



Australian Government

Australian Maritime Safety Authority

# Positions and horizontal datums on paper and electronic charts

## Fact Sheet

Modern technology has improved substantially the safety of navigation through satellite based navigation systems such as the Global Positioning System (GPS). However, the incorrect use or application of this technology can prove dangerous, and in particular the improper use of or lack of account for horizontal datums. This brochure provides information that will assist mariners in understanding horizontal datums. It also explains how to make sure positions obtained using GPS are safely transferred to a paper chart or fed into an electronic equivalent such as an Electronic Charting System (ECS) or an Electronic Chart Display and Information System (ECDIS).

### Horizontal datums on charts and their electronic equivalents

All charts, electronic or paper, are based on a horizontal datum (also known as a geodetic datum), and positions determined by GPS, including Differential GPS, are also based on a horizontal datum. Should the chart and GPS position datums be different and an allowance is not made to account for this difference, there is every likelihood that a significant error in position will result. This can be up to 6.5 cables in certain parts of the world.

### What is a horizontal datum?

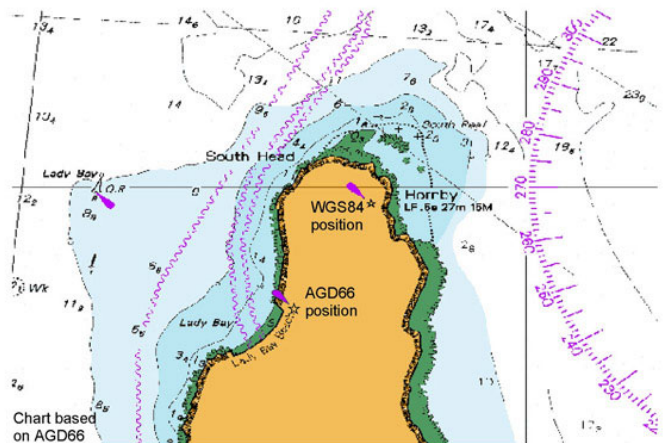
The International Maritime Organization has provided guidance on chart datums and the accuracy of horizontal positions on charts. This guidance states, "A horizontal datum is a reference system for specifying positions on the Earth's surface. Each datum is associated with a particular reference spheroid 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 metres."<sup>1</sup>

This means that, in practice, a given geographical position described as latitude and longitude but without a specified datum can actually indicate different physical locations on the earth. In other words, a physical location can have as many geographical positions as there are datums.

For example, the position of Hornby Light at South Head varies according to whether the Australian Geodetic Datum 1966 (AGD66) or the World Geodetic System 1984 datum (WGS84) is used:

WGS84	33° 50.014' S	151° 16.860' E
AGD66	33° 50.109' S	151° 16.791' E

The following diagram shows the WGS84 and AGD66 positions of Hornby Light on an extract of chart Aus 201, which is a WGS84 chart. The difference in positions represents a distance on the ground of 204 metres (~ 1 cable).



### What is the status of horizontal datums on Australian charts?

There are many different horizontal datums used throughout the world. Australian charts fall into three main categories with regards to the datums they use.

- The first and largest category is metric unit charts that have been produced on, or converted to, the WGS84 datum. The Australian Hydrographic Service is progressively updating all its charts to the WGS84 datum since this is the datum used by GPS, the predominant position fixing aid used by mariners.
- The second category of charts includes metric and imperial (fathoms) charts that are based on either AGD66 or other older datums.

<sup>1</sup> Guidance on chart datums and the accuracy of positions on charts dated 31 May 2000 (Ref. T2/2.07 SN/Circ.213)

- The third category of charts includes only a few imperial charts that are not referred to any datum at all. When using these older charts it is important that positions are determined only by reference to charted features; this means employing traditional terrestrial navigation techniques such as the measuring of bearings and/or radar ranges to charted features.

Australian charts provide clear advice to mariners about the horizontal datum being used. This advice is placed outside the margins of the chart along the upper left and lower right sides and takes the form of a note indicating that observed GPS positions in the WGS84 datum either CAN or CANNOT be directly plotted onto the chart. If the chart is based on the AGD66 or another older datum then a "Satellite Derived Positions" note near the main title of the chart will describe the shifts that must be applied to observed GPS WGS84 positions to enable them to be plotted on the chart.

### System based datum conversions

Manufacturers of GPS receivers, ECS and ECDIS often incorporate a user selectable datum transformation capability into their software. This capability enables users to deal with datum differences in a systematic and apparently automatic manner. Whilst this might appear to be a good thing, considerable caution needs to be exercised.

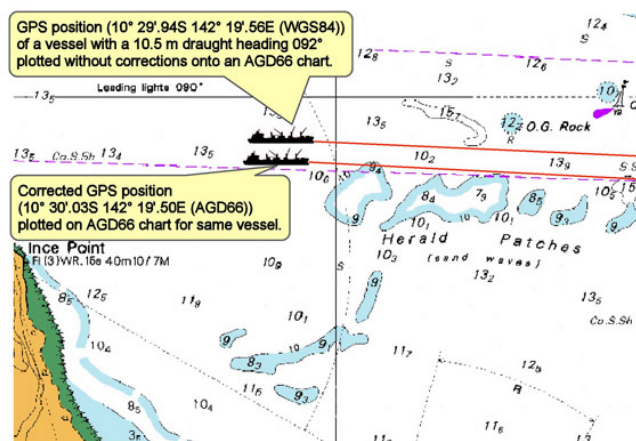
A potential problem is that a single systematic transformation is not always accurate for large regional datums. A GPS receiver position (WGS84) transformed to a regional datum by means of an average set of shifts may differ from the GPS receiver position (WGS84) amended to the regional datum by the shift note on an individual chart. The shifts provided on an individual chart are calculated specifically for the chart and the area that it covers and will be more accurate than a set of generalised shifts.

Interoperability issues might also emerge when connecting a GPS receiver to an ECS or ECDIS,

particularly if the GPS receiver is configured to convert its position output to a local or regional datum. Care must be taken to ensure that GPS receivers are configured to provide positions in the datum that is expected by the ECS or ECDIS. In the majority of cases this will be the WGS84 datum, but manufacturer's instructions should always be carefully consulted to ensure correct system operation.

### Example of incorrect application of horizontal datum

In the following example a deep draft east bound vessel is using a chart based on AGD66 with GPS positions, which are based on WGS84. The satellite derived positions note on the chart says that WGS84 positions must be moved 0'.09 southwards and 0'.06 westwards in order to be plotted on the chart.



Whilst it is unlikely that a prudent mariner would rely solely on GPS in navigationally constrained waters, this example highlights the errors that can arise if datum corrections are ignored. Further, if using an ECS or ECDIS it is conceivable that a datum correction might be applied twice; once by the GPS receiver and again by the ECS or ECDIS. Once again, system manufacturer's instructions should be consulted to ensure this problem is avoided.

### Further information about horizontal datums

The following websites provide useful information about datums:

Geoscience Australia: <http://www.ga.gov.au/nmd/geodesy/datums/>

Intergovernmental Committee on Surveying and Mapping: <http://www.icsm.gov.au/icsm/gda/index.html>

International GPS Service: <http://igscb.jpl.nasa.gov/>

EUROCONTROL, the European Organisation for the Safety of Air Navigation: <http://www.wgs84.com/default.htm>

### Further information may also be obtained from:

Australian Maritime Safety Authority  
 Manager Navigation Safety  
 Tel: (02) 6279 5049  
 Fax: (02) 6279 5002

Australian Hydrographic Office  
 Director Charting and Information Management  
 Tel: (02) 4221 8615  
 Fax: (02) 4221 8599