

**3rd NCWG MEETING
ESRI HQ, Redlands, California, USA 16-19 May 2017**

**Paper for Consideration by NCWG
Revised IHO Resolution 3/1919: impact on S-4**

Submitted by:	Secretary
Executive Summary:	NCWG Work Item A30 requires NCWG to check the impact of the IHO Resolution 3/1919 as amended on S-4 when it is approved
Related Documents:	IHO CLs 27/2016 and 10/2017. M3 Resolution 3/1919 as amended 2017. S-4 B-302, B-380 and B-405.
Related Projects:	None

Introduction / Background:

1. NCWG Work Item A30 requires NCWG to check the impact of the IHO Resolution 3/1919 (Res 3/1919) as amended on S-4 when it is approved. It was promulgated by IHO CL 27/2016 and approved by IHO CL 10/2017.
2. S-4 B-302.2 currently provides guidance on the plane of reference for heights based on Res 3/1919 (as amended 2008). B-380.1 provides guidance on vertical clearances based on Res 3/1919 (as amended 2008). B-405 and subsequent paragraphs provide guidance on Chart Datum and is largely derived from Res 3/1919 (as amended 2008). All these clauses need updating.

Analysis / Discussion:

3. Annex A is the approved version of Res 3/1919 (2017). Annex B contains excerpts from S-4 which reference Res 3/1919. Annex C contains suggested changes to S-4 consequent on the revision of Res 3/1919.
4. It is acknowledged that there are various ways in which these changes could be made, e.g. replace much of the text with a reference to Res 3/1919 (but that would force the cartographer to refer to M3), incorporate all the text of Res 3/1919 directly into S-4 (but much of it is not relevant to cartographers).
5. The method chosen is to use the text of Res 3/1919 that specifically refers to charting as directly as possible, but using S-4 terminology and style, and retain related existing guidance that is not covered by Res 3/1919 and the existing S-4 clause numbers and order of information.
6. It should be noted that Res 3/1919 refers to 'heights on shore, including elevations of lights' referred to a HW datum, implying that 'elevation' and 'height' are synonymous (paragraph 5). This conforms to the generally and historically accepted definition of height used outside the Americas and the subject of much debate within CSPCWG/NCWG. Although this has been accepted by the Chair of HDWG, the definitions in S-32 have still not been corrected. The explanation in S-4 B-302 therefore remains valid. See also NCWG2 Action 4 and NCWG2-03B for background.

Action required of NCWG:

7. The NCWG is invited to:
 - Consider the draft changes to S-4 consequent on revision of IHO Resolution 3/1919 at Annex C.

- Advise the Secretary of any changes required to the drafts.
- Decide when and how these changes should be included in S-4.

Approved revised IHO Resolution 3/1919 on Datums and Bench Marks

TITLE	Reference	Last amendment (CL or IHC)	1st Edition Reference
DATUMS AND BENCH MARKS	3/1919 as amended	CL 10/2017	A2.5

1 It is resolved that the datum of tide/water level observations and predictions for mariners shall be the same as chart datum (datum for sounding reduction).

2 It is resolved that chart datum and other tidal/water level datums used should be clearly stated on charts and all other navigational products.

3 It is resolved that chart datums (datums for sounding reduction), the datums of tide/water level prediction and other tidal/water level datums 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.

4 It is resolved that ellipsoidal height determinations of the vertical reference marks used for tidal/water level 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), the World Geodetic System 1984 (WGS 84), or other geodetic reference systems coincident with ITRS.

In oceanic tidal areas

5 It is resolved that heights on shore, including elevations of lights, should be referred to a Highest Water (HW) datum.

6 It is resolved that the Lowest Astronomical Tide (LAT*), or a datum as closely equivalent to this level as is practical and acceptable to Hydrographic Offices, be adopted as chart datum. Alternatively, another, similar datum may be used if low water levels in a specific area frequently deviate from LAT, or a different datum has been established by national policy.

7 It is resolved that Highest Astronomical Tide (HAT*), or a datum as closely equivalent to this level as is practical and acceptable to Hydrographic Offices, 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.

8 It is recommended that LAT and HAT be calculated either over a minimum period of 19 years using harmonic constants derived from a minimum of one year's observations or by other proven methods known to give reliable results. Tide levels should, if possible, reflect the estimated uncertainty values obtained during the determination of these levels.

In mixed waters (where water level variability is due to both tidal and regionally specific forcing mechanisms) and inland waters

9 It is resolved that depths, and all other navigational information should be referred to an appropriate level that is practical and acceptable to Hydrographic Offices (such as lowest water (LW) as a reference level for depths and HW for vertical clearances).

The selection of which one of the alternatives to be used is a difficult issue which can only be determined locally and which will be largely dependent on seasonal hydrological conditions. LW and HW are defined preferably as the mean of lowest/highest water levels, or as a suitable percentile of lowest/highest water levels, observed over a long time period from a minimum of one year's observations of free water level.

In geographical areas where the tidal range is negligible (for example less than 0.30m) and in non-tidal areas

10 It is resolved that 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.

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.

11 In order to support other non-navigational applications and also to indicate the characteristics in the area, it is recommended to adopt the mean of yearly lowest/highest water levels, or a suitable percentile of lowest/highest water levels, observed over a long time period from a minimum of one year's observations.

** Note: LAT (HAT) is defined as the lowest (highest) tide level which can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions.*

Current wording of S-4

B-302.2 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.

Comments: TR 3/1919 (as amended 2008), contains the following statements:

1. It is resolved that heights on shore, including elevations of lights, should be referred to a HW datum. Heights should be referred to Mean Sea Level (MSL) where the tidal range is not appreciable. The datum used should be clearly stated on all charts.
- 2b. It is resolved that Highest Astronomical Tide (HAT) be adopted as the datum for vertical clearances where tides have an appreciable effect on the water level. 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. It is further resolved that a HW datum be used for vertical clearances in non-tidal waters.

B-380 OVERHEAD OBSTRUCTIONS AND CLEARANCES: BRIDGES, CABLES, PIPES

On charts which include vertical clearances under overhead obstructions, a statement of the height datum from which the vertical clearance is measured must always be given in the title block, see B-241.6

B-380.1 Vertical clearance: IHO Resolution 3/1919 (as amended 2008), paragraph 2b, states that:

It is resolved that Highest Astronomical Tide (HAT) be adopted as the datum for vertical clearances where tides have an appreciable effect on the water level. 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. It is further resolved that a HW datum be used for vertical clearances in non-tidal waters.

Vertical clearances must be rounded **down** to the nearest whole metre (unless under 10m, when metres and decimetres may be quoted, if the measurements are considered to be sufficiently accurate). The principle aim is to chart the predicted minimum safe clearance.

B-405 CHART DATUM

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 Technical Resolution 3/1919 (as amended 2008).

B-405.1 Uniformity of formulae for establishing CD for different nations would be difficult to achieve and is not essential for practical purposes. A general statement of the datum used must be included in the explanatory notes close to the chart title (see B-241.5) on charts of

scale 1:500 000 and larger.

B-405.2 Where the tidal range is not appreciable (that is: less than about 0.3m), CD may be Mean Sea Level (MSL).

B-405.3 Where the tidal range is appreciable, the Lowest Astronomical Tide (LAT), or as closely equivalent to this level as is practically acceptable to hydrographic offices, should be adopted as CD. Alternatively, the differences between LAT and national CD may be specified on nautical documents. If low water levels in a specific area frequently deviate from LAT, CD may be adapted accordingly. Since LAT is the recommended CD with worldwide application, and has the additional merit of removing all negative values from tide tables, this should be adopted as a long term objective, and be considered when opportunity for change arises.

Highest Astronomical Tide (HAT) should 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. A HW datum should be used for vertical clearances in non-tidal waters (see Technical Resolution 3/1919 as amended 2008).

B-405.4 In some offshore areas, co-tidal charts and atlases may be available for use as a basis for reduction of soundings (for new surveys) to CD, for example co-tidal charts for the North Sea compiled under the auspices of the North Sea Hydrographic Commission. In depths greater than 200m, a reduction for tide is not necessary.

B-405.5 Tide Tables and Chart Datum. Whatever CD is used, it is essential that it is the same as the datum adopted for the predictions given in the authoritative Tide Tables. Where, over a long period of time, datums are under adjustment to conform to LAT, or to take account of changes in sea level, the changes to Tide Tables and charts should be co-ordinated as far as possible.

B-405.6 The connection between Chart Datum and land survey datums should not be quoted on charts but should be readily available for the use of surveyors and engineers in national Tide Tables.

B-405.7 Rivers and estuaries. On the largest scale charts it may be desirable to indicate marked changes in CD over short distances by means of a diagram.

Draft revised wording of S-4

B-302.2 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. **Comments:** ~~TR~~ 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.)

~~1. It is resolved that heights on shore, including elevations of lights, should be referred to a HW datum. Heights should be referred to Mean Sea Level (MSL) where the tidal range is not appreciable. The datum used should be clearly stated on all charts.~~

~~2b. It is resolved that Highest Astronomical Tide (HAT) be adopted as the datum for vertical clearances where tides have an appreciable effect on the water level. 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. It is further resolved that a HW datum be used for vertical clearances in non-tidal waters.~~

B-380 OVERHEAD OBSTRUCTIONS AND CLEARANCES: BRIDGES, CABLES, PIPES

On charts which include vertical clearances under overhead obstructions, a statement of the height datum from which the vertical clearance is measured must always be given in the title block, see B-241.6

B-380.1 Vertical clearance: IHO Resolution 3/1919 (as amended 2017), ~~states that contains~~ the following guidance:

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).

However, 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).

~~It is resolved that Highest Astronomical Tide (HAT) be adopted as the datum for vertical clearances where tides have an appreciable effect on the water level. 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. It is further resolved that a HW datum be used for vertical clearances in non-tidal waters.~~

Vertical clearances must be rounded **down** to the nearest whole metre (unless under 10m, when metres and decimetres may be quoted, if the measurements are considered to be sufficiently accurate). The principle aim is to chart the predicted minimum safe clearance.

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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 ~~Technical~~ IHO Resolution 3/1919 (as amended 2017).

B-405.1 Uniformity of formulae for establishing CD for different nations would be difficult to achieve and is not essential for practical purposes. **On charts of scale 1:500 000 and larger** a general statement of the datum used must be included in the explanatory notes close to the chart title (see B-241.5 and Resolution 3/1919 paragraph 2) ~~on charts of scale 1:500 000 and larger.~~

B-405.2 ~~Where the tidal range is not appreciable~~ (that is: less than about 0.3m), ~~CD may be Mean Sea Level (MSL)~~ **In geographical areas where the tidal range is negligible** (for example less than 0.30m) and in non-tidal areas, CD should be Mean Sea Level (MSL) or other level as closely equivalent to this as is practical and acceptable to Hydrographic Offices (Resolution 3/1919 paragraph 10).

B-405.3 In oceanic tidal areas, Lowest Astronomical Tide (LAT), or a datum as closely equivalent to this level as is practical and acceptable to Hydrographic Offices, must be adopted as CD. Alternatively, another, similar datum may be used if low water levels in a specific area frequently deviate from LAT, or a different datum has been established by national policy (Resolution 3/1919 paragraph 6). ~~Where the tidal range is appreciable, the Lowest Astronomical Tide (LAT), or as closely equivalent to this level as is practically acceptable to hydrographic offices, should be adopted as CD. Alternatively, the differences between LAT and national CD may be specified on nautical documents. If low water levels in a specific area frequently deviate from LAT, CD may be adapted accordingly.~~ Since LAT is the recommended CD with worldwide application, and has the additional merit of removing all negative values from tide tables, this should be adopted as a long term objective, and be considered when opportunity for change arises.

For vertical clearances, see B-380. ~~Highest Astronomical Tide (HAT) should 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. A HW datum should be used for vertical clearances in non-tidal waters (see Technical Resolution 3/1919 as amended 2008).~~

B-405.4 In some offshore areas, co-tidal charts and atlases may be available for use as a basis for reduction of soundings (for new surveys) to CD, for example co-tidal charts for the North Sea compiled under the auspices of the North Sea Hydrographic Commission. In depths greater than 200m, a reduction for tide is not necessary.

B-405.5 Tide Tables and Chart Datum. IHO Resolution 3/1919 (as amended 2017) states that the datum of tide/water level observations and predictions for mariners shall be the same as CD. ~~Whatever CD is used, it is essential that it is the same as the datum adopted for the predictions given in the authoritative Tide Tables.~~ Where, over a long period of time, datums are under adjustment to conform to LAT, or to take account of changes in sea level, the changes to Tide Tables and charts should be co-ordinated as far as possible.

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