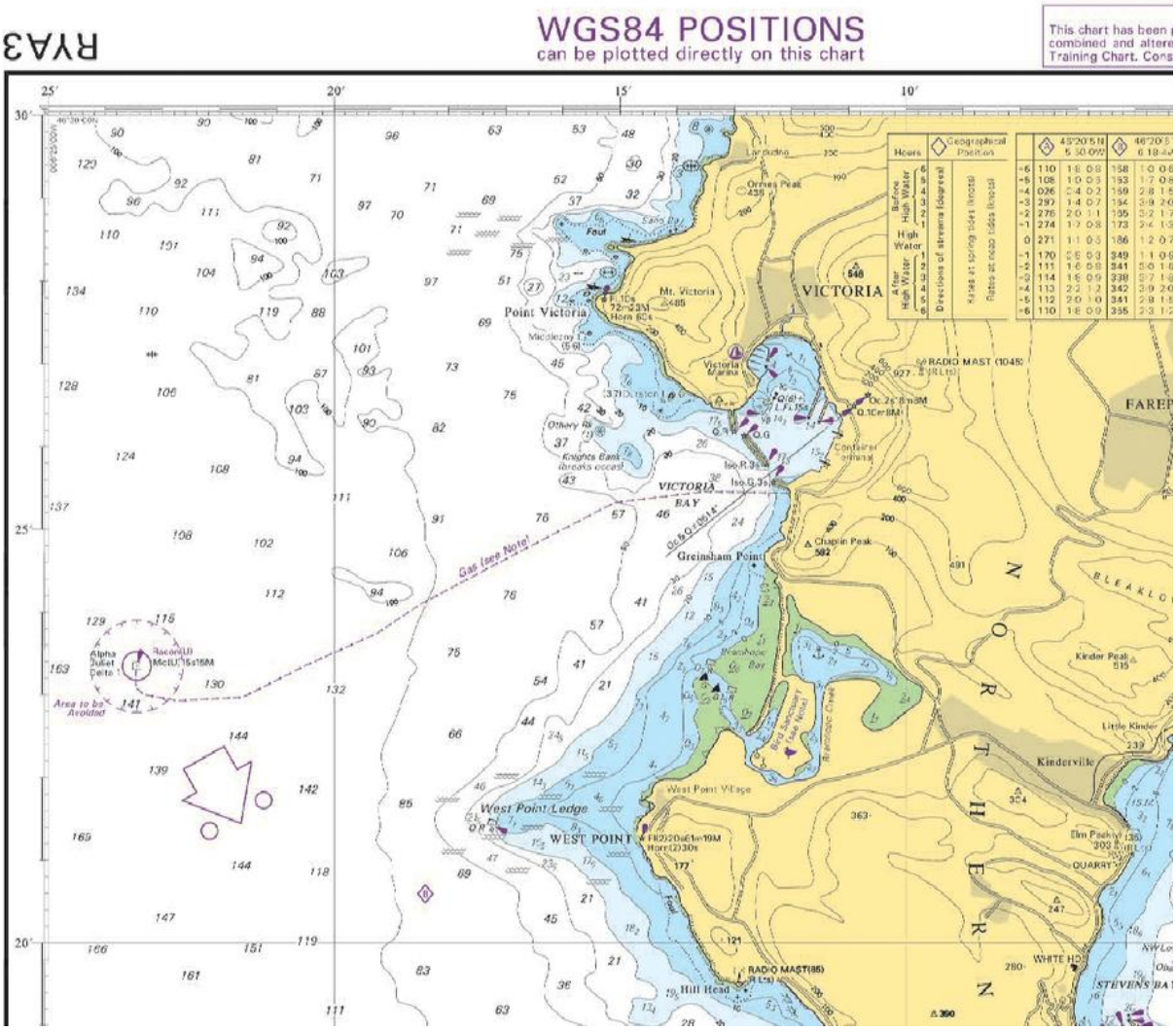
INTRODUCTION TO CHARTWORK



Introduction to Chartwork

Perhaps the first step towards proficiency in navigation to watchkeeping standards is understanding how to interpret a nautical chart. This fundamental knowledge will be the foundation from which all the other skills of the navigator can be built upon.

If the chart cannot be understood, then the ship's position cannot be determined, and dangers will not be recognised by the watchkeeper.

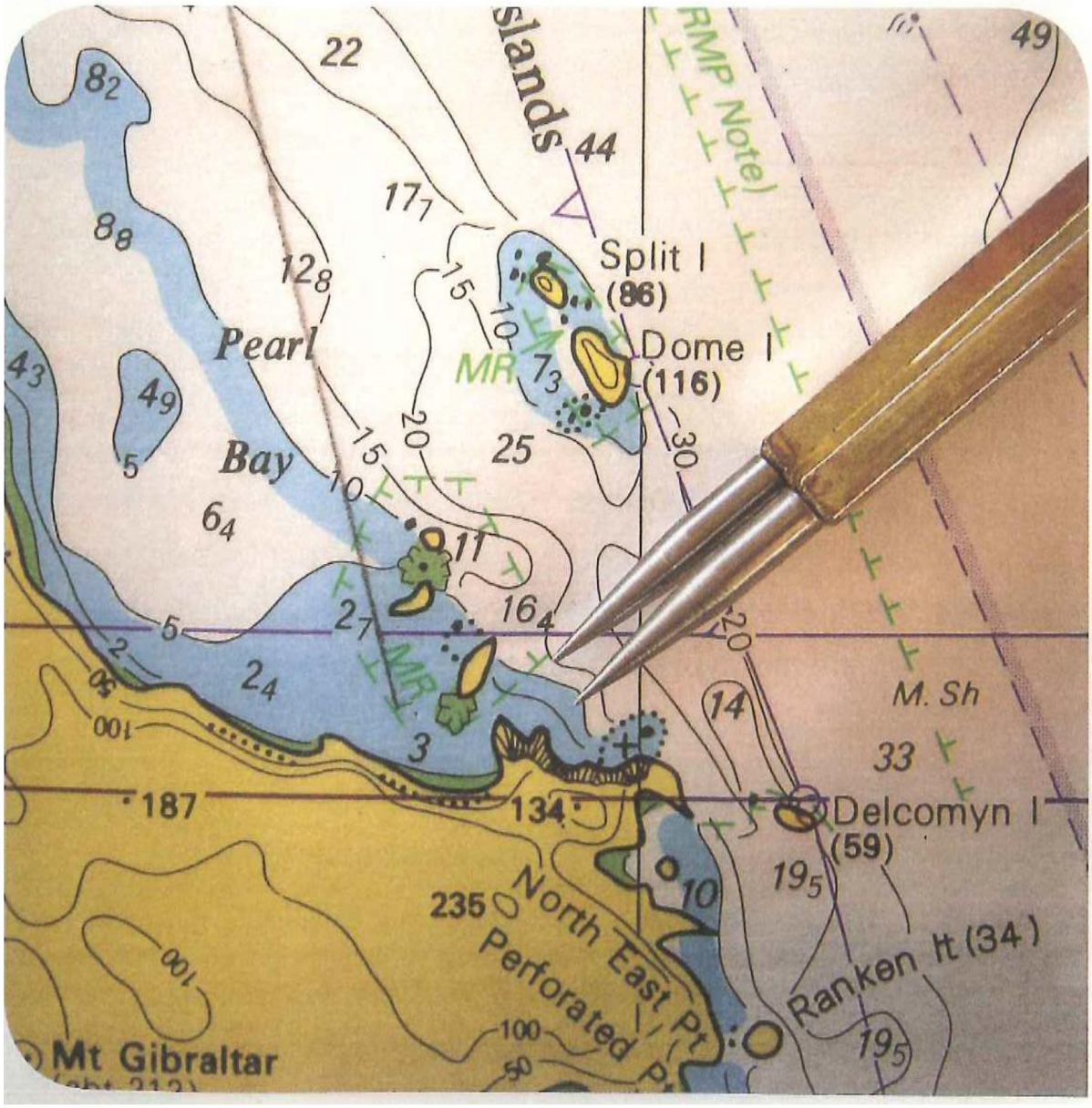


Chart interpretation

This section will concentrate solely on chart interpretation as a basis for further study.

'Chart or Map'?

Your credibility onboard will not be enhanced, should you make a request to the Master to see 'the map' - maps are used by landlubbers. Charts are used by mariners.

It is not a map... it is a *chart*.

Charts deserve respect, and any experienced mariner will treat his charts in a manner that reflects the many thousands of hours and huge amount of survey work that has gone into each and every one. Avoid folding them if possible, and keep them corrected and up to date at all times; in fact this is a statute requirement with regards to the seaworthiness of the ship.

Aside from a 'ready reference' chart that may be exposed to the elements, don't use ones that are laminated for watchkeeping purposes – they are slippery under the parallel rules, and impossible to use a pencil on. Laminated charts should not be used for position determination.

Even with today's modern satellite technology, there is no substitute for the paper chart. Combined with a magnetic compass, and traditional navigational tools such as dividers and parallel rulers, safe coastal navigation by a competent watchkeeper is always possible, independent of satellites and the Global Positioning System. Remember that ultimately the ship should be self-sufficient in every way. Should the GPS unit fail or the satellites drop from the sky, the ability to fix your position manually is paramount, and, like your knots, is the mark of a mariner.

Projections – how the earth appears on the chart

For centuries, cartographers (mapmakers) faced the challenge of representing the surface of a sphere onto a flat piece of paper.

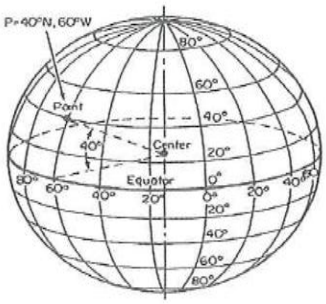
For navigation, two projections are used almost exclusively at sea. One – the *gnomonic* projection is used for plotting longer ocean passages. The other, the *Mercator* projection, is used for inshore and coastal navigation.

Understanding the Mercator projection is important knowledge for watchkeepers! This method of projecting the earth's surface onto a flat piece of paper distorts features and landmasses, and this distortion increases with distance from the equator. If this fact is not comprehended and understood, mistakes in the measurement of distance can easily be made with potentially dire consequences to the safety of the ship.

Mercator's projection

Lines of longitude (meridians) run through the north and south poles, and *converge* with each other as distance increases from the equator. *Think of the earth being cut into 'lemon wedges'.*

Lines of latitude (parallels) travel around the earth east to west, but never meet. *Think of the earth being cut into a rectangle, versus a sphere..*

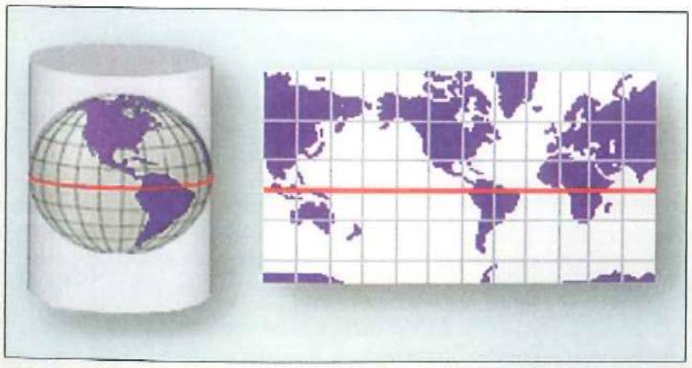


Both latitude and longitude represent angular distances, with the apex of that angle measured from the geometric centre of the earth, in two dimensions. North/south (latitude) and east/west (longitude).

As you look at a chart oriented to the north, remember;
LATs LIE FLAT!

These angular distances are represented on the chart. The scale of latitude runs down either side, and the scale of longitude runs across the top and the bottom.

With a Mercator chart, meridians of longitude *do not* converge at the poles. A Mercator projection of the world shows Antarctica extending across the bottom of the entire chart, and Greenland, which is in fact much smaller than Australia, to be much larger!



The principle of Mercator's projection.

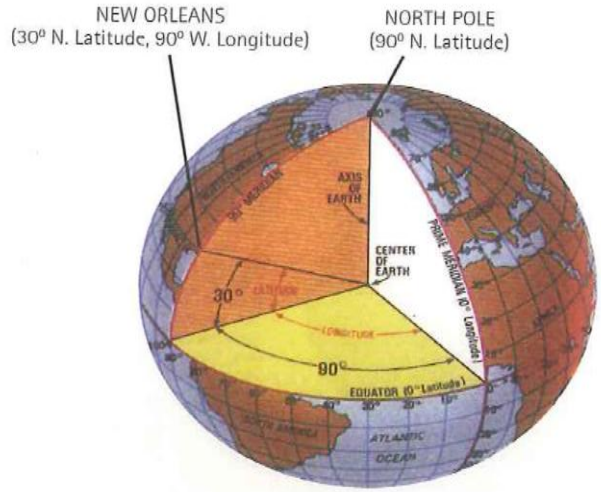
The charts used for coastal navigation are of course a much larger scale, however the same principle applies as they are still Mercator's projection.

Measuring distance

The unit of measurement at sea (and also in aviation and space travel) is the *nautical mile*, and measuring distances on the chart using this unit is fundamentally simple.

- one degree of arc is further divided into 60 minutes.
- one minute of arc *at the earth's surface* is equal to one nautical mile.

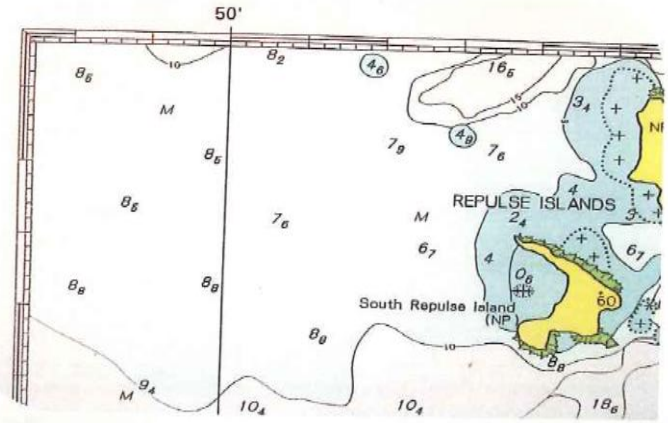
Therefore one degree of arc (measured from the centre of the earth) is equal to 60 nautical miles.



At 40 degrees north latitude it can be seen that New Orleans is 2400 nautical miles from the equator. 40 degrees x 60 minutes = 2400nm.

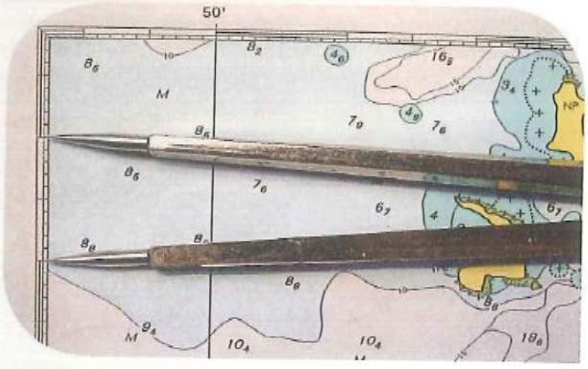
The earth therefore, at its widest circumference (such as the equator, or any meridian of longitude) measures 360 x 60 = 21,600 nautical miles.

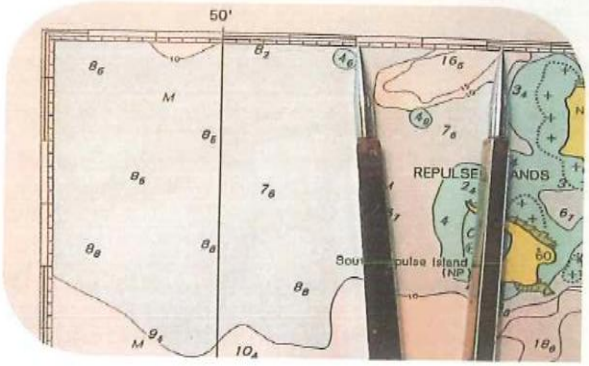
In applying this knowledge for practical purposes on the chart, *the scale of latitude must always be used.* This is due to the fact that meridians of longitude by their very nature, are not a consistent distance from each other. They are 'lemon wedges', not 'slices of bread'.



This chart is scaled at 1 : 75000. The scale of longitude runs along the top, and the scale of latitude down the side. Each division represents one minute, and every second division is bisected longitudinally for clarity. These divisions in turn are divided into 'tenths'.

Now study the pictures below:

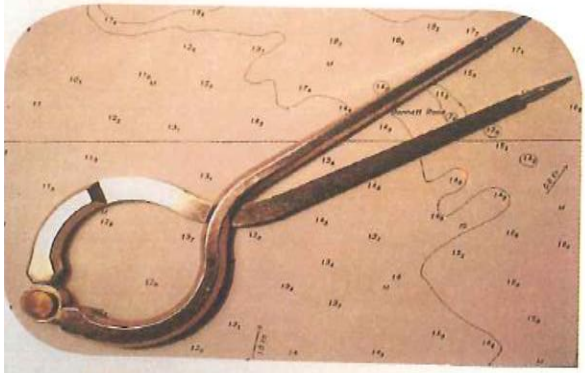




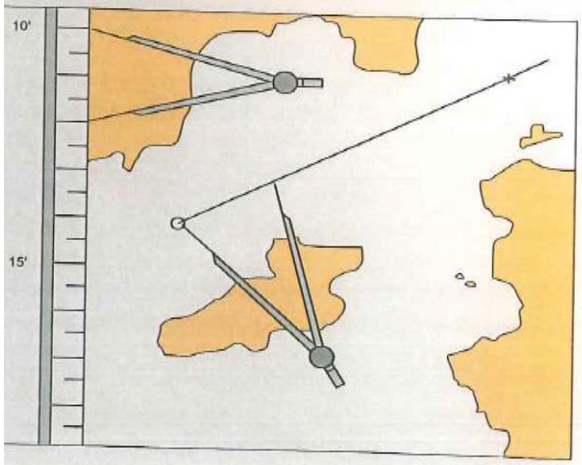
Note that one minute of latitude does not equal one minute of longitude. In fact it is longer by 1/10, even at only 20 degrees south of the equator. This difference increases markedly as one travels southwards. At the equator they are the same.

One minute of latitude is equal to one nautical mile, so only measure distance from the *sides* of the chart!

Dividers



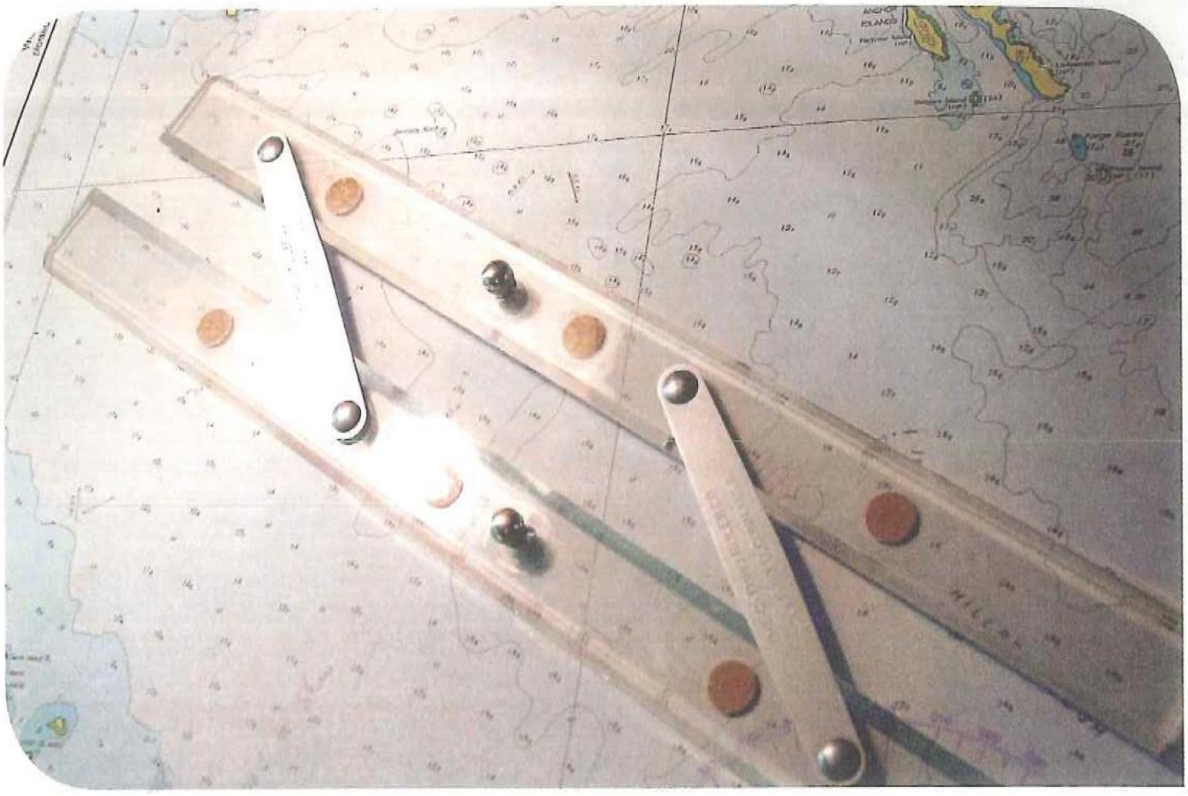
Good tools of the trade are essential for accuracy, and rarely a watch will pass without dividers being used for the measurement of distance on the chart. For larger distances, open the dividers to a smaller spread (say, four minutes of latitude – four nautical miles) and 'walk' them down the distance to be measured.



Measuring distance with dividers.

It is good practice to measure the scale of latitude in the vicinity of the area you are working on the chart, since the scale increases slightly as one moves south from the equator. In other words, don't measure from the southern end of the scale if you are working at the northern end of the chart! This difference is especially apparent on smaller scale charts.

Parallel rule



Primarily used for transferring bearings to or from the 'compass rose' on the chart, parallel rules are also used to read of the scales of latitude and longitude. Some practice is required to become proficient in the use of them, as they are prone to slip on the chart despite the non slip cork material that is applied to the underside of some types. Even a minute slip can result in a very large navigational error.

Practice 'walking' the parallel rules from one side of the chart to the other – see if they meet the opposite side of the chart aligned perfectly with the scale.

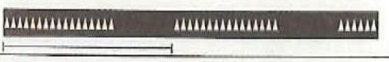
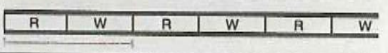
Chart interpretation – AUS5011

The Australian Hydrographic Office publishes all 'official' charts used on commercial vessels.

One of these 'charts' is *AUS5011*, and is in fact a booklet that is otherwise known as *Chart Symbols and Abbreviations.* It is an essential guide to the nautical chart for all navigators regardless of experience, and contains all of the information required for its full interpretation.

Extracts from AUS5011:

Lights

Light Characters			Light Characters on Light Buoys → IQ	471.2 K21-30a
	Abbreviation		Class of Light	Illustration — Period shown
	International	National		
10.1	F		Fixed	
10.2	Occulting (total duration of light longer than total duration of darkness)			
	Oc	† Occ	Single-occulting	
	Oc(2) Example	† GpOcc(2) Example	Group-occulting	
	Oc(2+3) Example	† GpOcc(2+3) Example	Composite group-occulting	
10.3	Isophase (duration of light and darkness equal)			
	Iso		Isophase	
10.4	Flashing (total duration of light shorter than total duration of darkness)			
	Fl		Single-flashing	
	Fl(3) Example	† GpFl(3) Example	Group-flashing	
	Fl(2+1) Example	† GpFl(2+1) Example	Composite group-flashing	
10.5	LFl		Long-flashing (flash 2s or longer)	
10.6	Quick (repetition rate of 50 to 79 - usually either 50 or 60 - flashes per minute)			
	Q	† QkFl	Continuous quick	
	Q(3) Example	† QkFl(3) Example	Group quick	
	IQ	† IntQkFl	Interrupted quick	
10.7	Very quick (repetition rate of 80 to 159 - usually either 100 or 120 - flashes per minute)			
	VQ	† VQkFl	Continuous very quick	
	VQ(3) Example	† VQkFl(3) Example	Group very quick	
	IVQ	† IntVQkFl	Interrupted very quick	
10.8	Ultra quick (repetition rate of 160 or more - usually 240 to 300 - flashes per minute)			
	UQ		Continuous ultra quick	
	IUQ		Interrupted ultra quick	
10.9	Mo(K) Example		Morse Code	
10.10	FFl		Fixed and flashing	
10.11	Al.WR Example	Alt.WR Example	Alternating	

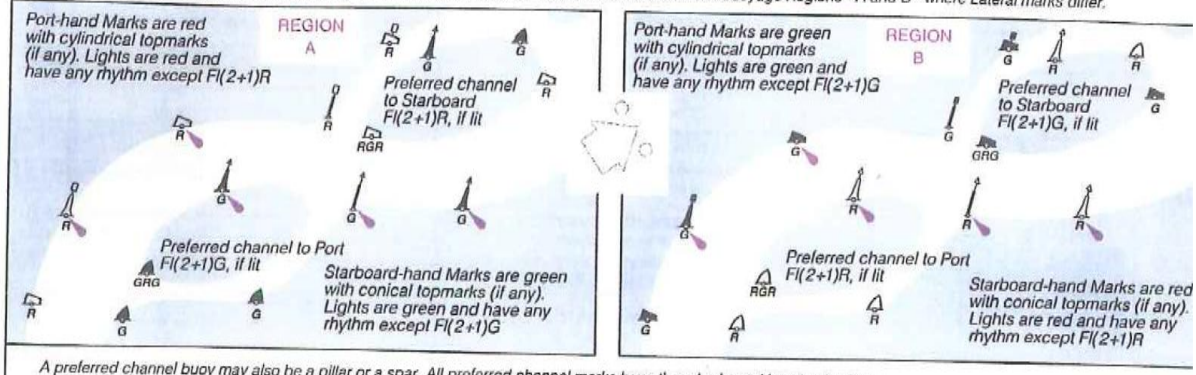
Buoys and beacons

130 IALA Maritime Buoyage System — *IALA International Association of Lighthouse Authorities*

Where in force, the IALA System applies to all fixed and floating marks except landfall lights, leading lights and marks, sectored lights and major floating lights.

The standard buoy shapes are cylindrical (can), conical, spherical, pillar, and spar, but variations may occur, for example: minor light-floats. In the illustrations below, only the standard buoy shapes are used. In the case of fixed beacons (lit or unlit) only the shape of the topmark is of navigational significance.

130.1 Lateral marks *are generally for well-defined channels. There are two international Buoyage Regions - A and B - where Lateral marks differ.*



A preferred channel buoy may also be a pillar or a spar. All preferred channel marks have three horizontal bands of colour.

Where for exceptional reasons an Authority considers that a green colour for buoys is not satisfactory, black may be used.

130.2

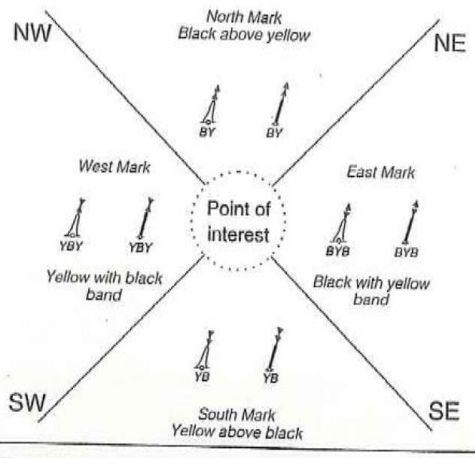
Symbol showing direction of buoyage where not obvious.

Symbol showing direction of buoyage where not obvious, on multicoloured charts (red and green circles coloured as appropriate).

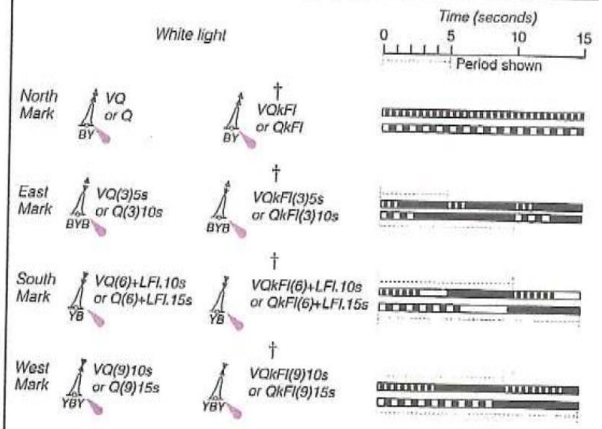
130.3 Cardinal Marks *indicating navigable water to the named side of the marks. Cardinal marks have the same meaning in Regions A and B*

UNLIT MARKS

Topmark: 2 black cones



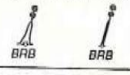
LIGHTED MARKS



The same abbreviations are used for lights on spar buoys and beacons. The periods, 5s, 10s and 15s, may not always be charted.

130.4 Isolated Danger Marks, stationed over dangers with navigable water around them.

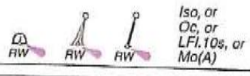
Body: black with red horizontal band(s)
Topmark: 2 black spheres



Fl(2) † GpFl(2) *White light*

130.5 Safe Water Marks, such as mid-channel and landfall marks.

Body: red and white vertical stripes
Topmark (if any): red sphere



Iso, or Oc, or LFl.10s, or Mo(A) † Occ *White light*

130.6 Special Marks, not primarily to assist navigation but to indicate special features.

Body: (shape optional): yellow
Topmark (if any): yellow X

Fl.Y etc. *Yellow light*

Chart datums

All depths on the chart (called *'soundings'*) are measured from the chart datum for depths. Usually, this will be the Lowest Astronomical Tide, or LAT – that is, the lowest tide that could be theoretically predicted to occur under average meteorological conditions.

All heights on the chart are measured from the chart datum for heights. Usually this will be Mean High Water Springs (MHWS) – that is, the long term average of the heights of high water at full and new moon.

All clearances on the chart (such as those under bridges or power cables) are usually measured from Highest Astronomical Tide (HAT) – that is, the highest tide that could be theoretically predicted to occur under average meteorological conditions.

In addition, a 'safety margin' is also added to clearances.


AUSTRALIA – EAST COAST

QUEENSLAND

BAILEY ISLET TO REPULSE ISLANDS

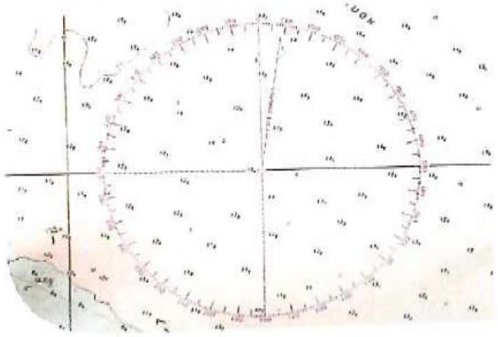
SCALE 1:75 000 at lat 27° 15'

Depths are in metres and are reduced to Chart Datum, which is approximately the level of Lowest Astronomical Tide. Depths shown in upright figures are from old or inadequate surveys.
Heights are in metres. Underlined figures are drying heights in metres and decimetres above Chart Datum; overhead clearance heights are above Highest Astronomical Tide; all other heights are above Mean High Water Springs.
Positions are related to the World Geodetic System 1984 Datum. (see SATELLITE DERIVED POSITIONS Note).
Projection: Mercator.
Navigational marks: IALA Maritime Buoyage System - Region A (Red to port).
Acknowledgements: Queensland Transport (Maritime Division), National Mapping.

Chart datum can be found in the charts 'title block', along with other important information including magnetic anomalies, recommended tracks and marine protected areas. The scale of the chart can also be found here.

The compass rose

Every chart will normally have at least two compass roses that are also printed in magenta. These are used in conjunction with parallel rulers to transfer bearing lines, course lines and so on across to the rose, so that they can be given a true angular notation.



For example, if a line is drawn across a body of water on the chart, along which your vessel is to travel, you must then transfer this line by 'walking' the rule from it across to the nearest compass rose, and so read off a true bearing.

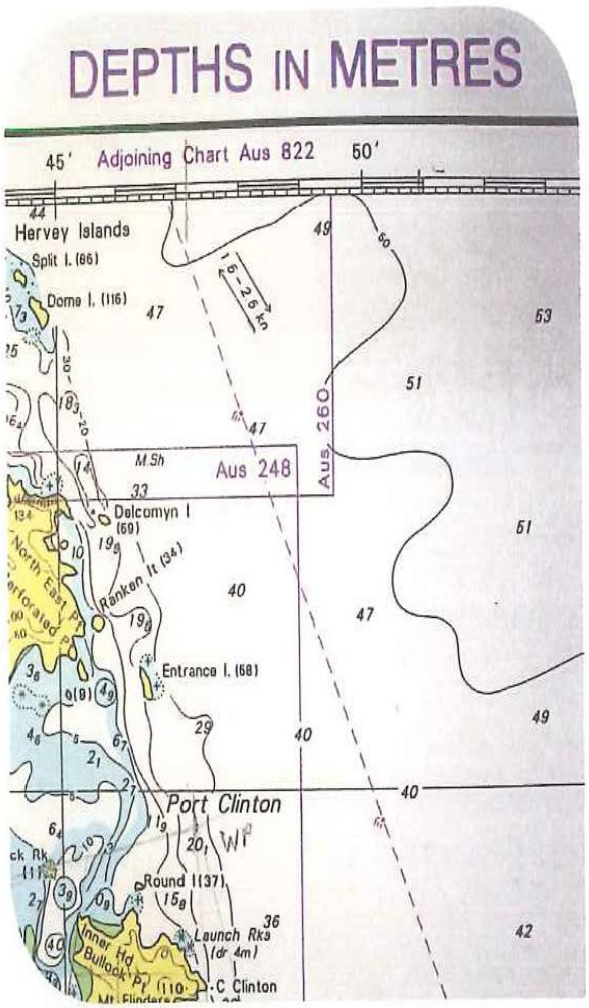
The process is reversed in the case of a compass bearing taken of a landmark.

The compass rose also indicates the variation of the earth's magnetic field in the area, and an indication of how much it is increasing or decreasing each year. This error *must* be applied along with any deviation of the compass caused by the influence of the ship itself (particularly those constructed of steel), and is the subject of further study beyond the scope of this section.

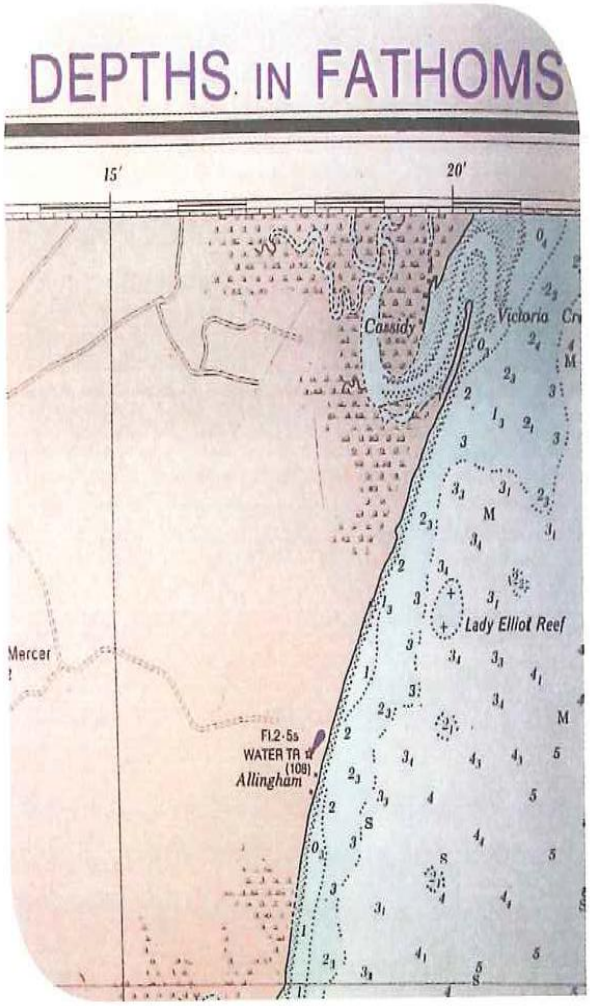
Metric and imperial charts

Although most charts of the Australian coastline are now metric, several older ones are still in use. Care needs to be taken when moving from one chart to another, particularly with regard to depths, as one fathom is nearly equal to two metres!

As shown, metric and imperial charts are not only indicated as such on the upper left, and lower right corners of the chart in large magenta print (magenta shows up boldly under red light which is used at nightime to protect the watchkeeper's night vision), but also by their colour schemes. The most obvious difference being that the land is yellow on metric charts and grey on the older imperial charts.



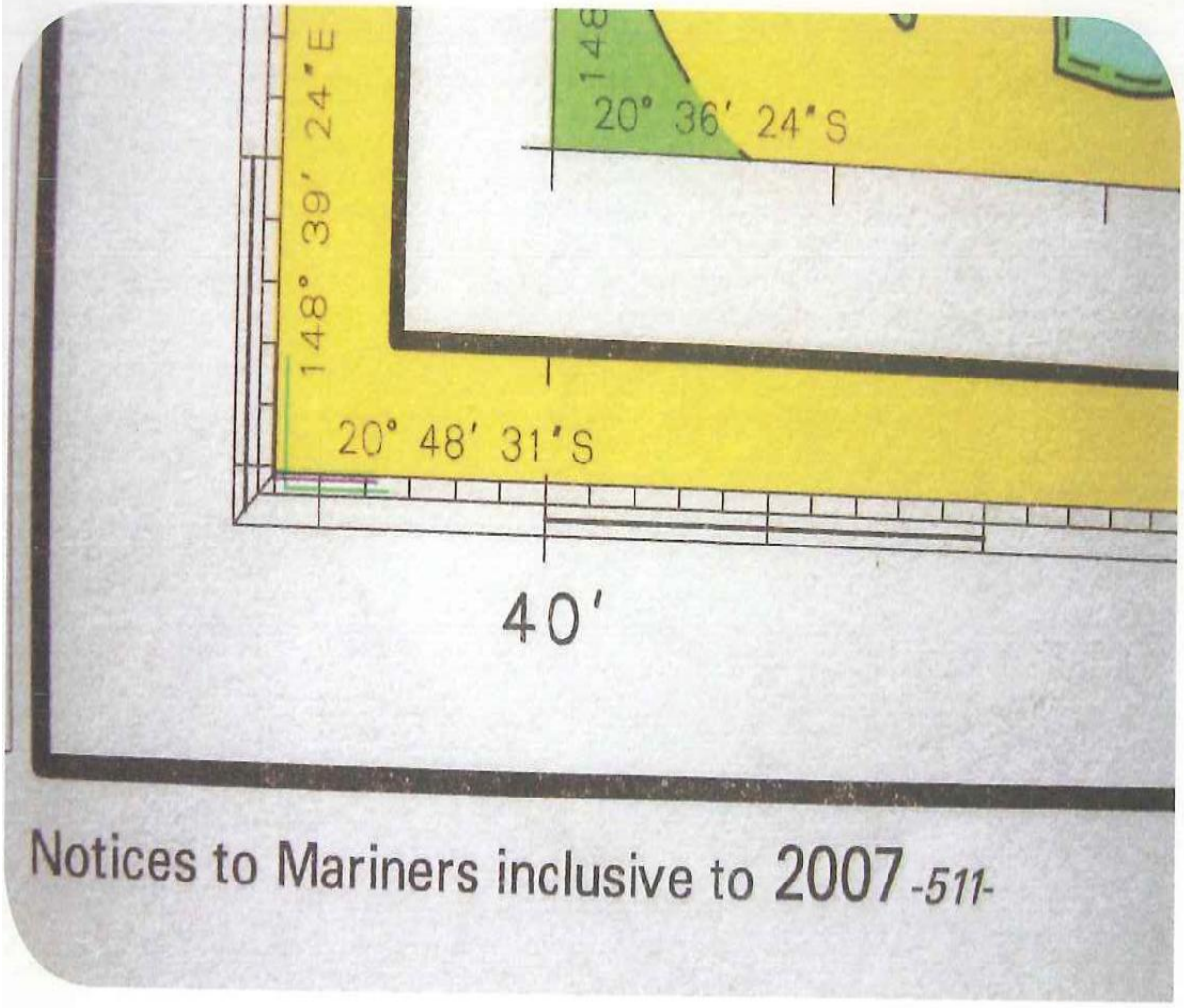
Metric chart.



Imperial, or 'fathom' chart.

Notices to mariners

The Australian Hydrographic Office issues corrections and changes to charts as an annual and 26 fortnightly editions. Corrections pertinent to a vessel's own charts must be made, and the correction year and number listed at the bottom left hand corner of the chart. Permanent corrections are to be made with a magenta pen, and temporary corrections made with a pencil.



This chart has been corrected at the date of purchase to the Notices to Mariners number shown. Further corrections are the duty of the Master/navigator.