

**9<sup>th</sup> CSPWG MEETING**  
**Seoul, Republic of Korea, 13-16 November, 2012**

**Paper for Consideration by CSPCWG**

**Derived from HSSC4-05.9B, with additional Annexes C & D**

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**Paper for Consideration by HSSC**

**S-32: Definitions of Altitude, Elevation and Height**

<b>Submitted by:</b>	UK (CSPCWG Chairman)
<b>Executive Summary:</b>	The definition of altitude, elevation and height have been changed in S-32, despite substantive objections raised by UK, some other MS and CSPCWG
<b>Related Documents:</b>	IHO Circular Letters (CL) 11 and 76/2012; HSSC4-05.9A (Report of HDWG)
<b>Related Projects:</b>	None

### **Introduction / Background**

After lengthy preparatory work, HDWG's report to HSSC3 (HSSC3-09.5A) listed a very large number of revised definitions for S-32 (Hydrographic Dictionary). HSSC was not the appropriate forum to discuss the technical detail and this was not done. However, HSSC3 did endorse the proposal to put all the revised draft definitions to MS by CL (Action HSSC3/16 refers). Accordingly, CL11/2012 was issued to MS, with the outcome announced by CL76/2012.

Throughout the development process, CSPCWG had raised concerns with HDWG regarding the proposed changes to the existing definitions of 'Altitude', 'Elevation' and 'Height'. CL76/2012 reports that the proposal to change these definitions had been discussed with the chairmen of CSPCWG and TWLWG; it did not make clear that they had not been agreed by CSPCWG. However, the subsequent HDWG report (HSSC4-05.9A) does acknowledge that *'there may be a requirement for further consideration of these definitions in the light of the comments received'*.

CSPCWG considered these draft definitions in detail at its meeting in November 2011. An action resulted to produce papers explaining the issues (pros and cons) of the revised draft definitions for Elevation, Height and Altitude; ideally to be included as annexes to the CL [CSPCWG8 Action 5]. An alternative course was proposed by Secretary HDWG, to remove these 3 definitions from the list submitted to MS in the CL and to include an explanation that further discussion would be undertaken.

In the event, neither course was adopted: the CSPCWG papers were not included in CL11/2012; and the 3 definitions were retained in CL11/2012. So the issues were not brought to the attention of MS during the voting process.

UK and some other MS submitted their reservations individually in response to CL76 [should read CL11]/2012 (summary annex to CL refers) but, of course, these were not visible to voting MS until CL76/2012 was published. CL76/2012 further states that MS' comments which were editorial – rather than substantive – had been taken into account in the final published versions. However, no response or changes were made regarding the substantive comments regarding the proposed definitions of Altitude, Elevation and Height. With respect to the particular comments by UK (and other MS), the response was merely that 'HDWG did not fully agree'; no explanation is provided.

## **Analysis / Discussion**

The detailed reasoning against the subject revised definitions is provided at Annex.

## **Conclusions**

The full set of revised definitions has been endorsed by MS with the required number of votes (CL76/2012).

However:

- reservations about individual definitions (including specific disagreements) have been submerged in the large number of definitions presented in CL11/2012;
- MS were not presented with all the arguments for and against the proposed revisions;
- HDWG has not explained their reasons for not accepting the arguments and reservations of UK (and some others) and CSPCWG.

## **Recommendations**

These 3 changed definitions require further consideration and scrutiny by the relevant WGs recognising that, for the reasons outlined, the original work was incomplete. Accordingly, a new work item is placed on HDWG, with support from CSPCWG and TWLWG.

Noting:

- this was the preferred route proposed by CSPCWG and (former) Secretary HDWG;
- HDWG's report (HSSC4-05.9A) states that '*there may be a requirement for further consideration of these definitions in the light of the comments received*';
- an assumption that, with the endorsement of the revised definitions by MS and their subsequent implementation in S-32, the new definitions must be retained for now, and cannot be reversed, notwithstanding the further scrutiny recommended.

CSPCWG will continue to forward new items to HDWG for consideration as they arise (e.g. the ongoing revision of S-4).

## **Action required of HSSC**

HSSC is invited to:

- Endorse the recommendations above.
- Consider whether there are any lessons in terms of the adequacy of process.

**Revised S-32 definitions: 'elevation', 'height', 'altitude'**

**Introduction**

1. Changes to the S-32 definitions of 'elevation', 'height' and 'altitude' were proposed in order to provide a clear distinction between the terms, as defined in the IHO S-100 Geospatial Information Registry, to remove ambiguity. A view that such a distinction may not be valid for paper charts and in general usage was raised in earlier correspondence between HDWG, CSPCWG and TWLWG.
2. At meeting CSPCWG8, November 2011, the delegates agreed that UK and AU would write separate papers outlining the two sides of the debate. These papers were prepared but, ultimately, were not included in CL11/2012 which requested Member States to vote on the revised draft definitions.

**Discussion**

3. It does not seem appropriate to redefine words to accommodate the needs of one particular product (ENC); where possible, definitions should be product neutral.
4. These words have been used synonymously for centuries on paper charts and in common English usage. (See similar situation with coastline and shoreline). The Oxford English Dictionary (OED) is an authority for the English language and has the following definitions:

**elevation** (OED definition 2): height above a given level, especially sea level.

**height** (OED definition 2): elevation above ground or a recognized level (typically sea level).

**altitude**: the height of an object or point in relation to sea level or ground level.

These are virtual synonyms in the geographic context (although the definition of height adds 'above ground', which is covered by the second S-32 definition).

5. Suggesting that 'elevation' should always be used for the surface of the earth, 'height' for the top of objects and 'altitude' for above the surface of the earth has no basis in common usage and causes particular problems. For example:
  - A 'spot height' always refers to the earth's surface measured from sea level.
  - The 'elevation' of a light refers to the focal plane of a man made object.
  - Although 'altitude' is not generally used on English language charts, in French 'altitude' is used with exactly the same meaning as 'height' and 'elevation'.
6. An assessment of many national charts shows that the English language notes below the title almost always refer to 'Heights' and cover all heights on the chart including: drying heights above CD (Chart Datum); heights above a sea level datum including heights of hills and the tops of objects; heights of the tops of objects above the ground.
7. Additionally, the official language versions of INT1 (and most national equivalents) refer to: heights of cliffs and islands in the introduction and K10; in relation to relief at C10-14; to heights of objects in sections D and E; to drying heights at H20 and I15. Elevation is only used in relation to lights, at P13. It is true, however, that a minority of countries use 'elevations' in exactly the same context and meaning as the majority use 'heights'.

8. There seems no good reason why, in the proposed [now new] definitions, elevations are considered to be 'usually referred to Mean Sea Level', whereas heights are 'usually referred to a High Water datum'. Both should state 'a sea level datum' as the actual datum will vary according to tidal/water level range and national practice, which should be stated on the chart.
9. Additionally, in one email exchange, an HDWG member stated that '*in the process of discussing the revised definitions, we conceded the synonymous use of the terms "elevation" and "height" in regard to paper charts, and have retained this in the definitions*'. And yet, in the revised definition of height, there is absolutely no indication that it could have any meaning other than the measurement of the **top of an object** (either above a specified datum or the ground). There is no mention that it can be synonymous with elevation (e.g. in its very common usage as a spot height).

### Conclusions

10. There has never been a distinction between 'elevation' and 'height' in normal English usage or on most paper charts. Any distinction only applies to ENC and has been generated for the particular needs of that product. Attempting to apply the distinction more widely will result in either:
  - a requirement to make major changes to most paper charts and INT1 (and its national equivalents), which may confuse the chart user, or
  - S-32 differing from the reality of conventional charting practice.
11. Rather than introducing an arbitrary and belated hydrographic distinction, we should accept that there is none, and indicate in S-32 that the terms are usually synonymous (as far as the first definitions apply; there is no disagreement with the 2nd and 3rd definitions).

### Recommendations

12. Recommended alternative definitions (based on the fact that 'height' is by far the commonest word used in this context):
  - Elevation** (1): see HEIGHT. On ENC, elevation excludes the vertical distance of the top of an object measured from a specified datum.
  - Height** (1): The vertical distance of a LEVEL, a point or the top of an object measured from a specified datum. On ENC, height only refers to drying heights and the top of an object affixed to the surface of the EARTH.
  - Altitude** (1): see HEIGHT.
13. It is further recommended that the definitions of 'spot height' and 'spot elevation' in S-32 should be reversed, as the former is the more common English usage by chart producers.

## Annex B to CSPCWG9-4.5B

This is the text of an email from Jerry Mills (Chairman HDWG) to IHB, following receipt of the HDWG paper 05.9B, with additional comments by Secretary CSPCWG in red.

In Peter's conclusions, #10, he states "there has never been a distinction between 'elevation' and 'height' in normal English usage or on most paper charts." However, there is and has been a distinction in the IHO Hydrographic Dictionary:

1. elevation (1590) - The vertical distance of a point or a LEVEL, on or affixed to the surface of the EARTH, measured from MEAN SEA LEVEL. The term elevation is sometimes used synonymously with ALTITUDE which in modern usage refers particularly to the distance of points or objects above the EARTH's surface.
2. height (2223) - The vertical distance of a LEVEL, a point, or an object considered as a point, measured from a specified DATUM.

**Comment:** This includes 'level' and 'point' which certainly does not restrict the usage to 'tops of objects', as in the new definition. (Note also that the 'American Practical Navigator' (Bowditch) definition of elevation quoted in Annex C states that 'the term HEIGHT is used for spots on or above the surface').

The above definition of "elevation" can be traced to the 1970 edition of S-32 (the date of the original adoption is uncertain) and also appears in the U.S. Navy's Navigation Dictionary of 1956. The Geodetic Glossary of the National Geodetic Survey makes a similar reference to MEAN SEA LEVEL while acknowledging that HEIGHT is frequently used as a synonym for elevation. However, in hydrography and marine cartography, HEIGHT is often used for the vertical distance from the top of objects (rocks, lights, etc.) to a high water datum for depiction on nautical charts. Adding to the confusion is the misunderstanding by the general public that elevation and height are precisely synonymous. ALTITUDE is simply a remnant left over from the days when the elevations of mountains were determined using barometric altimeters. This is an antiquated practice and in modern use ALTITUDE refers to the distance of objects above the ground (reference again to S-32 1970 and U.S. Navy 1956).

**Comment:** There is no basis for asserting that this is a misunderstanding; actually it is a correct understanding as far as nautical charts are concerned. Again, see the definitions of elevation and height from the 'American Practical Navigator' in Annex C.

Whatever the derivation of the word 'Altitude', it is not true that in modern usage it refers only to objects above the ground. People suffer from 'altitude sickness' from simply being a significant height above sea level, but with their feet firmly on the ground! The second definition accounts properly for its usage for angular measurement.

With all due respect, the Oxford English Dictionary (OED) may be the authority for the English language and indeed has definitions to support Peter's argument, but it in no way should be considered the authority over technical terms that have been adopted for several decades by the IHO or any other technical organization. The OED simply does not fully comprehend the nuances of such technical terms.

**Comment:** The issue is over HDWG revising definitions to mean something **different** from what has been accepted in technical usage for decades!

One of the main principles of the Hydrographic Dictionary Working Group is that changes to current definitions in S-32 should not be made lightly, but should be made to add clarity or reflect changes due to new technology. The definitions for the terms elevation, height and altitude have been the subject of extensive communications between the CSPCWG and the HDWG as well as internal discussions among HDWG members.

**Comment:** But certainly not agreed by CSPCWG! The revised definitions (especially of ‘height’) erode clarity by causing conflict between chart notes and user guides such as INT1 compared with S-32.

In November 2010 TSMAD proposed that the HDWG review 58 terms from the S-57 register which posed some potential conflict or clarity issues with terms in S-32. Among those terms was “land elevation” for which the S-57 definition was “An elevation is the vertical distance of a point or a level on, or affixed to, the surface of the earth measured from a specified vertical datum.” The description for that term noted that “This object class is used to encode both spot heights and land (height) contours.” The recommended action by TSMAD was “S-57 definition is derived. S-32 says “from mean sea level”, S-57 says “from a specified vertical datum.” Consistency required.”

**Comment:** But this is the wrong way around. TSMAD, having invented revised definitions for application in ENC, cannot then expect them to replace other well-established definitions used in other applications; at most they should be alternative definitions specifically for use in ENC.

It could be argued that no action was really required since the S-57 definition does not conflict with that in S-32, it just generalized it. Nevertheless, the HDWG did propose a minor modification to the existing definition which is as follows with the proposed changes in red:

elevation – “The vertical distance of a point or a level, on ~~or affixed to~~ the surface of the surface of the earth, measured from *a specified vertical datum, usually* Mean Sea Level.”

**Comment:** That seems sensible in that it widens the use of ‘elevation’ to be used more generally as a synonym for height (which to most people it is), instead of being restricted to points above MSL, which is something that might not be understood by the chart user. Evidently the use of ‘elevation’ made by the authors of S-57 ignored the limitation of the existing definition.

To add further clarity, it was proposed that the second part of the definition should also be modified: “The term elevation is sometimes ~~used synonymously~~ *confused* with altitude which in modern use refers particularly to the distance of points or objects above the earth’s surface. Subsequent discussion resulted in deletion of all wording after “altitude”.

**Comment:** There is no justification for this change; ‘used synonymously’ is correct. (And even if true, is hardly an appropriate part of a definition).

The point is that the HDWG did respond to the TSMAD recommendation in such a way that allowed more compatibility between S-32 and S-57 without discarding the

IHO definition for elevation that has been in use since at least 1970 and used by the U.S. Navy since 1956.

Comment: With which there is no argument. It is the redefinition of ‘height’ (and to a lesser extent with ‘altitude’) which is causing the problem.

It can be further argued that a term such as elevation is really more directly related to the field of geodesy. While I have been unable to determine if there is an international geodetic glossary, the glossary published by the U.S. National Geodetic Survey (September 1986) defines elevation as “The distance of a point above a specified surface of constant potential; ... the surface usually specified is the geoid ... Mean sea level was long considered a satisfactory approximation to the geoid and therefore suitable for use as a reference surface. It is now known mean sea level can differ from the geoid by up to a meter...”

Comment: This has no foundation. UK’s geodesists generally use the word ‘height’ where US uses ‘elevations’. Correspondence with UKHO’s Geodetic Support Manager is attached at Annex C, for information and corroboration. I understand that ‘Bomford’ is considered to be a definitive work on the subject of Geodesy.

But whatever the technical usage by geodesists, a nautical chart is intended for navigators, not geodesists, who have used charts where ‘heights’ include spot heights, drying heights, etc for hundreds of years.

In conclusion, in most situations the words ‘elevation’ and ‘height’ as used in general English, by geodesists and on paper charts are exactly synonymous and have been understood that way for centuries. Which word is actually used is simply a matter of preference or tradition, which appears to vary between North America and the rest of the English-speaking world. This synonymy (the state of being synonymous!) should be reflected in the definitions, with precedence given to the most widely used word, which is ‘height’. Any specific technical usage limited to ENC, or other meanings (such as light elevations) should be described as such, if necessary in a secondary definition.

## Comments by UKHO's Geodetic Support Manager

We were not aware of the discussions to alter the definitions of elevation, height and altitude.

I have consulted our library and can comment as follows:

Geodesy by G.Bomford - Chapter 3 "Heights above sea level"

Para 2 " Spheroidal heights are required for some purposes, but the geoid or MSL surface has greater significance, and a more generally useful height is the distance above the geoid. Such heights are called geoidal heights and, unless otherwise stated, the height of a point implies its geoidal height.....The height of a point above the geoid, measured in metres or other linear units, is known as its orthometric (geoidal) height, and these are the heights generally quoted."

'Altitude' and 'elevation' are not listed in the index! In fact none of our standard texts has an entry under elevation. Other geodesy references also only refer to the various definitions of height.

With regards to 'Altitude' I can only find 2 references and both are to do with making astronomical observations:

Principles and practice of navigation - p81, "True altitude: This is the angular distance of a body above the rational horizon"

The Admiralty Manual of Hydrographic Surveying p489-491

The Admiralty Manual of Hydrographic Surveying also has a chapter on heights and levelling (ch 9).

Bowditch - American Practical Navigator. This book is freely available from the NGA web site and the glossary gives the following definitions:

**altitude.** , *n.* Angular distance above the horizon; the arc of a vertical circle between the horizon and a point on the celestial sphere, measured upward from the horizon. Angular distance below the horizon is called negative altitude or depression. Altitude indicated by a sextant is called sextant altitude. Sextant altitude corrected only for inaccuracies in the reading (instrument, index, and personal errors, as applicable) and inaccuracies in the reference level (principally dip) is called apparent or rectified altitude. After all corrections are applied, it is called corrected sextant altitude or observed altitude. An altitude taken directly from a table, before interpolation, is called tabulated altitude. After interpolation, or if determined by calculation, mechanical device, or graphics, it is called computed altitude. If the altitude of a celestial body is computed before observation, and sextant altitude corrections are applied with reversed sign, the result is called precomputed altitude. The difference between computed and observed altitudes (corrected sextant altitudes), or between precomputed and sextant altitudes, is called altitude intercept or altitude difference. An altitude determined by inexact means, as by estimation or star finder, is called an approximate altitude. The altitude of a celestial body on the celestial meridian is called meridian altitude. The expression ex-meridian altitude is applied to the altitude of a celestial body near the celestial meridian, to which a correction is to be applied to determine the meridian altitude. A parallel of altitude is a circle of the celestial sphere parallel to the horizon, connecting all points of equal altitude. See also EQUAL ALTITUDES.

**elevation.** , *n.* 1. Vertical distance of a point above a datum, usually mean sea level. Elevation usually applies to a point on the surface of the earth. The term HEIGHT is used for points on or above the surface. See also SPOT ELEVATION. 2. An area higher than its surroundings, as a hill.

Perhaps this glossary entry is the source of the new definition (Ref Annex A para 8).



**height**, *n.* Vertical distance above a datum.

**spot elevation**. A point on a map or chart where height above a specified datum is noted, usually by a dot and the height value.

**contour**, *n.* The imaginary line on the ground, all points of which are at the same elevation above or below a specified datum.

From the American reference above I think it is clear that cultural literary factors are at play. Where we would generally use the word height the Americans use elevation as standard hence it appears in all their text books.

As mentioned in your paper the majority of people (navigators, surveyors or general public) consider the terms height and elevation to be interchangeable and to retrospectively amend the definitions will cause considerable confusion.

As a Surveyor I always quote the datum specifically (both hz and vertical) including any geoid models used in the calculation of vertical height.

It would appear there is no precedent for the use of the word 'Altitude' with respect to navigation or geodesy except for taking astro obs. It is not used in the context of height as far as I can ascertain.

I personally only think of altitude with regards to the flying height of aircraft.

I agree with all your discussion points in Annex A.

I hope the situation can be resolved swiftly.