Paper for Consideration by ENCWG4

Consistent Use of Vertical Reference Datums in ENCs

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Executive Summary:	This paper proposes encoding guidelines and validation checks aimed at the consistent encoding of vertical reference datums.
Related Documents:	S-57 ENC Product Specification, S-101 Product Specification, S-58 ENC Validation Checks
Related Projects:	

Introduction / Background

The S-57 ENC [1] and S-101 [2] product specifications define two types of vertical reference datums.

1. **Vertical Datum**: Any level surface from which to reference elevations. (adapted from IHO Dictionary – S-32). This applies to heights, elevations and vertical clearances.
   Vertical Datums are encoded 1) within the dataset header, DSPM/VDAT (S-57) and CSID/VDAT (S-101); 2) Metafeatures, M_VDAT (S-57) and VerticalDatumOfData (S-101); 3) as feature attributes, VERDAT (S-57) and verticalDatum (S-101).
2. **Sounding Datum**: The horizontal plane or tidal datum to which soundings have been reduced. (adapted from IHO Dictionary – S-32).
   Sounding Datums are encoded 1) within the dataset header, DSPM/SDAT (S-57) and CSID/VDAT (S-101); 2) Metafeatures, M_SDAT (S-57) and SoundingDatum (S-101).

The attribute VERDAT (verticalDatum for S-101) carries the allowable values for both **Vertical Datum** and **Sounding Datum**.

For datums that are based on a tidal regime, it is reasonable to expect that **Vertical Datums** are referenced at *Mean sea level* or higher, and that **Sounding Datums** are referenced at *Mean sea level* or lower.

Analysis/Discussion

The S-101 DCEG, § 3.9 [3] constrains the possible values for **Vertical Datum** to *Mean sea level* or higher or *Local datum*.

Table 1 – Values of VERDAT (verticalDatum) applicable for a Vertical Datum.

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 (HAT)

However, the S-101 DCEG, § 3.8 does not constrain the possible values for **Sounding Datum**, i.e. all values are allowed. The reason for this is unclear. This paper proposes that values for **Sounding Datum** be constrained to the values presented in the table below, i.e. *Mean sea level* or lower or *Local datum*.

Table 2 - Values of VERDAT (verticalDatum) applicable for a Sounding Datum.

1	Mean low water springs
2	Mean lower low water springs
3	Mean sea level
4	Lowest low water
5	Mean low water
6	Lowest low water springs
7	Approximate mean low water springs
8	Indian spring low water
9	Low water springs
10	Approximate lowest astronomical tide
11	Nearly lowest low water
12	Mean lower low water
13	Low water
14	Approximate mean low water
15	Approximate mean lower low water
19	Approximate mean sea level
22	Equinoctial spring low water
23	Lowest astronomical tide
24	Local datum
25	International great lakes datum 1985
26	Mean water level
27	Lower low water large tide
44	Baltic Sea chart datum 2000 (S-101 only)

What about non-tidal areas?
The values presented in tables 1 and 2 also cater for non-tidal areas. For non-tidal navigable waterways, **Sounding Datum** could be encoded as *Local datum*, *International great lakes datum 1985*, *Mean sea level*, *Approximate mean sea level*, *Mean water level* or *Baltic Sea chart datum 2000* (S-101 only). **Vertical Datums** could be encoded as *Local datum*, *International great lakes datum 1985*, *Mean sea level*, *Approximate mean sea level* or *Mean water level*.

Note: For inland navigable waterways, the Inland ENC Product Specification [4] may be used. It defines values for the verdat (lower case) attribute specific to inland waterways. Further discussion on vertical reference datums relating to the Inland ENC Product Specification is beyond the scope of this paper.

Intertidal areas
Intertidal areas are defined here as DEPARE features where DRVAL2 <= 0 (see S-58 checks 61a and 61c [5]). In this case, the -H value of DRVAL1 represents the vertical difference between the **Vertical Datum** and the **Sounding Datum**. Intertidal areas are only possible where **Vertical Datum** and **Sounding Datum** are not equal. This means that if both the **Vertical Datum** and **Sounding Datum** for an area are equal, or equal to *Mean sea level*, *Approximate mean sea level* or *Mean water level*, then there cannot exist an intertidal area.

How to constrain values for Vertical Datum and Sounding Datum
For S-101 values for **Vertical Datum** are already constrained by the S-101 DCEG and the S-101 Feature Catalogue. This paper recommends that the values for **Sounding Datum** also be constrained, based on the values presented in table 2.

For S-57 ENC, it is recommended that the values for DSPM/VDAT, M_VDAT/VERDAT, and the VERDAT attribute of features other than M_SDAT, be constrained based on table 1. It is recommended that the values for DSPM/SDAT, M_SDAT/VERDAT be constrained based on table 2.

S-58 Validation Checks

The values of VERDAT for features can be constrained via check 2000. Putting all this together, this paper recommends the following changes and additions to S-58.

Check 2000:

VERDAT		185	
	BRIDGE	11	3-16-17-18-19-20-21-24-25-26-28-29-30
	CBLOHD	21	3-16-17-18-19-20-21-24-25-26-28-29-30
	CONVYR	34	3-16-17-18-19-20-21-24-25-26-28-29-30
	CRANES	35	3-16-17-18-19-20-21-24-25-26-28-29-30
	GATCON	61	3-16-17-18-19-20-21-24-25-26-28-29-30
	LIGHTS	75	3-16-17-18-19-20-21-24-25-26-28-29-30
	PIPOHD	93	3-16-17-18-19-20-21-24-25-26-28-29-30
	M_SDAT	309	1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-19-22-23-24-26-27 (#)
	M_VDAT	312	3-16-17-18-19-20-21-24-25-26-28-29-30 (#)

Check A:

Check description	**Check message**	**Check solution**	**Cat**
If the VDAT subfield of the DSPM field is not equal to 3, 16, 17, 18, 19, 20, 21, 24, 25, 26, 28, 29 or 30.	DSPM/VDAT does not refer to a high water or local datum.	Encode a legal value for VDAT.	E

Check B:

Check description	**Check message**	**Check solution**	**Cat**
If the SDAT subfield of the DSPM field is not equal to 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 19, 22, 23, 24, 26 or 27.	DSPM/SDAT does not refer to a low water or local datum.	Encode a legal value for SDAT.	E

Check C1:

Check description	**Check message**	**Check solution**	**Cat**
For each intertidal feature object (DEPARE feature object where DRVAL2 is Less than or equal to 0) where both the Vertical Datum and Sounding Datum of that area are Equal.	Vertical and sounding datums are the same for intertidal area.	Amend datum values so that the vertical datum is above the sounding datum.	E

Check C2:

Check description	**Check message**	**Check solution**	**Cat**
For each intertidal feature object (DEPARE feature object where DRVAL2 is Less than or equal to 0) where both the Vertical Datum and Sounding Datum of that area are Equal to a Mean Sea Level datum (3 (Mean sea level), 19 (Approximate mean sea level) or 26 (Mean water level)).	Vertical and sounding datums are the same for intertidal area.	Amend datum values so that the vertical datum is above the sounding datum.	E

Conclusions

In S-57 ENC and S-101 **Vertical Datum** and **Sounding Datum** are encoded based on values taken from the VERDAT (verticalDatum) attribute. However, the allowable values for **Vertical Datum** and **Sounding Datum** can be constrained to those presented in tables 1 and 2. ENC Validation software can check that vertical reference datums are encoded consistently within ENC data.

Recommendations

1. Update the S-101 DCEG and S-101 Feature Catalogue so that the values for a **Sounding Datum** are constrained to those presented in table 2.
2. Update the encoding guidance for vertical reference datums within the S-57 Use of the Object Catalogue for ENC based on tables 1 and 2.
3. Amend S-58 with the modified check 2000 and the additions of checks A, B, C1 and C2.

Justification and Impacts

S-101 already constrains the possible values for **Vertical Datums**. This paper proposes to extend this for **Sounding Datums** as well. The proposed changes will ensure that vertical reference datums are encoded based on logical values, and that intertidal areas reference a **Vertical Datum** that is above the **Sounding Datum**.

The validation checks proposed for S-58 will ensure that the S-57 based ENCs that are converted to S-101 datasets will conform to the S-101 DCEG in relation to vertical reference datums.

Action Required of ENCWG

The ENCWG is invited to endorse recommendations 1, 2 and 3 presented in this paper.

Acknowledgements

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References

[1] IHO S-57 Appendix B.1 ENC Product Specification, Ed. 2.0, International Hydrographic Organization, 2000

[2] IHO Electronic Navigational Chart Product Specification, IHO Publication S-101, Ed. 1.0.0, International Hydrographic Organization, 2018

[3] IHO Electronic Navigational Chart Product Specification, IHO Publication S-101, Annex A - Data Classification and Encoding Guide, Ed. 1.0.0, International Hydrographic Organization, 2018

[4] Product Specification for Inland ENCs, Ed. 2.4, Inland ENC Harmonization Group, 2015

[5] IHO ENC Validation Checks, IHO Publication S-58, Ed. 6.1.0, International Hydrographic Organization, 2018