Australian Government

Geoscience Australia

PROCEDURES

FOR

DESCRIBING MARITIME

BOUNDARIES

Version 1.0

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Procedures for Describing Maritime Boundaries

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Disclaimer

This document provides procedures for technical aspects of writing maritime boundary descriptions. It is also intended as an aid for Government departments and agencies developing policy in Australia's offshore area.

Due to the complexities of Australia's offshore regime and the legislative instruments covering that area, this document is not comprehensive and does not replace the need to seek appropriate legal and geospatial advice**.**

More information

For legal information relating to maritime boundaries, please contact:

The Attorney-General's Department,
Office of International Law

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Acknowledgments

This document replaces the *Guidelines for Describing Maritime Boundaries* that was prepared by the Law of the Sea and Maritime Boundaries Advice (LOSAMBA) project, Geoscience Australia with the advice and assistance of the Australian Government Office of Spatial Data Management's former Marine Boundaries Working Group.

This document was produced by LOSAMBA under the auspices of the Interdepartmental Committee on the Law of the Sea (IDCLOS) with guidance from the Technical Subcommittee (TSC) of that group

Document history

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Guidelines v1.0	December 2006	Endorsed by Spatial Data Management Group.
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1 Purpose

The purpose of this document, *Procedures for Describing Maritime Boundaries* ('the Procedures'), is to provide unambiguous descriptions that give a consistent framework for government departments and agencies involved in the marine area.

They provide:

- policy makers and negotiators with a broad understanding of the geospatial issues that need to be considered when defining maritime boundaries;
- geospatial professionals with technical advice on how to describe and map maritime boundaries unambiguously; and,
- all stakeholders with legally defensible boundaries that improve administration over Australia's offshore jurisdiction and minimise the potential for litigation.

The Procedures do not replace the need to seek appropriate legal and geospatial advice when determining and describing maritime boundaries.

2 Introduction

The fundamental legislative basis for Australia's jurisdiction in the offshore area is the Seas and Submerged Lands Act 1973. This act reflects the provisions of the United Nations Convention of the Law of the Sea [as done at Montego Bay, Jamaica on 10 December 1983, and to which Australia is a signatory]. It is not practical to identify all the various pieces of legislation and regulations that maybe relevant when preparing a maritime boundary description.

Boundary setting in the marine environment has become increasingly complex as governments seek to manage a growing range of marine activities and interests; including border protection, fishing, environmental management, petroleum and mineral leases, native title and shipping. To manage effectively Australia's maritime jurisdiction, agencies need to know where areas and limits of rights, obligations, restrictions and interests are located, and how they relate to each other.

The fundamental aim of a maritime boundary description is to produce a document that can be realised by navigators on either paper or electronic navigation charts (ENC), and provides an unambiguous framework for administration, surveillance and enforcement of Australia's maritime jurisdiction. It is important to write descriptions in 'plain English', but not at the expense of specific technical words or terms that provide precise meanings to the description.

Descriptions of maritime boundaries may occur in treaties or legislation, such as statutes, regulations and subsidiary instruments, including zoning plans and boundaries of marine protected areas.

Descriptions of boundaries have tended not to be consistent and the quality can vary considerably. In some cases, there is insufficient and/or imprecise information to identify clearly, where the boundary is located. This may make it difficult, if not impossible, to realise its location on a map, or within a Geographic Information System (GIS). This situation has prompted the writing of these Procedures.

Establishing and describing maritime boundaries pose some unique navigational challenges and they should not be confused with cadastral boundaries. Therefore, it is important that the descriptions have a geospatial framework that is mathematically definable to enable them to withstand legal scrutiny. The dynamic nature of some coastlines, coupled with existing tidal and seasonal regimes, can complicate boundary descriptions.

Modern navigational aids, known generically as Global Navigation Satellite Systems (GNSS), allow location to be determined with greater accuracy. That is why, it is important to write descriptions of boundaries that can be realised, and ensure effective management of Australia's offshore jurisdictional limits.

To define maritime boundaries and offshore jurisdictional limits effectively, a combination of policy, legal and technical skills are required. While it is not necessary for policy makers and negotiators to understand the technical details, it is essential they understand that getting them wrong can have a significant impact on surveillance, enforcement and management.

The provision of technical advice and assistance at the beginning of the process of determining an area or boundary can avoid problems later on. The Law of the Sea and Maritime Boundary Advice (LOSAMBA) project of Geoscience Australia (GA) have a team of geospatial specialists to provide technical advice to all Government departments and agencies. Contacts for LOSAMBA are:

Email: maritime@ga.gov.au or
Phone: 02 6249 9111 (Reception)

While these Procedures consider aspects of written descriptions of maritime boundaries, they also recognise the need for compatibility with digital 'map' data. Digitally reproducible descriptions provide reliable repeatability of the depiction of the line or area concerned, at least reducing if not eliminating transcription errors.

These Procedures aim to raise awareness of the geospatial issues related to describing maritime boundaries and offshore jurisdictional limits, and provide information to assist in preparation of unambiguous, technically complete descriptions. Knowing 'where' a boundary is located will contribute towards the better management and enforcement of activities applying to Australia's maritime jurisdiction.

3 Before you start writing

Issues relating to the geospatial definition of a maritime boundary can arise at any time throughout the process; from the early concept/negotiation stage through to the final drafting stage. Agencies involved in determining maritime boundaries need to be aware of the geospatial issues involved and engage a geospatial expert from the outset of negotiations. Before you start drafting, it is important to know:

- ***where*** the boundary is to be located
- ***what*** is the purpose of the boundary
- ***whether*** other interests exist in the area
- ***who*** can provide specialist geospatial advice

3.1 Know where the boundary is to be located

It is important to have a clear understanding of where a maritime boundary is to be located, as well as any inclusions, or exclusions, to it. The following aids are useful for depiction of a proposed offshore area:

- nautical charts and bathymetric maps for issues related to the coastal zone, water surface area, water column and seabed;
- topographic maps for issues related to coastal zone, hinterland;
- aeronautical charts for air space issues and aerial surveillance of offshore jurisdictional limits; and
- rectified aerial photography or satellite imagery is especially useful when recent or current information is required, but it will need interpretation by an expert in the field to maximise its use.

To ensure a successful outcome when discussing maritime boundaries with other stakeholders, it is important to be flexible and know what variations to the intended boundary are acceptable.

When defining boundaries it is essential for the policy makers to communicate clearly to the geospatial specialists where the boundary is to be located, also the regime over which it is to operate, i.e. airspace, seabed or water column or a combination of these.

An important consideration is whether a new boundary needs to align with an existing legally defined boundary or physical feature (such as the coastline or edge of a reef) or does it stand alone and as such can be defined solely by coordinates.

Some boundaries are subject to more frequent change than others are; some examples of these types of descriptions are marine nature reserves and fisheries access areas. While boundaries, such as those negotiated between countries and formalised by treaty arrangements are, for all practical purposes, at least a long-term arrangement, if not permanent. When the intention is that a new boundary should abut an existing one, the description should specify the portion of existing boundary that is common to both.

Where the abuttal is with an existing boundary that is possibly subject to change, the description should not include coordinates that are common to both boundaries; as any future changes to the coordinates of the existing boundary will then create either an hiatus or an overlap.

Overlapping boundaries can at times be mutually exclusive and invalidate the described area. There is also a risk that the description could in part, wind up being beyond the jurisdiction of an overarching piece of legislation or regulatory instrument and consequentially also be invalid.

GISs are now the norm for handling geospatial data. Where possible, this has resulted in a trend to produce descriptions that are compatible to a "cut and paste" process to eliminate transcription errors that may lead to positional errors when producing maps and diagrams that depict the intent of the description. Therefore, if the area or line is suitable, aim to produce a description, in an appropriate format, for direct insertion into a GIS with minimum manipulation.

Aim to make maritime areas and boundaries as simple as possible. While simplicity in design is desirable, it is not always possible, and some descriptions by their nature are complex. Above all, it is essential to avoid any ambiguity.

Mariners and other users are more likely to refer to products derived from written descriptions, rather than the description itself. Distribution of boundary locations may be in the form of charts; customised maps; lists of coordinates; or digital data. While these products compliment and assist in the interpretation of the original written description, it is essential they reference that description as the primary source from which to define the location and extent of an area, line, or point

3.2 Know what the intention is for defining the area

To produce an appropriate description it is important for all concerned to have a clear understanding of the intention of the boundary; this will ensure a description that provides a location that is capable of being realised in a practical way.

3.3 Know whether other interests exist in the area

A diverse and growing number of rights, restrictions, obligations and interests exist within Australia's maritime jurisdiction; making it an increasingly complex area to manage. It is important to understand what interests may exist within your area of interest, and whether they can co-exist or are in conflict with each other. It is important to identify and consult with all of the relevant stakeholders.

Maps provide a valuable visual aid that enables all parties involved in the process to have a common understanding of where the proposed boundary is to be located in relation to other interests in the area. Maps are a valuable part of the process from initial discussions by stakeholders and advising agencies through to the final drafting and presentation of the boundary.

3.4 Know who can provide expert advice

Issues that arise when describing boundaries often occur in the early stages of discussions by stakeholders of a new maritime boundary. Quite often the people involved have little knowledge or understanding of the complex geospatial issues that may confront them. It is important to know who can provide specialist advice, both geospatial and legal. The Procedures focus on the geospatial issues; see below for contact details of geospatial experts from Geoscience Australia.

A collaborative working relationship and clear communication between the policy makers and the geospatial experts is essential to achieving effective outcomes. A problem often encountered is when people try to explain where a boundary is to be located in technical terms (they try talking the geospatial expert's language), rather than clearly articulating the intention and allowing the geospatial expert to interpret this. Poor communication between the policy makers and geospatial experts can result in the boundary being located in the wrong place. To avoid problems that may result from the provision of inadequate or ambiguous information, seek the involvement of geospatial experts from the outset of the process.

Geoscience Australia (GA) provides advice to the Australian Government on the location of Australia's maritime limits. GA can provide specialist assistance to Australian Government and agencies to prepare or review written descriptions and maps, as well as other advice relating to maritime boundaries. For assistance or advice, please contact LOSAMBA at the contacts given previously.

4 Describing maritime boundaries

4.1 Documenting a boundary

Unlike most land-based boundaries, pegs, walls or fences cannot readily, or permanently, mark maritime boundaries. Normally written descriptions are the authoritative sources of maritime boundaries, often with supporting maps to complement the description.

Given the reliance on written descriptions, it is important that boundary definitions are unambiguous and have legal integrity. A map that complements the description is important as it helps to visualise where the boundary is located. However, any map produced needs appropriate annotation that clearly states that it not the authoritative source of information. Boundary definitions should include the following information:

- the extent of the area
- any exclusions (where applicable)
- seabed, air space and water column (where applicable)
- definitions of any terms used
- a map (recommended)
- horizontal datum (or geodetic datum) where coordinates are used
- digital data (optional)

4.2 Components of a boundary

The description of a maritime boundary is usually by a series of lines that enclose an area (e.g. a marine park, port limit or fishing zone) and usually reference one, or a combination, of the following components:

- coordinates;
- existing legally-defined boundaries;
- physical features;
- lines (e.g. meridians, parallels, geodesics, etc.);
- a geodetic datum – all descriptions require a reference to a geodetic datum (refer to section 6.4.1 — *Horizontal Datums*).

Boundaries generally enclose an area. It is important when describing a boundary to indentify unambiguously the outer extent, together with any exclusion areas that occur within the boundary.

4.3 Applicable areas within a boundary

Sometimes it is necessary to exclude an area, or areas, that occur within the extents of the primary area. In such cases, the description of the excluded area should immediately follow the primary description. The same techniques to describe the outer extent of area also apply when describing an excluded area.

4.4 Existing boundaries

Maritime boundaries can reference existing boundaries as part of their description. When using this technique, make a clear statement to identify the existing boundary, and provide an accurate reference to the source of this boundary.

Example

All of that area of the Southern Ocean bounded by the line commencing at [*]*:*

(a) the point of Latitude 38°50'00" South, Longitude 139°59'47" East;

(b) from there east along the parallel of Latitude 38°50'00" South, to its intersection by the ***offshore area*** [**] *boundary between South Australia and Victoria;*

(c) from there south-westerly along that offshore area boundary to its intersection by the parallel of Latitude 39°43'00" South;

(d) from there west along that parallel to its intersection by the meridian of Longitude 139°02'42" East; and

(e) from there north-easterly along the geodesic to the point of commencement.

All geographic coordinates are expressed in terms of the World Geodetic System 1984 (WGS 84).

(When the area described is subject to surveillance and enforcement activities express the coordinates in terms of WGS 84. This datum is the same as used for hydrographic charts, electronic charts and aeronautical charts. It is a positive aid to surveillance and enforcement activities. Should there be a prosecution of an infringement, it removes the necessity of expert witness statements on datum transformations. It is also be in accord with a National Mapping Council resolution from the 70's/80's that stated that for all areas outside of the Australian Map Grid framework coordinates would be expressed in terms of the WGS.

Where the area being described relates to petroleum or mineral lease the current appropriate datum to reference to coordinates to is the Australian Geodetic Datum 1966 (AGD 66).)

[**] *The offshore area in relation to each State and the Northern Territory is that part of the scheduled area relating to that State or the Northern Territory between that outer limit of the coastal waters and the outer limit of the continental shelf. The scheduled areas are defined in Schedule 1 of the Offshore Petroleum and Greenhouse Gas Storage Act 2006.*

As a rule, avoid re-describing an existing, legally defined boundary. Although this may appear to be accurate, it can result in a boundary different to the one intended, especially if one of the boundaries changes.

As mentioned above in Part 3, where an existing boundary may be subject to change, re-describing the coordinates of this boundary should be avoided. The reference to the existing boundary should by a statement that it follows the particular portion that abuts the new area.

For example, when aligning a boundary with the outer limit of the coastal waters of a State, or the Northern Territory, include a statement to this effect. This means that both descriptions will then reflect any subsequent amendment to the outer limit of the coastal waters.

In this example, by describing the coastal waters boundary as ‘three nautical miles seaward of the low water line’ would lead to incorrect interpretations and discrepancies between the boundaries when that was not the intention. In addition, use of a term, such as ‘low water line’ is not specific, as it could be one of several low tide levels.

Sometimes a description includes a reference to a coordinate located on an existing boundary. Any amendment to the existing boundary (as happens from time to time), will result in the coordinate reference no longer being located on that boundary. This creates ambiguity, and raises the question, which point forms part of the boundary: the coordinate itself; or a point located on the boundary closest to that coordinate?

Example

(a) *from there north-easterly along the geodesic (*see ‘line type’ below*) to its intersection by the outer limit of the exclusive economic zone of Australia at the point of Latitude 50°33’44” South, Longitude 160°22’44” East;…*

By including the words ‘*the point closest to*’ to the above description, avoids any ambiguity and provides greater certainty:

(b) *from there north-easterly along the geodesic to its intersection by the outer limit of the exclusive economic zone of Australia <u>at the point closest to</u> the point of Latitude 50°33’44” South, Longitude 160°22’44” East;…*

5 Procedural Rules

This section provides some advice on the procedures to follow when preparing a description or map of maritime boundaries.

5.1 Commencing a description

There are several ways to commence a description, the nature of the line or area will influence the wording of the opening phrase. It is important that this opening phrase stands alone from the distinct points that make up the boundary. The reason for this is that it enables the unique identification of each point within the description, which means any reference to a specific point is unambiguous, and does not need restating in the reference.

Examples

The line commencing at: or

The area commencing at: or

The area the boundary of which commences at:

(a) the point of Latitude 18°23’45” South. Longitude 122°36’25” East;

(b) from there east along the parallel of Latitude 18°23’45” South to its intersection by the meridian of Longitude 123° East;….

The particular point of commencement may be a specific point of latitude and longitude, or the intersection of a particular type of line (the description of types of lines is below at paragraph 6.4).by a specific feature or existing boundary.

5.2 Point identification

Identifying turning points, or bends, on a boundary line by a unique reference in the description assists users when relating coordinates in the description to points on an accompanying map. Also, when discussing a description, or referring to specific points in correspondence, a unique identifier removes any ambiguity about the point under consideration. The preferred standard is to identify points is using bracketed, lower case letters. Where large numbers of points are involved start at *(a)* then if required to *(aa), (ab)…* or if more required *(ba), (bb)* …etc

Example

The line commencing at:

(c) the point of Latitude 18°23’45” South. Longitude 122°36’25” East;

(d) from there east along the parallel of Latitude 18°23’45” South to its intersection by the meridian of Longitude 123° East;….

(bb) from there to the point of commencement

5.3 Direction of lines

Specify the direction when describing individual lines within a boundary; for example, *in a* *<u>southerly</u>* *direction to the point of latitude.* The direction is important where more than one line could be drawn between the two points. For example; *along the low water line of the island to the point of latitude* could be ambiguous as there is presumably two ways around the island. Using a direction, *<u>generally southerly</u>* *along the low water line of the island to the point of latitude* will normally add clarity and resolve the ambiguity. Theoretically, there are two lines between any two points of latitude and longitude: the shortest distance between the two points, and another longer line around the world.

While there are mandated rules for describing a direction, the following terminology is recommended:

- If following a parallel of latitude or a meridian of longitude use precise terms, such as north, south, east, or west.

Example

…from there east along that parallel to its intersection by the meridian of Longitude 123° East;

- If following a line (geodesic or loxodrome) between two points then less specific terms are acceptable, such as northerly, southerly, easterly, westerly, north easterly, etc.

Example

…from there north-easterly along the geodesic to the point of Latitude …

- If following a sinuous or curved feature, such as a coastline or curved boundary, then the overall direction or series of directions, can be specified in less specifically by using the word 'generally'.

Example

…from there generally southerly along the mean high water line to its intersection by the parallel of Latitude 12°34' South;

5.4 Units of measure

Specify whether you are using *nautical miles* or *kilometres* when measuring the distance of maritime boundaries. Mariners prefer to use *nautical mile* (1,852 metres) as it closely approximates one minute of latitude. Hydrographic charts generally use nautical miles and the Mercator projection.

There are a number of symbols used to represent a nautical mile. The symbol 'nm' is frequently used; however this is also the International System of Units' (SI) symbol for a nanometre. The symbol 'M' was adopted by the United Nations Commission on the Limits of the Continental Shelf. As there is still no internationally agreed symbol for a nautical mile, it is important to specify which symbol is used.

5.5 Typographical errors

Carefully proof read your document for typographical errors, particularly in the use of numbers. An incorrect number while not always obvious may radically alter the location of the intended boundary.

To reduce the risk of entering coordinate values incorrectly, if possible transpose these values from a digital source by 'cutting and pasting' the values into the document. Another simple for obvious errors is to plot the coordinate values from the written description using suitable background data that will help identify obvious errors.

5.6 Independent check

It is important that an independent person with appropriate skills and knowledge check the written description and map. LOSAMBA at GA are able to assist agencies with checking.

5.7 Finishing a description

There are basically two finishing phrases for a description, one is when the boundary being defined is a closed area and therefore the commencing point will also be the terminating point, or, as often happens with delimitations between countries, the line will terminate at a totally different point from the starting point.

Examples

…from there generally southerly along the mean high water line to the point of commencement. or

…from there south-westerly along the geodesic to the point of commencement. or

from there north-easterly along the geodesic to the point of Latitude 12°15'28". Longitude 144°41'03" where it terminates.

5.8 Maritime boundary checklist

Appendix C provides a checklist as an aid to ensure that all the key elements of describing a maritime boundary are covered.

6 Description specifics

The following sections deals in some detail with some of the specifics involved in writing a description. However, keep in mind that technical issues covered here are not exhaustive, as on many occasions the description will involve complex issues.

Geospatial specialists in LOSAMBA at GA have the technical expertise and broad corporate knowledge of boundaries in Australia's offshore jurisdictional limits and can provide sound advice on the specifics relating to boundary descriptions.

6.1 Coordinates

Maritime boundaries and offshore jurisdictional limits can be described by a series of geographic coordinates connected by lines (see section 6.5 – *Types of Lines*), or as a boundary projected out to a specific distance from a point. All coordinates must reference a horizontal datum. Use of a geodetic datum removes any ambiguity about the geographic reference framework for the description. With advanced positioning systems, it is easy for people responsible for enforcement and management of these areas to identify where they are located.

Examples

The area the boundary of which commences at:

(a) the point of Latitude 60°34'45.05" South, Longitude 153°47'39.87" East;

*(b) from there south-easterly along the geodesic to the point of Latitude 60°35'20.22" South, Longitude 153°49'40.12" East;…*or

The limit of the Dodgy Reef Marine Nature Reserve is the circle of radius 2.5 nautical miles centred at the point of Latitude 12°23'45.67" South, Longitude 123°45'56.78" East. or

(a) from there clockwise easterly along the geodesic arc of radius 200 nautical miles concave to Macquarie Island to the point of Latitude 51˚ 01' 38.44" South, Longitude 158˚ 59' 53.57" East ("Point ANZ 31");

6.2 Format

It is normal practice to express geographic coordinates (latitude/longitude) as (°) degrees, (') minutes and (") seconds; rather than using decimal degrees. However, at times coordinates expressed in degrees and decimal minutes may be useful for mariners.

It is good practice with values for minutes and seconds from 0 to 9 to include a leading zero, that is, Latitude 12°0'1" South should be written as Latitude 12°00'01" South. Similarly, for single digit degrees of latitude add a leading zero, that is, 8° becomes 08°. This clearly indicates that a digit is not missing.

For all practical purposes, one minute of arc of latitude is approximately one nautical mile, and one second of arc of latitude is approximately 30 metres. These are useful references when using navigation charts and provide a more readily adaptable coordinate than one merely expressed as decimal degrees.

Symbols or words can be used to denote (°) degrees (') minutes and (") seconds. The use of symbols is preferred as they make the description more readable and can be directly cut and pasted into mapping applications. While not wrong to write degrees, minutes and seconds as words, it is a carry over from the era of typewriters and telex machines. These machines did not have facilities for all symbols, especially the degrees symbol. They are easily inserted from computer keyboards. (The degree symbol can be inserted by typing [ALT]248).

Example

(a) *from there to the point of Latitude 60°34'45.05" South, Longitude 153°47'39.87" East; …….*

Where there are a series of coordinates connecting sequentially by a consistent method, it is possible, and convenient, to use a table or tables within the description.

Where pre-existing boundaries that form part of the description are expressed in terms of a specific geodetic datum that is different from the bulk of the other coordinates, then it is desirable, for the sake of repeatability and consistency, that a supplementary table be attached.

In all cases, whether describing an area, line or point, describe the coordinates by reference to a specific geodetic datum (See Section 6.4).

This practice is useful when providing coordinates in more than one format or datum is required. For example, the coordinates of a boundary may be in the form of a running description. However, having a list in degrees, minutes and seconds might be useful, as separate coordinate lists facilitates the boundary to be easily reconstructed for input into mapping systems and plotted directly onto navigation charts (or other geospatial products). In addition, the provision of a list in digital form should eliminate transcription errors when producing a map, chart or plot of the boundary.

If a separate coordinate list is supplementary to the written description, then make it clear that it is secondary to the description. The following example provides appropriate wording.

Example

Note:

The coordinates provided in the following table reference <datum> *and correspond to the written description of the* <name of marine area>. *In the event of a discrepancy between the written description and the coordinates given in the table below, the description takes precedence.*

6.3 Precision and accuracy

People quite often interpret *precision* and *accuracy* to have a similar meaning. In a geospatial setting, these two words have very different meanings. Keep the following in mind when writing a description.

6.3.1 Accuracy

This relates to the degree of uncertainty of the location of a boundary on the ground. For example, 'along the coastline' is a vague statement and as a result inaccurate, as there may be considerable variation in the coastline between high and low tide, this leads to uncertainty when relating the description to its location on the ground. Positional uncertainty is another term for positional accuracy.

6.3.2 Precision

This relates to the resolution or exactness of the description. For example, 20° 35’ 20.357” is more precise than 20° 35’ 20". *However, in terms of treaty documents or legislative instruments both are equally accurate.*

While some surveyors interpret a coordinate to have an accuracy of plus or minus so many units, treaties and legislative instruments treat the coordinates in a description as an absolute value. For example, a surveyor may interpret the coordinate 20°35’ to mean that the coordinate is correct to the nearest minute or in other words, ± 30”. However, when used in a treaty or legislative instrument it is interpreted as being the same as 20°35’00.000”

When possible, to make points easier to read, plot and locate, define coordinates with low precision coordinates, such as whole degrees or whole minutes.

However, sometimes the intention is for a new boundary (for all practical purposes) to be coincident with an existing boundary but using a different geodetic datum. To maintain the relationship between the two datums, a higher level of precision is necessary, requiring the expression of the coordinates one or two decimal points of a second (equivalent to 3 metres and 0.3 metres respectively).

The use of GNSS and other sophisticated navigation tools means that location to less than the one metre is now possible. In practical terms however, most boundaries do not require such precision or accuracy.

The following table equates coordinate precision with distance on the ground (note: ground distances are approximate only).

Precision (latitude)	**Nautical miles (approx.)**	**Metres (approx.)**
one minute	1	1,852
one second	0.16667	30
0.01 second	0.00167	0.3

6.4 Datums

All coordinates must reference a datum or the accuracy and precision of those coordinates is meaningless. There are two principal types of datums: horizontal and vertical.

6.4.1 Horizontal datums

The horizontal (or geodetic) datum is a mathematical model used to define the basis of a coordinate system. It is important to include a reference to a horizontal datum when using coordinates to describe a boundary, as its omission can lead to positional uncertainty. A coordinate location can vary several hundred metres depending on which datum is used.

Horizontal datums commonly used in Australia include:

- Geocentric Datum of Australia (GDA 94)
- Australian Geodetic Datum (AGD 66) (AGD 84)
- International Terrestrial Reference Frame (ITRF)
- World Geodetic System (WGS 84)

Seek expert advice if there is any doubt about the appropriate geodetic datum to use when using coordinates to define a maritime boundary. Advice is available from Geoscience Australia.

6.4.1.1 World Geodetic System

The World Geodetic System 1984 (WGS 84) coordinate system is a conventional terrestrial reference system; the definition of this coordinates system follows the criteria outlined in the International Earth Rotation Service (IERS) Technical Note 21.

WGS 84 is the datum used for aeronautical and hydrographic navigation and charts. It is also the default operational framework for GPS units.

It is the obvious and appropriate choice for maritime boundary descriptions where surveillance and enforcement activities are concerned.

WGS 84 varies by less than one metre from GDA 94 and at the centimetre level from ITRF.

The US National Geospatial-Intelligence Agency (NGA) periodically undertakes computations to maintain centimetre level alignment between WGS84 and ITFRF. As the differences between the two reference frames are at the centimetre level worldwide; while not identical, they are for practical purposes the same.

Example

Note:

The coordinates in this legislation/proclamation are expressed in terms of the World Geodetic System 1984 (WGS84).

6.4.1.2 International Terrestrial Reference Frame

The Earth is constantly changing shape, and to understand this in context, when observing the motion of the Earth's crust, it must have a reference frame. This has resulted in the adoption of the International Terrestrial Reference Frame (ITRF). For those requiring more information the following website provides details on ITRF; http://itrf.ign.fr/general.php or contact Geoscience Australia.

A Terrestrial Reference frame provides a set of coordinates of selected points located on the Earth's surface, and can be used to measure plate tectonics, regional subsidence or loading and/or used to represent the Earth when measuring its rotation in space.

It is continually monitored and modified. However, new versions will be very close to the ITRF2000 and transformation parameters will be available to convert coordinates between the various determinations. If sub-centimetre accuracy is required, the version of ITRF and the epoch will ensure boundaries can be very accurately located at any time in the future.

[For Australia, ITRF2000 is currently the most appropriate datum to use for national boundaries requiring long-term certainty of location.]

As mentioned above, at the centimetre level, for all practical purposes and day-to-day operational requirements, it is the same as WGS 84. *From a practical perspective in Australia's offshore jurisdictional area, the default datum to use is WGS 84 as it has direct relevance to currently used positioning systems, as well as ENCs and paper charts.*

For further information go to: http://itrf.ensg.ign.fr/general.php

6.4.1.3 Australian Geodetic Datum

The Australian Geodetic Datum (AGD) was the predecessor of GDA. AGD -was based upon the best available data at 1966 (AGD66), and was readjusted in 1984 (AGD84) - not all Australian States and Territories adopted the new adjustment.

AGD was also a model for the Australian mainland and Tasmania only. GDA replaced AGD as it was not appropriate for use with GNSS. The horizontal difference between AGD and GDA94 is approximately 200 metres.

The *Geodetic Datum of Australia Technical Manual* (version 2.2; http://www.icsm.gov.au/gda/gdatm/index.html) provides transformation parameters to convert coordinates represented in AGD66 and AGD84 to GDA94.

Note:

- Do not use this datum for new maritime boundary descriptions.
- The datum is still valid for Offshore Petroleum and Greenhouse Gas Storage Act 2006.

6.4.1.4 Geocentric Datum of Australia

The Geocentric Datum of Australia (GDA94) is part of a global coordinate reference frame derived as a sub-set of ITRF92 and is directly compatible with the GPS as at the 1994.0 epoch. It has been in use since 2000 and replaces (AGD66).

Similar to AGD, GDA94 is most appropriate for the Australian mainland and Tasmania only and should be avoided in the offshore area.

Example

All geographic coordinates are expressed in terms of the Geocentric Datum of Australia 1994 (GDA94) as described in the Commonwealth of Australia Gazette GN35 of 6 September 1995.

6.4.2 Vertical (tidal levels) datums

Vertical (tidal levels) datums are used to define a variety of limits. In terms of the offshore area, a specific tidal datum is the inner limit defining the territorial sea, while another defines the limit of the States and Northern Territory. Some maritime boundaries may use a particular tidal level in order to manage a specific resource or activity.

For example, in the case of native title claims, a claim may not only encompass pastoral and property leases as defined in deposited plans under the cadastral systems of the relevant state, but may also include the offshore areas abutting them. Therefore, to maintain continuity of the claim, while keeping the offshore area separate from the cadastre, the landward limit of the offshore area may be described as being mean high water, or in the case of Queensland mean high water springs (see Annex B).

Water depths shown on hydrographic charts relate to chart datum, this is usually *Lowest Astronomical Tide* (LAT).

Descriptions of maritime boundaries usually refer to the territorial sea baseline as defined under the Seas and Submerged Lands Act 1973, that is, lowest astronomic tide, although other tidal levels may be used.

When the maritime boundary description references the coastline it also needs to state the appropriate tidal datum; for example, *mean high water* or *the territorial sea baseline*.

Ambiguity arises when a general term like *high water mark* is not clearly defined, as it could refer to *mean high water springs*, *mean high water*, etc. — each representing a different line where the tidal datum intersects with the land. Appendix B outlines the relevance and definition of some selected tidal levels.

6.5 Types of lines

As different types of lines have different properties, it is important to specify the type of mathematically definable line that connects points in a description. The difference between the various types of lines can make a significant difference to where a boundary is located. The following types of lines are commonly used in maritime boundary descriptions.

6.5.1 Geodesic

Geodesics, also referred to as great circles, are lines representing the shortest distance between two points on the surface of a sphere. Descriptions of treaty lines frequently use them as the preferred method of connecting the agreed coordinates for a maritime delimitation between two countries. As segments of a *great circle,* they generally appear as curved lines on maps and charts using the Mercator projection; and straight lines on maps using the Universal Transverse Mercator projection. Another property is that they more accurately reflect a line of equidistance between adjacent coastlines.

Example

The line commencing at:

(a) *the point of Latitude 18°23'45" South. Longitude 122°36'25" East;*

(b) *from there south-easterly along the geodesic to the point of Latitude 18°56'27' South, Longitude 123°05'03" East;……….*

6.5.2 Loxodromes

Loxodromes, also referred to as *rhumb lines,* are lines of constant bearing that appear as straight lines on maps and charts using the Mercator projection. They do not reflect a line of equidistance between adjacent coastlines, particularly if the coastlines are more north/south of each other. An "equidistant" (median) line described by loxodromes will not be truly equidistant and will favour a coastline closer to the equator.

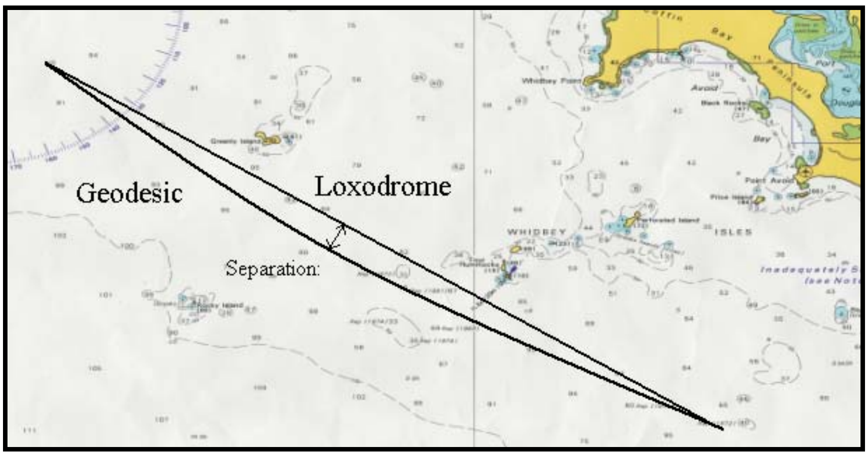
Example

The line commencing at:

(c) *the point of Latitude 18°23'45" South. Longitude 122°36'25" East;*

(d) *from there south-easterly along the loxodrome to the point of Latitude 18°56'27' South, Longitude 123°05'03" East;……….*

Where lines extend over a long distance, the location of loxodromes and geodesics can vary significantly (see Figure below). The extent of the difference is dependent upon the direction of the line and its distance from the equator.



Difference between a geodesic and loxodrome (Mercator Projection

6.5.3 Parallels of latitude

Parallels of latitude are lines running east/west and parallel to the Equator. They intersect meridians of longitude at right angles and therefore are lines of constant bearing and small circles on the surface of the Earth. As such, they are a particular type of loxodrome, except for the equator which, because it is a great circle, is both a loxodrome as well as a geodesic.

Example

The line commencing at:

(a) the point of Latitude 18°23'45" South. Longitude 122°36'25" East;

(b) from there east along the parallel of Latitude 18°23'45' South to its intersection by the meridian of Longitude 123°05'03" East;

(c) from there north along that meridian to its intersection by the parallel of Latitude 18°00'52' South;

(d) from there south-westerly to the point of Latitude 18°15'45" South, Longitude 122°48'29" East;……….

6.5.4 Meridians of longitude

Meridians of longitude are the angular measurement measured east or west from the prime meridian and they are great circles, as well as being both geodesics and loxodromes.

Example

The line commencing at:

(a) the point of Latitude 18°23'45" South. Longitude 122°36'25" East;

(b) from there north along the meridian of Longitude 122°36'25" East to its intersection by the parallel of Latitude 18°00'32" South;

(c) from there east along that parallel to its intersection by the meridian of Longitude 123°12'05" East

(d) from there south-westerly to the point of Latitude 18°15'45" South, Longitude 122°48'29" East;……….

Notes:

(a) It is accepted practice when writing a maritime boundary description *not* to use the terms loxodromes or geodesics for parallels or meridians but to refer to them specifically as parallels or meridians together with the specific direction that boundary is running in, i.e. east or west for parallels and north or south for meridians.

(b) In both examples above for parallels and meridians the description starts at a point of latitude and longitude, as it is a point then standard practice in the next sub-paragraph is specify the parallel or meridian that the line then follows.

6.6 Physical features

Boundaries can reference physical features, such as coastlines, the edge of a reef, or an isobath (i.e. a line of constant depth). It is important to consider whether it is practical to reference such features; as well as the legal, management and technical consequences of doing this. It may well be that it is not physically possible to realise the location of the feature.

Coastlines, for example, are dynamic and depending on the geomorphology, constantly changing by varying degrees. Terms such as 'edge of a reef'; 'low water mark' or 'high water mark' are inadequate without further definition. When using these types of phrases, it is important to include a clear definition of the meaning of these terms to avoid ambiguity.

Another example is a boundary following the *high water mark.* This is complicated as there are many definitions of high water (e.g. mean high water or highest astronomical tide). As mentioned above, determining the actual position of such lines can be difficult, particularly in areas of large tidal range and gradually sloping foreshores. Furthermore such features change over time due to erosion and/or accretion.

Example

…from there generally southerly along the coastline at ***mean high water springs*** *to* its intersection by…

The example above identifies a specific tidal level; however, it may not be possible to realise the exact location of this line on the ground due to the dynamics of the coastline.

Similarly, the use of an isobath (depth contour) is difficult to realise, as such features are frequently not accurately defined and very difficult to enforce. A series of coordinates that approximate the isobath could overcome this problem.

Features, such as 'Smith Headland' or 'the edge of Jones Reef', should be qualified by use of coordinates and/or further definition to avoid ambiguity.

Cadastral law normally recognises a 'monument' over a 'measurement'. For instance, a description stating "*the harbour fairway beacon at Latitude 23°45'52.36" South, Longitude 152°26'32.51" East*" may be ambiguous if the coordinates are located some distance from the beacon. If disputed, a court is likely to, but not necessarily, rule in favour of the beacon ('monument') over the coordinates ('measurement'). This can be resolved by using descriptions similar to the following example.

Example

- *…the harbour fairway beacon nearest the point of Latitude 23°45'52.36" South, Longitude 152°26'32.51" East*; or

6.7 Reference to a distance from a feature or point

Sometimes a specific distance defines a boundary from a physical feature or coordinated point.

Example

- The outer limit of the territorial sea of Australia is *12 nautical miles from the territorial sea baseline*.
- The limit of a specific zone can be *an arc (or circle) of radius <x.x> nautical miles (or metres) centred at the point of Latitude 12°23'45.67" South, Longitude 123°45'56.78" East*.

Where the distance from a feature or point is large, the computation of the boundary can be complex. Geoscience Australia uses specialised software to compute such boundaries taking into consideration the spheroidal shape of the earth.

Computer mapping systems generally represent a curved line, such as an arc, by a series of short line segments. Where boundaries comprise an arc or series of arcs, take care to ensure that these display correctly when digitally depicted.

6.8 The use of tables

Some descriptions lend themselves to the use of tables listing sets of coordinates that are linked by the same type of line (geodesic or loxodrome).

The two main benefits of this technique are:

- It provides coordinates in a format that can easily be transposed directly into a GIS application, thereby reducing transcription errors; and,
- Other columns can be included that show the coordinates transformed to other geodetic datums that may be used in the area or reference to existing treaties or other legislated boundaries.

The following example is indicative of how tables may be used in a description. In this example the points in the column labelled *'Treaty'* refers to the treaty numbering of the particular point and the superscript notation refers to notes at the end of the description that provide the details of the specific treaty. The column labelled 'Datum' identifies the specific datum for the coordinates listed under the *'Latitude'* and *'Longitude'* columns. These are the coordinates used in the original document.

A further table may be appended at the end of the description that expresses the transformed coordinate values of these points to the geodetic datum used for the bulk of the points in the description. As explained previously, this approach of providing transformed coordinates should only be used for boundaries or areas that can be considered as 'permanent', namely treaty boundaries with neighbouring countries or boundaries satisfying obligations under international conventions.

Example

The line:

(a) commencing at point AUS-CS-1 and running thence along the loxodromes sequentially connecting the following points, defined by their coordinates, in the order stated;

POINT	LATITUDE	LONGITUDE	TREATY	DATUM
AUS 1	11° 35' 00.0000"S	123° 14' 00.0000"E	A25 (1)	AGD66
AUS 2	11° 23' 00.0000"S	123° 26' 00.0000"E	A24 (1)	AGD66

AUS 3	11° 28' 00.0000"S	123° 40' 00.0000"E	A23 (1)	AGD66
AUS 4	11° 26' 00.0000"S	124° 00' 00.0000"E	A22 (1)	AGD66
AUS 5	10° 50' 00.0000"S	139° 12' 00.0000"E	A3 (3)/A (4)	AGD66

(b) thence along the geodesics sequentially connecting the following points, defined by their coordinates, in the order stated

POINT	LATITUDE	LONGITUDE	TREATY	DATUM
AUS 6	11° 09' 00.0000"S	139° 23' 00.0000"E	B (4)	AGD66
AUS 7	10° 59' 00.0000"S	140° 00' 00.0000"E	C (4)	AGD66
AUS 8	14° 04' 53.4176"S	156° 37' 26.0152"E		ITRF2000
AUS 9	14° 05' 02.9157"S	156° 38' 08.3967"E		ITRF2000

ANNEX -A

The tables below express coordinates in terms of the International Terrestrial Reference Frame 2000 (ITRF2000) coordinates as defined by the International Earth Rotation Service at epoch 1 January 2000. These tables are to provide consistency in expressing treaty coordinates in terms of ITRF2000. The original treaty documents remain the primary source for the location of the boundaries as defined in the treaties.

POINT	LATITUDE	LONGITUDE	TREATY	DATUM
AUS-CS-1	11° 34' 54.9391"S	123° 14' 04.4777"E	A25 (1)	ITRF2000
AUS-CS-2	11° 22' 54.9291"S	123° 26' 04.4777"E	A24 (1)	ITRF2000
AUS-CS-3	11° 27' 54.9291"S	123° 40' 04.4777"E	A23 (1)	ITRF2000

7 Accompanying maps, diagrams and digital data

A map that complements a description is a useful visual aid that helps users to visualise where the boundary is located, in relation to other interests. A map and associated digital geospatial data will also help to validate the description and facilitate dissemination and presentation of the boundary. Digital data should always include appropriate metadata to the agreed ANZLIC Metadata Profile national standard (http://www.anzlic.org.au/).

Always include a cautionary note on the map or digital data to state that the description of the boundary is the primary reference and takes precedence over the map or other supporting information, should there be a difference between the two.

The Law of the Sea and Maritime Boundaries Advice project of Geoscience Australia has the necessary expertise to provide guidance to Australian Government agencies to produce compliant maps.

A map and corresponding metadata of digital data should generally contain the following information:

- title
- responsible agency or agencies
- datum
- projection
- north point
- scale
- grid lines
- data reference or source
- date
- disclaimer
- copyright
- additional notes (e.g. about limitations).

It is important that the boundary "lines" display correctly on the accompanying map/s. Depending on the length of the line and the map projection used, it may be necessary to compute additional points along the line for it to depict correctly. These additional points are for cartographic representation only and it is not necessary to include them in the description.

In addition, computer-generated arcs plot using a series of short line segments to account for the spheroidal shape of the earth. Again, there is a need to compute additional 'in-fill' points so that the depiction is correct and the chord to arc separation is within acceptable limits.

Geoscience Australia uses specialised geodetic software that adds extra points along the various types of lines and along arcs of circles to ensure they plot correctly regardless of the map projection used.

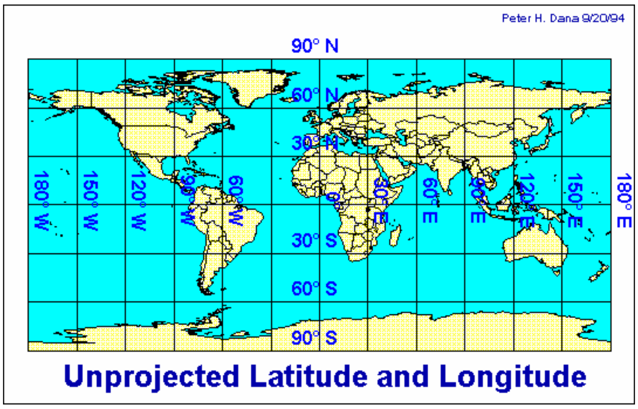
7.1 Projections

A map projection is a systematic representation of a spherical body such as the Earth on a flat (plane) surface. Each map projection has certain properties that make it useful for specific purposes. To represent accurate boundaries on a map it is necessary to know what the purpose of the map is, so that an appropriate projection is used.

A map projection is a mathematical model that represents the earth's three-dimensional surface on a flat two-dimensional plane. Projections can show true directions (azimuthal), true distances (equidistant), true areas and size (equal area), or true shapes and angles (conformal). It is possible to depict one or more of these properties on a map or chart, but never all — there is always some distortion. Reference to the projection used needs to be included on map or nautical chart. There are many different types of projection. The following sub-paragraphs describe some common projections and their characteristics.

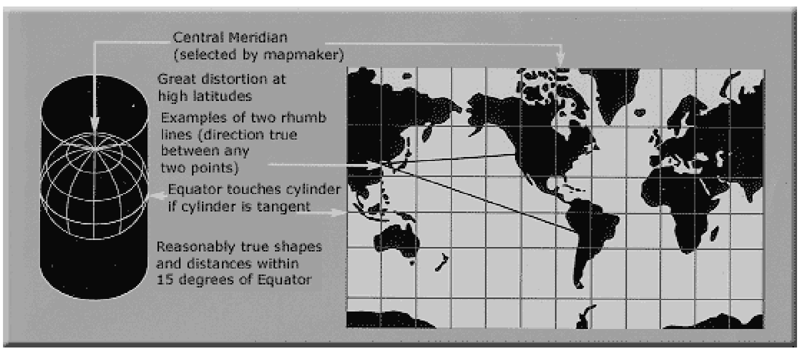
7.1.1 Geographic projection

This projection is a simple rectangular projection which is often the default setting for some GIS applications. Its use should be limited to simple, small-scale diagrams (A4 size at most), as considerable distortion can occur over large areas, particularly as distance increases from the equator.



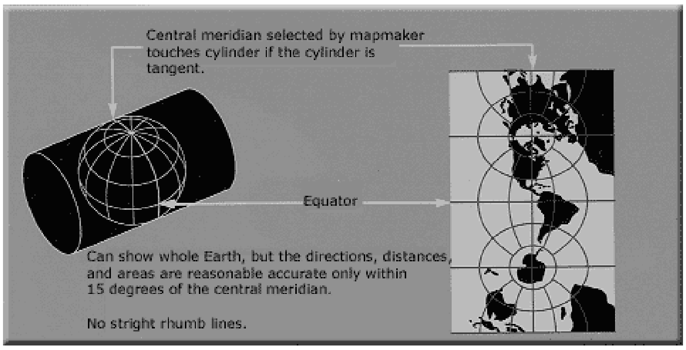
7.1.2 Mercator projection

This projection is ideal for navigation purposes as lines of constant bearing, such as rhumb lines and loxodromes, plot as straight lines. Scale is true at the equator or at selected parallel of latitude; scale increases towards the poles resulting in distortion of shapes. Meridians and parallels are straight and meet at right angles.



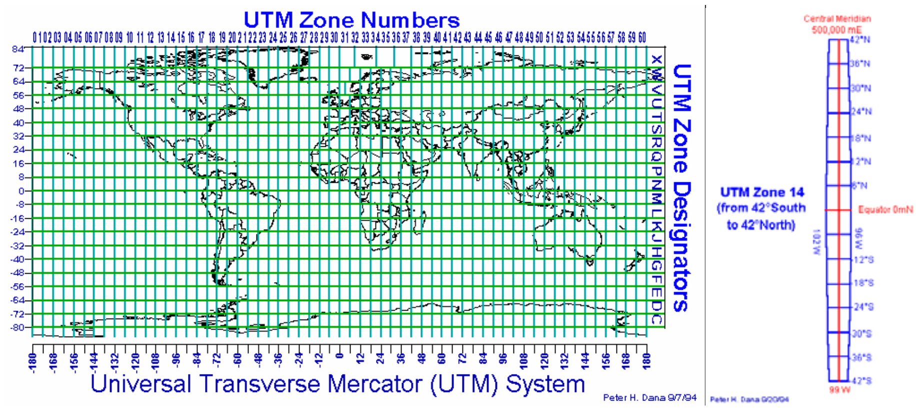
7.1.3 Transverse Mercator projection

This projection projects the sphere onto a cylinder tangent to a central meridian. Transverse Mercator maps are often used to portray areas with larger north-south than east-west extent. Distortion of scale; distance; direction, and area increase away from the central meridian.



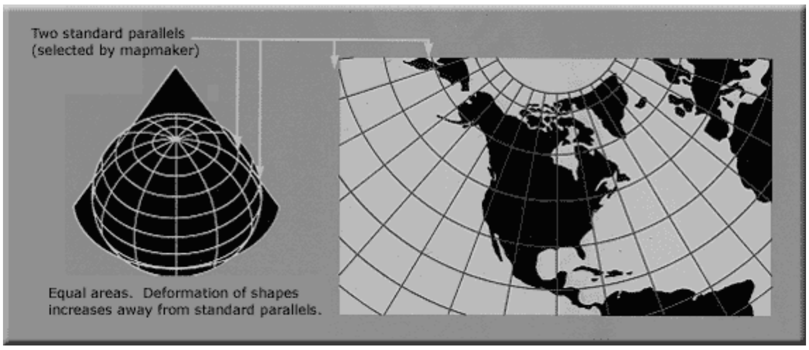
7.1.4 Universal Transverse Mercator projection

This projection is used to define horizontal positions worldwide by dividing the surface of the Earth into 6° zones, each mapped by the Transverse Mercator projection with a central meridian in the centre of the zone. UTM zone numbers designate 6° longitudinal strips extending from 80° South latitude to 84° North latitude. A map grid subdivides the zones; *Eastings* - measured from the central meridian (with a 500 km false easting to insure positive coordinates). *Northings* - measured from the equator (with a 10,000 km false northing for positions south of the equator). It is widely used for topographic mapping.



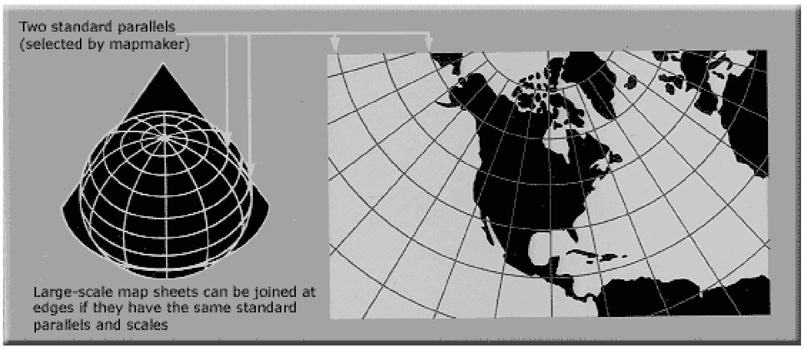
7.1.5 Albers Equal Area Conic projection

This projection distorts scale and distance except along standard parallels. Areas are proportional and directions are true in limited areas. Used in the United States and other large countries with a larger east/west than north/south extent.



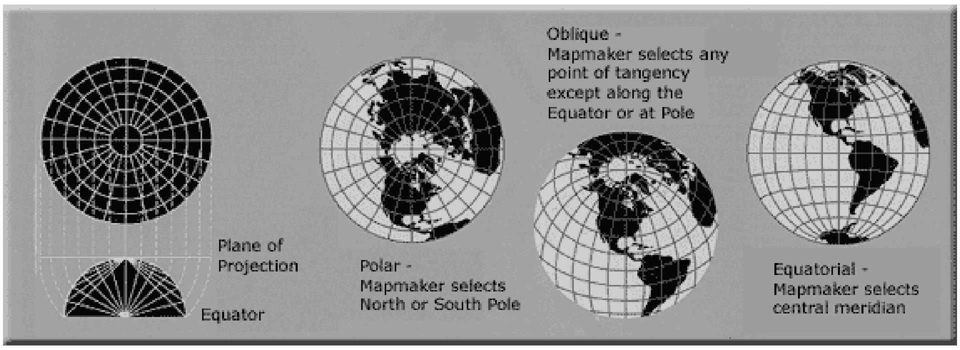
7.1.6 Lambert Conformal Conic projection

This projection distorts area and shape away from standard parallels. Directions are true in limited areas.



7.1.7 Lambert Azimuthal Equal Area projection

This projection can be used to map large ocean areas. The central meridian is a straight line others are curved. A straight line drawn through the centre point is on a great circle.



Acknowledgement

The above diagrams are reproduced with permission from:

- *Peter H. Dana, The Geographer's Craft Project, Department of Geography, The University of Colorado at Boulder(Unprojected Latitude .and Longitude, and UTM Zones diagrams);, and*
- *the U. S. Geological Survey (the remaining diagrams).*

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Appendix A — Glossary

Aeronautic Chart

An aeronautic chart is a map designed to assist in navigation of aircraft, much as nautical charts do for watercraft. Using these charts and other tools pilots are able to determine their position, safe altitude, best route to a destination, navigation aids along the way, alternative landing areas in case of an in-flight emergency, and other useful information such as radio frequencies and airspace boundaries. They used for navigation for aerial surveillance of Australia's offshore jurisdictional limits.

Australian Fishing Zone (AFZ)

The *Fisheries Management Act 1991* defines the AFZ as the waters adjacent to Australia and its External Territories within the outer limits of the Exclusive Economic Zone (EEZ). Generally, it does not include Coastal Waters except where there is a special agreement between the Commonwealth and a State. Some areas of the EEZ are excepted from the AFZ (e.g. waters adjacent to the Australian Antarctic Territory).

Australian Geodetic Datum 1966 (AGD 66)

This datum was adopted in 1966 and is defined by the parameters of the Australian National Spheroid and the coordinates of the Johnston Geodetic Station. This datum is used for the determination of coordinates for some Geoscience Australia products. AGD has been superseded by the Geocentric Datum of Australia (GDA 94).

Baseline

See *Territorial Sea Baseline*.

Bathymetric Map (Chart)

A bathymetric map is the submerged equivalent of an above-water topographic map. Bathymetric charts are designed to present accurate, measurable description and visual presentation of the submerged terrain. A bathymetric chart differs from a hydrographic chart in that accurate presentation of the underwater features is the goal while safe navigation is the requirement for the hydrographic chart. A hydrographic chart will obscure the actual features to present a simplified version to aid mariners in avoiding underwater hazards.

Coastal Waters of a State or Northern Territory

Those waters that within the Adjacent Area of the State or Territory that are within 3 nautical miles of the baseline from which the breadth of the Australian territorial sea is measured. The relevant baseline is that portion of the baseline that would be valid if the breadth of the Australian territorial sea had continued to be 3 nautical miles. It does not include waters that are within the limits of the State or Territory. For a definitive interpretation, refer to the Coastal Waters (State Power) Act 1980, or the Coastal Waters (Northern Territory Powers) Act 1980; or contact LOSAMBA or the Attorney-General's Department, Office of International Law for advice relating to coastal waters.

Coordinate systems

There are many basic coordinate systems in geometry and trigonometry. These systems can represent points in two-dimensional or three-dimensional space. René

Descartes (1596-1650) introduced systems of coordinates based on orthogonal (right angle) coordinates. These two and three-dimensional systems used in analytic geometry are often referred to as Cartesian systems. Similar systems based on angles from baselines are often referred to as polar systems.

The most commonly used coordinate system for maritime boundaries and offshore jurisdictional limits is the latitude, longitude system.

The Prime Meridian and the Equator are the reference planes used to define latitude and longitude. The geodetic latitude (there are many other defined latitudes) of a point is the angle from the equatorial plane to the vertical direction of a line normal to the reference ellipsoid. The geodetic longitude of a point is the angle between a reference plane and a plane passing through the point, both planes being perpendicular to the equatorial plane. The geodetic height at a point is the distance from the reference ellipsoid to the point in a direction normal to the ellipsoid.

Datum

A reference datum (mathematical model) is a known and constant surface which is used to describe the location of unknown points on the earth. See geodetic datum.

Electronic Navigation Chart

The electronic chart is a relatively new technology that provides significant benefits in terms of navigation safety and improved operational efficiency. More than simply a computer display, an electronic chart is a real-time navigation system that integrates a variety of information that is displayed and interpreted by the Mariner. It is an automated decision aid capable of continuously determining a vessel's position in relation to land, charted objects, aids-to-navigation, and unseen hazards. The electronic chart represents an entirely new approach to maritime navigation.

There are two basic types of electronic charts. Those that comply with the International Maritime Organization (IMO) requirements for vessels, known as the Electronic Chart Display and Information System (ECDIS), and all other types of electronic charts, regarded generically as, Electronic Chart Systems (ECS).

Geodesic

See section 6.5.1

Geocentric Datum of Australia 1994 (GDA 94)

The set of geographical coordinates based on the Geocentric Datum of Australia. GDA 94 was adopted in 1994 and implemented in the year 2000. It is compatible with Global Navigation Satellite Systems (GNSS).

Geodetic datum (see section 6.4.1)

Geodetic datums define the size and shape of the earth and the origin and orientation of the coordinate systems used to map the earth. Hundreds of different datums have been used to frame position descriptions since the first estimates of the Earth's size were made by Aristotle. Datums have evolved from those describing a spherical earth to ellipsoidal models derived from years of satellite measurements.

Modern geodetic datums range from flat-earth models used for plane surveying to complex models used for international applications which completely describe the size, shape, orientation, gravity field, and angular velocity of the earth. While cartography, surveying, navigation, and astronomy all make use of geodetic datums, the science of geodesy is the central discipline for the topic.

Referencing geodetic coordinates to the wrong datum can result in position errors of hundreds of meters. Different nations and agencies use different datums as the basis for coordinate systems used to identify positions in geographic information systems, precise positioning systems, and navigation systems. The diversity of datums in use today and the technological advancements that have made possible global positioning measurements with sub-meter accuracies requires careful datum selection and careful conversion between coordinates in different datums.

Geographic Information System

A geographic information system (GIS), or geographical information system captures, stores, analyses, manages, and presents data that is linked to location. Technically, GIS is geographic information systems that includes mapping software and its application with remote sensing, land surveying, aerial photography, mathematics, photogrammetry, geography, and tools that can be implemented with GIS software. Still, many refer to "geographic information system" as GIS even though it does not cover all tools connected to topology.

Geographic coordinates

A position given in spherical coordinates commonly known as latitude and longitude. See Coordinate systems.

Geodesic

The line of shortest distance between two points on the surface of the reference ellipsoid.

Global Navigation Satellite System (GNSS)

Global Navigation Satellite Systems (GNSS) is the standard generic term for satellite navigation systems that provide autonomous geospatial positioning with global coverage. GNSS allows small electronic receivers to determine their location (longitude, latitude, and altitude) to within a few metres using time signals transmitted along a line-of-sight by radio from satellites. Receivers on the ground with a fixed position can also be used to calculate the precise time as a reference for scientific experiments.

As of 2009, the United States NAVSTAR Global Positioning System (GPS) is the only operational GNSS. The Russian GLONASS is a GNSS in the process of being restored to full operation. The European Union's Galileo positioning system is a GNSS in initial deployment phase, scheduled to be operational in 2013. The People's Republic of China has indicated it will expand its regional Beidou navigation system into the global Compass navigation system by 2015.

The global coverage is achieved by constellations of about 30 MEO satellites in different orbital planes. The actual systems use orbit inclinations of >50° and orbital periods of 12 hours (height 20,200 km).

Hydrographic charts (nautical chart)

A hydrographic chart is a graphic representation of a maritime area and adjacent coastal regions. Depending on the scale of the chart, it may show depths of water and heights of land (topographic map), natural features of the seabed, details of the coastline, navigational hazards, locations of natural and man-made aids to navigation, information on tides and currents, local details of the Earth's magnetic field, and man-made structures such as harbours, buildings, and bridges. Hydrographic charts are essential tools for marine navigation; many countries require vessels, especially commercial ships, to carry them. Hydrographic charting may take the form of charts printed on paper or computerised ENCs.

International Earth Rotation and Reference Systems Service (IERS)

The IERS was established as the International Earth Rotation Service in 1987 by the International Astronomical Union and the International Union of Geodesy and Geophysics and it began operation on 1 January 1988. In 2003 it was renamed to International Earth Rotation and Reference Systems Service.

The primary objectives of the IERS are to serve the astronomical, geodetic and geophysical communities by providing the following:

- The International Celestial Reference System (ICRS) and its realization, the International Celestial Reference Frame (ICRF).
- The International Terrestrial Reference System (ITRS) and its realization, the International Terrestrial Reference Frame (ITRF).
- Earth orientation parameters required to study earth orientation variations and to transform between the ICRF and the ITRF.
- Geophysical data to interpret time/space variations in the ICRF, ITRF or earth orientation parameters, and model such variations.
- Standards, constants and models (i.e., conventions) encouraging international adherence.

International Terrestrial Reference Frame (ITRF)

The ITRF is an accurate global terrestrial reference frame produced and maintained by the International Earth Rotation Service (see IERS above), independent of the US military organisations who maintain WGS84. As mentioned in section 6.4.1, the US National Geospatial-Intelligence Agency (NGA) periodically undertakes computations to maintain centimetre level alignment between WGS84 and ITFRF.

Latitude (Parallel)

The latitude of a feature is its angular distance on a Meridian, measured northwards or southwards from the terrestrial Equator. See section 6.5.3.

Longitude (Meridian)

An angular distance measured east or west from a reference meridian (usually Greenwich) on the earth's surface. See section 6.5.4.

Loxodrome (Rhumb Line)

See section 6.5.2.

Meridian

See section 6.5.4

Nautical chart (hydrographic charts)

A chart specifically designed to meet the requirements of marine navigation, showing depths of water, nature of bottom, elevations, configuration and characteristics of coast, dangers and aids to navigation. Also called *marine chart*, *hydrographic chart*, or simply chart. It may be in paper form, or digital form as an electronic navigation chart (ENC).

Nautical mile (M)

A unit of distance equal to 1,852 metres. The International Hydrographic Conference adopted this value in 1929 and the International Bureau of Weights and Measures subsequently adopted it. The length of the nautical mile is very close to the mean value of the length of 1 minute of latitude, which varies from approximately 1,843 metres at the equator to 1,861.6 metres at the pole.

Navigation charts

Include both aeronautic and hydrographic charts

Offshore area

The offshore area in relation to each State and the Northern Territory is that part of the scheduled area for that State and the Territory as lies between that outer limit of the coastal waters and the outer limit of the continental shelf. Schedule 1 of the Offshore Petroleum and Greenhouse Gas Storage Act 2006 defines the scheduled areas. Sections 13 and 14 of the Offshore Minerals Act 1994 also reference Schedule 1 of the Offshore Petroleum and Greenhouse Gas Storage Act 2006, as defining the limits of its application.

Offshore Constitutional Settlement (OCS)

The Offshore Constitutional Settlement (OCS) deals with Commonwealth and State jurisdiction within the three nautical mile limit from the territorial sea baseline – in general, the States have responsibility for areas up to three nautical miles from the baseline. These waters are referred to as the Coastal Waters The Settlement also includes arrangements on managing oil, gas and other seabed minerals, the Great Barrier Reef Marine Park, other marine parks, historic shipwrecks, shipping, marine pollution and fishing. As the Settlement affects, and is reflected in, various pieces of legislation, it cannot found in a single document. The legislation that mirrors the provisions for power and title enacted for the States, has also been implemented covering the Northern Territory. A Commonwealth information booklet, 'A Milestone in Co-operative Federalism' (ISBN 0 642 04780 4) contains a summary of the arrangements.

Parallel

See section 6.5.3.

Rhumb line (Loxodrome)

Is a line that crosses all meridians at a constant angle. See section 6.5.2.

Territorial Sea Baseline (TSB)

The Territorial Sea Baseline is the line around the coast from which the limits of the Territorial Sea and other maritime zones are measured. The TSB for Australia is defined under the Seas and Submerged Lands (Territorial Sea Baseline) Proclamation 1006, subject to sections 9, 10 and 11 of that proclamation. [The TSB is frequently referred to as the 'baseline'.]

Topographic map

Topographic maps show information about the shape of the land—both natural features and purpose-built structures. They can be used to obtain precise measurements (within map scale limits) of distance, direction, area and quantity. Topographic maps can be:

- image maps that use aerial photography corrected to scale as a base. This is selectively enhanced with topographic information;
- line maps that are traditional topographic maps where all features have been interpreted for the map user from aerial photography;
- orthophoto maps that are similar to image maps but depict relief, selected enhanced roads and railways on an ortho-rectified image base—generally available only in hard copy; or
- double-sided maps that have image maps on one side, and the line map on the reverse.

UNCLOS 1982

Is the acronym for the United Nations Convention on the Law of the Sea as done at Montego Bay, Jamaica on 10 December 1982.

World Geodetic System 1984 (WGS84)

WGS is a reference system developed by the United States Department of Defense is currently the reference system for use with GPS. It is geocentric and globally consistent within ± 1m. The WGS84 system has been refined on several occasions since its inception. As mentioned above in the section on datums, the US National Geospatial-Intelligence Agency (NGA) periodically undertakes computations to maintain centimetre level alignment between WGS84 and ITFRF.

Appendix B — Selected Tide Levels – relevance & definition

The following is a table of selected tide levels based on one produced by the Intergovernmental Committee on Surveying and Mapping (ICSM) Tidal Interface Working Group. The Australian Hydrographic Service *Tidal Glossary* and the International Hydrographic Organisation *Hydrographic Dictionary* are the sources for the definitions. More information about tide levels is available online at http://www.hydro.gov.au/prodserv/tides/tidal-glossary.htm or http://www.iho.shom.fr/publicat/free/files/S-32-eng.pdf or http://www.icsm.gov.au/icsm/tides/tidal_interface.html

Tidal Datum	Relevance	Definition
1. HAT	• Limit of landward extent of tidal water under normal atmospheric circumstances.	***Highest Astronomical Tide*** The highest level of water that can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions.
2. MHWS	• Tidal datum for cadastral (boundary) purposes for Queensland under the Lands Act 1994, further interpreted *State of Queensland v Beames [2001] QSC 132 (8 May 2001)* and *Svendsen v State of Queensland and Anor (unreported) Supreme Court of Queensland No 32 of 1996.* • Nominally the high water coastline for hydrographic charts.	***Mean High Water Springs (MHWS)*** The average of all high water observations at the time of spring tide over a period time (preferably 19 years). Applicable in semi-diurnal waters only.
3. MHW	• Common law datum for cadastral (land boundary) purposes. Used in Australia unless amended by legislation (see above). • Frequently used as the coastal limit on topographic mapping.	***Mean High Water (MHW)*** The average of all high waters observed over a sufficiently long period.

Tidal Datum	Relevance	Definition
4. MSL	• Average limit of the tides.	***Mean Sea Level (MSL)*** The arithmetic mean of hourly heights of the sea at the tidal station observed over a period of time (preferably 19 years).
5. MLWS	•	***Mean Low Water Springs (MLWS)*** The average of all low water observations at the time of spring tide over a period of time (preferably 19 years). Applicable in semi-diurnal waters only.
6. MLW	• Is the definition of 'low water' in respect of determining the limit of Australian States and the Northern Territory.	***Mean Low Water (MLW)*** A tidal level. The average of all low waters observed over a sufficiently long period.
7. LAT	• Chart low water datum. • The tidal datum defined under the Seas and Submerged Lands (Territorial Sea Baseline) Proclamation 2006 as the baseline from which to measure the breadth of the territorial sea (subject to sections 9, 10 and 11 and with the exceptions of section 6 (b), (c), (d) or (e) of that proclamation).	***Lowest Astronomical Tide (LAT)*** The lowest tide level which can be predicted to occur under average meteorological conditions and under any combination of astronomical conditions.

Appendix C — Maritime Boundary Checklist

Consider the following when describing a maritime boundary:

- ☐ Involve geospatial specialists
- ☐ Unambiguously define the boundary, including:
    - o Outer extent of area
    - o Exclusions and/or inclusions
    - o Seabed / airspace / water column
- ☐ Use unambiguous terms and precise location references
- ☐ Use geographic coordinates in degrees (°), minutes (’) and seconds (”), (symbols not words)
- ☐ Clearly state an appropriate horizontal datum, such as, WGS84, ITRF2000 or GDA94
- ☐ Clearly state vertical (tidal) level – when required
- ☐ Use mathematically definable lines to connect the geographic coordinates
- ☐ Define terms used in the written description (e.g. high water mark)
- ☐ Annotate all measurements with a statement of units (e.g. nautical mile)
- ☐ Consistently use symbology, terms and formats throughout description
- ☐ Precision of coordinates
- ☐ Point numbering
- ☐ Directions of lines
- ☐ Independently check the written description for factual and typographic errors
- ☐ Prepare suitable maps or diagrams produced as an aid to the description, including the use of an appropriate projection