IHB File S3/3055

**CIRCULAR LETTER 47/1999**

**22 October 1999**

**GUIDANCE ON CHART DATUMS AND THE ACCURACY OF POSITIONS ON CHARTS**

Ref: IHB Circular Letter 38/1998 of 25 August 1998

Dear Sir,

IHB Circular Letter 38/1998 invited IHO Member States to comment on a proposal by the United Kingdom that IMO should issue a SN Circular on "Guidance on Chart Datums and the Accuracy of Positions on Charts". Member States were also requested to report any actions taken by them in regard to guidance or advice given to mariners.

28 responses have been received which are summarized at Annex A. Comments received indicate that while nearly all HOs are promulgating guidance on chart datums, a majority of them consider that an IMO SN Circular would be beneficial.

Accordingly, the IHB submitted a paper to IMO for consideration by NAV 45, a copy of which is at Annex B.

The matter was addressed by NAV 45 (September 1999) and it was agreed to recommend that MSC 72 (May 2000) approve the draft SN Circular. Copies of the relevant sections in doc. NAV 45/WP.2 (dated 22 September 1999), including the draft SN Circular, form Annex C.

France has indicated that the French text, as provided by IMO, contained translation errors and that they would also prefer precise dates in the fourth line of paragraph 13 and the first line of paragraph 14. This is the subject of an IHB letter to IMO for MSC 72. As there is no change of substance, the IHB will circulate the resulting IMO Note to Member States for information when it is ready. Changes proposed have been emphasized in Annex C (striked-through and/or shaded characters).

Member States are invited to take note of the above.

On behalf of the Directing Committee
Yours sincerely,

Rear Admiral Neil GUY
Director

Encls: 3 annexes

# GUIDANCE ON CHART DATUMS AND THE ACCURACY OF POSITIONS ON CHARTS

## Summary of MS Replies to IHB Circular Letter 38/1998

### ARGENTINA

This Office has taken the necessary steps to give advice to the users of nautical information, which has been affected by the application of the satellite navigational systems, not always compatible with the reference systems, as follows:

a) Publication of articles and dissemination papers on the subject;
b) Printing of legends, as warnings, on the charts;
c) Publication of notes in the Sailing Directions and Notices to the Mariners.

However, **we think that an IMO Circular Letter on the subject could help** to its understanding and, on such Circular, we suggest to make the difference between the application of the autonomous systems (GPS) and the differential ones (DGPS), explaining that the latter are only applicable in their full capacity if the chart is expressly entitled to use them, with an explanation about the origin of the differential amendment to be considered. It would also be convenient to include in such Circular an information on the error margins, which could result in both cases (GPS or DGPS), explaining that, in the first case (GPS), the errors relevant to cartography - which was not always conceived to have a similar positioning system - should be added to the errors due to the system.

### AUSTRALIA

Australia already promulgates appropriate information with regard to the subject and considers that this a satisfactory arrangement. Furthermore, Australia sees it as **more appropriate that national administrations (HOs, etc) and the IHO deal with these issues.**

### BAHRAIN

The State of Bahrain is currently in the process of transforming its navigational charts into WGS 84 according to IHO resolution. Presently two charts have been changed to WGS 84 and two more will be published within this year. At present, these charts also include a note on the reverse adjustments for backward compatibility with previous editions.The remaining charts carry a note about the transformation from WGS 84 to local co-ordinates. As the local datum has been tied in to ITRF 95, the transformation parameters are well defined.

### BRAZIL

Brazilian charts published by the DHN as of 1996 are referred to the WGS 84 Datum. To assist users and ensure the safety of navigation, in the period of October 1997 to September 1998, the DHN published in *Notice to Mariners* explanatory notes (shown below), for all of our charts, considering all Datums used, guiding the mariner to plot correctly satellite-derived positions on WGS 84 on charts on another Datum.

*Satellite positioning. Positions obtained from satellite navigation systems, referred to the WGS-84 Datum, must be adjusted by xxx minute north/southward and xxx east/westward for plotting on this chart.*

**CANADA**

In 1986, the CHS started a program of providing information as to its chart horizontal datum and the corrections necessary to incorporate WGS 84 (or NAD83) positions onto the chart. Most CHS starts at that time were based on NAD27. As well, there were about 25% of the charts that were based on earlier datums, astronomic positions, positions taken from small scale charts, or simply "unknown". The datum information was added when the chart was next printed, either as a Reprint, or as a New Edition. New Charts since 1986 have been prepared based on NAD83. These facts are more fully described in the article "Ten Years of Experience in Converting Canadian Hydrographic Service Charts to a World-based Geodetic System" International Hydrographic Review, March 1998.

CHS also advises mariners through its Sailing Directions (since at least 1990) and through the Annual Notices to Mariners of the implications of chart horizontal datum.

Consequently, **CHS believes that issuing an IMO S/N Circular would be beneficial.**

**CHILE**

**An IMO Circular Letter would be useful.** We think that it is always necessary to arbitrate measures which, even being redundant, are reinforcing certain safety principles, as it is the case.

With respect to the steps taken by this Service to advise the users on the use of GPS and WGS 84, it could be mentioned that:

- With the Notice 194/92 published in the Bulletin No. 18 of 30 September 1992, an information related to the reference datums of the National nautical Cartography was issued;

- With the Notice No. 04/94, published in the Bulletin No. 1 of 15 January 1994, an information was given on the "Datum of the Nautical Cartography issued by the SHOA and Satellite Positioning". Such Notice comprised: Introduction, Accuracy of the GPS Positioning, Datum of the Nautical Cartography, Tables of Transformation Parameters and Conversion Table in general", information to be included in the Publication No. 3.000 "Catalogue of Charts and Nautical Publications".

- In the 11$^{th}$ Edition of the Publication No. 3.000 (1996) was included specific information concerning the datum of each one and all of the charts contained in the Portfolio, including furthermore the information given in the Notice No. 04/94 above mentioned.

- The first nautical charts with information on their datum were issued in 1979, while the first charts with such information and the corresponding transformation parameters were edited in 1985.

**CYPRUS**

The proposal has no practical application in our case, so we have not any comments.

**DENMARK**

Concerning the implications of changes in datum to WGS 84 and the accuracy of charts, notes are written explaining generally in short terms status of the chart concerned. Additionally, Danish Hydrographic Office, Kort & Matrikelstyrelsen has issued a publication called "BEHIND THE NAUTICAL CHART", surveying, reliability, using. This book describes the survey techniques 1829-2000 and inform of the age and status of the Danish surveys with reference to source diagrams printed on charts.

Furthermore the changes of datums on charts and the complex of problems concerning the accuracy with DGPS and the expected (in)accuracy of the data on charts with consideration to the survey-age is explained. The book will be a part of the education of all Danish navigators.

It is recommended that the IHO considers issuing similar advice/guidance covering IHO Member States area of responsibility. **An IMO SN Circular drawing attention to the publication** – if decided to publish – **would be beneficial.**

**ECUADOR**

**It would be convenient to issue an IMO SN Circular** about the "Guidelines on charts datums and on the accuracy of the positions in the charts". It has to be mentioned that our conventional charts are in SAD 56; if they have to be in WGS-84, the datum described in such charts should be adapted accordingly.

**ESTONIA**

No comments.

**FINLAND**

Finland has already, for many years, given information on the accuracy of its charts on Notices to Mariners.

Finland **has nothing against that the proposed IMO S/N Circular will be distributed by IMO** and has no specific comments on the draft S/N Circular.

**FRANCE**

SHOM sees to it that the important information presented in the draft circular is brought to the attention of mariners through the appropriate nautical documents. This information may thus be found in the following SHOM publications:

- The Mariner's guide (*Le Guide du navigateur*)
- Hydrography, nautical documents, their imperfections and their good use (*l'Hydrographie, les documents nautiques, leurs imperfections et leur bon usage*)
- GPS and maritime navigation *(GPS et navigation maritime*)

In other respects, the necessary technical data are marked on SHOM's nautical charts, in accordance with IHO's recommendations. The principle of the widespread use of the WGS-84 system for nautical charts is accepted. The ENC produced by SHOM are linked to this system but the transformation program of the whole portfolio of paper charts, which represents a significant amount of work, is still being examined; the idea which has been adopted is a progressive transfer by navigation basins.

In these conditions, **SHOM believes that an IMO S/N Circular is not necessary**, as it would duplicate existing nautical documents. Moreover, this is a matter which is strictly the IHO's responsibility. The fact that electronic navigation systems have now become commonplace, and the resulting loss of basic navigational skills, may nevertheless justify making more of an effort as regards information for mariners, in particular during their initial training. SHOM therefore suggests that the preliminary draft circular be changed into an IHO information note and that each hydrographic service should examine with their maritime authorities the mode of distribution which is best adapted to each Member State.

Finally, I note that para. 8 of the preliminary draft contains a relevant recommendation related to the reporting of significant, but unknown, variances between the chart system and the WGS84 system. SHOM has been using a parallel arrangement since April 1998 and suggests that the Chart Standardization Committee be invited to come up with an appropriate modification to the IHO Chart Specifications and, more generally, to examine the adequacy of the present specifications (M-4 and Technical Resolution B 2.10) to facilitate the identification and the exploitation of charts linked or not to the WGS system.

*Note by the IHB: SHOM also suggested a number of changes to the French version of the proposed text.*

**ICELAND**

Since 1988 the Icelandic Hydrographic service has inserted a note in most of its charts with the corrections to change from Hjorsey Datum to WGS-72/WGS-84 Datum.

**We don't think that IMO SN Circular would be beneficial** or necessary.

**ITALY**

On most Italian Nautical Charts, a specific Position Note inform users on shifts to be adopted for converting the chart's co-ordinates into WGS 84 and into other datums when necessary (ED 50, Roma 40). Furthermore, on the Italian Annual Summary of Notices to Mariners (Premessa agli Avvisi ai Naviganti), Notice No. 12 titled "Satellite Navigation System and Nautical Charts - Geodetics Systems and GPS" gives special guidance to users on the implication of changes in datum and on the use of GPS for position fixing; also it reports a list of the position shifts of those Italian Charts and of English Charts of the Mediterranean, which do not yet carry the above Position Note.

**We think that an IMO S/N Circular would be necessary**; this circular should be reported, or referred to, on nautical documents.

**JAPAN**

It has already been decided that the geodetic datum on ENC will be based on the WGS 84. It is desirable to unify all geodetic datums to the WGS 84. However, I believe there could be some difficulty in unifying the datums of paper charts to WGS 84 in the near future.

I think that the IMO should be informed of the result of the comparison between the accuracy of the geodetic datums of paper charts and that of the WGS 84.

Japan adopts the Tokyo Datum. The WGS 84 shifts 470 meters northwest from it. To cope with this difference, we take the following measures:

- Publication and distribution of the copies of an educational brochure. This explains the WGS 84 and how it differs from the Tokyo Datum.

- Indicating the reference to the Tokyo Datum and the transmission notes in charts at scales larger than 1:500,000.

- Drawing green graticule lines, based on the WGS 84, on charts at scales larger than 1:50,000 that cover major traffic routes.

- Providing the graticule based on the WGS 84 by the Notice to the Mariners.

**MONACO**

No comments.

**NEW ZEALAND**

**We would like to support the proposed IMO S/N Circular**, and believe that it would be beneficial to all the Member States.

New Zealand is currently in the process of establishing a raster Chart Folio, along with reviewing ENC data requirements for NZ mariners, and are very aware of datum and other issues arising from the use of traditional paper chart as the source of these digital products, including the fact that accurate GPS positioning will be linked to this data.

New Zealand's current paper chart folio will continue be shifted to WGS84 Datum from the local datum NZGD-49. Approximately 80 of 170 charts are already on WGS84 Datum.

The current layout of NZ charts dictates that charts not in terms of WGS84 carry a note that specifies the corrections that must be applied before data in terms of WGS84 can be applied. Charts that are on WGS84 have a note similar to the DEPTHS IN METRES note that portrays to the mariner that his charts is in terms of WGS84, a caution is also included warning them of the transfer of data not in terms of WGS84 between charts.

**NORWAY**

NHS has taken the following steps in order to inform users of problems which might arise when using GPS for position fixing in Norwegian waters:

- Notices to Mariners: General information is given in Norwegian Notice to Mariners No. 1 for each year.

- Catalogue of Norwegian Charts: General information about datums used on Norwegian charts is given.

- Charts: Information about WGS corrections is given on charts in our Main Chart Series (1:50,000) and in the Harbour Chart Series. On charts of older origin an additional notice is given warning the users to be aware that the given WGS correction is approximate and that the coastline in certain areas might be incorrect in relation to the graticule of the chart.

- Special publications: The NHS has published an information brochure "Electronic Chart System – a brief introduction" which gives examples of errors and misunderstandings which can arise when using GPS for position fixing in Norwegian waters.

- Yachting magazines, etc.: The NHS is contributing when information about chart datums, quality of charts, GPS positioning and related matters is published.

- Workshops etc: The NHS has taken the initiative to arrange workshops for shipping companies, mariners and others, focusing on the use of electronic charts, quality of charts, datums, positioning by use of GPS etc.

As information about charts datums and accuracy of positions on charts are important in order to avoid groundings due to lack of knowledge, **we agree that an IMO/SN Circular focusing on this matters would be very beneficial.**

**OMAN**

All charts issued by the Oman National Hydrographic Office are referred to WGS 84 datum, and include a note stating that "Positions obtained from a satellite navigation system referred to WGS 84 can be plotted directly on to this chart". However, **there is certainly no harm in issuing an IMO S/N Circular** to provide ready-reference guidance to the mariner regarding chart datums and the accuracy of position on charts.

**PERU**

The Hydrographic Office of Peru has implemented the use of datums with coordinates related to WGS-84, on nautical charts.

This modification has been carried out to the new nautical charts published. Later, this change will be expanded to all nautical charts. Also, this Directorate is guiding the users about the use of coordinates referred to WGS-84 through its Notices to Mariners, and on the charts itself.

**PORTUGAL**

Official Nautical Charts from IHPT have a note in the title referring the satellite navigation systems, which introduces a correction in latitude and longitude with an accuracy of 0.01 minute. This note, according to TR B-2-10, is used in the Official Nautical Charts with scales between 1:50,000 and 1:500,000 (referred to WGS) and in scales larger than 1:50,000 (referred to WGS 84).

**IHPT considers that an IMO Circular Letter on this subject would be beneficial.**

**RUSSIA**

Data on horizontal datum with related corrections for geodetic systems difference, as well as data on sounding datum, are placed on Russian charts. **In our view, an IHO or IMO Circular Letter on this issue is not necessary.**

**SOUTH AFRICA**

This Office prints 2 differents notes on GPS position fixing on all SAN charts. The type of note varies with scale as follows:

- 1:50,000 and smaller. The note reads "GPS positions may be plotted directly on this chart".

- Larger than 1:50,000. The actual shift to be applied to a GPS position is printed as a note.

All new editions of SAN charts are compiled in WGS 84 and contain the note that GPS positions can be plotted directly.

There is still a lot of confusion amongst chart users about the results of datum shifts and **an IMO SN Circular would be beneficial.**

**SPAIN**

What we are doing, regarding chart datums is:

- To insert a written warning in every chart, reading *SATELLITE-DERIVED POSITIONS. Positions obtained from satellite navigation systems are normally referred to WGS 84 Datum, such positions should be moved xxx minutes Northward and xxx minutes Eastward to agree with this chart,* both in English and Spanish.

- We are planning a transition to WGS 84 datum on new charts. This is underway for Canary Islands.

- We are trying to disseminate to users, through papers, presentations, journals, etc. a number of issues on chart datums, datum transformation, accuracy of position (both inherent to positioning system itself and relative to a different datum), accuracy of data depicted on charts and consequences of changing the chart scale.

**We strongly support the IMO issuing an SN Circular on the matter**, as the best way to reach the mariners, through the Maritime Administration. It should cover those issues already mentioned in 3rd point above.

**SWEDEN**

Sweden has already transformed all charts at scales smaller than 1:200 000 into WGS 84. On charts at smaller scales, the differences in positions are not visible. In addition to notes on the charts, guidance is given in NtM No. 1 every year.

Because modern differential GPS is more accurate than traditional old survey positioning fixing and that waters around Sweden are very rocky, it is difficult to state the accuracy of positions on charts. It is a matter of education for the mariners to learn that they must have safety distances to shoals and obstacles, etc. navigating with positions given in DGPS or navigating with ECDIS in future. Sweden is very aware of this problem and is carrying out surveys and controls along the fairways, taking into consideration modern positioning available for navigation. Those controlled areas and fairways will be specially marked on the charts.

**THAILAND**

Nautical Charts in Thai Waters were produced based on Everest Spheroid 1930 and on Indian datums 1975. The guidance to the users concerning the use of position fixing on chart had been done by printing the offset-value on each relevant chart.

Each member country could check the accuracy of the offset-value from feedback information received from ship at sea or by sea-trial.

**TONGA**

Of the eleven charts covering Tonga's waters, only three charts are related to the WGS 84 spheroid. The remaining eight charts are based on undetermined spheroids and datums and the shifts to WGS 84 cannot be established with sufficient accuracy and consistency. The shifts are, however, considered to be large enough to make navigation by GPS hazardous. These eight charts therefore carry the legend: *Positions obtained from satellite navigation are normally referred to the Word Geodetic System; adjustments for plotting such positions cannot be determined for this chart and should be used with extreme caution.*

In spite of this, however, I believe some mariners either ignore the warning or do not read it and navigate by GPS, including by GPS waypoints entered into their receivers. I therefore believe **it would be useful to publish an appropriate IMO Safety of Navigation Circular** and support UK's proposal.

**TURKEY**

Our Department is giving guidance to the users on our charts, regarding datum transformations and shifts between chart datum and WGS 84 and the usage of GPS as well.

**UNITED KINGDOM**

Many Hydrographic Offices do already provide advice to their users. Additional recommendations and guidance to Hydrographic Offices will also be included in the Specifications of the IHO when the section is revised during 1999. Although this will be based on the content of the draft IMO Safety of Navigation Circular and can include the need for Hydrographic Offices to provide guidance to chart users, the IHO Specifications are not a direct means of providing guidance to chart users.

It is considered therefore, that the issuing of the guidance in the form of **an IMO Safety of Navigation Circular provides the benefit of an additional/alternative route for such guidance** to reach those involved in Marine Navigation and, in particular, chart users. Awareness of the problems by all involved, both directly as chart users, and indirectly by associated staff, must be to the advantage of all concerned.

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INTERNATIONAL MARITIME ORGANIZATION

SUB-COMMITTEE ON SAFETY OF NAVIGATION
45th session
Agenda item 7.1

NAV 45/7/2
2 June 1999
Original: ENGLISH

**NAVIGATIONAL AIDS AND RELATED MATTERS**

**Guidance on chart datums and the accuracy of position on charts**

**Submission by the International Hydrographic Organization (IHO)**


**SUMMARY**

***Executive summary:*** This IHO submission provides information on the International Hydrographic Organization's views on the proposal by the United Kingdom (NAV 44/14, annex 15)

***Action to be taken:*** Paragraph 3.

***Related documents:*** (NAV 44/7/9) and NAV 44/14, annex 15.


## Background

1. The United Kingdom proposed a preliminary draft IMO SN Circular (NAV 44/14/ Annex 15) at the 44th Navigation Sub-Committee meeting held in London from the 20-25 July 1998. As guidance on chart datums was already a function of most Hydrographic Offices the IHO requested that the matter be referred to them for comment. NAV 44 approved this proposal and required the IHO to comment before the NAV 45 meeting in 1999.

2. The IHB informed the Member States of the IHO of the UK proposal and the comments received indicate that while nearly all the Hydrographic Offices of coastal states are promulgating guidance on chart datums they were almost unanimous that an IMO SN Circular would be beneficial. France and Russia feel that a SN Circular would be a duplication of the work done by Hydrographic Offices. France feels that the proposed SN Circular should become an IHO Information Paper and there are also a number of changes to the SN Circular proposed by France.

## Action requested of the Sub-Committee

3. As France and Russia are the only Member States holding this view, the IHB requests that NAV45 give favourable consideration to the proposal by the United Kingdom. The views of France and Russia can be made directly during NAV 45.

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**IMO**

SUB-COMMITTEE ON SAFETY OF NAVIGATION
45th session
Agenda items 6, 7 and 8

NAV 45/WP.2
22 September 1999
Original: ENGLISH

# NAVIGATIONAL AIDS AND RELATED MATTERS

## Report of the Technical Working Group (excerpts)

## 1. INTRODUCTION

1.1 As instructed by the Sub-Committee, the Technical Working Group on Navigational Aids and Related Matters met from 20 to 22 September 1999, during the forty-fifth session of the Sub-Committee, under the Chairmanship of Mr. K. Fisher (United Kingdom).

1.2 The following Members, Associate Members and international organizations were represented in the Working Group:

CANADA
CHINA
FINLAND
FRANCE
GHANA
GERMANY
HONG KONG, CHINA*
JAPAN
LIBERIA
NETHERLANDS
NORWAY
REPUBLIC OF KOREA
RUSSIAN FEDERATION
SWEDEN
TURKEY
UNITED KINGDOM
UNITED STATES

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)
INTERNATIONAL CONFEDERATION OF FREE TRADE UNIONS (ICFTU)
INTERNATIONAL ASSOCIATION OF MARINE AIDS TO NAVIGATION AND LIGHTHOUSE AUTHORITIES (IALA)
INTERNATIONAL RADIO-MARITIME COMMITTEE (CIRM)
INTERNATIONAL FEDERATION OF SHIPMASTERS' ASSOCIATIONS (IFSMA)

1.3 The following documents were considered by the Working Group:

NAV 45/6 (Germany), NAV 45/6/1 (IEC), NAV 45/7 (Technical Working Group), NAV 45/7/1 (IEC), **NAV 45/7/2 (IHO)**, NAV 45/7/3 (ISO), NAV 45/7/4 (Denmark, Finland, Germany, Netherlands, Norway and Spain), NAV 45/7/5 (IEC), NAV 45/7/6 (United Kingdom), NAV 45/7/7 (Sweden), NAV 45/INF.6 (ICAO), NAV 45/8 (Secretariat), NAV 45/8/1 (United States), NAV 45/INF.2 (Secretariat) and NAV/INF.7 (ICAO).

* Associate Member

1.4 The Technical Working Group was instructed to consider all relevant documents submitted under agenda items 6, 7 and 8 and, taking account of all decisions of Plenary:

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5. Prepare a draft SN Circular containing guidance on chart datums and the accuracy of positions on charts taking into account NAV 45/7/2 (IHO) and the views expressed;

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## 2. NAVIGATIONAL AIDS AND RELATED MATTERS

### WORLD-WIDE RADIONAVIGATION SYSTEM

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### Guidance on chart datums and the accuracy of positions on charts

2.5 The Working Group was informed by IHO (NAV 45/7/2) that, while nearly all the hydrographic offices of coastal States were promulgating guidance on chart datums, they were almost unanimously of the opinion that an IMO SN Circular containing guidance on chart datums and the accuracy of positions on charts would be beneficial. France and the Russian Federation felt that an SN Circular would be a duplication of the work done by hydrographic offices.

2.6 The Working Group agreed on the draft SN Circular - Guidance on chart datums and the accuracy of positions on charts, given in annex 1, and recommended to invite the Committee to approve it.

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**ANNEX 1**

**DRAFT SN CIRCULAR**

**GUIDANCE ON CHART DATUMS AND THE ACCURACY OF POSITIONS ON CHARTS**

1. The Maritime Safety Committee, at its seventy-second session (17 to 26 May 2000), approved guidance on chart datums and the accuracy of positions on charts, given at the annex.

2. Member Governments are invited to bring this guidance to the attention of all concerned for information and action, as appropriate.

ANNEX

## GUIDANCE ON CHART DATUMS AND THE ACCURACY OF POSITIONS ON CHARTS

1. Many different definitions of a horizontal datum (also known as geodetic datum) exist. However, a practical working definition in use is:

   *"A horizontal datum is a reference system for specifying positions on the Earth's surface. Each datum is associated with a particular reference spheroid that can be different in size, orientation and relative position from the spheroids associated with other horizontal datums. Positions referred to different datums can differ by several hundred meters."*

2. The practical result is that a given geographical position, not associated with a specific datum, could refer to different physical objects. In other words, a physical object can have as many geographical positions as there are datums. For example, South Foreland Lighthouse, United Kingdom, has the following positions:

| GEOGRAPHICAL POSITION | HORIZONTAL DATUM |
|---|---|
| 51°08.39' N 01°22.37' E | referred to OSGB(36) Datum (the local datum for the United Kingdom). |
| 51°08.47' N 01°22.35' E | referred to European (1950) Datum (the continental datum). |
| 51°08.42' N 01°22.27' E | referred to World Geodetic System 1984 (WGS 84) Datum (the world-wide datum used by Global Positioning System (GPS)). |

3. Most charts are not yet referred to WGS84 Datum. This means that, in those cases, positions obtained from satellite navigation receivers will not be directly compatible with the chart and **must** not be used without adjustment. Hydrographic Offices are attempting to refer as many new charts as possible to WGS84, but there remain many areas of the world where information does not exist to enable the transformation to be performed.

4. When known, the horizontal datum of the charts is usually named in the chart title albeit, on its own, this information is of limited benefit to the mariner. Since 1982 many hydrographic offices have been adding "Satellite-Derived Positions" notes (usually situated close to the title) when charts have been revised. This note provides a latitude and longitude adjustment to be applied to positions obtained directly from satellite navigation systems (such as GPS) to make them compatible with the horizontal datum of the chart.

5. The following provides a worked example:

| | |
|---|---|
| Satellite-Derived Position (WGS84 Datum) | 64°22.00' N 021°30.00' W |
| Latitude/longitude adjustments | 0.07' S 0.24' E |
| Adjusted position (compatible with chart datum) | 64°21.93' N 021°29.76' W |

In this example, the shift equates to approximately 230 metres which can be plotted at scales larger 1:1,000,000.

6. Where known, these adjustments are an average value for the whole area covered by the chart and are quoted to 2 decimal places of a minute in both latitude and longitude, so that the maximum uncertainty is about 10 metres in both latitude and longitude (0.005' and 0.014' will both be rounded to 0.01'). This uncertainty can be plotted at scales larger than 1:30,000 (where it is represented by 0.3 mm on the chart).

7. Inevitably, cases exist where overlapping charts show different latitude or longitude shift values. For example, one chart might show 0.06' and its neighbour 0.07'; for each individual chart the value will be an average, but in the area common to both charts the value will range from 0.064' to 0.066'.

8. In the cases where an adjustment cannot be determined because of the lack of knowledge about the relationship between WGS84 Datum and the datum of the chart, the hydrographic office may add a note to that effect warning that adjustments "may be significant to navigation". The largest difference between satellite navigation derived and charted position reported so far is 7 miles in the Pacific Ocean, but even larger undiscovered differences may exist. Where charts do not contain any note about position adjustment it **must** not be assumed that no adjustment is required.

9. Most manufacturers of GPS receivers are now incorporating datum transformations into their software which enable users to (apparently) receive positions referred to datums other than WGS84 Datum. Unfortunately, many cases exist where a single transformation will not be accurate for a large regional datum. For example, the relationship between WGS84 Datum and European Datum (1950) is very different between the north and south of the region, despite the datum name being the same. Therefore, the position transformed to European Datum (1950) in the receiver by means of a Europe-wide average may differ from the WGS84 Datum position output by the receiver, amended to European Datum (1950) by the shift note on an individual chart. In the light of the 100 metre accuracy of the Standard Positioning Service of GPS, this may not be significant, but it is an additional source of error and is of major significance if differential GPS (DGPS) is being used for navigation.

10. It must not be assumed that all charts in a region are referred to the regional datum. For example, although most metric charts of mainland European waters are referred to European Datum (1950), many charts are also referred to local datums. Additionally, as there are no international

standards defining the conversion parameters between different horizontal datums; the parameters used by the GPS devices may be different. The hydrographic offices use the best adopted parameters, so mariners are advised to keep their GPS receiver referred to WGS84 Datum and apply the datum adjustment note from the chart.

11. Apart from the differences in positions between different horizontal datums, two other aspects affect charted positional accuracy. These aspects are:

- the accuracy to which features are surveyed (paragraphs 12 to 16) and

- the accuracy with which they are compiled on to a chart (paragraphs 17 to 21).

**Surveying**

12. Hydrographic surveys are generally conducted using the best position-fixing technology available at the time. This was limited to accurate visual fixing until the Second World War, but used terrestrial based electronic position fixing (such as Decca, Hifix, Hyperfix and Trisponder) until the 1980s. DGPS is the current standard for most hydrographic surveys.

13. Until 1980, generally, position fixing for surveying was more accurate than that for navigation in the first two categories, but DGPS is being made more widely available for use by all mariners with the appropriate equipment. The result is that current navigation with DGPS is, commonly, more accurate than position-fixing used for surveys conducted ~~longer ago than 15 years~~ before 1980. The consequence is that, although a modern vessel may know its position to an accuracy of better than 10 metres, the positions of objects on the seabed may only be known to an accuracy of 20 metres or much worse, depending on the age of the latest survey and/or its distance from the coast.

14. Furthermore it is only ~~comparatively recently (the last 20 years or less)n~~ since the 1970s that surveying systems have had the computer processing capacity to enable the observations to be analysed to enable an estimate of the accuracy of position fixing to be generated. The result is that, although the current accuracy standard of position fixing surveys can be stated (see para. 15 below), it is impossible to provide anything other than general estimates for older surveys.

15. The current accuracy standard for positioning is 13 metres for most surveys with the standard of $\pm$ metres (both 95% of the time) for certain special purpose surveys. It can be confidently stated that the former value is often significantly improved upon. Further improvements will undoubtedly be made as a result of technological developments, but at present there has to be a balance between the cost of a survey and the quality and quantity of the results achieved.

16. In summary, although the positions of maritime objects derived from modern surveys will be accurate to better than 10 metres, this cannot be used as a general statement about all such objects.

**Chart compilation**

17. Most paper charts and their derived digital versions are assembled from a variety of sources as maps, surveys, photogrammetric plots, etc.. The intention is to provide the mariner with the best available information for all parts of that chart and the usual procedure is to start with the most accurate sources, but is often impossible to complete the whole chart without resource to older, less accurate sources. When sources are referred to different datums, transformations have to be calculated and applied to make the sources compatible. The intention is for such transformations to have an accuracy of 0.3 mm at chart scale, this being the effective limit of manual cartography, but depending on the information available, this may not always be possible.

18. When the positions of objects critical to navigation are accurately known, the intention is that they are located on a chart to an accuracy of 0.3 mm. The obvious consequence is that accuracy varies with chart scale:

    0.3 mm at a scale of 1:10,000 is 3 metres
    0.3 mm at a scale of 1:50,000 is 15 metres
    0.3 mm at a scale of 1:150,000 is 45 metres.

19. The situation will change as chart data becomes available digitally, but much of the early digital data will be derived from these paper charts and the limitations will remain. Furthermore, a pixel on a computer display screen is approximately 0.2 mm square, roughly equivalent to the accuracy available on the paper chart.

20. The situation for mariners is improving with recent surveys referred directly to WGS84 Datum, increasing numbers of charts referred to WGS84 Datum (or to North American Datum 1983, which is the same to all practical purposes) and increased international co-operation in the exchange of information. Unfortunately, it will be many years before all areas are re-surveyed and all charts revised.

21. Until that happens, mariners should remain alert to danger. A satellite navigation receiver may output a position to a precision of three decimal places of a minute, but does not mean that all its positions are accurate to 2 metres or that the resulting position is compatible with the positions of objects shown on modern charts (paper or digital) which may have been established 100 years ago and not surveyed since. The chart title notes and cautions and the source Diagram, which shows the ages of surveys must always be consulted for indications of limitations.

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