

CHAPTER 10

ELECTRONIC NAVIGATION

THIS CHAPTER COVERS THE NEW ADDITIONAL ITEM OF ELECTRONIC NAVIGATION AND CONSISTS OF THREE PARTS:

1001 ELECTRONIC CHARTS

1002 SATELLITE NAVIGATION

1003 RADAR

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Suggestions for additional items or improvements are welcomed and should be submitted to the Author either by post or e-mail.

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Reading/Video/CD ROM list:

E Charts:

CD – RYA Chart Plotter (£21.00 in 2005)

GPS:

Book – “GPS Afloat” by Bill Anderson. Pub: Fernhurst. (£14.95 in 2005)

Radar:

Video – “Radar” by Amberley Marine. (29.50 in 2005)

CD – “Radar Trainer” by Lightmaster Softwear. (£ nk)

Book – “An Introduction to Radar” by the RYA (£nk)

1001 ELECTRONIC CHARTS

1001.1 General

There are both Official Government and Commercially produced electronic charts. There are however only two basic types – Raster and Vector – depending on the electronic make up of the charts produced.

1001.2 Raster data Charts

These are pure electronic reproductions of the paper charts.

They are not intelligent i.e. you cannot ask questions about chart features using the chart plotting systems electronic cursor. What you see is what you get – just like a paper chart.

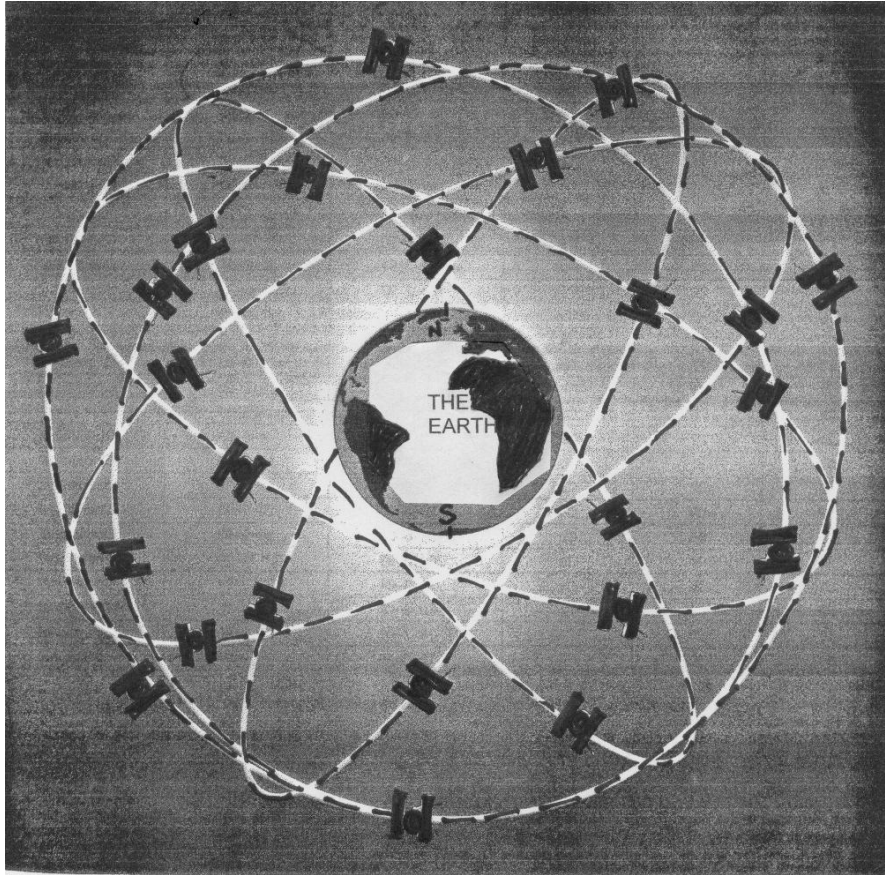
The British Admiralty (BA) electronic charts fall into this category. The BA system is called ARCS – Admiralty Raster Chart Service.

1002 SATELLITE NAVIGATION (GPS)

1002.1 Navstar GPS

GPS or to give it its full title “NAVSTAR Global Positioning System” is a satellite navigation system owned and operated by the United States Department of Defence. It is freely available to all mariners.

The system consists of 24 satellites, about 11,000 miles above the Earth, evenly spaced between 6 orbital planes.



GPS: Satellites

1002.2 Other systems

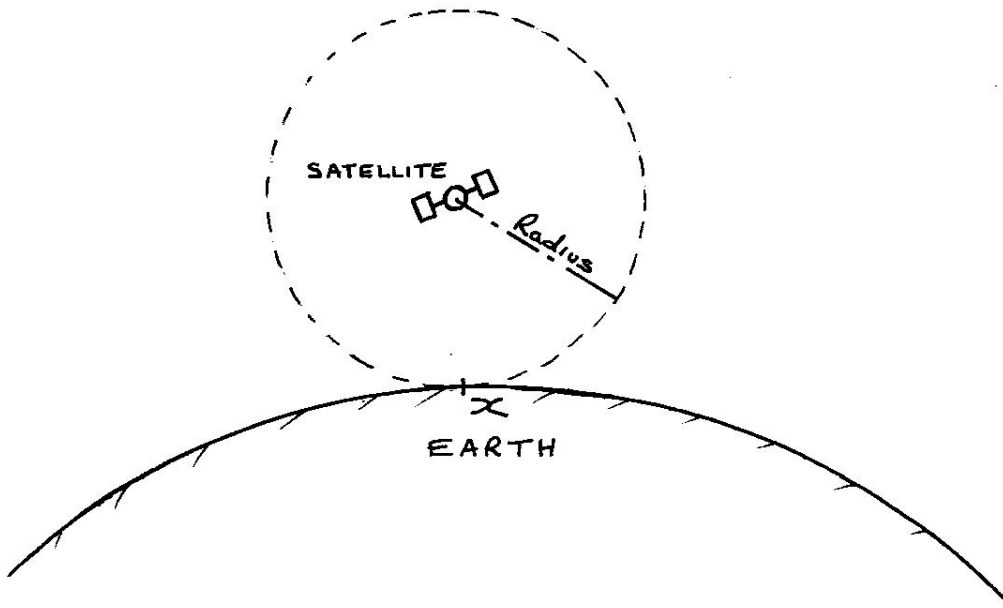
“GLONASS” is a similar Russian operated system.

“GALILEO” is a European system presently (2005) under development.

1002.3 How GPS gives a position

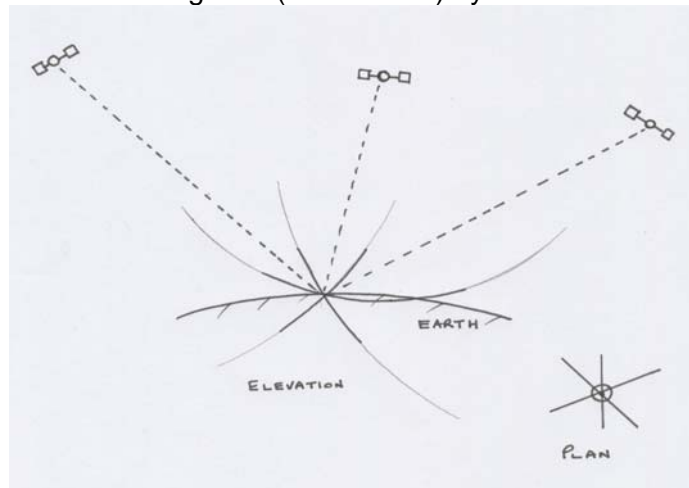
Four satellites (with a good angle of cut) are required to give a good fix or position. Your GPS set will (in normal circumstances) have up to 12 satellites available at any one time. It will select the satellites that give the best angle of cut for a good fix.

The system works by the satellite making a transmission that is received by the observing vessels aerial/set. The time taken by the signal from transmission to reception is used to produce a radius. Thus it places the vessel somewhere on the circumference of a circle, the centre of which is the satellite. We are interested in the part of this circle that touches the Earth's surface.



GPS: Single position line

The other satellites selected by the set will each produce a position line. The point where these position lines all cross on the Earth's surface gives our position. This is converted to Latitude and Longitude (LAT & LON) by the GPS set.



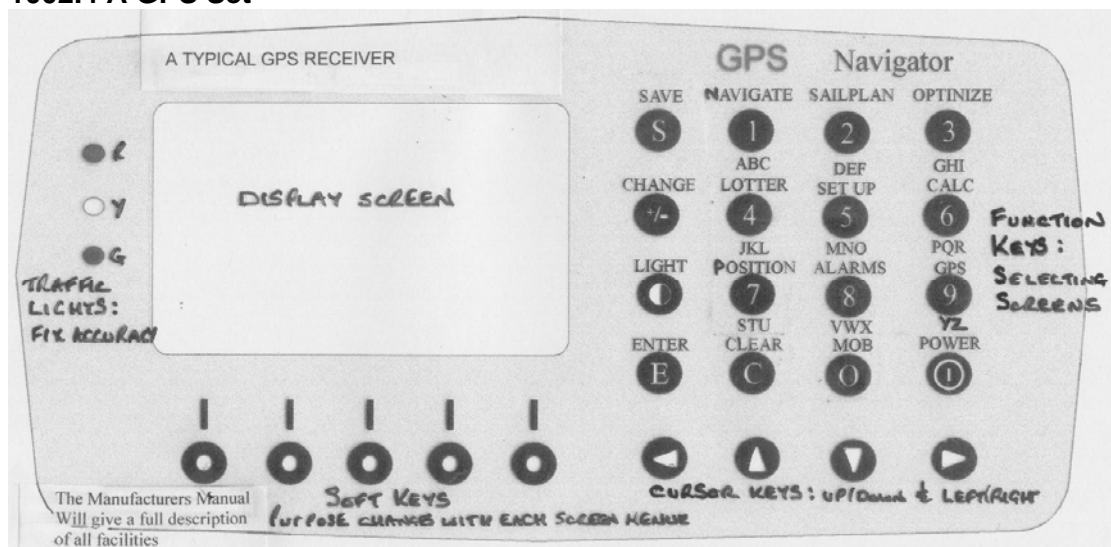
GPS: Position lines and fix

POSITION	WGS 84 Datum		
N	52° 37'.068		
W	009° 22'.123		
COG	180°	SOG	25 Kn

GPS: The set – A positional screen

The system has an accuracy of +/- 10metres on your actual position. The position can be made even more accurate by the use of Differential GPS (DGPS).

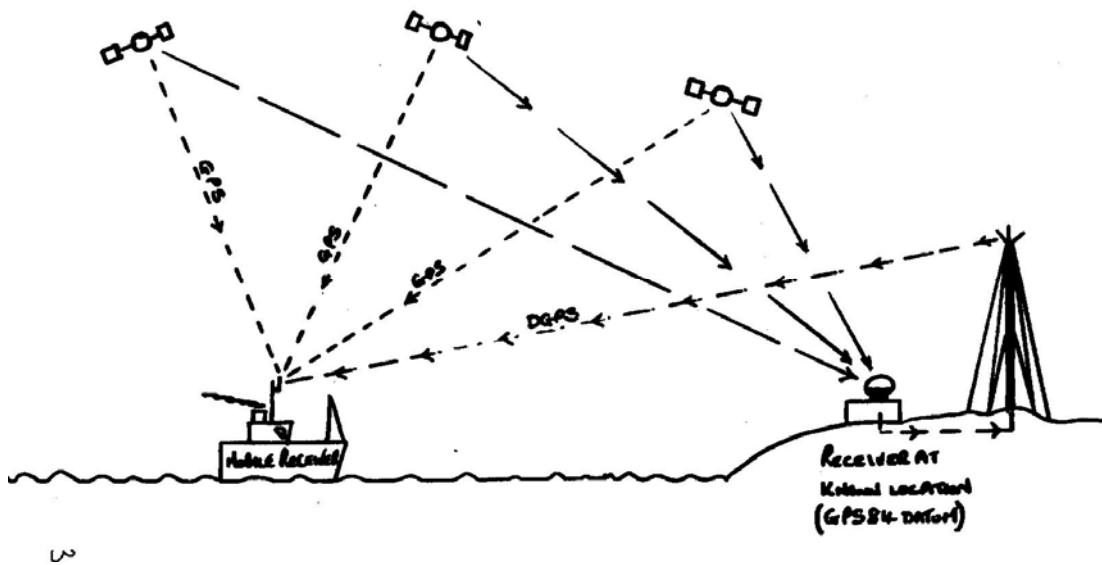
1002.4 A GPS Set



A typical GPS Receiver (By kind permission of RNLI)

1002.5 Differential GPS (DGPS)

There are various forms of DGPS – we will look at the coastal system. DGPS is a land based radio system that sharpens up the accuracy of GPS in coastal waters. The use of DGPS produces an accuracy of +/-5metres.



DGPS: The system

Essentially the land based Reference Station (RS) knows exactly where it is by the datum used by the GPS system – WGS84 - World Geodetic Survey 1984.

This is the same datum that is used for all current (i.e. say from 2004) British Isles Admiralty paper charts.

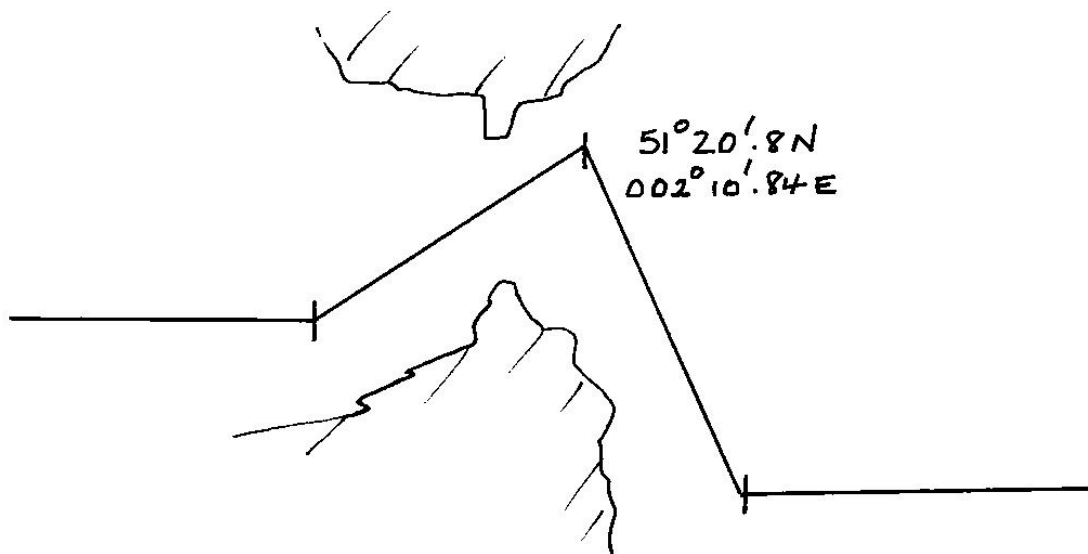
The observed differences between the actual position of the RS and its position as given by an individual satellite are broadcast by a radio signal to vessels fitted for DGPS. This produces a more accurate position.

1002.6 The navigational use of GPS

Apart from giving a constant Lat & Lon position of your vessel the GPS can be used for Navigating.

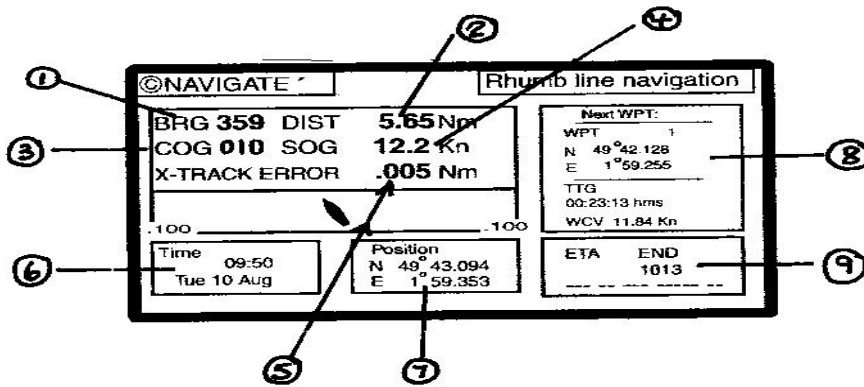
Many vessels use electronic charts in conjunction with GPS. This aspect is discussed under section 1 - Electronic Charts.

Without Electronic chart plotting systems your planned route on a paper chart can be input manually to the GPS. Each course alteration point becomes a Waypoint (Wpt). You work out the Lat & Lon of each waypoint in turn and input them to the GPS



Waypoints: the paper chart – working out Lat & Lon

The GPS will produce navigational information such as:



GPS: The Set – Navigational information

- 1: The course to steer to the waypoint – this will allow for TS&D
- 2: Distance to run – to waypoint
- 3: Course made good – over the ground
- 4: Speed made good – over the ground
- 5: Cross track error – how much and to what side you are off course/track
- 6: Local time – BST or UTC
- 7: Vessels current position
- 8: Details of the waypoint you are approaching:
 - a. The number in your route/passage plan (see section 4 for Passage Planning)
 - b. Its Lat & Lon and c. TTG – Time to go to the waypoint
- 9: An Estimated Time of Arrival (ETA) at the last waypoint in your loaded route

1003 RADAR

1003.1 A Radar set



A typical radar set (By kind permission of RNLI)

1003.2 General

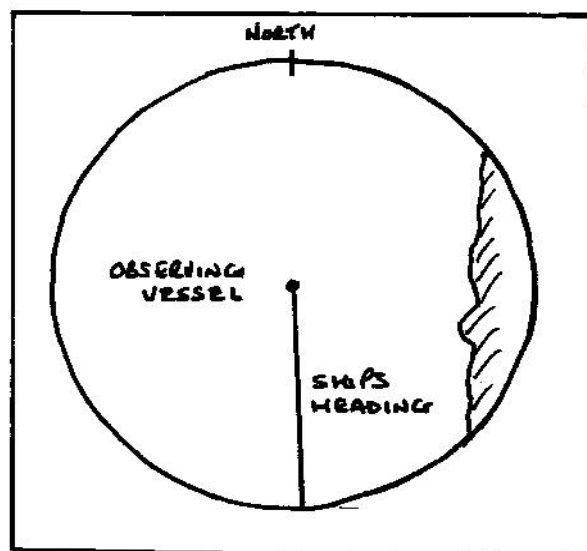
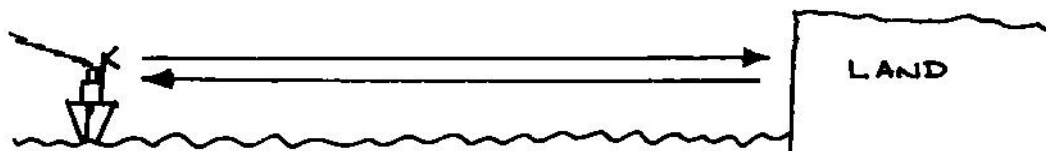
Radar stands for:

Radio
Aid
For determining
Direction
And
Range

Radar can be used both as an aid to collision avoidance and an aid to navigation. It is the navigational aspects of radar we will discuss here.

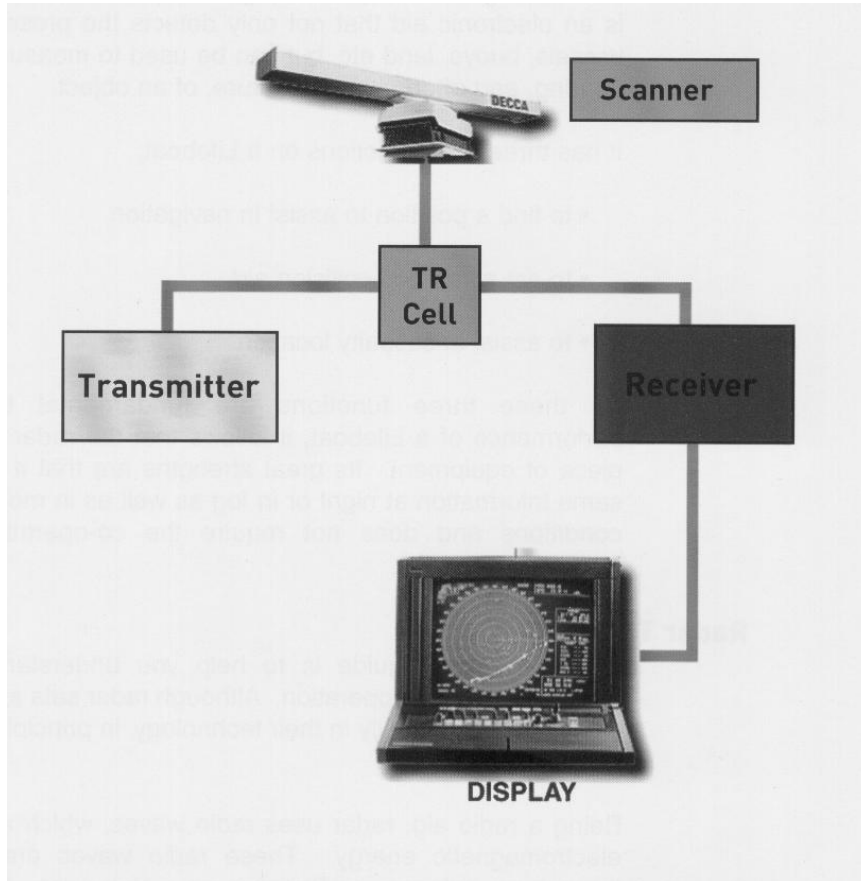
1003.3 The Echo Principle

Radar works by transmitting a pulse of radio energy and receiving some of that energy (the echo) back. Energy is reflected back when it hits an object (target) such as land, a vessel or navigational mark etc. This returning echo from the target paints in a picture on the radar screen



Radar: The Echo Principle

1003.4 Components of the Radar Set (By kind permission of RNLI)



The Transmitter produces correctly formed pulses of energy.

This pulse of energy goes via the T/R Cell (Transmit/Receive) to the Scanner. The Scanner is also known as the Aerial or Antenna.

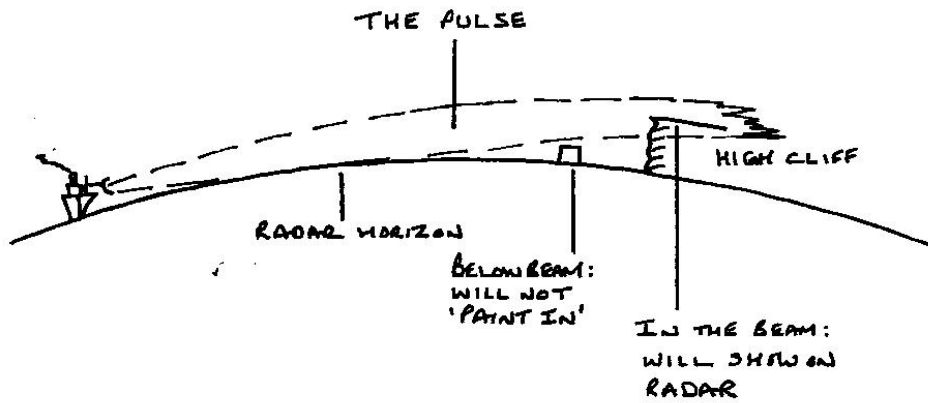
As soon as the scanner has transmitted the pulse, the T/R cell switches from Transmit to Receive.

A scanner spends 99.5% of its time listening for returning echoes.

The Receiver receives then amplifies the returning echoes and sends them to the Display. The Display is the radar screen itself.

1003.5 Radar Horizon

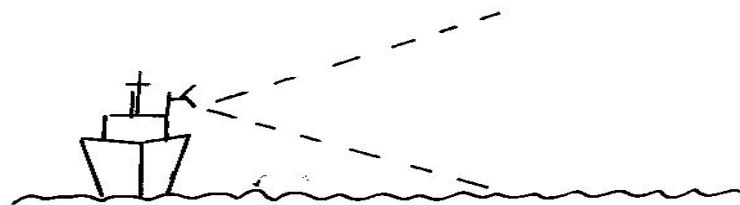
As we have seen the scanner transmits a pulse of energy. The path of the pulse may be considered 'line of sight'. The higher the scanner the further the radar can see. You will note that the pulse/beam bends slightly over the horizon – thus it is sometimes possible to detect a target that may be below your visible horizon.



Radar Horizon & Beam

The radar beam has a vertical and horizontal component:

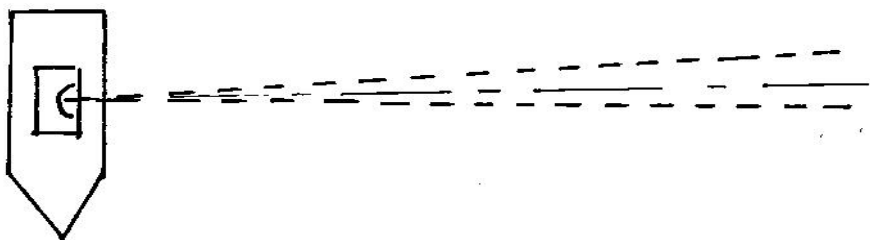
1003.6 Vertical Beamwidth (VBW)



Vertical Beamwidth – typically 20° to 30°

This ensures that at least some part of the beam is horizontal even when the vessel pitches and rolls.

1003.7 Horizontal Beamwidth (HBW)



HBW – much smaller between 2° and 5°

1003.8 Radar Bearings

As all the energy is concentrated in one narrow direction at a time the radar is able to measure a bearing along the axis of the beam. The narrower the Beam the better the accuracy.