S-101PT12-06.8

Paper for Consideration by S-101PT

Referencing Other Vertical Datums**.**

Submitted by:	UK
Executive Summary:	Proposal to add new complex attribute **Vertical Reference Frame** to meta feature **Vertical Datum of Data** and **Sounding Datum**
Related Documents:	S-101 DCEG 1.2.0 DQWG16_2021_10.1A_EN_Informative_Chart_and_Land_Survey _Vertical_Datums (iho.int). BS EN ISO 19111:2020+A2:2023
Related Projects:	MASS PT, S-102 PT

Introduction / Background

1. Vertical datum information is encoded using the meta feature **Vertical Datum of Data**, or by populating the attribute **vertical datum** on individual geo features. The values encoded in the attribute's **elevation**, **height,** and **clearance vertical** (positive values up) are referenced to the specified datum(s). Unlike in S-57 the DSID only contains coordinate reference system information for geometries and not for attribute values.

2. There is currently no ability to reference additional datums, for example, geodetic land based datums allowing interoperability between datasets. Although this does not apply in S-100 ECDIS there are many changes beyond ECDIS where integration of data on different vertical datums is necessary. Therefor this change supports steps towards MSDI.

Analysis/Discussion

3. The horizontal Coordinate Reference System (CRS) for S-101 products must be 3D EPSG:4326 (WGS84). The vertical CRS is reference to a vertical datum, a 1D reference plane, used for expressing vertical measurements on the Earth's surface. The Meta feature Vertical Datum of Data is used to capture the vertical datum information for elevation, height, and clearance vertical. The S-101 attribute vertical datum is, due to the nature of navigation at sea, a tidal vertical datum.

4. The height of a hilltop on an ENC maybe referenced to the vertical datum MHWS, but the source from which this data was derived may well have been captured using a land-based data, for example in the UK an Ordnance Survey Datum. A reference to that datum in the vertical datum of data meta feature would be useful, allowing the integration of data.

5. Data collected by a LiDAR survey reference to a land Geodetic datum, cannot easily be integrated with future S-102 bathymetry, a vertical geodetic reference would contribute to the interoperability of such emerging data sets.

The Netherlands Hydrographic Office has published an integrated geoid vertical datum for land (1cm accurate) and sea (3cm accurate) and LAT (6.6 cm accurate). In this case a geodetic datum reference could be used to highlight the difference between the integrated geoid and LAT, for example.

6. The primary goal for S-100 is to support a greater variety of hydrographic-related digital data sources. However, currently the vertical datum of data feature does not allow a refence beyond the tidal datum model. Many land-based surveys, for example, do not use the same datums used for bathymetry, and more commonly referenced to a 3D geodetic datum. The most widely recognised sources for geodetic datums are the European Petroleum Survey Group (EPSG) registry.

7. It is envisaged this additional attribute would be useful for MAAS to determine what vertical datum or transformation calculations the MASS would need to make to ensure it is operating safely, from an UKC and OHC perspective.

Conclusions
We have concluded that adding the attribute. **Vertical Reference Frame** to **Vertical Datum of Data** would better support interoperability with Land based surveys and allow for integration of datasets with different vertical datums and other S-100 datasets, including S-102. This would also support the cross-referencing products from different geographic area with the same LAT vertical datum.

Justification and Impacts
This work is considered low priority; however, additional attribute is relatively easily to implement and will have a low impact on the progress of testing towards PS 2.0.

Recommendations
S-101PT to consider adding Complex Attribute **Vertical Reference Frame** to the Meta feature **Vertical Datum of Data** and **Sounding Datum**. **Vertical Datum of Data** example listed in Annex A.

Annex A

IHO Definition: **VERTICAL DATUM OF DATA**. Any level surface (for example Mean Sea Level) taken as a surface of reference to which the elevations within a data set are reduced. Also called datum level, reference level, reference plane, levelling datum, datum for heights. (Adapted from IHO Dictionary – S-32).				
S-101 Metadata Feature: Vertical Datum of Data (M_VDAT)				
Primitives: Surface				
Real World	*Paper Chart Symbol*	*ECDIS Symbol*		
S-101 Attribute	**S-57 Acronym**	**Allowable Encoding Value**	**Type**	**Multiplicity**
vertical datum	(VERDAT)	3 : mean sea level 16 : mean high water 17 : mean high water springs 18 : high water 19 : approximate mean sea level 20 : high water springs 21 : mean higher high water 24 : local datum 25 : international great lakes datum 1985 26 : mean water level 28 : higher high water large tide 29 : nearly highest high water 30 : highest astronomical tide 44 : baltic sea chart datum 2000	EN	1,1
vertical reference frame			C	0,1
CRS source		e.g., EPSG	(S)TE	1,1
CRS identifier		e.g., 5101	(S)TE	1,1
CRS name		e.g., Ordnance Survey Newlyn	(S)TE	1.1
CRS offset			(S)RE	1,1
information		See clause 2.4.6	C	0,*
file locator			(S) TE	0,1
file reference	*(TXTDSC)* *(NTXTDS)*		(S) TE	0,1 †
headline			(S) TE	0,1
language		ISO 639-2/T	(S) TE	1,1

text	*(INFORM)* *(NINFOM)*		(S) TE	0,1 †

† For each instance of **information**, at least one of the sub-attributes **file reference** or **text** must be populated.

INT 1 Reference:

Vertical datum

Vertical datum information is encoded using the meta feature **Vertical Datum of Data**, or by populating the attribute **vertical datum** on individual geo features. The values encoded in the attributes **elevation**, **height** and **clearance vertical** (positive values up) are referenced to the specified datum(s). **vertical datum** must not be encoded on any feature unless at least one of the above attributes is also encoded on that feature.

The vertical datum of the dataset must be encoded using the meta feature **Vertical Datum of Data**:

All parts of the dataset containing data must be covered by **Vertical Datum of Data** features, with the attribute **vertical datum** indicating the vertical (height) datum. **Vertical Datum of Data** must not overlap.

Various height datums may be used within an ENC. For example, different datums may be used for the following:

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

Where different vertical datums are used for the various vertical measurements, the default value given in the metadata for the **Vertical Datum of Data** applies to the first group of the above list. The attribute **vertical datum** on an individual feature applies to the elevation of lights and vertical clearances and must only be populated if different from the value given by **Vertical Datum of Data**.

Remarks:

- Height contours, going across areas having different values of vertical datum, must be split at the border of these areas.
- Height and elevation data can be reference to different vertical datums, commonly the vertical datum attribute is reference to a tidal datum for heights and elevations, for example MHWS. information gathered from land based surveys commonly uses a geodetic datums to obtain ellipsoidal heights for example MSL. The **vertical reference frame** allows for a comparison between such datum's allowing for better integration of height information for S-100 products and services.

Distinction: Sounding Datum

geodetic reference datum

Definition: **VERTICAL REFERENCE FRAME**. vertical datum
reference frame describing the relation of gravity-related heights or depths to the Earth.

Indication: The complex attribute provides information to enable the comparison and integration of height data referenced by 1D vertical tidal datums and 3D geodetic datums.

Sub-attributes:

CRS source	see clause
CRS identifier	see clause
CRS name	see clause
CRS offset	see clause.

Remarks:

- **The CRS source** should reference a recognised CRS registry e.g., EPSG Registry.
- **The CRS identifier** must match that identified in the CRS source.
- **The CRS name** must match that identified in the CRS source.
- **The CRS offset** is the difference (negative of positive) in metres of the geodetic reference datum, compared to the vertical datum

CRS source

IHO Definition: **CRS SOURCE**

Attribute Type: Free text

Indication: The string encodes the reference to a recognised CRS registry.

Remarks:

- The attribute CRS source should in the format e.g. EPSG.

CRS identifier

IHO Definition: **CRS IDENTIFIER**

Attribute Type: Free text

Indication: The string encodes the identifier or code corresponding to the CRS source.

Remarks:

- The attribute CRS identifier should be in the format e.g., 5101 (Ordnance survey Newlyn)

CRS name

IHO Definition: **CRS NAME**

Attribute Type: Free text

Indication: The string encodes the CRS name corresponding to the CRS source.

Remarks:

- The attribute **CRS name** should be in the format e.g., Ordnance survey Newlyn)

CRS offset.

IHO Definition: **CRS OFFSET**

Attribute Type: Real

Unit: metre (m).

Resolution: 0·1m

Format: xx.x

Minimum value: 0

Example: **3** for a difference of metres (positive) of the geodetic reference datum, compared to the vertical datum

Remarks:

- The offset can be positive or negative.
- Example. A height on land of 56m referenced to vertical datum MHWS, if referenced to Ordnance survey Newlyn it would be 58m. The CRS offset would be 2m (positive)