

Tidal and Water Level Working Group
(5-7 April 2011 – Jeju, Republic of Korea)

Paper for Consideration by TWLWG

Review of the IHO Chart Datum Definitions

[28 February 2011]

Submitted by: Finland

Executive summary: This paper reports the results of the work for TMLWG2 Action 4.7.1: *Chile, Finland, France, Korea, Norway, Spain, UK and IHB (Finland) to review the definition of MSL and resolution 3/1919, as amended, (A2.5) "Datums and Benchmarks" using the draft text provided in TWLWG2/4/7A as a starting point with the intention of separating tidal waters, non tidal waters connected to the oceans and inland waters, and make proposal to TWLWG3.*

Related documents:

Related projects: *Work of the BSHC ChartDatumWG*

1. Proposal for the new definition of MSL (S-32)

a. The current definition

mean sea level. The average HEIGHT of the surface of the SEA at a TIDE STATION for all stages of the TIDE over a 19-year period, usually determined from hourly height readings measured from a fixed predetermined reference level.

b. Proposed new definition

mean sea level. The average HEIGHT of the surface of the SEA at a TIDE STATION for all stages of the TIDE over a 19-year period, usually determined from hourly height readings measured from an earth fixed predetermined reference level.

It should be noted that:

The measured value of **mean sea level** is tied to the location and the observation period. Therefore the tide gauge location and the observation period should always be quoted where the value of **mean sea level** is to be used as a precise reference level.

The measured **mean sea level** is only an apparent level. Vertical movements of the earth's crust at the location of the tide gauge will affect the mean value measured.

Sea level also has long period variations (the global rise of the oceans). These also affect the mean value measured.

Where modelling is used to eliminate the movement of the earth's crust (post glacial rebound for example) and/ or the effect of the global rise of the oceans, the resulting **mean sea level** is relevant to a specific epoch. This epoch (year) and the modelled annual change of **mean sea level** should always be quoted when **mean sea level** is used as a precise reference level.

c. Working history of this proposal

- *Jukka Varonen* presented his proposal to *Steve Shipman* in BSHC-conference in Gdynia, Poland, September 2010
- *Jukka Varonen* had a discussion with *Dr. Wilfried Ellmer*, BSH Rostock, Germany in November 2010
- *Steve Shipman* sent his comments and corrections to English language in December 2010

d. Comments

There is no common practice or advice for the length of the observation series in non-tidal areas. At first my proposal was ten years as a minimum. But this selection has no scientific background and 20 years seem to be common practice. Therefore we might well stay in the same requirement (minimum 19 years) as set for tidal areas.

Therefore the only change to the current definition is to add the word "earth" to "from an earth fixed predetermined..". But the notes, which are added to the definition, will assist the reader to understand the difficulties in the interpretation of small variations which occur when separate realizations of the mean sea level are compared.

2. Draft proposal for renewing the Technical Resolution A2.5

1. The selection of the vertical datum for a chart is dependent on the type of the water area

I. For sea areas where the tide has a significant effect

a) It is resolved that the Lowest Astronomical Tide (LAT), or other LW level as closely equivalent to this level as is practically acceptable to Hydrographic Offices, be adopted as Chart Datum. Alternatively the differences between LAT and national chart datums may be specified on nautical documents. If low water levels in a specific area frequently deviate from LAT, the Chart Datum may be adapted accordingly.

b) It is resolved that the datum for tide predictions shall be the same as Chart Datum (datum for sounding reduction).

c) It is resolved that Highest Astronomical Tide (HAT) be adopted as the datum for vertical clearances. Alternatively the differences between HAT and national datums for vertical clearances may be specified on nautical documents. If high water levels in a specific area frequently deviate from HAT, the datum for vertical clearances may be adapted accordingly.

d) It is resolved that heights on shore, including elevations of lights, should be referred to a HW datum. The datum used should be clearly stated on all charts.

II. For sea areas where the tide has not a dominant effect (e.g. tidal range less than 30 cm) but are connected to ocean so that the long time variations of the ocean level are reflected:

a) It is resolved that all vertical information should be referred to one Chart Datum which shall be reasonably close to MSL (mean sea level). This Chart Datum may be

- a well-defined geodetic vertical datum with the same zero value for heights as used in land survey applications of this datum (in case this zero value deviates significantly from the local MSL, another height value of this scale may be selected to Chart Datum).

- or an observed local MSL based on long series of water level observations. It is recommended to use the expression MW to distinguish this local realization from the slowly but continuously drifting MSL.

b) It is resolved that the name/definition of the Chart Datum shall be printed on charts. If the Chart Datum is not based on the realization of MSL the local difference of MSL and the Chart Datum shall be given too.

c) It is resolved that the same Chart Datum should be used for vertical clearances and heights on shore, including elevations of lights. However, if a HW-datum is already used for vertical clearances it is allowed to continue this practice. The difference of this HW and Chart Datum shall be published.

d) It is resolved that it is necessary to coordinate the broadcasted information about water level to mariners. The information should be related to the Chart Datum.

III. For inland waters and water areas like estuaries where state of the water level in reference to sea level is disturbed by natural or man-made constructions

It is resolved that two levels, the low water level LW and the high water level HW shall be determined based on the local circumstances. The selected LW / HW should represent the lowest/highest water level (94 – 100 percentiles) during the navigational season. These shall be expressed as height values in a well defined geodetic datum. If such datum is not available, these levels shall be given as heights on a local fixed height scale.

- LW shall be used as Chart Datum
- HW shall be the Datum for vertical clearances.
- the shoreline should be referred to Chart Datum whenever it is critical for navigation.

However, if the changes of water level are not significant during the navigational season, it is possible to use only one selected level (LW or MW) as the Chart Datum for all vertical information.

2. It is resolved that chart datums (datums for sounding reduction), the datums of tide prediction and other datums used in defining critical tidal or water levels shall always be connected with the general land survey datum, and, in addition, with a prominent and permanent fixed mark in the neighbourhood of the tide gauge, station, observatory etc.

3. It is resolved that ellipsoidal height determinations of the vertical reference marks used for tidal observations should be made, in order to support the production of seamless data sets; i.e. to allow the translation between data sets with differing vertical datums. It is further resolved that such observations should relate to a geocentric reference system, preferably the International Terrestrial Reference System (ITRS) or one of its realizations e.g. the World Geodetic System 1984 (WGS84).

2.1 History of this draft proposal

- first draft of the structure was presented for TWLWG2
- *Jukka Varonen* had a discussion about it with *Dr. Wilfried Ellmer* in November 2010
- this version 28Feb2011 will be sent first time for the other members of the team only one month before TWLWG3

2.2 Comments about this proposal and the issues related to it

The following basic principles of the proposal should be notified and discussed before further development of proposed text

- it is based on the principle of three different water area types as it was decided in TWLWG2
- this division to three different water area types will cause a lot of work to be done for renewing S-4 (chapters B-405 and B-380)
- although the definition of the MSL will be clarified (S-32), this draft A2.5 recommends that instead of MSL some other more precisely realized reference level (close to MSL anyhow) should be selected as Chart Datum in non-tidal waters.
- the previous change to A2.5 by Tidal Committee (accepted 2008) included a recommendation to use long-time observation profiles for determination of LW and HW in non-tidal waters and set a requirement to use HW datum for vertical clearances in non-tidal waters. This new draft would revoke the earlier decision. It should be noted that this amendment 2008 was adopted to S-4 chapter B405.3 but chapter B-380.1 was not changed, which causes confusion.
- The hierarchy between the issues is maybe not the best possible in the present A2.5. This should be clarified and it would then assist the renewing of the respective chapters in S-4.
- this proposal does not put any requirements or even recommendations for the other height information than vertical clearances in inland waters. Shoreline is noted in the proposal, but there may exist water areas, which would require both low water and high water shoreline.
- also the effect of slope in water level in rivers and streams in lakes is left unattended

3. The definitions of LW, HW and MW

These abbreviations are commonly used in IHO technical documentation, but they have no definition in S-32.

There exists definitions for "L.W." and "H.W." but these are related to the single oscillation of the tide. There is also a definition of mean water level.

The following proposals could serve as a basis for the discussions.

low water LW. A selected and realized (earth fixed) level to represent the lowest water level under normal conditions. In inland waters this selection is also adopted to be the Chart Datum. In tidal waters LW is usually equal to the defined Chart Datum.

high water HW. A selected and realized (earth fixed) level to represent the highest water level under normal conditions. In tidal waters the HW level is usually equal to the charted coastline.

mean water MW. A realized (earth fixed) height of the local mean sea level. Depending on the principle used for the calculation of MW from the sea level observations the defined MW may be epoch related i.e. MW2010. MW is typically the Chart Datum for non-tidal waters. (MW on large lakes?)