrypted dataset
8	Specification or method used for data protection	protectionScheme	Character	Eg. S-63
9	Valid Time of Earliest Value	dateTimeOfFirstRecord	Character	DateTime
10	Valid Time of Latest Value	dateTimeOfLastRecord	Character	DateTime
11	Time interval	timeRecordInterval	Integer	Seconds
12	Number of time records	numberOfTimes	Integer	
13	Type of Waterlevel data	typeOfWaterlvelData	Enumeration	1. Historical observation 2. Real-time observation 3. Astronomical prediction 4. Analysis or hybrid method 5. hindcast 6. forecast
14	Data organization index, used to read the data	dataCodingFormat	Enumeration	1: Time series at fixed stations 2: Regularly-gridded arrays 3: Irregularly-gridded arrays
15	Number of fixed stations	numberOfStations	Integer	Used only if dataCodingFormat = 1
16	Vertical datum reference	verticalDatum	Enumeration	Chart datum as per Clause 12.2.6
17	Longitude of grid origin	gridOriginLongitude	Real	Arc Degrees (if dataCodingFormat=2)
18	Latitude of grid origin	gridOriginLatitude	Real	Arc Degrees (if dataCodingFormat=2)
19	Grid spacing, long.	gridSpacingLongitudinal	Real	Arc Degrees (if dataCodingFormat=2)
20	Grid spacing, lat.	gridSpacingLatitudinal	Real	Arc Degrees (if dataCodingFormat=2)
21	Number of points, long.	numPointsLongitudinal	Integer	iMax (if dataCodingFormat=2)
22	Number of points, lat.	numPointsLatitudinal	Integer	jMax (if dataCodingFormat=2)
23	First grid point num., long.	minGridPointLongitudinal	Integer	0 (if dataCodingFormat=2)
24	First grid point num., lat.	minGridPointLatitudinal	Integer	0 (if dataCodingFormat=2)
25	Nodes in irregular grid	numberOfNodes	Integer	Used if dataCodingFormat=3

26	Land mask value	gridLandMaskValue	Real	Negative value (e.g. -1.0 or -99.999). Also denotes a missing value.
27	Horizontal position uncertainty	uncertaintyOfHorizontalPosition	Real	-1.0 (unknown) or positive value (m)
28	Vertical position uncertainty	uncertaintyOfVerticalPosition	Real	-1.0 (unknown) or positive value (m)
29	Time uncertainty	uncertaintyOfTime	Real	-1.0 (unknown) or positive value (s)
30	Methodology	methodCurrentsProduct	Character	Brief description of current meter type, forecast method or model, etc.

12.4 ~~Generic~~ Data type specific metadata

Commented [JZM25]: S100 Review: clarify text or move to correct section.

Single point metadata

Name/Role	Source	Multiplicity	Value	Type	Remarks
Time_interval (delivery)		1		Real	
Unique Identifier		1		Character/numerical	Port Number as given in Tide Table
Unique Name		1		Character string	Port Name as given in Tide Table
Value for missing data		1		Real	

Feature Type: WaterLevel

Name/Role	Source	Multiplicity	Value	Type	Remarks
Position (x,y)	S100	1			Latitude and Longitude of the entity
Water level Height including tide		1			metres Maximum 2 decimal places Observed/ predicted
Water level uncertainty		1		Real	metres – maximum 2 decimetres -99 if uncertainty is unknown

Water level trend	ASM	1	* to be confirmed in enumeration list starts at 1 or 0 0 1 2 3	Enumerate	0 = steady 1 = decreasing 2 = increasing 3 = not available

ANNEX A – Data Classification and encoding guide

A.1 Features

1.
2. Water Level (*WaterLevel*)

IHO Definition: FEATURE: **WATER LEVEL:** The vertical position of a water surface			
S-104 Geo Feature: Water Level			
Primitives: S100_GridCoverage, S100_PointCoverage			
S-111 Attribute	**Allowable Encoding Value**	**Type**	**Multiplicity**
Water Level Height	must be in decimal metres, maximum resolution of 0.01 metres	RE	1
Water Level Trend	1: Steady 2: Decreasing 3: Increasing 4: Not available	EN	1

A.2 Feature Attributes

The number of attributes is two.

1. Water Level Height (*waterLevelHeight*)

Water Level Height: The height of a water surface relative to a vertical datum

Unit: metre (m)

Minimum Resolution: 0.01 m

Format: xxx.xx

Example: 10.54

Remarks:

- Land mask or missing value is denoted by a unique number as specified in the metadata.
- The height is relative to some vertical datum, which is defined in the metadata.
- 0.01 m equals 0.3937 in (1 cm)

2. Water Level Trend (*waterLevelTrend*)

Water Level Trend: The average rate of change of the water level height over a given period of time. IHO Definition: TREND. The general direction of something, such as a coastline.

1: Steady (*steady*)

2: Decreasing (*decreasing*)

3: Increasing (*increasing*)

4: Not available (*notAvailable*)

Unit: none (enumeration)

Minimum Resolution: N/A (enumeration)

Format: x

Example: 2

Remarks:

- The default value is 4: not available, which may be used in non-tidal or similar regions.

ANNEX B – Data Product Format (encoding)

Annex C- Application Schema (UML **Diagrams**)

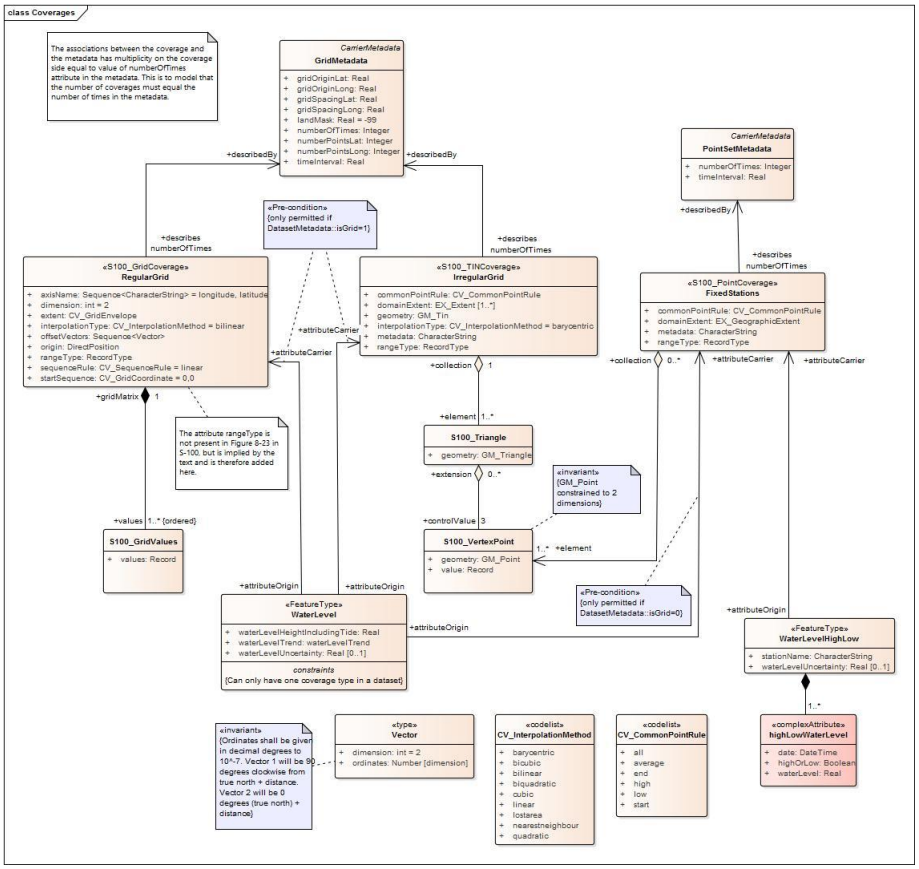


Figure 23 Coverages

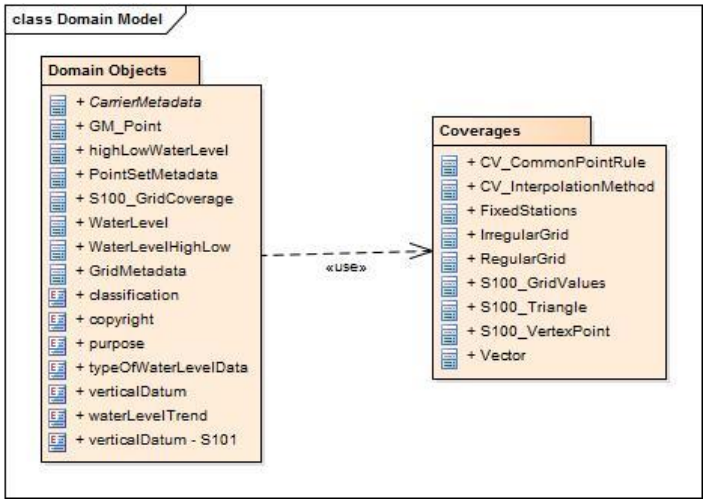


Figure 34 Domain Model

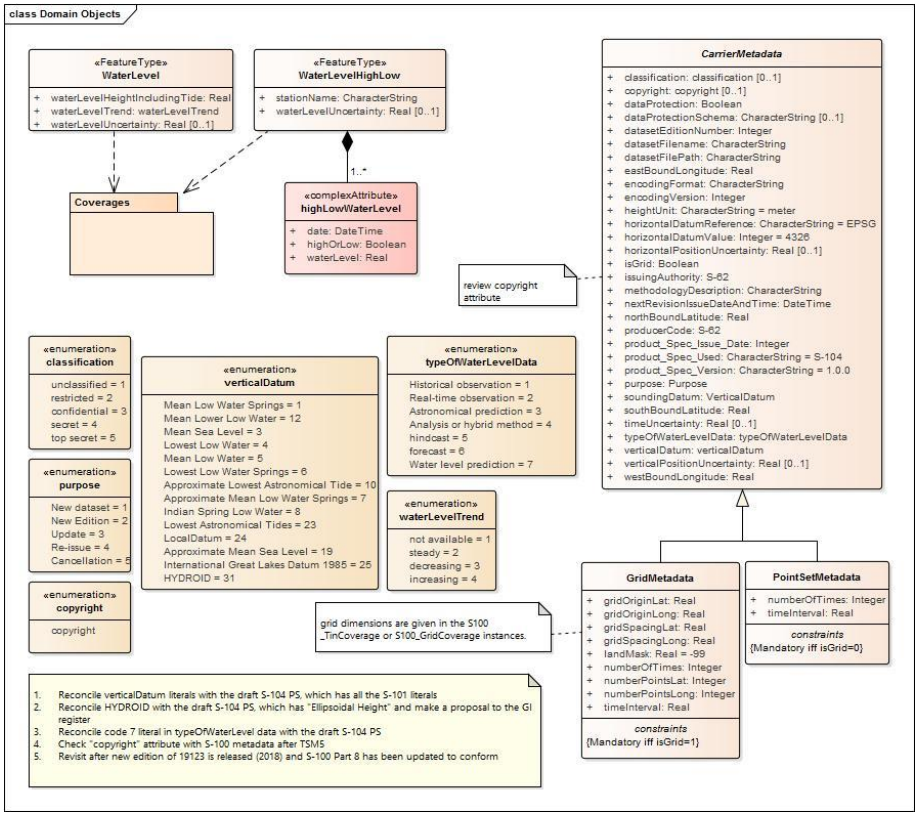


Figure ~~45~~ Domain Objects

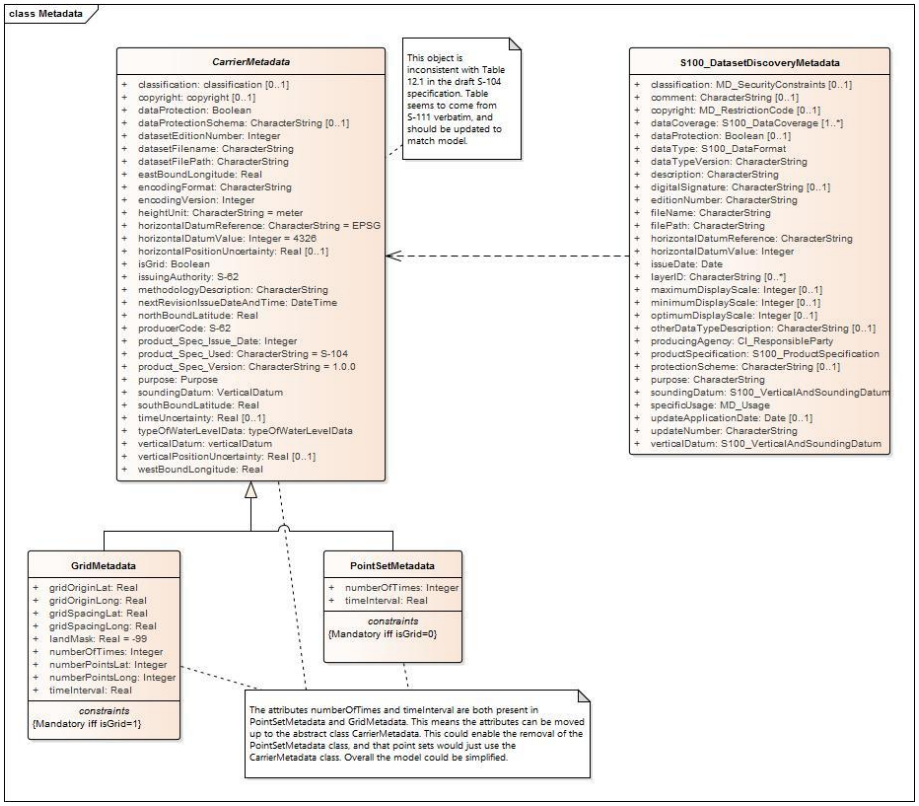


Figure 56 Metadata

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Field Code Changed

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Annex D – Feature Catalogue

Annex F – Portrayal Catalogue

Annex G – Validation Checks

Annex H - Meteorological and Hydrographic Data AIS Application-Specific Message

1.1 This message allows the distribution of meteorological and hydrographic information.

1.2 This message should not be transmitted when positional information or time of measurement are not available. If there is no data available for that particular data field, it should be displayed as "not available".

1.3 Not all the information specified in the table below will be available at all stations.

Parameter	No. of bits	Description
Message ID	6	Identifier for Message 8, always 8.
Repeat Indicator	2	Used by the repeater to indicate how many times a message has been repeated. 0 - 3 0 = default 3 = do not repeat anymore
Source ID	30	MMSI number of source station
Spare	2	Not used. Set to zero.
IAI	16	DAC = 001; FI = 31
Longitude	25	Longitude in 1/1,000 min, ±180 degrees as per 2's complement (East = positive, West = negative). 181 = not available = default
Latitude	24	Latitude in 1/1,000 min, ±90 degrees as per 2's complement (North = positive, South = negative). 91 = not available = default
Position Accuracy	1	1 = high (<10 m; Differential Mode of, e.g., DGNSS receiver) 0 = low (>10 m; Autonomous Mode of, e.g., GNSS receiver or of other electronic position fixing device) default = 0
Time Stamp		UTC date and time of the data.
UTC Day	5	1 - 31 0 = not available = default
UTC Hour	5	0 - 23 24 = not available = default
UTC Minute	6	0 - 59 60 = not available = default
Average Wind Speed	7	Average of wind speed values for the last 10 minutes, in 1 knot steps. 0 - 125 knots 126 = wind 126 knots or greater 127 = not available = default
Wind Gust	7	Maximum wind speed reading during the last 10 minutes, in 1 knot steps. 0 - 125 knots 126 = wind 126 knots or greater

		127 = not available = default
Wind Direction	9	Direction of the average wind during the last 10 minutes, in 1 degree steps. 0 - 359 degrees 360 = not available = default 361 - 511 (reserved for future use)
Wind Gust direction	9	Direction of the maximum wind during the last 10 minutes, in 1 degree steps. 0 - 359 degrees 360 = not available = default 361 - 511 (not for use)
Air Temperature	11	Dry bulb temperature in degrees Celsius (as per 2's complement), in 0.1 degree steps. -60 to +60 degrees Celsius 601 - 1,023 (reserved for future use) -1,024 = data not available = default -1,023 to -601 (reserved for future use)
Relative Humidity	7	Relative Humidity, in 1% steps. 0 - 100% 101 = not available = default 102 -127 (reserved for future use)
Dew Point	10	Dew point temperature in degrees Celsius (as per 2's complement), in 0.1 degree steps. -20.0 to +50.0 degrees 501 = not available = default 502 - 511 (reserved for future use) -511 to -201 (reserved for future use)
Air Pressure	9	Air pressure, defined as pressure reduced to sea level, in 1 hPa steps. 0 = pressure 799 hPa or less 1 - 401 = 800 - 1200 hPa 402 = pressure 1201 hPa or greater 403 - 510 (reserved for future use) 511 = not available = default
Air Pressure Tendency	2	0 = steady 1 = decreasing 2 = increasing 3 = not available = default
Horizontal Visibility	8	Horizontal visibility, in 0.1 Nautical Miles steps (00000000 to 01111111). 0.0 - 12.6 Nautical Miles The most significant bit (MSB) indicates that the maximum range of the visibility equipment was reached and the reading shall be regarded as > x.x NM. (e.g., if 10110010, then visibility is 5.0 NM or greater) 127 = data not available = default
Water Level (incl. tide)	12	Deviation from local chart datum, in 0.01 metre steps. -10.00 to +30.00 metres A value representing 0 - 4,000 is sent by the 12 binary bits. The

		water level is achieved by adding -10.0 to the sent value. Water level = (Integer value /100) – 10 for Integer = 0-4,000 4,001 = not available = default 4,002 – 4,095 (reserved for future use)
Water Level Trend	2	0 = steady 1 = decreasing 2 = increasing 3 = not available = default
Surface Current Speed (incl. tide)	8	Speed of Current measured at the sea surface, in 0.1 knot steps. 0.0 - 25.0 knots 251 = speed 25.1 knots or greater 255 = not available = default 252-254 (reserved for future use)
Surface Current Direction	9	Direction of Current at the sea surface, in 1 degree steps. 0 - 359 degrees 360 = not available = default 361 - 511 (reserved for future use)
Current Speed, #2	8	Speed of Current 2 measured at a chosen level below the sea surface, in 0.1 knot steps. (Same as Surface Current Speed)
Current Direction, #2	9	Direction of Current 2, in 1 degree steps. (Same as Surface Current Direction)
Current Measuring level, #2	5	Measuring level below sea surface, in 1 metre increment. 0 - 30 metres 31 = not available = default
Current Speed, #3	8	Speed of Current 3 measured at a chosen level below the sea surface, in 0.1 knot steps. (Same as Surface Current Speed)
Current Direction, #3	9	Direction of Current 3, in 1 degree steps. (Same as Surface Current Direction)
Current Measuring level, #3	5	Measuring level below sea surface, in 1 metre steps. 0 - 30 metres 31 = data not available = default
Significant Wave Height	8	Height of the waves, in 0.1 metre steps. 0.0 - 25.0 metres 251 = height 25.1 metres or greater 255 = data not available = default 252 - 254 (reserved for future use)
Wave Period	6	Wave period, in 1 second steps. 0 - 60 seconds 61 - 62 (reserved for future use) 63 = not available = default
Wave Direction	9	Direction of waves, in 1 degree steps. 0 - 359 degrees 360 = data not available = default

		361 - 511 (reserved for future use)
Swell Height	8	Height of the swell, in 0.1 metre steps. 0.0 - 25.0 metres 251 = height 25.1 metres or greater 255 = data not available = default 252 - 254 (reserved for future use)
Swell Period	6	Swell period, in 1 second steps. 0 - 60 seconds 61 - 62 (reserved for future use) 63 = not available = default
Swell Direction	9	Direction of swells, in 1 degree steps. 0 - 359 degrees 360 = not available = default 361 - 511 (reserved for future use)
Sea State	4	Beaufort Scale, defined in the table below. 0 = calm 1 = light air 2 = light breeze 3 = gentle breeze 4 = moderate breeze 5 = fresh breeze 6 = strong breeze 7 = near gale 8 = gale 9 = strong gale 10 = storm 11 = violent storm 12 = hurricane 13 = not available = default 14 - 15 = (reserved for future use)
Water Temperature	10	Temperature of the water in degrees Celsius (as per 2's complement), in 0.1 degree steps. -10.0 to +50.0 degrees 501 = data not available = default 502 - 511 (reserved for future use) -511 to -101 (reserved for future use)
Precipitation (type)	3	According to WMO 306 Code table 4.201: 0 = reserved 1 = rain 2 = thunderstorm 3 = freezing rain 4 = mixed/ice 5 = snow 6 = reserved 7 = not available = default
Salinity	9	Salinity, in 0.1‰ (ppt) steps. 0.0 - 50.0 ‰ 50.1 = salinity 50.1 ‰ or greater 510 = not available = default 511 = sensor not available 502 - 509 (reserved for future use)

Ice	2	0 = No 1 = Yes 2 = (reserved for future use) 3 = not available = default
Spare	10	Not used. Set to zero
Total	**360**	**Occupies 2 slots**

- All times should be indicated as Coordinated Universal Time (UTC).
- All directions indicated are true north.

Beaufort scale

Scale	Sea Conditions
0	Flat.
1	Ripples without crests.
2	Small wavelets. Crests of glassy appearance, not breaking.
3	Large wavelets. Crests begin to break; scattered whitecaps.
4	Small waves.
5	Moderate (1.2 m) longer waves. Some foam and spray.
6	Large waves with foam crests and some spray.
7	Sea heaps up and foam begins to streak.
8	Moderately high waves with breaking crests forming spindrift. Streaks of foam.
9	High waves (6-7 m) with dense foam. Wave crests start to roll over. Considerable spray.
10	Very high waves. The sea surface is white and there is considerable tumbling. Visibility is reduced.
11	Exceptionally high waves.
12	Huge waves. Air filled with foam and spray. Sea completely white with driving spray. Visibility greatly reduced.
13	not available = default
14 -15	(reserved for future use)

Annex J - Informative Implementation Guidance and General Notes for AIS message (*To be developed).*

System requirements

- AIS Application-Specific Messages are transmitted and received by shipborne mobile AIS devices and AIS base stations. Shore-based stations can receive AIS Application-Specific Messages and distribute them to shore-based users.

- The display capability of AIS Application-Specific Messages is not part of the mandatory functions of the Minimum Keyboard and Display (MKD). The display of the information transmitted by AIS Application-Specific Messages requires external hardware and dedicated software in addition to the AIS equipment.

- The generation and transmission of AIS Application-Specific Messages also requires dedicated software and suitable equipment for entering the information.

Points to note:

- IALA Guideline No. 1082 - An Overview of AIS Edition 1 June 2011 - AIS uses an open protocol and is not intended for secure communications. The means for ensuring the quality and correctness of the AIS information needs to be secured.

- Radio Technical Commission for Maritime Services RTCM is preparing a standard - RTCM standard for the Creation and Qualification of Application-Specific Messages.

- SN.1/Circ.289, 12 Environmental - messages providing environmental information from one to eight sensor reports. Each sensor report carries the dynamic or static information relating to a specific sensor, such as the Water level report.

- IALA Guideline No. 1028 - Use of AIS for Meteorological and Hydrographic purposes. Where such an application is intended for international use, the message format will be registered by IALA prior to being made available to system manufacturers. This will facilitate the correct presentation of the information on systems from different manufacturers.

- IALA Recommendation A-124 - This section introduces the AIS Service Data Model. It is meant to describe what data is used, received and transmitted by the AIS Service. It is important to understand that the data objects used by the AIS Service are derived from an over-arching data model called the IALA Universal Maritime Data Model (UMDM).

  The Basic AIS Services define the functionality provided by the AIS Service. They are operations performed on certain data objects. To provide a complete picture of what the AIS Service can deliver its clients, it is necessary to consider those data objects and their structure and mutual relationship. Eventually, it is the data, which is only relevant for the clients.

- IALA Guideline No. 1095 - Once the Common Shared Maritime Datamodel (CSDM), which is based on IHO's Registry, is developed, data elements used in ASMs should be drawn from and directly linked to that registry. There may be a requirement for a Dynamic Water Level Data domain or a Meteorological and Hydrographic AIS Application-Specific Message domain or similar in the IHO Registry.

- There may be a requirement for an AIS Application-Specific Messages section in S-100.

- IALA Guideline No. 1095 - Frequency of transmission. ASMs may be sent in different modes: Automatic, On request and Sequencing.

Extracts from papers to note:

AIS Binary Message updates IMO SN.1/Circ.289 and IMO SN.1/Circ.290 review, US Hydro conference 2011 - Tampa - Ted Read MRIN

IHO S-104 Water Level Information For Surface Navigation

Consequences from message changes from Circ.236 to Circ.289:

- Binary message restructure, needs two parses
- Variance from ITU-R M.1371 standard

Future requirements: Security and Website information

Conclusions:

Incorporation within the ECDIS standard, Expand on graphic display format, Harmonize Inland/Coastal usage

Range and accuracy Water Level - The new message has overcome the previous limit on Water Level resolution from 0.1m to 0.01m. Unfortunately it has parted from the AIS standard for 2˝s compliment numbers by having a constant offset of -10.0m.

Subjective or derived values - Many of the parameters defined in the IMO TideMet standard message are subjective so are not suitable for automated instrumentation (e.g. Sea State, Visibility, Precipitation). Other parameters such as Dew Point and Significant Wave Height are derived so could be calculated by a client program. A standard calculation of derived values should be formally stated.

Tide and Metrological data over AIS, written by E.F.Read & W.S.Heaps

The structure of an AIS message

As can be seen by the large number of zeros in the previous example of type 8 output the IMO specified message formats appear to suffer from the following faults:

- Over specified, much of the message is not of interest to many users.
- Badly aligned bit format so that data is not byte aligned and computer friendly.
- Messages not size optimised by splitting into rapid and slow change data.

The individual tide and metrological message is defined by parameters DAC=1 and FI=11, this is not very easy to use, as the software has to first decode a message as a type 8 then work out from the DAC/FI code if the data is relevant as a TideMet message. The limitations on use of a DAC code having been assigned to countries leaving the 63 possible FI codes a little limited.

Other useful references in this paper include: Standalone 'Real' AtoN TideMet station, Receiving software, Licensing of AIS AtoN devices, AIS TideMet applications.

Annex K - Bibliography

- RTCM Standard for the Creation and Qualification of Application-Specific Messages (CDV-RTCM 12100.0 draft)
- IALA Guideline No. 1028 - The Automatic Identification System (AIS) Volume 1, Part 1 Operational Issues, December 2004
- IALA Guideline No. 1082 - An Overview of AIS, June 2011

- IALA Guideline No. 1095 - Harmonised Implementation of Application-Specific Messages, May 2013
- IALA Recommendation A-124 - The AIS Service, December 2012
- IALA Recommendation A-126 - The Use of the Automatic Identification System (AIS) in Marine Aids to Navigation Services, June 2011
- AIS Binary Message updates IMO SN.1/Circ.289 and IMO SN.1/Circ.290 review, US Hydro conference 2011 - Tampa - Ted Read MRIN
- Tide and Metrological data over AIS - E.F.Read & W.S.Heaps
- Dynamic Application of Tides in ECDIS - submitted by IHB, TWLWG 5/4.4/1
- Proposed AIS Binary Message Format Using XML for Providing Hydrographic-related Information - Kurt Schwehr and Lee Alexander
- Providing Meteorological and Hydrographic Information via AIS Application-Specific Messages: Challenges and Opportunities - Dr. Lee Alexander