Paper for Consideration by S-102PT

Report from S-100WG

Submitted by:	NLHO / DQWG Chair
Executive Summary:	Usage of Sounding datum and vertical datum
Related Documents:	S4_V4-8-0_Oct_2018_EN; S-57 Appendix B.1: ENC Product Specification Annex A: Use of the Object Catalogue for ENC; S-102 Ed.2.0.0; S-101 Appendix C – Feature Catalogue Ed.1.0.0 (drafted by DQWG, reference document)
Related Projects:	S-101, S-104

Introduction / Background

During S-102PT6 meeting there are some questions regarding the use of the concept of sounding datum, vertical datum, height and elevation.

Analysis/Discussion

S-4 article B-302 Plane of Reference for heights – states:

'Height' may be defined as: 'The vertical distance of a level, a point or the top of an object measured from a specified datum.'

and as: 'The vertical dimension of an object'

In the latter definition, this is used to describe the vertical length of an object (that is: its height above ground level, see B-303).

In most charting contexts, the word 'elevation' is synonymous with 'height'. In S-4 (and INT1) the word 'height' is generally used, except that 'elevation' is used, in accordance with tradition, to describe the height of the focal plane of a light above height datum.

Notes:
1. In ENC, for the first definition above, 'elevation' and 'height' are differentiated:
   - 'Height' only refers to drying heights and the top of an object affixed to the surface of the EARTH.
   - 'Elevation' is the vertical distance of a point or a level, on the surface of the earth, measured from a specified vertical datum.

2. The IHO Hydrographic Dictionary Working Group is reconsidering these definitions in 2013.

This sub-section excludes drying heights (that is: heights of features submerged at high water; for drying heights, see B-413.1).

Article B-302.2 states:

The plane of reference for all heights (including elevations of lights but excluding drying heights) must normally be a High Water (HW) datum, for example: Mean High Water Springs (MHWS); Mean Higher High Water (MHHW); Highest Astronomical Tide (HAT). Where there is little appreciable tide or change in water level at the adjacent shoreline, then Mean Sea Level (MSL) may be used.

IHO Resolution 3/1919 (as amended 2017), contains the following guidance:

In oceanic tidal areas heights on shore, including elevations of lights, should be referred to a Highest Water (HW) datum (paragraph 5).

Highest Astronomical Tide (HAT), or a datum as closely equivalent to this level as is practical and acceptable to Hydrographic Offices, should be adopted as the datum for vertical clearances. Alternatively, another, similar

datum may be used if high water levels in a specific area frequently deviate from HAT, or a different datum has been established by national policy (paragraph 7).

In geographical areas where the tidal range is negligible (for example less than 0.30m) and in non-tidal areas depths, and all other navigational information, should be referred to Mean Sea Level (MSL) or other level as closely equivalent to this as is practical and acceptable to Hydrographic Offices (paragraph 10). (Note: The adopted level may be a well-defined geodetic datum as used for heights in land survey applications or an observed local Mean Sea Level (MSL) based on long series of water level observations.)
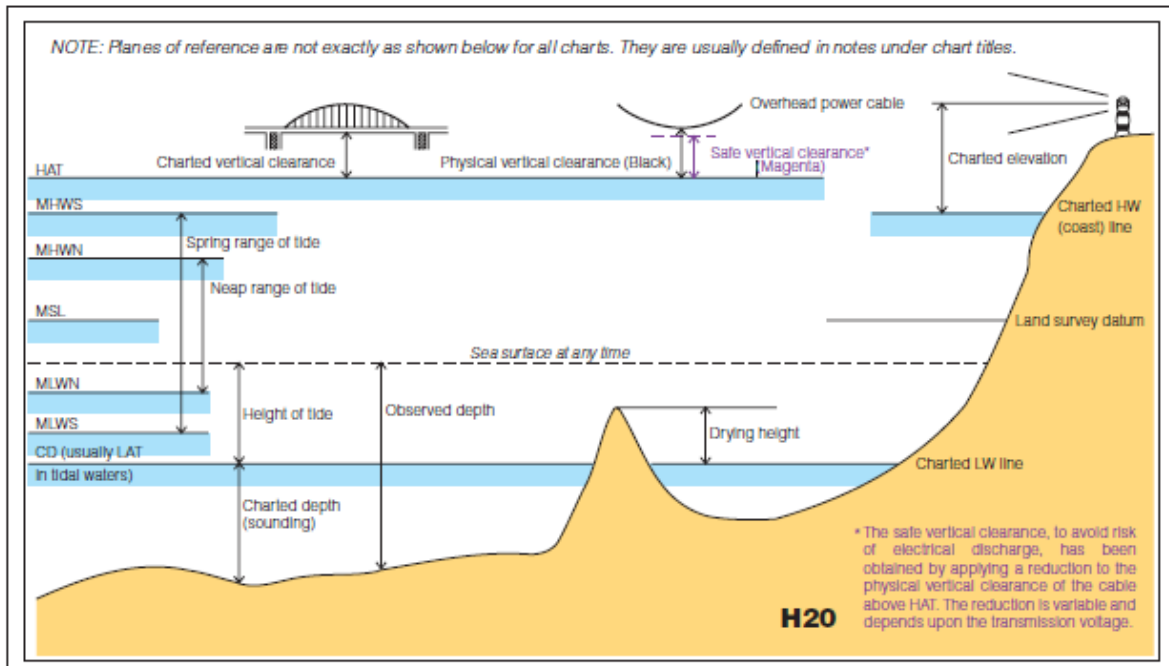
Article B-405 CHART DATUM states:

Chart Datum (CD) is the plane of reference to which all charted depths and drying heights are related. In tidal areas CD is chosen to show the least depth of water found in any place under 'normal' meteorological conditions. CD will vary from place to place in relation to the land survey datum or mean sea level. For further information, see IHO Resolution 3/1919 (as amended 2017).

S-57 Appendix B.1 UoC (use of object catalogue)

Paragraph 2.1.2 Vertical datum states:

Vertical datum information is encoded using the subfield VDAT, the metadata object M_VDAT, or the attribute VERDAT on individual objects. The values encoded in the attributes ELEVAT, HEIGHT, VERCCL, VERCLR, VERCOP and VERCSA are referenced to the specific datum(s). VERDAT must not be encoded on an object unless at least one of the above attributes is also encoded on that object.

The default value for the entire dataset must be given in the Vertical Datum (VDAT) subfield of the Data Set Parameter [DSPM] field. The vertical datum populated for VDAT and VERDAT on M_VDAT should be taken from the following table (see table 2.1).

If the vertical datum for an area is different to the value given in the VDAT subfield for the data set, it must be encoded using M_VDAT. The areas covered by these meta objects must not overlap.

Height contours, going across areas having different values of vertical datum, must be split at the border of these areas.

Paragraph 2.1.3 Sounding datum states:

Sounding datum information is encoded using the subfield SDAT or the meta object M_SDAT, and must be constant over large areas. The values encoded in the attributes VALSOU, DRVAL1, DRVAL2, and VALDCO, and the sounding values encoded in SOUNDG objects, are referenced to this datum.

The default value for the entire data set must be given in the Sounding Datum [SDAT] subfield of the Data Set Parameter [DSPM] field. The sounding datum populated for SDAT and VERDAT on M_SDAT should be taken from the following table (see table 2.2)

If the sounding datum for an area is different to the value given in the SDAT subfield for the data set, it must be encoded using M_SDAT. The areas covered by these meta objects must not overlap.

S-102 Ed.2.0.0 paragraph 5.4 Vertical Coordinate Reference System states:

All valid S-102 datasets shall be represented with a right-handed Cartesian coordinate system. This system shall have the x-axis oriented towards positive eastings (for projected grids), or east (for geographic grids), and y-axis oriented towards positive northings (for projected grids), or north (for geographic grids). These definitions imply that the z-axis for the sounding data is positive away from the center of mass of the earth (i.e., is positive up), rather than the usual hydrographic convention of positive down (i.e., deeper depths are larger numbers and negative depths are above datum). User-level code is free to make this reflection if required but must write the data using the positive-up convention. In order to make this distinction clear, the term "elevation" is used for the sounding component rather than "depth". The uncertainty component shall have the same coordinate system as the elevation component, with the exception that the z-axis is unipolar, and therefore the concept of direction of positive increase is irrelevant.

S-101 Ed.1.0.0 Appendix C – Feature Catalogue (drafted by DQWG – reference document)

Paragraph 3.93 Elevation – definition:
The altitude of the ground level of an object, measured from a specified vertical datum.

Paragraph 3.107 Height – definition:
The value of the vertical distance to the highest point of the object, measured from a specified vertical datum.

Paragraph 3.209 Value of sounding – defintion
The value of the measurement of a sounding relative to the chart datum.

Paragraph 3.211 Vertical datum – defintion
Vertical datum used for measuring elevations of points on the earth's surface. It's the datum to which both heights and soundings are referred.
listedValues: a list of 31 different datums

Paragraph 8.6 Sounding datum:
Definition: an area of uniform sounding datum
Alias: M_SDAT
Attribute ref: verticalDatum

Paragraph 8.7 Vertical datum of data
Definition: An area of uniform vertical datum
Alias: M_VDAT
Attribute ref: verticalDatum

8.15 Land elevation – definition
An elevation is the vertical distance of a point or a level, or affixed to, the surface of the earth, measured from a specified vertical datum.

Conclusions and recommendations

In S-101 the selection of a datum for both elevations and soundings is generated from the same list. The allowable values are different for Vertical datum of data and Sounding datum.

In S-57 both sounding and elevation can be a positive number. Soundings is positive when faced towards the centre of the earth, elevation is positive when faced away from the centre of the earth.

S-102 data is consistent, positive away from the centre of the earth, negative towards the centre of the earth. In portrayal however, it is possible that multiply by -1 for soundings, thus giving a positive value to depths.

When generating S-102 data, it is assumed that all data in one dataset is using the same vertical datum. If not, then the parts that use a different from the default vertical datum, should have a metadata field, specifying this.

Justification and Impacts

None identified at this time.

Action Required of the S-102PT

The S-102PT is invited to:

a.   Note this paper.

b.   Take any action as considered necessary.