Examples: Those due to trade winds, monsoons, and westerlies on the polar side of 40° latitude.

Stream Current

(a) A continuation of a drift current, which has changed its direction by meeting an obstruction in its path such as land mass or another current, or

(b) A counter-current which acts to replace water displaced by other currents, or

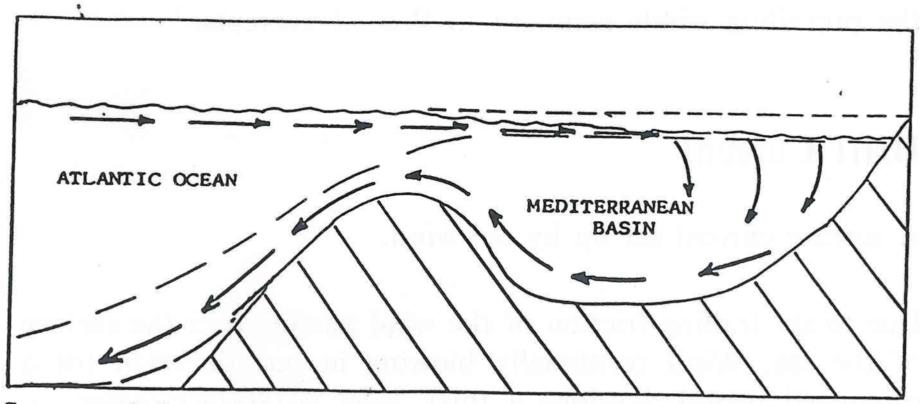
(c) A current flow due to unequal pressures brought about by differences of density, temperature or water level.

Examples: The Gulf stream, the Guinea current, the Kuro Shio, Agulhas and Equatorial counters.

The Gulf Stream being the most striking example, described as 'A river in an ocean'.

Example: current caused by difference in density: —

Strait of Gibraltar — East moving surface water, warmer and lighter flow along the surface from the Atlantic, while heavier layers flow out from the Mediterranean at a lower level.



Convergent Current

Convergent Current

A current established between basins which contain water of different densities. A surface current will flow into the sea with the higher density, while the lower bottom current will flow in the opposite direction.

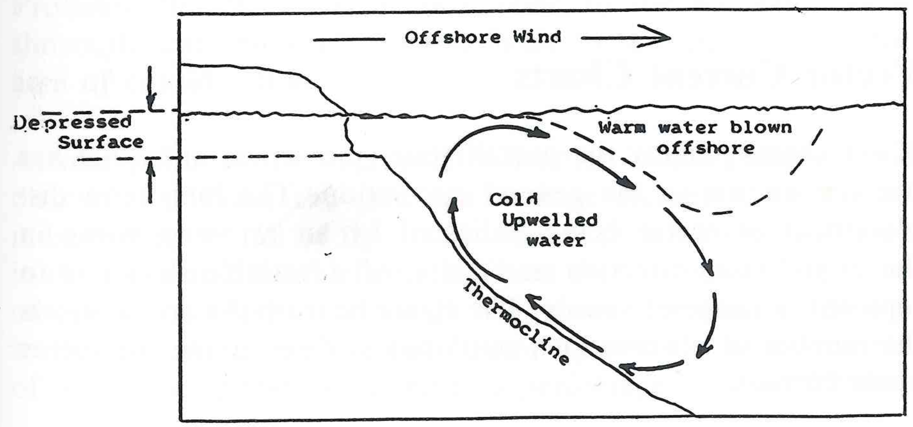
An example of this can be observed with the easterly flow of surface currents from the Atlantic Ocean into the Mediterranean Sea, via the Gibraltar Straits.

Upwelling Current

The term given to the movement of cold sea water from the lower depths of the ocean rising upwards to replace warmer surface water adjacent to the shoreline which is blown seaward.

Example: Peru or Humboldt Current.

They are a feature of the middle latitudes and are encountered when the thermocline shallows (10 to 20 fathoms). Sea life is usually greatly increased because an upwelling current provides important nutrients at surface levels. Mariners can therefore expect to meet increased traffic by way of fishing boats, factory ships and the like.



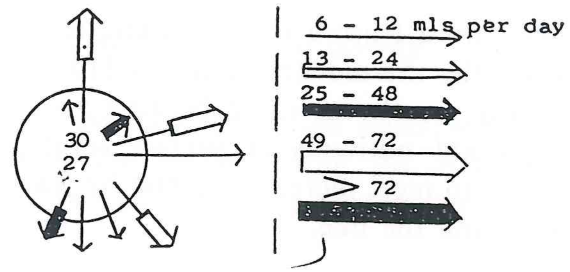
OCEAN CURRENT REFERENCES

Current Rose Charts

These current roses show the variability of the ocean current in the region that it covers. The information contained in the rose is derived from all available observations which are noted as being ½ knot or more. They are meant to be a representation of the current distribution over the total area.

In order to process the data, the compass is divided into 16 equal sectors (sub-division or amalgamation may occur in certain areas). The number of observed current settings, within the limits of each sector, is noted. This number is then expressed as a percentage frequency of the total number of observations. The obtained value is then used to determine the length of the 'arrow' which is constructed in the middle of the sector.
Each arrow is sub-divided to express the percentage frequency of occurrence, of certain ranges of speed, in that direction.

The upper figure in the rose represents the total number of observations.
The lower figure represents the percentage frequency of currents, having a rate of less than ½ knot.



Vector Current Charts

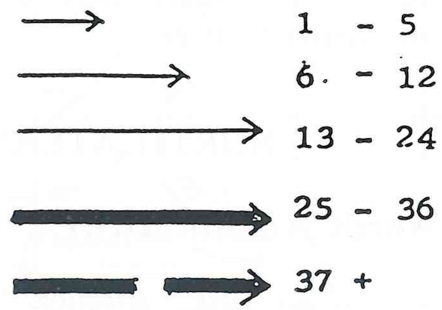
These charts portray the overall water movement and what has become known as the general circulation. The long term displacement of water being indicated by an arrow pointing in the appropriate direction and being of a variable thickness to represent a range of speeds. The figure beneath the arrow shows the number of observations employed in determining the vector mean current.

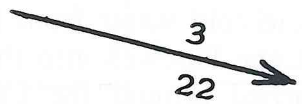
The vector mean current being the resultant value of all observations being considered for that area. That is to say the derived vector mean for each basic area is found from the difference in totals of the north-south components and the difference in totals of the east-west components.

The Vector Current Chart is used to calculate the drift of objects over long periods e.g. icebergs, derelicts, etc. The longer the period, the more likely the drift will approximate to the vector mean drift. Charts being devised for 3 month periods. Should periods of drift exceed this, then a combination of charts for the subsequent quarter would need to be employed.

Arrows flow with the current and represent the mean resultant. The mean position of the observation is at the centre of the arrow.

The upper figure represents strength (miles per day). The lower figure indicates the number of observations. Length and thickness of arrows represent strength (as shown in figure).





Predominant Current Charts

Probably the chart of greatest value to the navigator as it shows the current which is most likely to be experienced in the area of consideration.

Arrows point in the appropriate direction which represent the direction of flow, the rate (an average figure) is sometimes indicated at the tail of the arrow. Arrow presentations will vary in thickness and the thickness indicates the constancy. The value of constancy being obtained by comparing the number of observations in the predominant sector against the total number of observations and expressed as a percentage. 24 

Example:
High constancy when the percentage of observations is greater than, say 75%. Low constancy, less than 50% would imply variable rated and variability in direction.

The predominant direction is determined by examination of a 90° sector over the compass (e.g. 000°–090°). All data concerning currents is obtained within that sector together with the number of occasions that the current sets within the sector. The sector is then rotated 15° with new set limits of 015° — 105°, and the number of observations within the sector is noted again. The process is continued to provide 24 sectors in all and the mean direction of the sector containing the greatest number of observations is the direction of the charted predominant current.

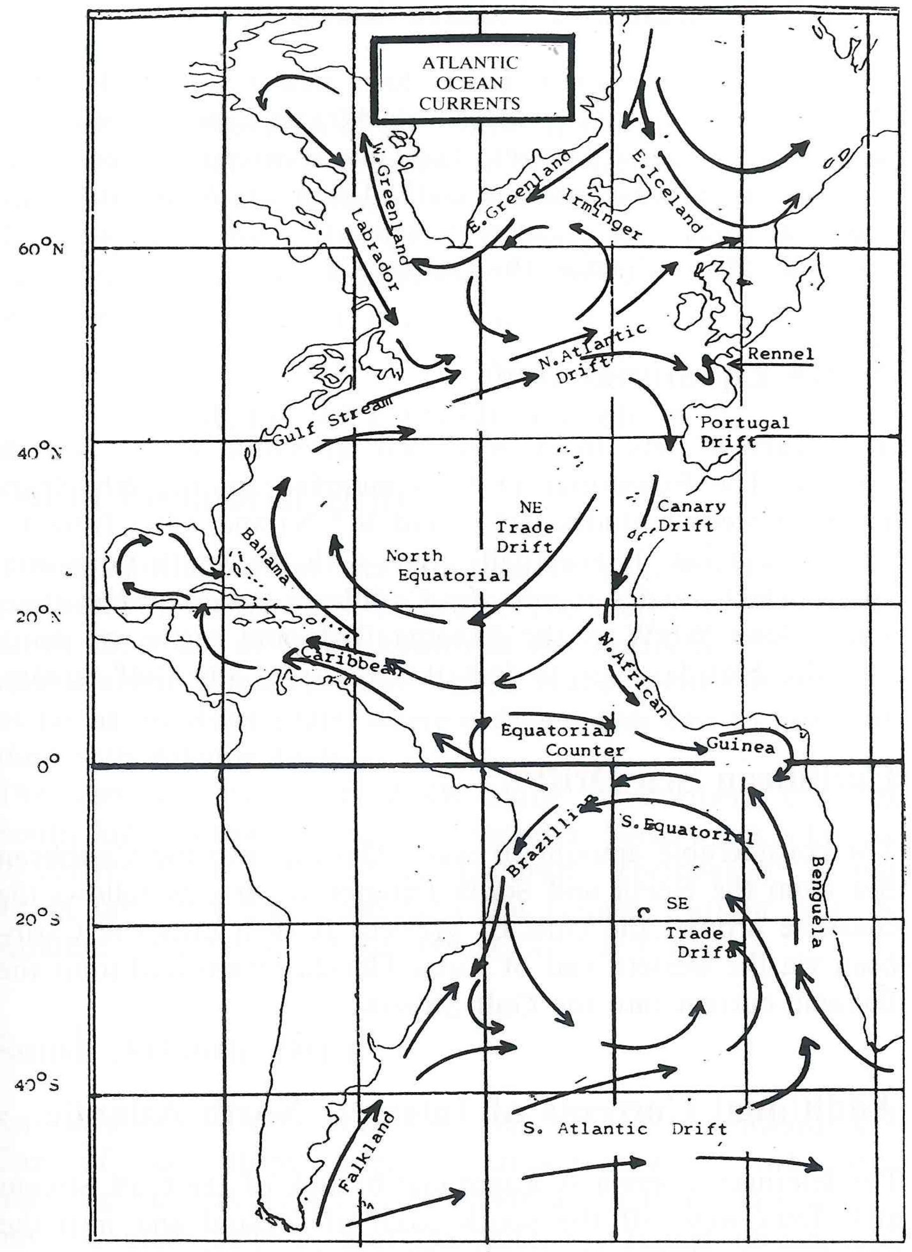
NORTH ATLANTIC CURRENTS

North Atlantic Drift

Sets in an ENE, direction from latitude 40° N, longitude 40° W, and has a general flow towards the United Kingdom and then on towards Norway. Some cold water from the East Greenland Current is divided off Cape Farewell into the North Atlantic Drift. Other water is carried around the Cape into the West Greenland Current north through Baffin Bay and then sets south in the Labrador Current.

Gulf Stream

The warm waters of the Gulf Stream meet the cold waters of the Labrador Current and cause a mix which continues a general westward flow as the Atlantic Drift. A southerly set on the east side of the Atlantic takes water down the Portuguese Coast and on into the Canary Drift current. This sets SSW from Cape St Vincent to Cape Blanco. Some water is then divided into the North African Coast Drift, while other water is carried into the North Equatorial Current.



North African and Guinea Currents

Water from the Canary Drift flows past Cape Verde (West Africa) and continues as the North African Coast Drift to join up with the Guinea Current. The Guinea Stream sets eastward, throughout the year into the Gulf of Guinea. Additional water from an Equatorial Counter Stream (sets east in about 5° N Latitude) also influences the Guinea Current.

North Equatorial Drift

This current sets in a westward direction about latitude 10° N. The Equatorial Drift is supplied by the NE Trade Drift (between latitudes 10° N and 30° N) and water from the Canary Current. It eventually joins with the South Equatorial (part) which carries it into the Caribbean Sea. The remaining water flows WNW as the Bahama Drift and carries on north past the Florida coast to join the waters of the Gulf Stream.

Caribbean Sea Drift

The considerable amount of water flowing into the Caribbean Sea from the North and South Equatorial currents follows the coastline around the Gulf of Mexico. It then exits the Caribbean via the western end of Cuba/Florida Straits and joins the Bahama current into the Gulf Stream.

Additional Currents of Interest, North Atlantic

The Irminger Current is a terminal branch of the Gulf Stream and flows west off the south coast of Iceland and into the East Greenland flow. A branch of East Greenland current passes north of Iceland into the North Atlantic Drift and is known as the East Iceland Current.

A branch of the Atlantic Drift turns inwards to the Bay of Biscay. Westerly winds bank up the water in this region and results in a variable NW offshoot known as the Rennel

Current, which flows across the southerly entrance of the English Channel.

The general circulation of the North Atlantic is of a right-hand flow (clockwise). The direction of the currents is virtually the same all year round although the strength experienced will vary with the time of year. As would be expected the current directions bear a striking resemblance to the wind patterns from which general circulation is partly derived.

SOUTH ATLANTIC CURRENTS

South Equatorial Drift

The equatorial current sets in a westerly direction and divides north/south off the coast of Brazil. The southerly divide flows down the coast of Brazil known as the Brazilian Stream at a rate of about 20 miles per day. The set is about South-West down as far as the River Plate, where it then curves east to join with the South Atlantic Drift.
The northerly divide sets WNW along the northern coast of South America towards the Caribbean Sea. Some water is known to deflect in the region of the 'Doldrums' (between 5° N and 9° N latitudes) and flows into the Guinea Current (ref: N Atlantic currents) as the Equatorial Counter Current.

South Atlantic Drift

Sets in a general ENE direction from Cape Horn towards the Cape of Good Hope. A branch turns northward, with water from the Agulhas current, to set NNW as the Benguela Current, but the main flow is into the Southern Indian Ocean and beyond.

Falkland Island Stream

Water of the South Atlantic Drift rounds Cape Horn and some sets NNE along the South American coast up to the River Plate area where it joins with waters of the Brazilian current. Other water has a tendency to set south of the Falkland Islands and turns east with the South Atlantic Drift.

South East Trade Drift

The eastward set across the South Atlantic provides water for the Benguela current and is also a source of water for the West African coast. This is assisted by the South East Trade Drift which eventually flows into the South Equatorial Current.

Comment — the general circulation of the South Atlantic is left-handed (anti-clockwise movement) throughout the year, although rate and intensity of currents can vary at certain periods.

NORTH PACIFIC CURRENTS

North Equatorial Current

Sets to the west and the latitude to which it extends varies with the seasons. Main source of water is from the Californian Current. It is deflected to the NW, and then northward on reaching the Philippine Islands, into the Kuro Shio Current.

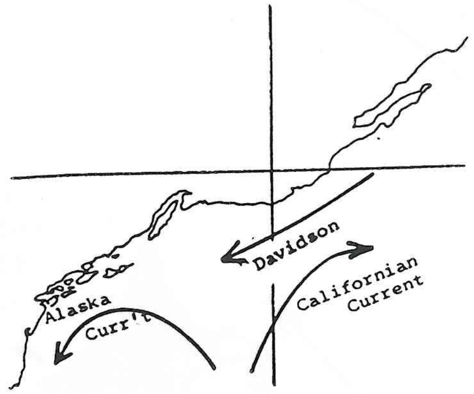
Kuro Shio

This is a warm current which flows generally NE, close to the Japanese coast. The rate is between 2 to 4 knots, but this is influenced by the monsoons. At about latitude 35° N, the current flows eastward and feeds into the North Pacific Drift.

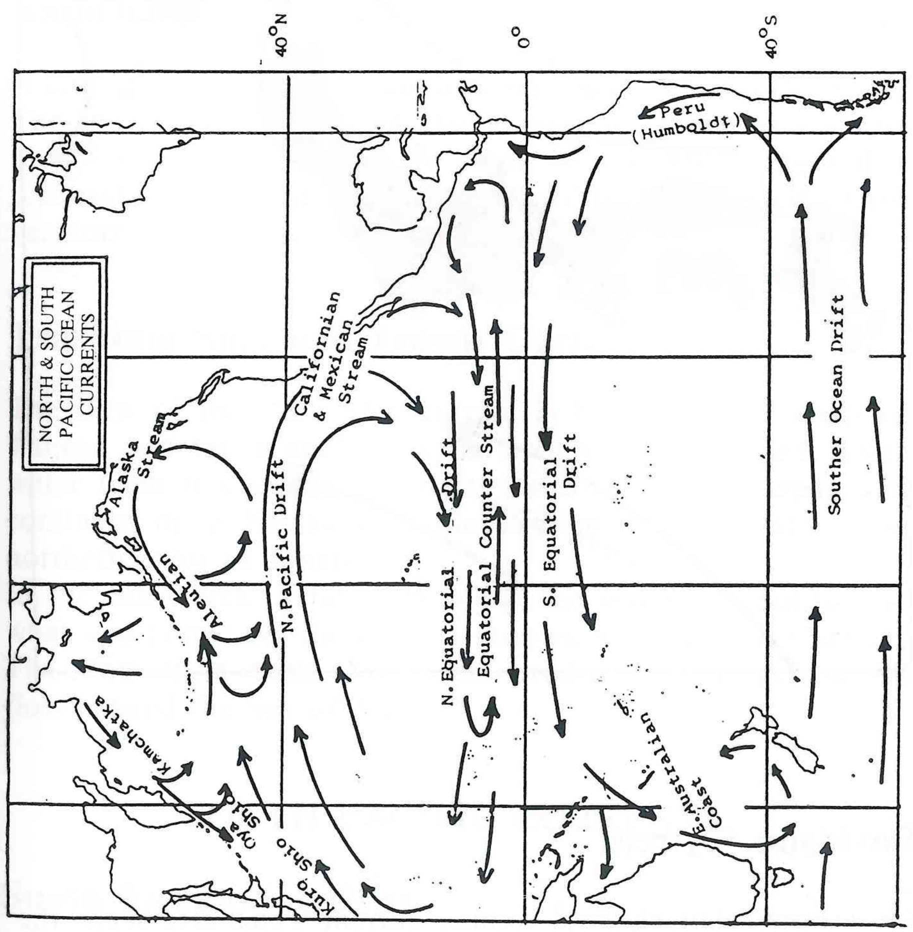
California Current

Sets south, at some distance off the United States west coast, from about 48° N to 23° N latitudes. It is a cold current which turns SW then west as it flows with the equatorial current.

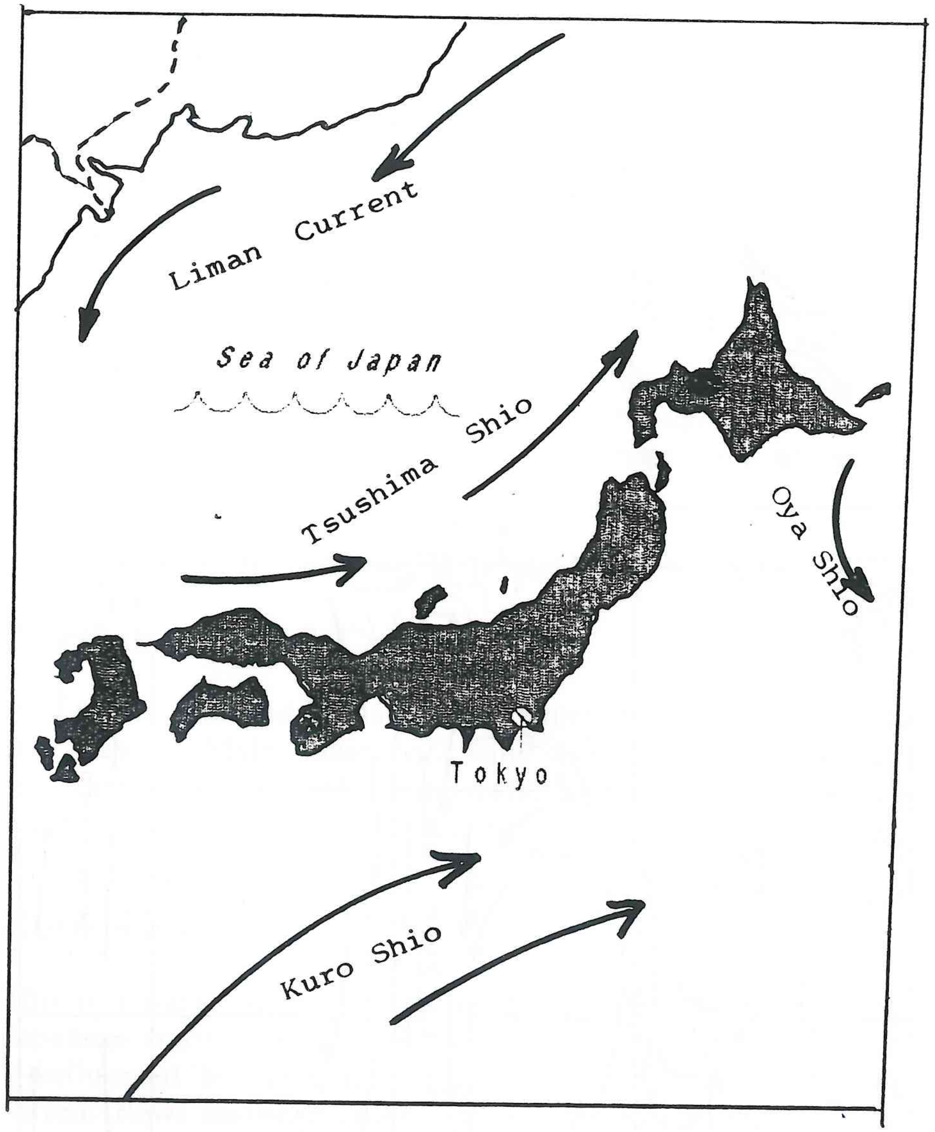
NB: It is upwelling during spring and early summer.



Davidson Current (Nov-Feb)



Currents in and around the Japanese Sea



Davidson Current

An inshore relatively cool counter current which sets inside the flow of the Californian between November to February and reaches up to 48° N latitude.

Alaska Coast Stream

The northerly branch of the North Pacific Drift which turns anti-clockwise round the coast of Alaska. Some water is carried on past the Aleutian Islands, from the Alaskan Current and is known as the Aleutian Current.
This is known to change direction depending on the season and in July some water is deflected north through the Aleutian Islands to join with the Kamchatka Current.
The Alaskan Current is reinforced by the Davidson Current and feeds water into the Aleutian Current and the Bering Sea.

Kamchatka Current

A cold current which sets south along the Kamchatka Peninsula. The most southern part of this current is known as the Oya Shio Stream which extends to about 40° N. This current then sets eastward flowing nearly parallel to the North Pacific Drift becoming the east setting Aleutian Current.

Tsushima Shio and Liman Current

The flow of the Kuro Shio current is NE along the coasts of Taiwan and Japan until the main stream turns eastward. Some water from this source is deflected into the Sea of Japan and continues on a NE flow as the Tsushima Current along the northern coast of Japan.
In the same area, a flow SW along the mainland coastline of what was previously the USSR is known as the Liman Current. The flow from these 2 currents produces an anti-clockwise flow around the Sea of Japan.

SOUTH PACIFIC CURRENTS

South Equatorial Drift

The flow of this current sets either side of the equator, extending between 1° N to 5° N at various longitudes. It sets

in a westerly direction from these northern limits to as far south as 25° S Latitude. Although after Latitude 6° S it becomes much weaker and more variable in direction.
The latitude limits will vary with the seasons across the ocean. The current divides as it approaches the Australian coast with some water being turned SW into the East Australian Current and the remaining water turning NW to flow past New Guinea (July).

East Australia Current

Sets southward off the east coast of Australia. It shows a marked strength between Latitudes 20° S to 25° S while it is notably weaker and of a broader flow after 32° S. It circles to the east, with some water moving northward past the west coast of New Zealand and the remaining water turning into the Southern Ocean Drift.

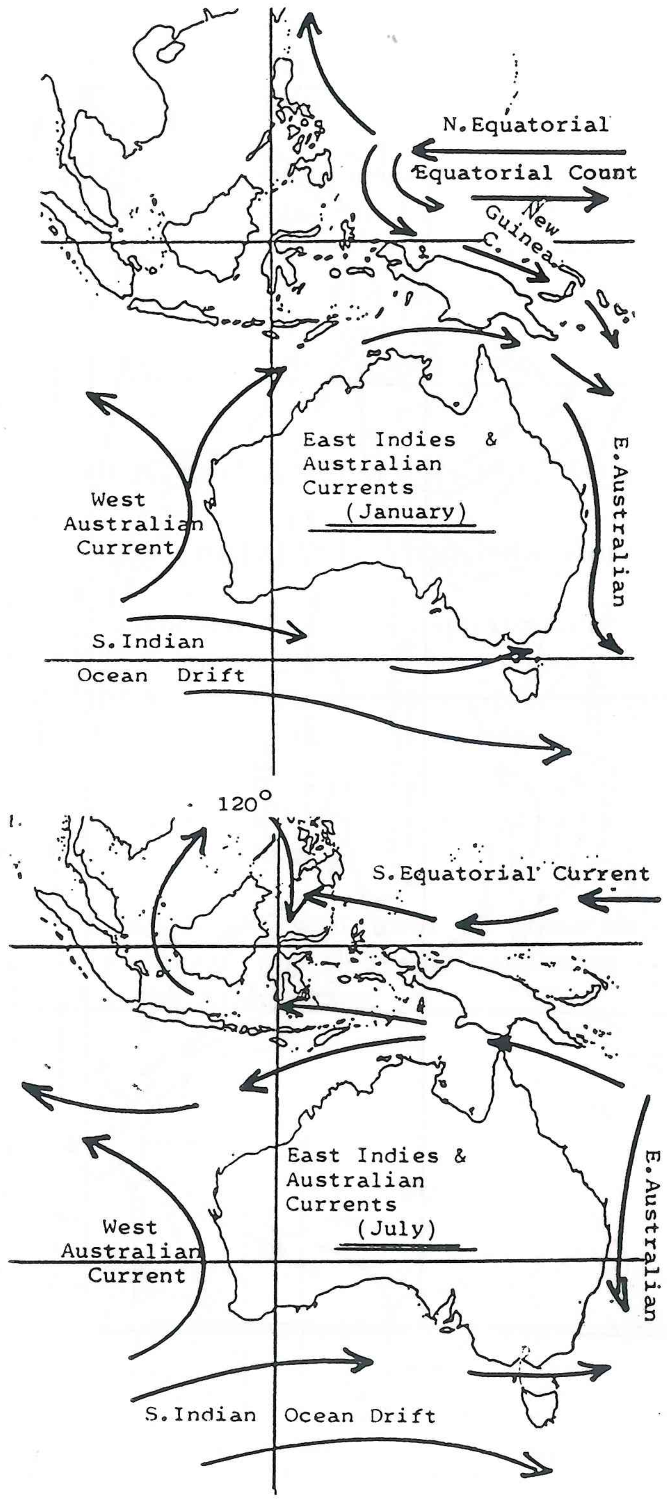
Southern Ocean Drift

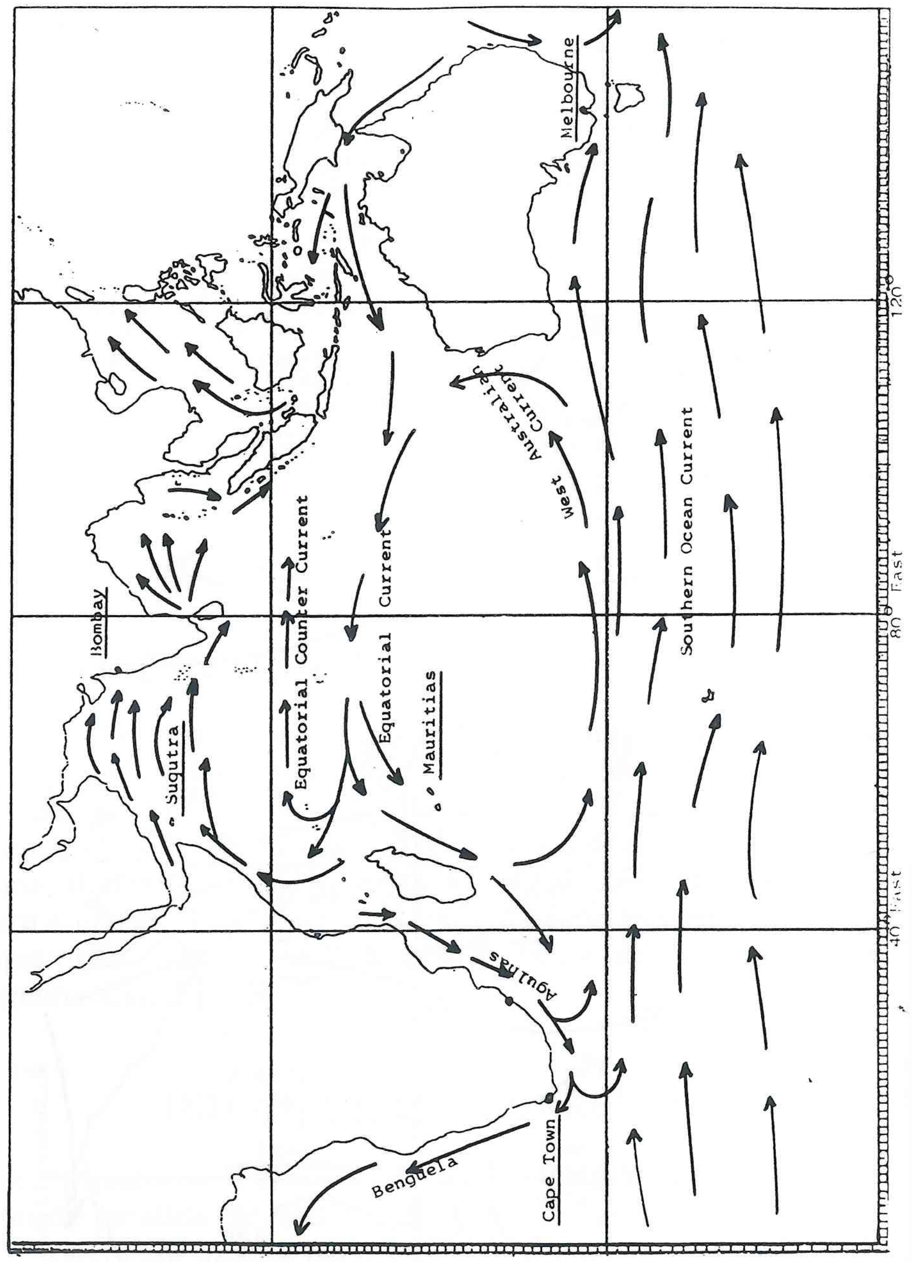
Sets to the east in the direction of the prevailing winds and is centred on lat. 50°S. The flow extends up to the South American coast where it divides into two stream currents, (i) around Cape Horn and into the South Atlantic Drift, (ii) northward along the coast to Peru, known as the 'Humboldt' or Peru Current. This water then joins with the westerly set of the Equatorial Current, with a branch being deflected into the Panama Canal region.

INDIAN OCEAN CURRENTS

The "Equatorial Current" has a westward flow between the latitude parallels 5° and 20° S. It divides at Madagascar with part water flow around the north of the island and down through the Mozambique Channel to join up with the alternative flow down the eastern side of the island. The current then flows around the Cape and is known as the "Agulhas Current" and varies in strength from about 1 to 4 knots. Some deflection

Seasonal changes of ocean currents around Australasia





INDIAN OCEAN (JULY) regional currents

takes place as it meets the east flowing waters of the South Atlantic and some water joins the eastern set of the "Southern Ocean Drift". Other water from the Agulhas turns into the South Atlantic and is carried north by the "Benguela Current".

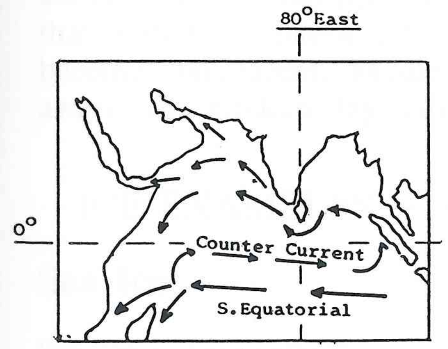
The West Australian Current sets northward off the west coast of Australia and eventually joins with the South Equatorial Current, which in turn streams to the Mozambique/Madagascar Currents. The Mozambique Current retains this name up to Delagoa Bay in latitude 26° S from where it becomes the Agulhas Stream towards the Cape of Good Hope.

BAY OF BENGAL AND ARABIAN SEA

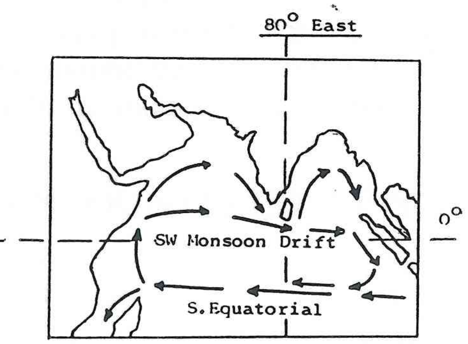
December/January (only) NE Monsoon Period

The East African Current sets down from approximately 10° N latitude to around 5° S latitude, from where it curves and sets eastward into the Equatorial Counter Stream. The strength of the current is greatly influenced by the prevailing monsoon. In the case of the NE monsoon the prevailing wind acts to retard the flow and it is subsequently not as strong as would be expected as with the SW monsoon.

The monsoon drift sets to the west from the Malacca Strait towards Sri-Lanka giving an anti-clockwise circulation in the Bay of Bengal and in the Arabian Sea.



Regional Currents of Bay of Bengal during NE Monsoon period.



Regional Currents of Bay of Bengal during the SW Monsoon period.

July South West Monsoon period

The East African Current sets in a NNE direction following the coastline from 11° S latitude. The main flow curves at about 7° N and sets eastward as the "SW Monsoon Drift" or sometimes referred to as the Counter Current. The strength of this current is influenced by the south west wind and can be experienced up to about 7 knots south of Socotra. Vessels will encounter this SW Monsoon Drift between the latitude of Sri-Lanka and the Equator and also as a clockwise circulation in the areas of the Bay of Bengal and the Arabian Sea.

Chapter Seven

ICE NAVIGATION

Introduction

Most mariners, at some time in their career can expect to encounter ice in one form or another. In order to navigate through an ice region it would seem prudent therefore to have some knowledge of what might become an expected hazard. A glossary of ice terms is available in the Mariners' Handbook, but by way of introduction to this chapter the following, most widely used terms are expanded.

Navigators will gain experience from each passage where ice is present. They will gain confidence in the ship and respect the dangers that ice can present. It should however be remembered that with the modern aids to navigation it is all too easy to become complacent. Masters should be ever vigilant and be aware that modern day aids bring modern day problems.

ICE EXAMPLES – ENCOUNTERED AT SEA

Sea Ice

Sea ice is originally formed by the sea water freezing, the salt content of the water lowering the freezing point. As the water freezes its density increases and it begins to sink, while warmer water from below rises and effectively a convection process is established. (The heat loss being mainly from the water to the air).

When fresh water is cooled (Baltic waters) to a temperature of 3° C it will attain a point of maximum density and the convection process will cease. It is at this point that the surface of the water begins to cool rapidly and freezing quickly occurs. In the case of seawater, that point of maximum density will occur at a much lower temperature than 4° C because of the salinity content.

Once freezing takes place, the early ice so formed is pure and contains little or no salt. Growth takes place downwards from the surface, and ice crystals and saltwater pockets are formed. Snow and freezing temperatures cover the ice at surface level and cause an upward thickening growth. This will later become more compact and eventually turn to ice.

New Ice

First indications of ice forming appears at surface level as small plates about 2.5 cms × 2.5 cms, often referred to as 'spicules'. It is slushy and has a soup-like consistency. Subsequent stages are known as 'frazil ice', and if freezing continues will coagulate and become known as 'grease ice'. Later stages following further freezing would cause sheets of 'ice rind' or 'nilas' to form. Nilas, are ice layers formed in water of high salinity, up to about 10cm thick and acts like an elastic crust. It very often forms a base for the growth of sea ice.

Early Formation of Sea Ice

First appearance as slush which may be several centimetres thick. Once frozen, sea ice could grow up to 10 cms in the first twenty four hour period, and between 15 — 18 cms in the following twenty four hours. Growth is especially noticeable

in shallow waters, especially where currents are weak or non existent, as in sheltered bays. Growth would also be expected to be encountered attached to and extending outward from an existing 'ice front'.

'First year ice' is normally less than 1.5 metres thick after the first winter. Wind and wave action can expect to cause some break-up and deterioration turning some into 'brash ice'. Brash ice being defined as floating accumulations of ice fragments, are taken offshore with prevailing winds. However, it can cause a damping effect on wave action and this in itself encourages the growth of additional ice forms. If larger ice concentrations are in the area it is quite likely that 'bergy bits' or 'growlers' could well be obscured within floating accumulations. Should poor visibility prevail at the same time, Radar may not prove as effective in discerning targets as the mariner might desire.

Pack Ice – Concentration

Found in open water and when under seven-tenths concentration often termed as 'drift ice'. One-tenth to three-tenths concentration is sometimes known as 'sailing ice' or more commonly referred to as "very open pack ice'.

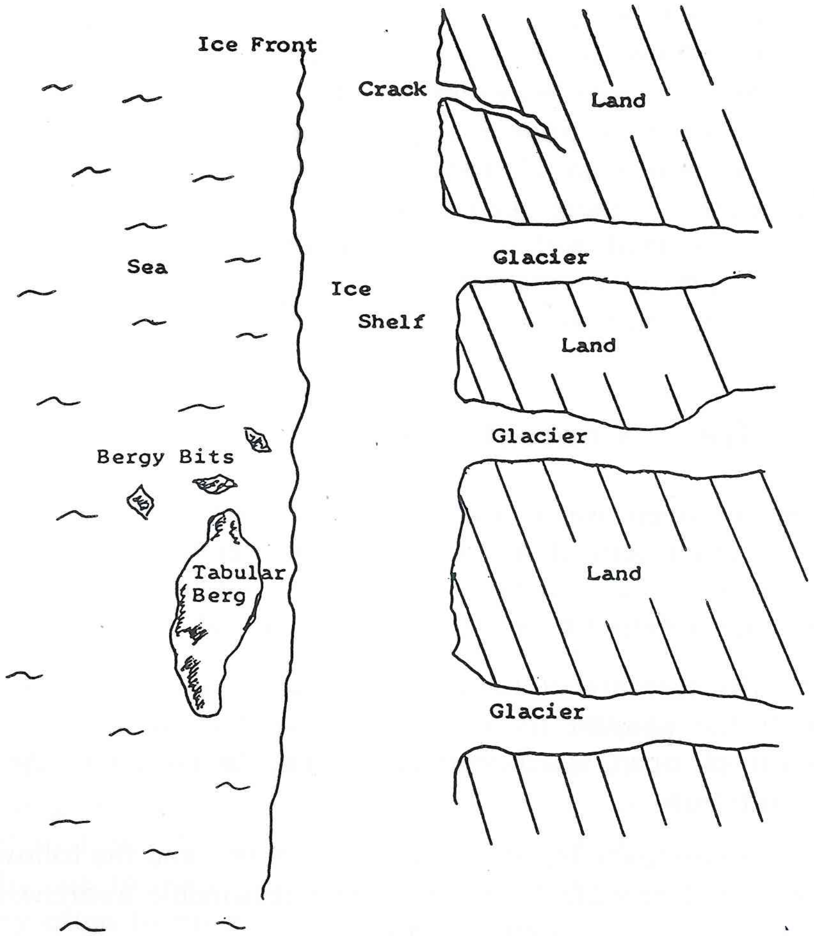
NB: The measure of tenths employed is a comparison which reflects the amount of ice coverage against the predominant amount of open water visible, by the observer, i.e. the ice concentration.

By definition 'pack ice' is defined by coverage, and the following table should provide the mariner with reasonable awareness of the type of ice his vessel is experiencing:—

1/10th — 3/10ths	Very open pack ice
4/10ths — 6/10ths	Open pack ice
Up to 7/10ths	Pack ice (still remains navigable)
7/10ths to 8/10ths	Close ice
Up to 9/10ths but less than 10/10ths	Very close pack ice
10/10ths	Consolidated pack ice (No open water visible and floes frozen together)

Ice Shelf

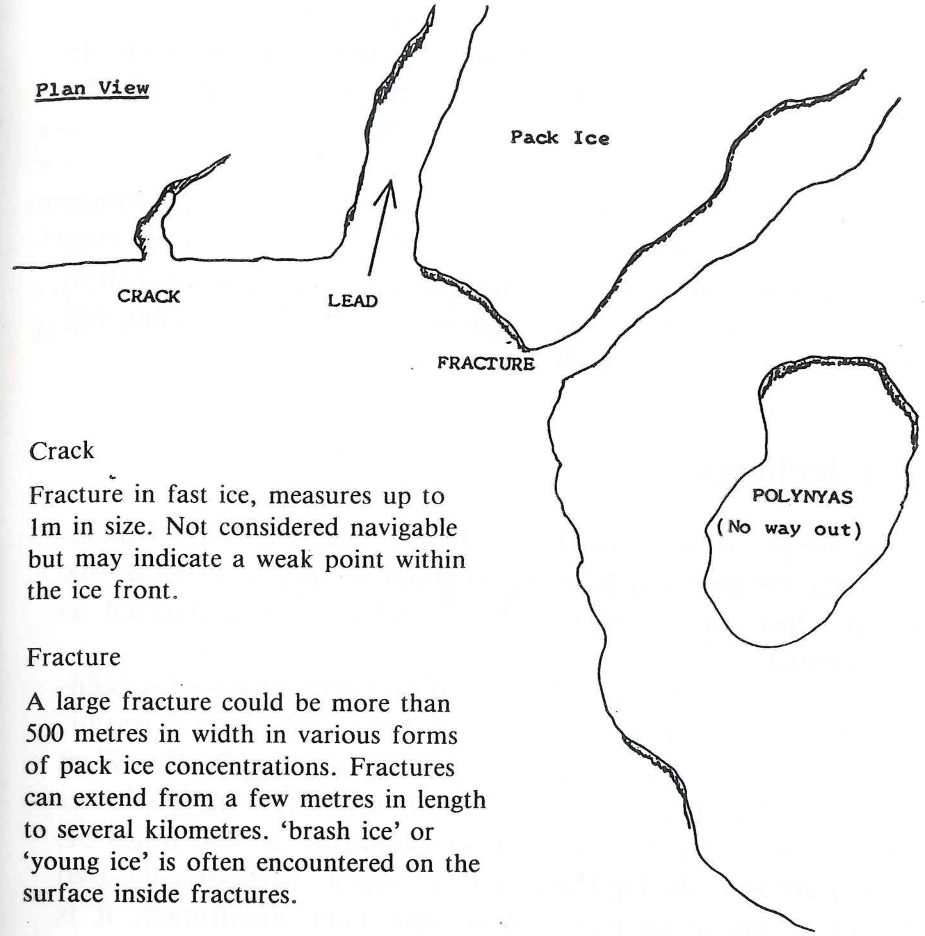
A floating ice sheet which is visible from 2m to 50m above sea level. The seaward edge being known as the 'ice front'. The shelf can extend for many miles to seaward and frequently contains the end of many 'glaciers and becomes the source of 'tabular bergs'.



Ice Tongue

Often the end of a 'glacier' (seaward end) and hence the source of 'glaciated bergs'. A projection of the ice front, which may extend several miles to seaward.

NAVIGATION ICE TERMS



Crack

Fracture in fast ice, measures up to 1m in size. Not considered navigable but may indicate a weak point within the ice front.

Fracture

A large fracture could be more than 500 metres in width in various forms of pack ice concentrations. Fractures can extend from a few metres in length to several kilometres. 'brash ice' or 'young ice' is often encountered on the surface inside fractures.

Lead

Any fracture in sea ice that permits navigation by surface vessels.

Polynyas

An enclosed area in the ice from which there is no visible way out. The water surface may be covered by 'brash ice' or other forms of 'new ice'.

Cracks, fractures and leads are generally formed when the pressure around the ice form relaxes. They can all be early signs of the deformation of the ice.

ICEBERG FORMATION AND LIFE CYCLES

There are two main types of ice encountered at sea, namely, 'sea ice' previously discussed and 'icebergs'. These are defined as an enormous piece of ice of varying shape which is visible more than 5.0 metres above sea level. The volume of the submerged section is about 90% of the total volume.

Icebergs can be divided by geography, in that they are either 'arctic bergs' or 'antarctic icebergs'. It is worth noting that there is approximately seven times more ice in Antarctica than in the Greenland Icecap and therefore many more bergs are produced in the Southern Hemisphere.

Arctic Icebergs

Most icebergs of the Northern Hemisphere are carved from either a glacier and will have an irregular shape, or from an ice shelf, in which case they may be 'Tabular' or encountered as an 'Ice Island'.
Many bergs are from the glaciers of the east coast of Greenland. They are carried south by the East Greenland Current, either round Cape Farewell and into Baffin Bay by the West Greenland Current or they drift south and melt in the lower latitudes. They have been known to extend up to 400 miles SE of Cape Farewell, during the month of April. Although the two tracks for bergs from this region have been mentioned, it is pointed out that in actual fact, very few bergs are carried round into Baffin Bay.

Icebergs in Baffin Bay are frozen into the pack ice during the winter months and there may be as many as 40,000 bergs in this area at any one time. As the pack ice melts during spring some bergs drift south and either ground or break up in Baffin Bay itself. Others are carried by the cold Labrador Current towards the region of the Grand Banks.

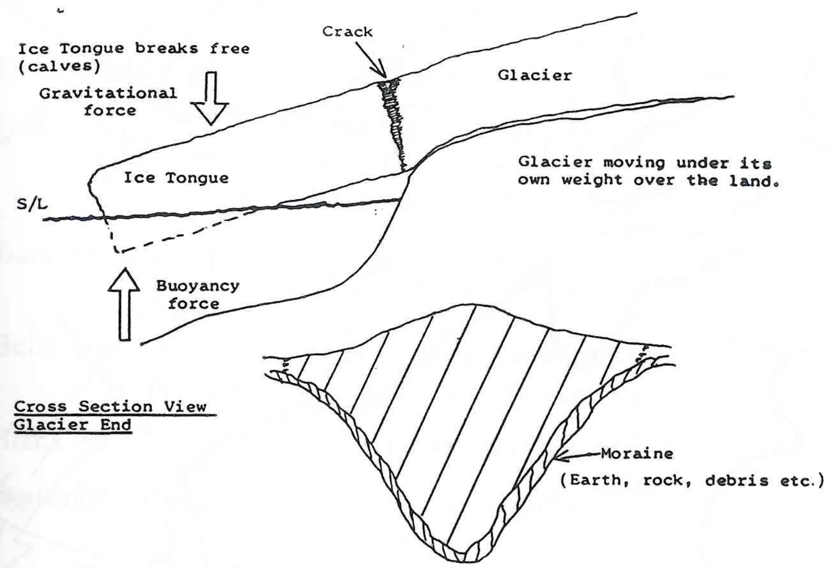
Iceberg season: Mariners are advised that the season for encountering icebergs off the Grand Banks and the Canadian

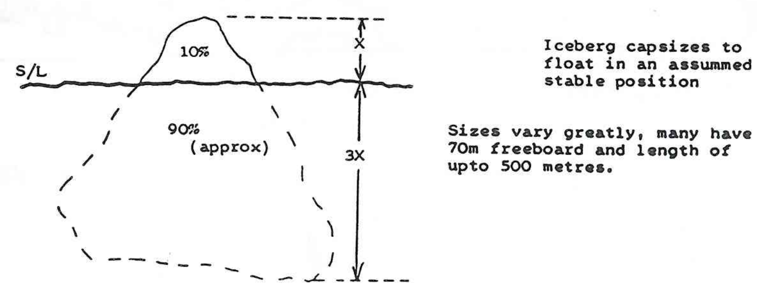
Coast is from February to August, with most bergs being encountered in April, May and June. An average figure for the worst month of April would be about 70 icebergs.

Iceberg limits will fluctuate slightly but in the region of the Grand Banks, latitude 48° N in February and 42° N, in May can be expected. Once bergs continue south of the Banks, they meet the warmer water of the Gulf Stream and melt. Icebergs are not encountered from October through to the end of January.

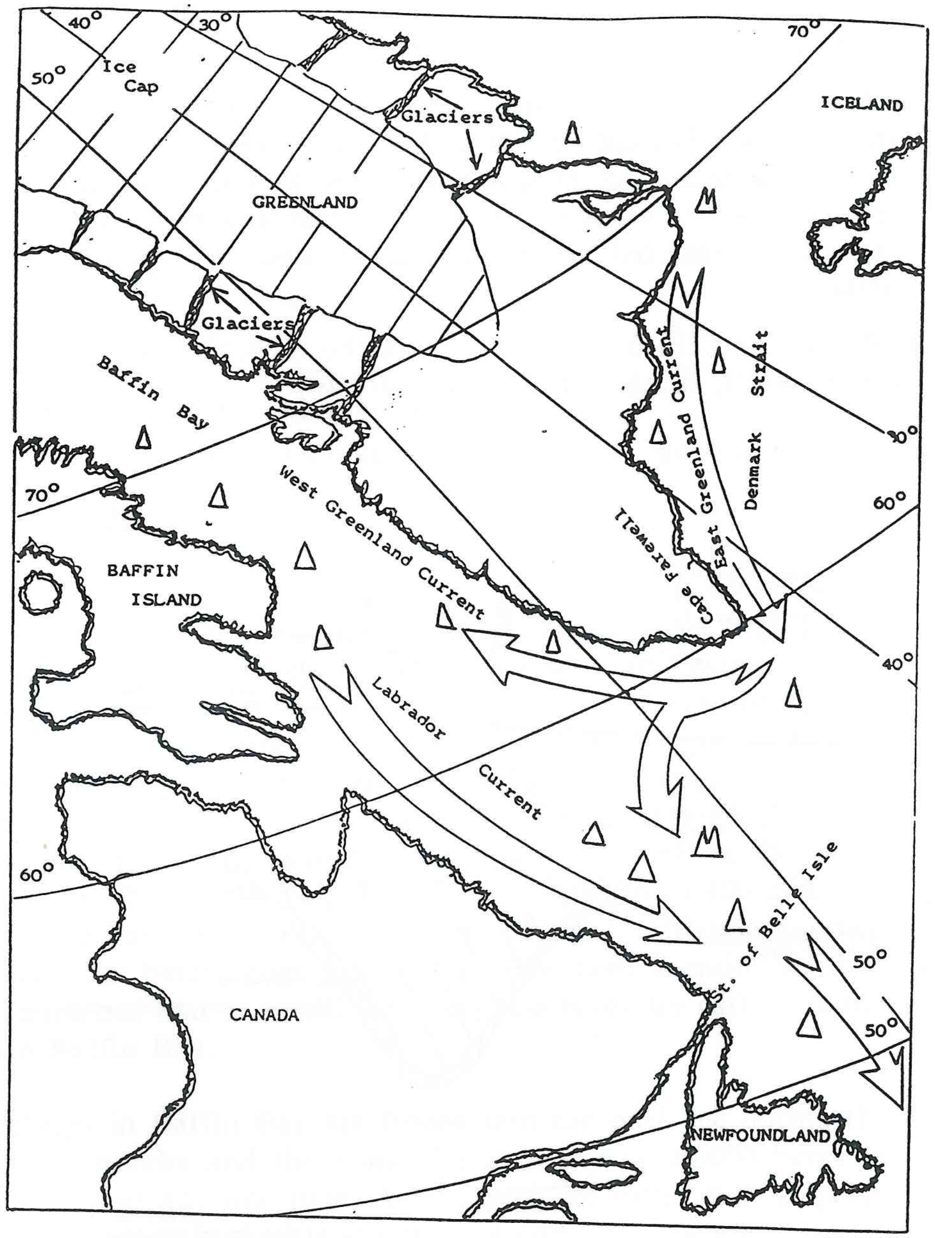
Only on rare occasions would icebergs be encountered south of latitude 40°N, or east of longitude 40° W.

Glacier Iceberg — Formation (example Greenland Berg)





General Drift and Iceberg Movement — North Atlantic



NORTHERN HEMISPHERE – NAVIGATOR'S GEOGRAPHIC INFORMATION

Winter Detail

The most southerly advance of pack ice in the northern hemisphere is dependent on the movement of the ocean currents. The East Greenland and the Labrador currents both bring cold water southwards and subsequently extend the 'ice edge'. Where as the ice edge, off the Norwegian west coast and in the 'Barents Sea' is restricted by the warm North Atlantic Drift Current and warm south westerly winds.

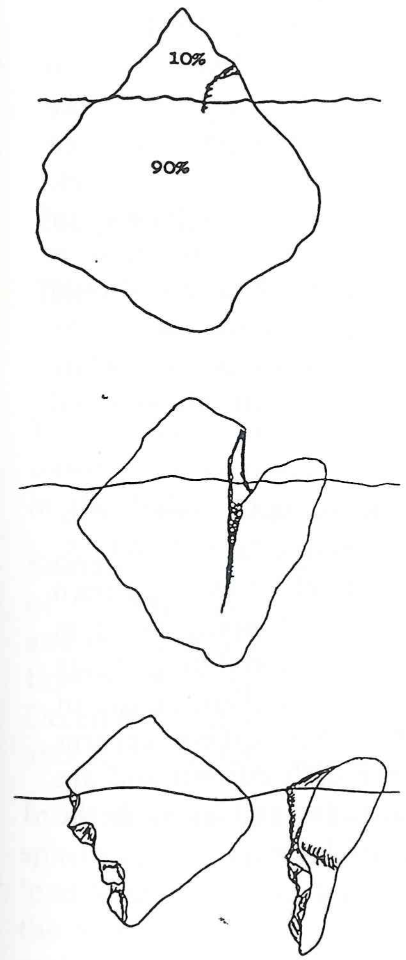
Affected Areas:

Baffin Bay Ice	Extends to Newfoundland
Baltic Sea	The northern part freezes over. In some years the whole sea area may be affected by pack ice.
Barents Sea	Coastlines to the east of longitude 40° are affected.
Belle Isle Strait	Frozen over and usually closed to navigation between December and June.
Black Sea	Northern part may be affected by freezing.
Denmark Strait	This may be totally closed to surface navigation.
Greenland Ice	Extends to engulf Jan Mayen Island
Hudson Bay	(Davis/Hudson Straits) This area freezes over completely. Seek information from the Ice Advisory Service operated by the Canadian Coast Guard.
North Sea	(January to March) The south coast of Norway, together with some Danish, German and Dutch ports may be affected.

St. Lawrence	Considerable ice formation is expected between December to April which may close areas to surface navigation. Ice breakers operate throughout this period and information should be sought from the Ice Advisory Service of the Canadian Coast Guard.
North Pacific	The Bering Strait and the Asian Coastline north of Latitude 45° N are affected. However, ice is not normally encountered in the vicinity of the Aleutian Islands.
The White Sea	This area is normally closed for navigation from December to May.
Ice Free Areas	These normally include the Gulf of Alaska and the west coast of Norway.

NB: The above areas are considered in winter for 'pack ice' it should be borne in mind that drifting icebergs can expect to be encountered in associated areas.

ICEBERG DEFORMATION



Iceberg after calving from a glacier is affected by:

1 Weather (wind and rain)
2 Melting on sunward facing side.
3 Erosion by wave action
4 Underwater melting from warm currents.

Cracks develop for one or more of the above reasons and cause a piece to break away often making the berg unstable.

Cracking of the ice cannot only be audible to an observer onboard ship, but may visually cause the iceberg to topple and assume a new surface position.

As the berg assumes a new stable position the broken piece, termed, a 'bergy bit' drifts from the main berg.

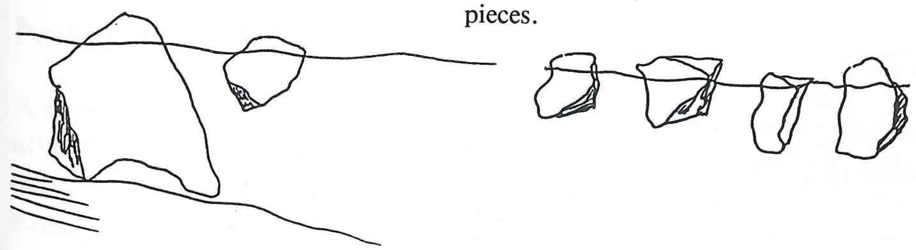
The bergy bit is defined as a large piece of floating glacier ice which has less than 5 metres visible height above sea level.

Bergy bits are affected by wave action and become known as 'growlers', where the height of ice above sea level does not exceed 1 metre.

Icebergs and bergy bits generally present themselves as good radar targets, but growlers should be considered as extremely dangerous and very poor radar targets.

An iceberg may also ground at any point where it encounters shallows. From this time onward it can be expected to break up rapidly.

Complete disintegration occurs into 'bergy bits', 'growlers' and small ice pieces.

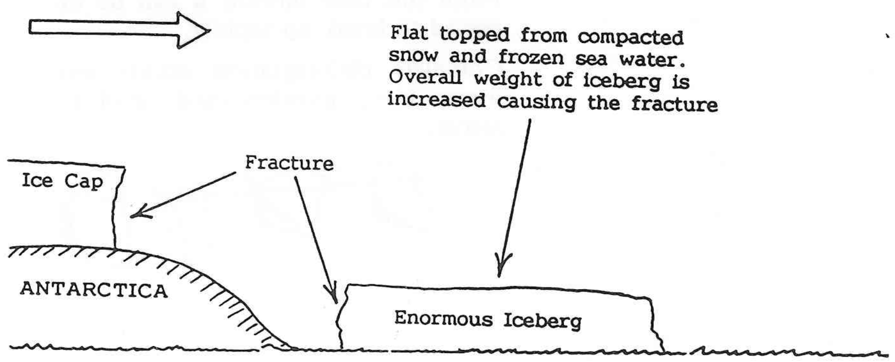


Antarctic Icebergs

Of the many icebergs encountered in the southern hemisphere, the main type is a tabular shape. These are defined as large flat-topped icebergs, which have usually calved from an ice shelf. They will vary considerably in size up to 30 miles in length and having an average height above sea level of 40–50 metres. The general appearance of Antarctic bergs is white providing the observer with a 'plaster of Paris' effect, given off by the white bubbly ice, common to this region's bergs. Occasionally bergs will be sighted and described as 'black' or of a 'greenish-black' appearance. The composition of these is often in a banded form or distinctive layers. Masters should note any distinctive features of icebergs as these should be incorporated in respective future ice-reports. Black and white icebergs, together with weathered bergs are often encountered in the Weddell Sea.

The general drift of Antarctic icebergs is in a west-north-west direction. They then move northerly below latitude 63° S, where they are influenced by the eastward set of the Southern Ocean Current. One of the main dangers to shipping being in the area of the tip of South America, with occasional bergs being sighted off the Cape of Good Hope and the southern coasts of Tasmania and New Zealand. Most southern hemisphere icebergs suffer erosion by weather and water of the drift current and are prevented from going into the lower latitudes and as such the main shipping routes are generally clear of icebergs.

Permanent ice-cap grows outward



Tabular bergs are characteristic of this type of formation. Sizes vary tremendously, hundreds are over 1 mile in length, scores are up to 25 miles long.

One of the largest on record measured 90 miles in length with a 35 metre freeboard.

ICE IN THE SOUTHERN HEMISPHERE

Ice Limits

The outer limits of pack ice will vary from year to year and a difference of 300 miles of the ice edge in 'good' and 'bad' seasons can be expected.

Winter Ice — new ice can be expected to form mid-March onwards to October. This can extend as far as latitude 56° S in the Indian Ocean and latitude 60° S in the Pacific Ocean.

Summer Ice — melting occurs extensively at the outer edges of the pack ice. Deformation is accelerated by offshore winds and the general increase in temperatures of the open sea waters. Erosion and melting occur during the months of November/December and is particularly pronounced at its most northern and southern boundaries.

In comparison with Arctic ice, the ice of the southern hemisphere usually carries a heavier snow layer. This tends to resist 'puddling' (deterioration of the ice from water puddles absorbing the sun's rays and causing weakening of the ice mass). The major factors causing deformation to take place being swell action and the contact with warm ocean currents.

Navigator's Information

Although greater detail from satellites is now more readily available than in the past, the limits of ice should be treated with extreme caution, great circle sailing will be restricted at seasonal times on the following routes:—

Cape of Good Hope to Cape Horn	South Atlantic Ocean
Australian/New Zealand ports to the southern ports of South America	South Pacific Ocean
Southern ports of South Africa to the coasts of Australia	South Indian Ocean

SIGNS OF THE PROXIMITY OF ICE

In Clear Visibility

An 'ice blink' may appear over the ice pack, particularly on a clear day. It will be sighted as a yellowish haze usually well before the ice itself is detected. If the weather is overcast an 'ice blink' will tend to have a white glare reflecting with the cloud formation.

The sea surface temperature is a distinctive indication of ice proximity. If the recorded temperature is 1° C then ice can be assumed to be within 150 nautical miles. If the temperature is −0.5° C ice is within 50 miles. Ice fragments would also be a distinctive feature, indicating the proximity of pack ice.

If navigating in ice regions, mariners should note that the ice edge is often accompanied by a thick band of fog. Prior to actually sighting ice or fog bands, it is more likely that observation of wildlife will provide indication of ice.

Examples of wildlife which indicate ice presence:
walrus, seals, and different species of birds far from land.
In the case of Antarctica, the sight of the 'Antarctic Petrel' or the 'Snow Petrel' indicates the presence of ice.

In Poor Visibility

A distinct change in sea state, where an abrupt smoothing of the sea and a reduction in swell indicates that ice could well be to windward.

Also white patches or discolouration in the fog, could well indicate ice at a short distance and close to visible range.

Proximity of Icebergs

Reliable indication of icebergs is extremely difficult to establish. A cold iceberg bearing current and the sea temperature of the same provides indication that icebergs may be in close proximity. A more positive indication is the sighting of growlers or bergy bits. This coupled with wildlife away from land provides circumstantial evidence. Effective use of radar and the plotting of a virtually stationary target will of course enhance any visual sightings.

Visibility of Icebergs

From a high bridge or masthead 16 to 18 miles on a clear day. From an average bridge height 12–15 miles could be expected under the same conditions. If the day is cloudy detection ranges by the naked eye would be reduced by approximately 2 miles.

Where conditions are obscured, i.e. by haze, only the tops of bergs would be sighted at a range of about 11 miles.
In the case of 'mist' or 'drizzle' conditions 2 to 3 miles should be the expected maximum range of visual contact.

If navigating in 'dense fog' it is unlikely that detection will occur more than 100 metres and then the wash will probably be detected first. In conditions where no sun is experienced a dark mass may become the first indication of the iceberg. If navigating in fog, when sunshine is present, then a sunny-luminous mass is usually detectable.

Detection of Icebergs at Night

When no moon is present, the naked eye may detect an iceberg at approximately 0.25 miles. If binoculars are used then this range may extend to about 1.0 mile. In conditions where a moon is prominent, and it is a clear night, an iceberg could well be detected up to 5.0 miles range. However, it is pointed out that if the moon is situated in a position behind the observer then the detection range can be expected to be quite good. Should the moon be in a position in front of the observer, then this could be more of a hindrance than an asset.

Poor Visibility and Iceberg Detection

Icebergs may indicate their position by radiating a white patch around its volume. Observation of such a 'white patch' would signify that the observer is at close quarters with the iceberg. A more reliable indication would be the sound of breakers in the nearby proximity of the ice or loud cracking heard on the occasions when bergy bits break away from the icebergs.

A point worth noting is the absence of vigorous sea conditions in strong breezy weather. This would indicate either pack ice or a large iceberg to windward. This is particularly the case in Antarctic regions and in the proximity of large 'tabular bergs'.

ICE DETECTION BY RADAR

The use of radar is invaluable when navigating through ice affected regions, but mariners should be aware of the limitations and constraints that may be imposed by use of the equipment. Abnormal weather conditions could well affect and reduce detection ranges and overall performance of the equipment in use, possibly from ice accretion.

If calm seas are considered — ice formations of all types should be detected and the following is a general guide to types and detection ranges:

Large icebergs	15–20 miles
Small growlers	2 miles
Bergy bits (3 metres exposed)	3 miles maximum.

If in rough seas, where the sea clutter extends greater than 1.0 mile, it should be considered unsafe to rely on radar alone.

Strength of Radar Echo

A radar return from an ice formation will be greatly influenced by:

1. Range of target from the vessel
2. The size of target above the water surface
3. The inclination of the targets reflecting surface.

Observers should note that icebergs generally provide a strong echo which is regular and visible on the PPI. However, growlers are more often than not extremely poor targets and very often lost in clutter. They are not regular targets and frequently do not paint on the PPI.

Ice Features and Radar Detection

Ice Field — An ice field of concentrated pack ice, hummocked ice would normally be detected in all sea conditions at a range of about 3.0 miles.

Leads — A lead through static ice will not show unless it is at least 0.25 miles wide.

Small Islands/Large Icebergs — Often difficult to segregate and identify. Extreme caution is advised when position fixing.

River Mouths — These are very often frozen over and become difficult to distinguish. The coastline is subsequently presented as a continuous feature on the PPI.

Ice Targets — These are often obscured by the shadow from islands or large icebergs. Pack ice and large icebergs create a shadow area over a wide arc of the screen. Hence a field of icebergs always appears less dense than it really is.

Close inshore navigation for position fixing should be resisted at all times.

POSITION FIXING AND RADAR LIMITATIONS (Inside Ice Regions)

The limitations in the use of radar have been previously stated, but the use of radar in position fixing presents the observer with particular problems. With these in mind Masters should therefore ensure that watch officers employ alternative position fixing methods when using radar and not rely on radar alone.

Ice features are continually changing due to movement, growth and deformation. It should not be assumed that they will present themselves in the same manner or aspect to an observer on a vessel outward bound and later when homeward bound.

Coastlines

Prominent points of a coastline, such as headlands and inlets are regularly employed in position fixing. The observer should be wary in the event that headlands may be extended due to 'fast ice' or icebergs which may have grounded in shallows in close proximity to a headland, the obvious mistake being made by the observer in assuming that the headland is longer than it actually is and a distorted range or bearing being plotted on the chart.

Frozen Bays/River Mouths

These provide a continuous radar feature which would otherwise be discernible for use of bearings or range identification. Compacted snow on frozen areas, including coastlines, often distort the visual aspects when making comparisons with radar features.

Small/Large Icebergs

These will be detected at ranges commensurate with their size but it will be rarely possible to distinguish them from small

islands of equivalent size. The identification of the target is essential, and bearings and/or ranges from islands should be double checked prior to plotting on the chart.

Icebergs with 'Pack Ice'

This type of ice feature effectively creates shadow areas over a wide sector of the screen. The consequences of this is that a field of icebergs always looks less dense than it really is. Masters should resist the temptation to navigate their vessels in close for the purpose of more detailed position fixing data.

It should be expected practice in this day and age that the limitations and performance of instruments, especially radar, are employed with extreme caution. Additional systems such as Decca, Satellite or Direction Finding should be employed additionally as primary as well as secondary position fixing options. In any event navigators are advised to make full use of visual bearings whenever the opportunity presents.

ICE SIGHTING – RADAR USE AND IMMEDIATE ACTION

As officer of the watch on sighting ice (visually).
On first sighting, advise the Master of the vessel of the following:

1. Type of ice
2. Position of ice
3. Relative position of ice to the ship's track/position

Radar Activity

1. Reduce working range of radar to 6 miles or less, appropriate to the prevailing weather conditions.
2. Carry out regular long range scan checks for associated ice targets.
3. Instigate continuous radar watch (by second watchkeeper).

In addition to the above the officer of the watch should enter a statement into the log book, obtain the most up to date ice report possible and ensure that ice limits are entered on the navigational chart. Occasional icebergs should also be plotted.

MASTER'S DUTIES ON MEETING DANGEROUS ICE

Obligatory reports are required from Masters of ships which encounter dangerous ice on route.

The ice report should contain the following information:

a) The type of ice observed.
b) The position of the observed ice.
c) The GMT and the date of observation.

Shipping reports should additionally include the size and shape of ice formations as this will aid iceberg identification. Such facts as the thickness of ice, the sea temperature and the concentration of ice (in 10ths) would all be considered relevant.

It should be noted that the SOLAS convention also requires that the Master of every ship which reports ice to proceed at a moderate speed at night or to alter her course to pass well clear of any danger zone.

NB: It is not unusual to stop the vessel at night when navigating inside ice limits. This would most certainly be prudent action if ships' radars were considered unreliable for any reason.

OPERATIONAL NAVIGATION IN ICE REGIONS

Open Pack Ice

Alternative routing should be a priority option for any Master who finds concentrations of pack ice either close to or on his intended track. However, where avoidance is impossible and

the vessel has no option but to proceed then the Master should organise and brief his bridge team prior to entry into the ice. Ice operations dictate that the Master would take the 'con' when entering ice. Entry should take place at slow speed, reduced to take account of ice thickness and relevant dangers. Main propulsion systems should be retained on immediate notice and at a status that could provide immediate and continuous manoeuvring of the vessel.

Lookouts

Bridge lookouts should be advised by the officer of the watch to report all traffic and navigation marks. Ice leads and/or dangerous ice formations should also be reported. Officers in charge of watches should be aware of extreme cold conditions which may affect the efficiency and awareness of lookouts. Regular rotation to overcome fatigue or discomfort should be considered an acceptable management decision by the officer.

Helmsman

Manual steering should be the order of the day from prior to entry until the vessel is clear of ice regions. It would not be unreasonable to expect steerage to be lost if the vessel is navigating under heavy ice conditions. Any such loss of steerage should be reported to the officer of the watch by the helmsman. Regular checks on steering gear by engineers must be considered essential when navigating in such conditions.

Radio Officer

If a radio/communications officer is carried aboard the vessel his talents should not be wasted and Masters should ensure that essential communications are continually monitored. In particular, such items as ice reports, weather reports, navigational warnings, ship to ship or ship to shore operations, together with ice breaker communications, should be assumed to be a vital link within the established progress of the vessel.

The Officer of the Watch (OOW)

The relationship between the Master and the Watch Officer is unique at any time but in the transit of ice it becomes clear that each relies on the other to function at peak efficiency. The OOW should not hesitate to use engines or any navigational equipment as he thinks necessary to ensure the safety of the vessel. He should at all times maintain the freedom of movement of the vessel and not allow the ship to become 'beset' in ice. To this end Masters are expected to brief their watch officers, especially those officers with little or no ice experience. Officers should be made aware that excessive speed in ice leads to ice damage and cautionary speeds are more appropriate.

USE OF TOPOGRAPHICAL FEATURES IN ICE

The experienced mariner will be well aware that navigational information, topographical features and soundings are extremely scarce in ice regions. Polar regions where the use of polar charts is a requirement, are based on air photography, which tends to make geographic features unreliable. This, coupled with extreme adverse weather conditions, tend to reduce or eliminate position fixing options to a minimum.

The following problems may be encountered when navigating in and around ice regions:

Headlands, especially where icebergs have grounded, may present themselves as being longer and more greatly extended than they actually are. Notable when position fixing with visual bearings or by radar observation.

Special care should also be exercised if using clearing lines/ bearings off such headlands.

The pack ice limit, especially when snow covered, may be mistakenly compared with coastline features portrayed in the sailing directions. The reliability and use of such features should be treated with extreme caution and should never be taken as the sole indicator when position fixing.

Beacons and navigation marks may be partially or totally hidden by a build up of snow. Buoys and surface markers could also be 'under' ice formations or destroyed by previous ice movement, and no longer visible for navigational purpose.

The general maintenance on such beacons in extreme weather regions must by the very nature of the difficulties involved be considered as limited and irregular.

Survey details of high latitude areas, especially soundings, cannot be considered reliable, depending on date of survey. Navigation in areas of a low underkeel clearance should be undertaken only with adequate margins of safety. Deep draught vessels are especially prone to experience related problems in this field.

If sights are being taken to fix the vessel's position when in the vicinity of 'pack ice', errors of up to 4.0' may be inherent within observations and calculations. The horizon being often difficult to discern, and a subsequent 'clean cut' difficult to obtain.

NAVIGATION IN HIGH LATITUDES

Although navigation in high latitudes is generally considered as the rarity rather than the norm, the professional mariner would be expected to adopt safe working practices. The following points are discussed to provide insight to potential problems and expand on suggested main navigational points.

1. In 'high latitudes' the use of meridians and parallels as references becomes impracticable. Ship's position is changing extremely fast with movement of the observer.
2. All 'zone times' meet and local time has little significance. Sunset/sunrise and periods of night and daylight become quite different if compared to the average day within middle latitudes.
3. Navigational practice will involve 'polar charts', which are based on air photography which usually do not have

adequate control of 'triangulation'. Consequently, geographic positions and features may appear as being unreliable.

4. Soundings and topographical features, together with navigational information, is scarce in the accessible parts of the polar regions.

5. Celestial observations cannot be relied upon. When in the navigational season, namely when ice conditions permit, clouds tend to hide the sun, during periods of long days and short nights.

6. Fog, low cloud and ice conditions generally pose continual navigational problems.

7. Sights when only the sun is available tend to be used with a method of 'transferred position line'. Accuracy is questionable in the upper latitudes.

8. The use of the magnetic compass near the magnetic poles is of little value. However, it is pointed out that if the ship is 'swung' to suit navigation of that region then its use can be gainfully employed.

9. Gyroscopic compasses tend to lose all directive force at the geographic poles and are subject to errors. Appropriate settings and corrections should be applied and regular checks by Azimuth of celestial bodies should be made, to ensure continued accuracy.

10. Celestial observations, less than 10° of altitude may have to be used. Corrections to these altitudes may have to come from tables employed for specific low altitudes, found in the Nautical Almanac and, should also include allowances for temperature and pressure where appropriate. Margins of error on celestial observations in pack ice could incorporate up to 4.0' observer error.

11. Radio aids, radar, satellite and inertia navigation systems are as effective as in other parts of the world, but they do have limitations in use and good seamanship practice should not be disregarded.

12. The use of the echo sounder should be encouraged as necessary, but it should be remembered that soundings can change abruptly and its reliability in high latitude regions becomes questionable.

13. A lack of tidal information prevents accurate use of dead reckoning and use of estimated position techniques. This is made more difficult because speed relative to ice is difficult.

14. A large scale, running plot should be established, where all alteration of course points can be checked and changes in speed can be clearly noted.

15. Overall weather conditions can change very quickly and position fixing opportunities should be taken when presented.

ICE CONVOYS – INSTRUCTIONS FOR OPERATIONS

Ice convoys, where several ships are being escorted by an Icebreaker tend to assume formation at a focal point like a harbour entrance or off a prominent land mark. The Master of the icebreaker will act as Convoy Commander and participating ships would be expected to pass all communications through him.

Prior to formation, the Commander will require relevant details of the vessels in the convoy and these could include: —

1. Length of the vessel
2. Turning radius of the vessel
3. Loaded tonnage
4. Sailing draught
5. Horsepower and effective maximum speed

Each participating vessel will have a designated position within the convoy, in relation to the lead commanding icebreaker vessel. This position, and the distance required between other ships, must be maintained. Vigilance by watch officers for irregular movement, including stopping or astern motions of ahead vessels, should be continuous.

The actual distance between vessels, on station in convoy, can be expected to be a variable, depending on prevailing conditions. Seemingly the optimum benefit received from an icebreaker will be about 150 metres astern. However, Masters of vessels in convoy should establish a safe distance, which must be adequate to allow his own vessel to stop without involving collision. Whatever distance off is adopted Masters should invariably be prepared for changes of instructions either from the Convoy Commander or relayed from the vessel ahead. Engine movements by vessels in convoy must be expected and Masters of following vessels should note and respond to appropriate signals and actions made by accompanying vessels.

The adjustment of speed while engaged in convoy should be at the disposal of the officer of the watch or that person who has the 'con' when adjustment is required. Orders may be received at any time to operate astern propulsion, and such orders should be responded to immediately. An understanding of signals made by icebreakers and escorted vessels, should be clearly understood by "bridge personnel". These signals could well relate directly to speed or course changes required by the command vessel. The use of the 'International Code' could also be expected to be employed during such operations.

All vessels should be aware that towing operations by the Icebreaker may become a necessity. If such an event occurs, mariners are advised that icebreakers carry towing wires and winches. These towing wires will be hauled aboard and secured aboard the escorted ship. Personnel should be kept well clear once towing commences.

NAVIGATION IN COLD CLIMATES

In any area where air/sea temperatures are consistently cold and remain below freezing, possibly for several days in succes-

sion, related problems must be anticipated. Various steps can be taken prior to entering cold climates, in order to reduce future damage due to the cold weather:

Ballast

Air pipes and sounding pipes are often found to freeze up and anticipation of the problem, especially if soundings change for no apparent reason, could well highlight the problems developing within the tank. Any vessel which is approaching cold water climates from warm weather areas should consider taking on fresh ballast, i.e from the Gulf Stream.

It should be borne in mind that any tanks above the water line will be more likely to freeze than those tanks below the water line. The reason behind this is the fact that tanks in a high position are exposed to the chill factor of the winds.

In any event it is always prudent action to pump out a few tonnes from each tank. This ensures that the air pipes are clear of water. However, the effect on free surface needs to be calculated, especially for high positioned tanks. Do not forget lifeboat water tanks or these may end up cracked and empty when reaching warmer latitudes. If free surface is of concern consideration should be given to pumping tanks empty though this is not compatible with the idea of obtaining a deep draught when navigating in ice regions.

The Canadian Coast Guard recommend that where possible 'ballast should be recirculated' where freezing conditions persist. Alternatively, the addition of salt or anti-freeze to ballast may be considered as a viable option. Salt additions are cheaper but usually more corrosive than anti-freeze and it would be a matter of experience and the length of stay within the region that could well influence the choice of which to use to prevent damaged tanks.

Machinery Spaces

Heat circulation on the main engine in extremely cold conditions is not unusual and boiler conditions should be closely monitored. Specific areas are prone to damage, namely the 'steering gear compartment' and could well require the use of a continuous heater to prevent cracking of packing in and around the stuffing box about the rudder stock.
Additionally, the use of a steam hose into any fresh water tanks set against the ship's side could well prove useful and prevent damage long term.

Deck Machinery

All water carrying pipelines should be drained prior to entering cold climates. If this is not possible then continuous circulation should be considered. Steam pipes for such items as a 'steam windlass' or 'cargo winches' should be kept turning over at slow speed throughout passage and especially overnight when not in use.

Derricks, cranes or cargo grabs, where sheaves are likely to freeze should be topped, slewed and used at periodic intervals. While hydraulic pumps for hatches etc. should be kept operational under continuous running. Oil reservoir tanks could also benefit from the use of a portable heater overnight.

Navigation & Personnel Problems

Extreme cold will bring about the freezing and frosting of bridge windows together with any window washing arrangements. A high internal wheelhouse temperature will go some way to keeping windows clear but the use of window heaters in today's modernised ships perform the task with a lot more efficiency. These should be checked prior to entering the cold weather. The use of fan heaters directed towards windows and onto 'clear view' motors could also prevent icing up.

Navigation lights may also accumulate snow and ice on the outer glass. These may require some positive cleaning with a spirit. Spare bulbs and fuses should be readily available to remedy simple faults due to cold or moisture.

Watchkeeping personnel should not be over-exposed to extreme cold. Long periods on bridge wings or in an exposed look-out post will lend to fatigue and loss of attention. Look-outs need to be rotated at shorter intervals in order to maintain efficiency. They need to be adequately clothed and protected against the cold and if possible maintained in a warm environment. Contingency actions for adverse weather should be put into operation before the temperature falls, when working becomes difficult. Rigging of lifelines to assist in providing full and complete access to all parts of the vessel, should be rigged as standard. Rock salt needs to be stored in an accessible place to be used on steel decks which can be expected to become slippery. Pipe lagging should be checked and replaced where appropriate and insulation positioned on or around sensitive equipment.

Useful Stores for Cold Weather Climates

Rock salt, electric/fan heaters (portable), warm protective clothing, paraffin, axes, shovels, brushes, masking tape, anti-freeze, protective gloves, steam hose lengths and couplings, heat lamps.

Chapter Eight

TROPICAL REVOLVING STORMS & ABNORMAL WEATHER PHENOMENA

Navigation and Tropical Storms

In order to avoid the 'tropical revolving storm' (TRS), Masters should be familiar with what it is and what they are likely to do. Any action taken will depend on numerous variables, but will also depend on the circumstances the ship finds herself in, e.g. at anchor, moored to buoys, alongside or at sea.

Some vessels which are better founded than others may take one option, whereas an alternative vessel may choose a different option to suit, i.e. Motor vessels, compared with a sailing vessel. Whatever action is taken the Master's decision should be made in the light of all available data and with regard to the safety of his vessel.

In this day and age it is highly unlikely that a tropical storm would materialise without some positive indication, say by radio, navtex, or satellite information. However, recognition of the evidence that may present itself to the mariner should be readily understood. More detailed information will no doubt become available as the storm develops following its formation. The fact that action might need to be taken by a ships Master, who meets the storm early, following its immediate generation, would not be outside the realms of possibility.

The tropical storm An intense depression which generates in tropical latitudes in all oceans except the South Atlantic. They are accompanied by very high winds and extremely heavy seas. Depending on position they tend to have alternative names:

North Atlantic, West Indies areas
North East Pacific
South Pacific
New Zealand (North Island) .... 'Hurricanes'

Arabian Sea, Bay Of Bengal,
South Indian Ocean (West of 80° E)
North Indian Ocean,
NW Australia[1] .... 'Cyclones'

North East Pacific, China Sea .... 'Typhoons'

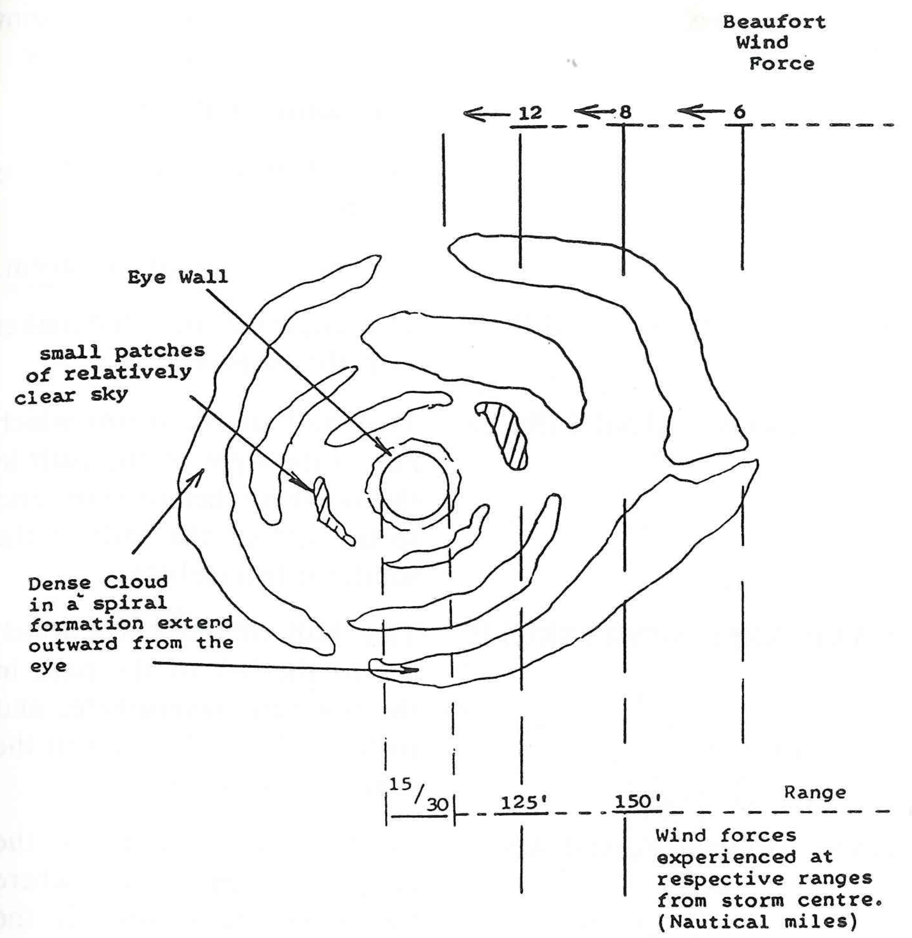
Tropical revolving storms (TRS) are a circular feature with an average diameter of 500 nautical miles. They are known to cause excessive damage at sea or on land as they cross the shoreline, because of the associated violent winds that accompany their progress from generation to deterioration.

The Tropical Storm Feature

Circular feature of average 400/500 miles diameter.
Centre eye diameter 15/30 miles.
Steep pressure gradient with high wind speeds.

The eye wall which is approximately 15 miles wide has an area of dense cloud associated with heavy rainfall and high winds.

[1] NB: North, north west and west coasts of Australia often use the term 'Willy-Willies".



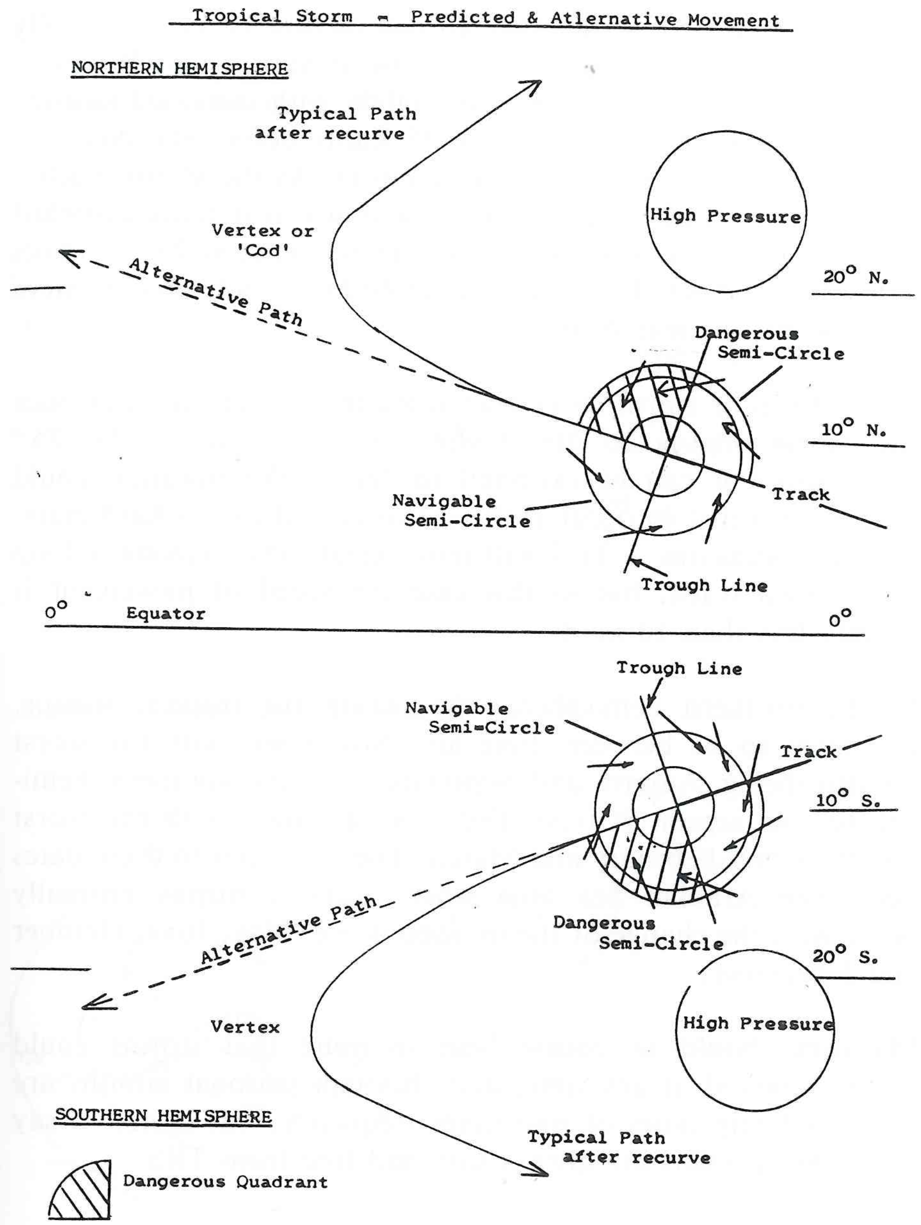
Tropical Revolving Storms – Definitions

PATH	The direction in which the storm is moving.
TRACK	That area that the storm centre has already moved over.
STORM FIELD	That horizontal area covered by the cyclonic condition of the storm.
SOURCE REGION	That region where the storm first forms.

VERTEX (or COD)	The furthest westerly point reached by the storm centre.
EYE of STORM	The centre of the storm.
BAR of the STORM	The advancing edge of the storm field.
VORTEX	The central calm of the storm.
ANGLE of IN-DRAUGHT	That angle that the wind makes with the isobars.
DANGEROUS SEMI-CIRCLE	That half of the storm which lies to the right of the path in the northern hemisphere, and to the left of the path in the southern hemisphere.
NAVIGABLE SEMI-CIRCLE	That half of the storm which lies to the left of the path in the northern hemisphere, and to the right of the path in the southern hemisphere.
DANGEROUS QUADRANT	The leading portion of the dangerous semi-circle, where the winds blow towards the path.
TROUGH	That line of lowest barometer reading, which passes through the storm centre, nearly at right angles to the path.

General Particulars TRS

The tropical revolving storm is known to generate between latitudes 5° to 10° north or south of the equator. They never occur on the equator itself. Their size will vary from 50–800 miles in diameter but they generally average a diameter size of 400/500 miles.



They are associated with violent winds and over 130 knots may be experienced inside the storm field. High seas, often confused, will be predominant within 75 miles of the storm centre. Torrential rainfall around the 'eye wall' (but not in the centre), will restrict visibility in this vicinity to about zero.

Movement of the storm, after formation will be in a generally westward direction, and relatively slow moving, about 10 knots. The speed of travel will increase slightly with increased latitude but will probably not go above 15 knots before the direction changes at the point of recurve. (vertex). As the storm reaches the vertex it can be expected to slow down as it turns eastward from where an increase in movement to between 20–25 knots could be anticipated. Speeds of over 40 knots, following recurve have been experienced in the past.

The pattern of storm movement will vary in each case but once the storm moves to the higher latitudes around the 35° north/south it can be expected to decay. Deterioration could also be expected to occur if the storm moved over a land mass. On rare occasions a TRS will move erratically, making a loop on its own track, but in this case the speed of movement is usually less than 10 knots.

In the northern hemisphere, the season for tropical storms, is known to be between June and November, with the worst months being August and September. In the southern hemisphere, the season is from December to May, with the worst months being February and March. The exception to these dates being the Arabian Sea area where tropical storms normally occur with the change of the monsoons, i.e. May, June, October and November.

Mariners should of course bear in mind that storms could be encountered at any time, and although seasonal months are given as being times of maximum frequency, this is not to say that other periods are always safe and free from TRS.

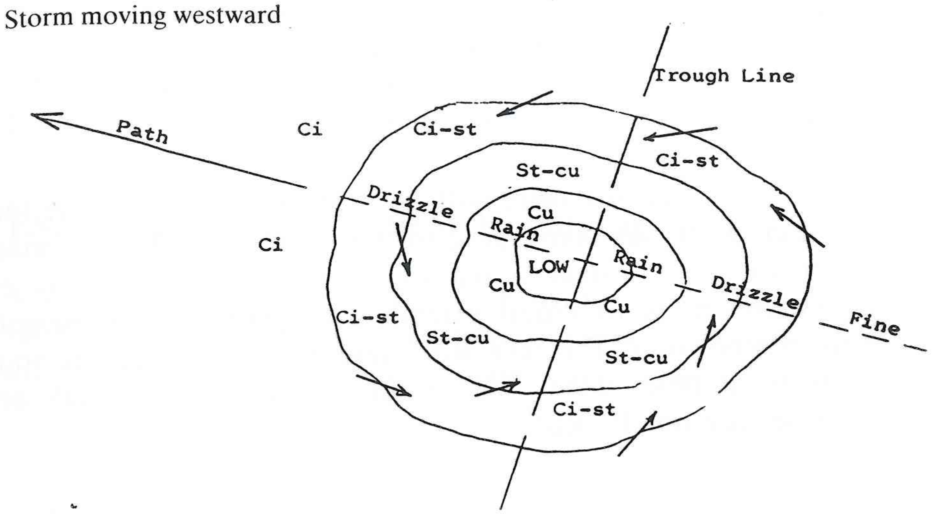
TRS – Weather Sequence – Features

Pressure

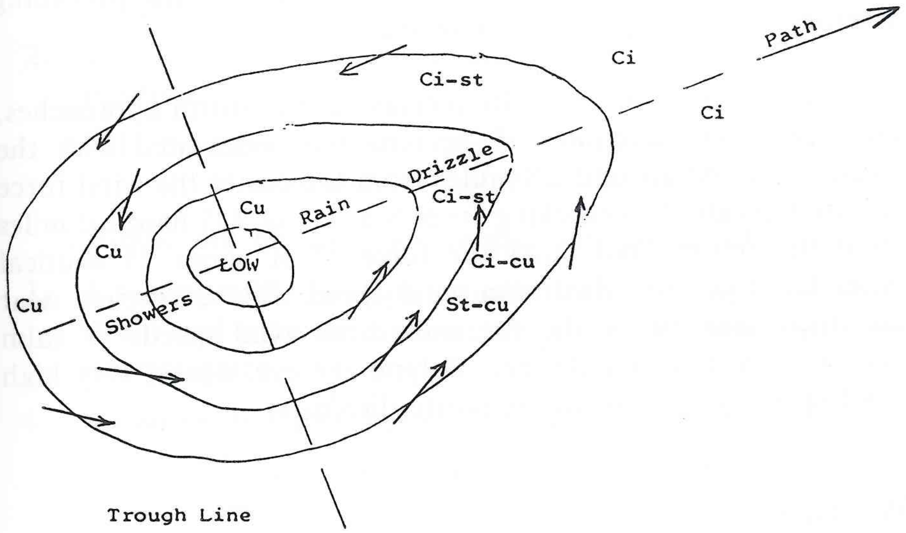
On the outside of the storm the pressure slowly decreases and this pressure fall becomes much more rapid as the eye of the storm approaches. Minimum pressure will be within the eye

Tropical storm – weather pattern
& cloud sequence

Storm moving westward



Storm moving eastward (after recurve)



of the storm. Behind the eye, the pressure will rapidly increase and this will be followed by a slow increase as the eye moves away.

Cloud

In the outer regions there will be broken coverage of the long spiral cloud banks converging on the inner central cloud mass, where the cloud cover is mainly continuous. Around the eye is a dense mass of cloud extending to great vertical heights. This is known as the 'eye wall' and forms an annulus some 15 nautical miles wide. Within the eye the clouds break and the skies are much clearer.

Wind

On the outer edge of the storm approximately 250′ from the centre the winds are light and are associated with the prevailing weather system, e.g. trade winds etc.

The wind speed will gradually increase as the storm approaches, and the wind direction will become that associated with the storm itself. At around 200 miles from the centre the wind force will be typically 5/6 reaching force 8 at about 125 nautical miles from the centre, and hurricane force 12 at about 75 nautical miles from centre. Maximum wind speed will be reached near the inner margins of the eye wall. Low wind speeds or calm may well exist within the eye. Behind the eye, again, very high wind speeds but from the opposite direction.

Weather

In the outer regions intermittent spells of heavy rain associated with the spiral feeder banks of cloud. The rain becomes more intense and widespread in the inner regions, reaching to a maximum in the eye wall, where visibility is reduced to fog levels in torrential rain.

Within the eye, rain ceases and visibility improves. Very high seas exist in the inner regions and also within the eye itself. After the eye has passed, the sky again becomes overcast, the torrential rain returns and the visibility drops, conditions gradually improve after the second crossing of the eye wall although heavy spells of intermittent rain are likely to continue.

Evidence of the Tropical Revolving Storm

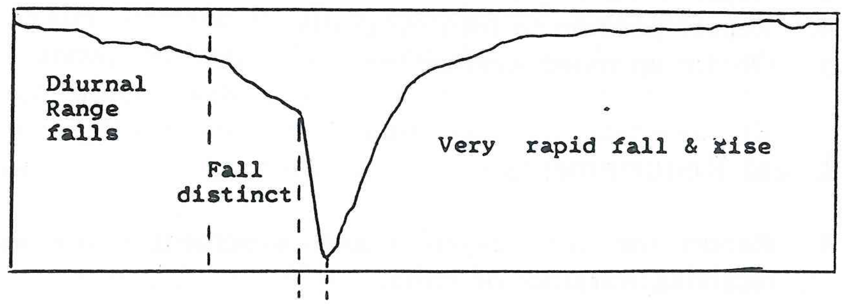
Masters should be aware that even in this day of the weather satellite, little warning of the formation and development of an intense storm of small diameter can be anticipated. To this end the mariner must depend a great deal on his own observations.

The following list should provide the observer with detailed evidence for determination of a storm presence:

1. Geographic conditions and ship's position should lie between the latitudes where storms are experienced. i.e. latitudes 5°–35°.
2. The location and season are compatible with the ship's position.

   NB N. Hemisphere June — November.
   S. Hemisphere December — May.

   Should not be taken to the exclusion of all other periods.
3. A heavy swell develops, usually from the direction of the storm and may be experienced up to 1000 miles from the storms centre.
4. An unsteady barometer or a cessation in the diurnal range.



5. Increased wind velocity or a change in the trade wind, becoming violent.
6. Open ocean, high sea temperature over 27° C.
7. A growth of cumulus (Cu) and/or cumulonimbus (Cb) cloud will develop with bands of showers.
8. A changing appearance of the sky, cirriform cloud with cirrus bands converge towards the centre. These are followed by cirrostratus, cirrocumulus, alto-cumulus and nimbostratus (black cloud).
9. Thunderstorms may occur within 100 mile radius of the storm centre.
10. Oppressive atmosphere, with squally and heavy rainfall in the vicinity of the storm.

Masters Action Following TRS Evidence

Ascertain own ship details in relation to storm position:

1. Bearing of storm centre. (by Buys Ballots Law)
2. Semi-circle in which the vessel is situated.
3. Path of storm.

Ship Security

Order the following:

1. Additional lashings to cargo.
2. Reduction in free surface in all tanks.
3. Improve stability as much as possible.
4. Report position to owners/agents.
5. Obtain up dated weather reports.

Legal Requirements

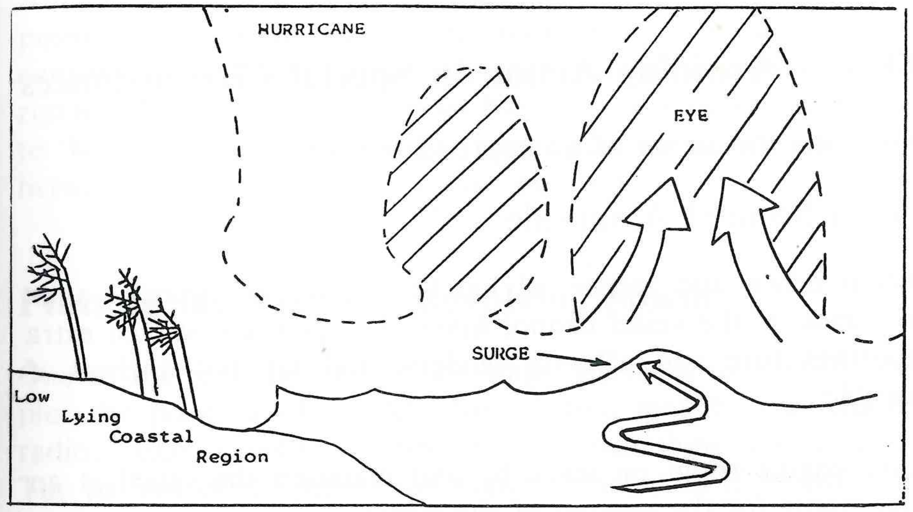
1. Report the storm position and movement if not already receiving warnings of same.

2. Log any deviations of course for charter party purpose.

Ship Handling

1. Heave to, while ascertaining storm details. (Plot storm position).
2. Avoid passing within 75 miles of storm centre.
3. Preferable to remain outside a radius of 200 nautical miles.
4. Adopt a course that takes the vessel away from storm centre.
5. Take frequent checks to ensure that any action taken is having the desired effect.

Storm Surge — Generation Inside TRS



Considerable damage is often experienced, especially in low coastal areas, outlying islands and the like, by storm surge, increased water levels 2–4 metres is not unusual (Hurricane Andrew — North Atlantic, August 1992) can cause severe flooding and many fatalities through drowning.

The surge occurs because of an acute drop in pressure within the 'eye' of the storm. This has a plunger effect on the sea surface which generates high walls of water moving outwards, similar to ripples from a stone thrown into a calm lake. Obvious dangers to the mariner, and especially to the smaller coastal traffic are clear. Moorings will tension and could break or vessels could find themselves beached after the surge recedes. Dock areas are often flooded and associated damage to moored ships could well come from weakened harbour structures. e.g. cranes, pre-fabricated buildings etc.

For vessels secured alongside, with the passing of a tropical storm, Masters should be aware of the main areas of destruction as being from the wind and flood producing rain, however, the most lethal is 'storm surge'. Consideration for persons going ashore, and the cancellation of such shore leave should be considered necessary not only for the individuals safety but also for 'stand-by' for the safety of the ship.

TRS – Avoiding Action in Special Circumstances

Following indication of an approaching storm: —

Vessel Secured Alongside

Batten down and secure all hatches, lower all derricks and/or cranes. If the vessel cannot make the open sea, stretch extra moorings fore and aft, rig fenders, and lay out anchors if possible.

Place engine room on stand-by and maintain the vessel at an alert status for the passing of the storm.

Vessel at Anchor

Have both anchors down at maximum scope of cable, as an alternative to heaving up and riding the storm out in open sea conditions.

If remaining at anchor, engines should be employed to ease the weight on cables.

Vessel at Open Roadstead

Probably far better to run for open sea conditions to provide more sea room for manoeuvre. There is also less chance of a 'lee shore' situation developing. Decision to run for open water should be made early.

In all the above cases the vessel should be made as 'stable' as possible, with no free surface, slack tanks etc. Additional securing should be added to movable deck objects and to specific parcels of cargo. e.g. Heavy lifts, hazardous chemicals/fluids etc.

Vessel in Open Sea Conditions

Any action taken by the Master will depend on the ships position relative to the storms movements, and general circumstances pertinent to the ship involved. The options of outrunning the storm if the vessel has sufficient power/speed, or to 'heave too' and then let the storm pass by to open distance between the storm and the vessels position.

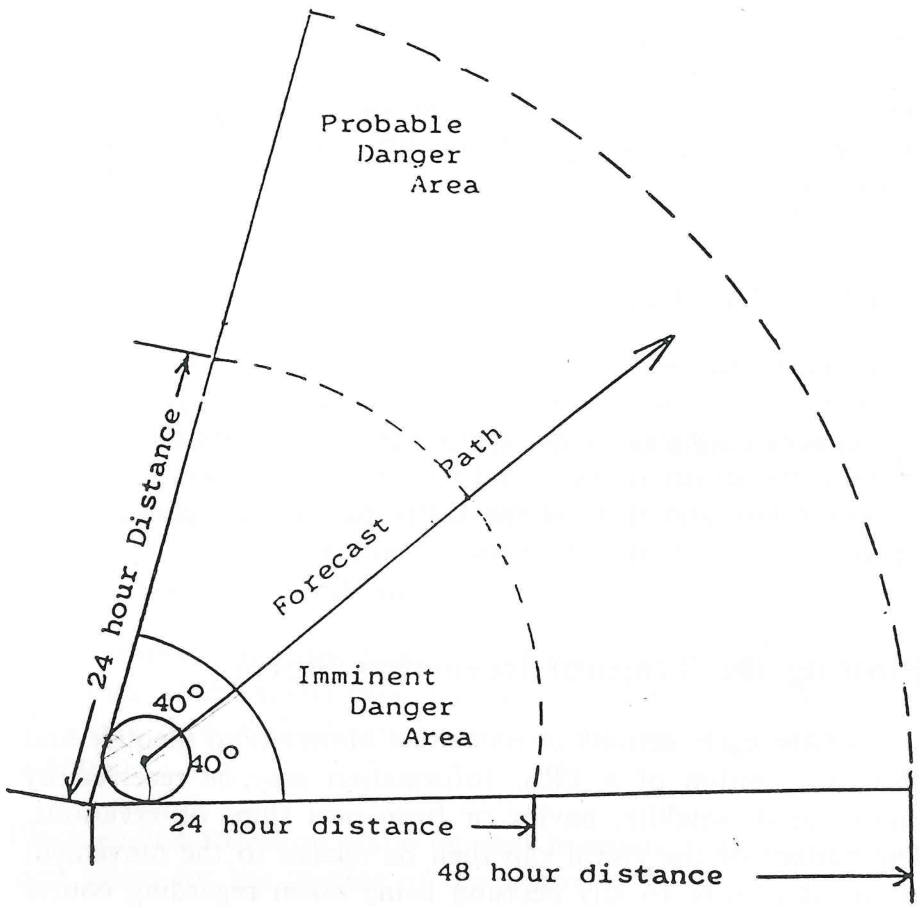
Plotting the Tropical Revolving Storm

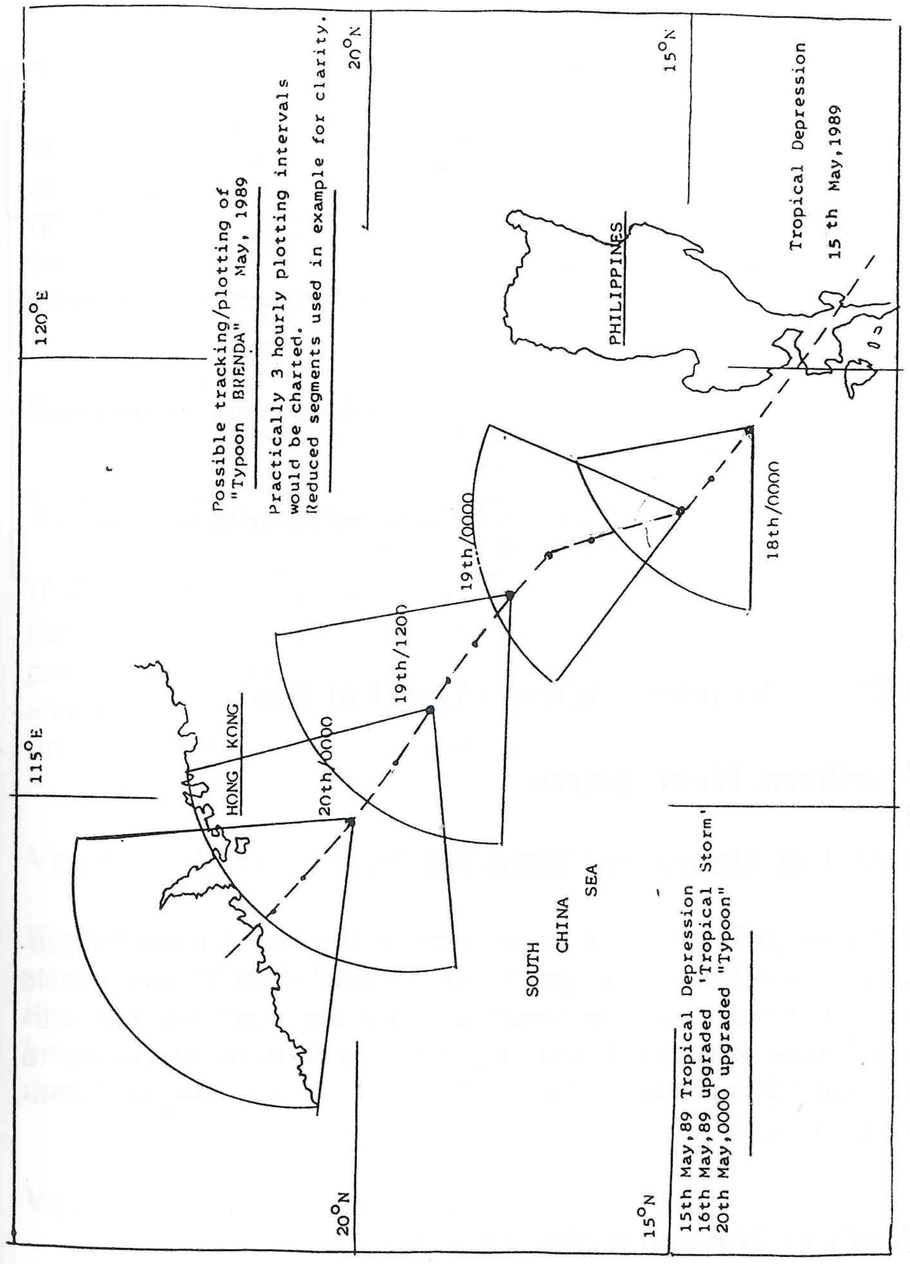
One of the early actions of any ships Master is to identify and plot the position of a TRS. Information may be received by radio, radar, satellite, navtex or from own ships observations. The pattern of the storm can then be related to the movement of the ship prior to any decision being taken regarding course alteration.

Method of Plotting the Storm

1. Plot the storm centre on the chart.
2. Construct a circle to equal the storm radius.
3. Construct tangential lines to the storm circle at approximately 40° from the forecast path.

4. Construct quadrant from the storm centre to equal 1 days movement of the storm (24 hrs × speed of storm). This is then known as the 'imminent danger area'.
5. By projecting the storms movement for an additional 24 hour period, the 'probable danger area' can be charted.





Plotting example tropical revolving storm

TRS — Establishing Ships Location

The location of a vessel in the proximity of a tropical revolving storm is determined by observation of the 'true wind shift' and of any 'pressure change'.

Wind obs'n	N. Hemisphere	S. Hemisphere
Veering	Vessel located in Dangerous Semi — Circle	Vessel located in Navigable Semi — Circle
	If the pressure is falling vessel is in the advance quadrant	
Backing	V/l located in Navigable Semi-Circle	V/l located in Dangerous Semi-Circle
	If the pressure is falling, vessel is in the advance quadrant.	
Steady	If the pressure is falling the vessel is in the 'PATH' of the storm.	

TRS — Avoiding Action (Vessel at Sea)

Northern Hemisphere

Vessel in Dangerous Semi-Circle:

If the wind is observed to be veering the vessel must be confirmed to be in the 'dangerous semi-circle'. The Master should make the best possible speed keeping the wind on the starboard bow between 1 and 4 points. Alterations of course to starboard being made to keep the wind on this bow as it continues to veer.

Vessel in Navigable Semi-Circle:

If the wind is observed to be backing the vessel in the 'navigable semi-circle', the Master should make all possible speed

with the wind on the starboard quarter. Alterations of course to port being made to keep the wind on this quarter as it continues to back.

Vessel in the Path or Nearly in the Path:

When the wind is remaining steady or nearly steady, the Master should alter course to obtain the wind well on the starboard quarter and proceed towards the navigable semi-circle. Once within this semi-circle alter course to port to maintain the wind on this quarter.

Southern Hemisphere

Vessel in Dangerous Semi-Circle:

If the wind is backing the vessel must be confirmed to be in the 'dangerous semi-circle'. The Master should make the best possible speed keeping the wind on the port bow between 1 and 4 points. Alterations of course to port, being made to keep the wind on this bow as it continues to back.

Vessel in Navigable Semi-Circle:

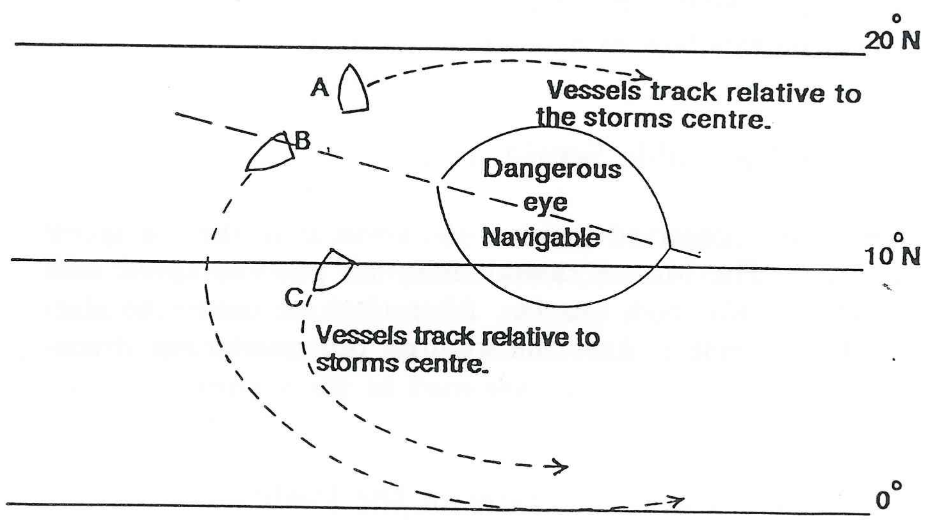
If the wind is observed to veer, the vessel is in the 'navigable semi-circle'. The Master should make all possible speed with the wind on the port quarter. Alterations of course to starboard being made to keep the wind on this quarter, as it continues to veer.

Vessel in the Path or Nearly in the Path:

When the wind is remaining steady or nearly steady, the Master should alter course to obtain the wind well on the port quarter and proceed towards the navigable semi-circle. Once within this semi-circle alter course to starboard to maintain the wind on this quarter.

Action of Vessel in TRS vicinity

Location	N. Hemisphere	S. Hemisphere
Dangerous Semi — Circle (A)	Put wind on the starboard bow & alter course to Starboard as the wind 'Veers' ,	Put the wind on the port bow & alter course to port as wind 'backs'
Navigable Semi — Circle (C) Path (B)	Put wind on the starboard quarter and alter course to port as the wind 'backs'.	Put the wind on the port quarter and alter to starboard as the wind 'veers'

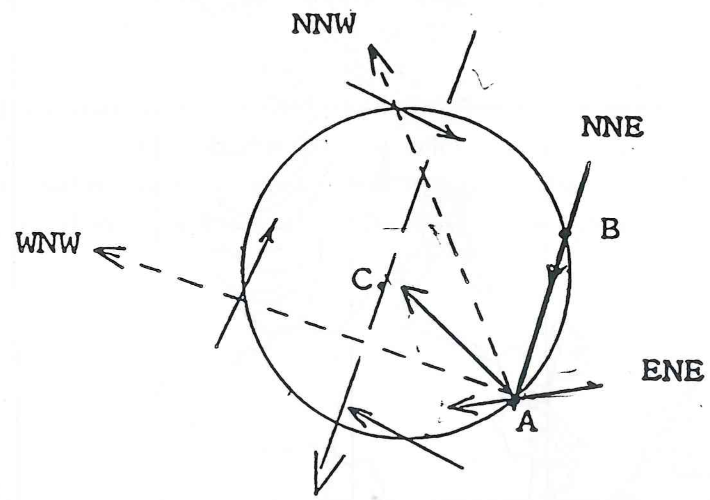


Application of Buy's Ballot's Laws for TRS

Example

A vessel in the southern hemisphere observes the wind in an approaching cyclone to blow from the east north east (ENE). How is the probable centre of the storm estimated if the wind then changes to north north east (NNE).

Circle represents right hand wind circulation in southern hemisphere.



'A' represents the position of the ship when the wind is ENE.

Face the wind — Take a bearing 8 compass points left = NNW.
Take a bearing 12 compass points left = WNW.

(Taking bearings LEFT because the vessel is in south hemisphere).

Centre of storm bears between NNW and WNW (represented by AC).

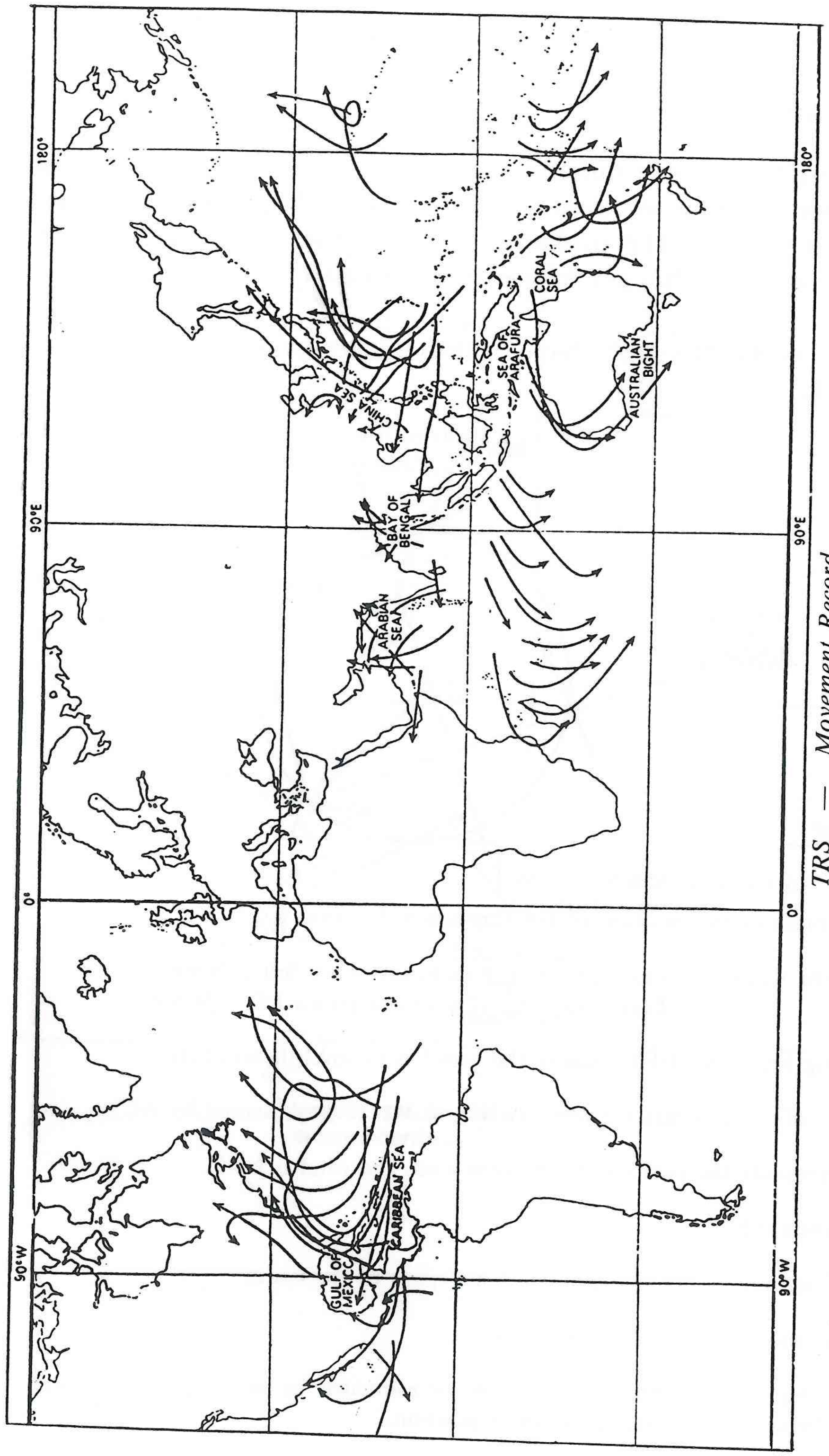
'B' represents the position of the ship when the wind is NNE.

Construct AB

'AB' then represents the apparent track/path of the storm.

(Storm moving from B towards A).

NB. Ships range from the storm can be estimated by use of the wind force being experienced at the ships position.



TRS — Movement Record

Ships range from the storm can be estimated by use of the wind force being experienced at the ships position.

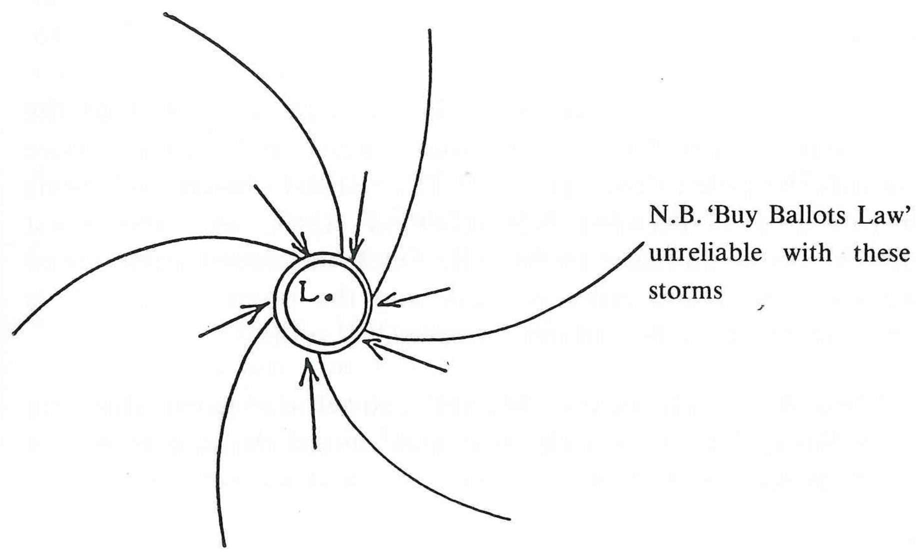
Regional Information – Tropical Revolving Storms

Indian Ocean Storms

These generally originate about latitude 10° South, longitude 70° east and travel in a west south west direction towards Mauritius. They tend to haul more southerly as they proceed to a point of recurve in about latitude 20° south.

The position of the 'vertex' will vary considerably in both latitude and longitude. The season is from October to July, with December to April being the worst months.

A specific feature of storms in this region is the very large angle of indraught experienced by cyclones passing over Mauritius. This is sometimes so great that in some parts of the storm the wind may be observed to blow directly towards the storm centre.



The speed of a TRS in the Indian Ocean is between 50 to 200 nautical miles per day (2.5–8.0 kts). They are known to travel at their slowest at the beginning and end of the season.

Arabian Sea Storms

These generally originate near the Laccadive Islands or a little to the west or north of them. They tend to travel in a curved path towards the Arabian Coast from May/June, and towards the Indian coast in November. These periods often coinciding with the times of change of the monsoons, and the storms usually bring exceptionally heavy rainfall to the Bombay area.

Bay of Bengal

These storms may originate anywhere in the bay or may enter the bay from the Gulf of Thailand on occasions. They have a tendency to travel in a north easterly to a north westerly direction before and after the monsoon seasons. The speed of travel varies but the general average is about 200 miles per day. Paths of storms are irregular because the general circulation is seasonal and interrupted by the monsoons, consequently the point of curvature cannot be reliably defined.

South Pacific Storms

These storms generally originate in the area north east of the Fiji Islands, travelling to the south west, and hauling more towards the pole as they proceed. The normal season for storms in this area is between November to April, with the worst months being January to March. Once developed their speed averages about 200 miles per day and the point of recurve is often observed to be around latitude 20° south.

* 1986 April. Hurricane 'Martin' caused the worst flooding in Suva, Fiji, 10 people died and caused damage in excess of 26 million dollars.

China Sea, Taiwan, Japan and North Pacific

These storms usually originate to the north eastward of the Philippine Islands. They tend to travel in a west north westerly direction towards the Chinese mainland. Some recurve and

move north easterly towards Japan. Experienced all year round, worst months July-October.

* 1985 Oct. Typhoon 'Brenda' was the first storm to affect South Korea in 20 years. 69 people were lost and 1,459 fishing boats were destroyed.

* 1977 July. Typhoon 'Thelma' destroyed Kao-Hsiung harbour, Taiwan. Thirty persons died, and 32 ships were sunk. This was recorded as being the most destructive event since the second world war.

North Atlantic Hurricanes

These storms originate in about 10° north latitude and travel in a west north westerly direction. The general movement is towards the West Indies hauling northwards towards the pole as they proceed. Some have been known to sweep into the Gulf of Mexico, but usual behaviour is for them to recurve in about latitude 30° north. The tendency then is for them to move eastward of north and experience has shown that the southern ports of the USA, and the eastern atlantic coasts of the USA are frequently effected.

* 1983 August. Hurricane 'Alicia' developed over the Gulf of Mexico, and came ashore near Galveston, Texas. A storm surge of several metres high caused extensive coastal damage.

* 1988 September. Hurricane 'Gilbert' described as the most intense cyclone on record in the western hemisphere, devastated large areas of Jamaica. Greatest loss of life occurred in Mexico which it hit twice. Associated rains caused the Santa Catarina river to burst its banks with the loss of 200 lives.

Tornadoes and Waterspouts

It is appropriate at this time to discuss the navigation in and around a 'tornado', especially so when it is realised that they are a compact whirling storm. The diameter of them will vary between 50 to 1000 metres and their wind speed may reach as high as 450 knots. They are quite noticeable as a slim column, which is almost vertical, made up of dust, condensation and some debris, usually protruding from and attached to an area of cumulonimbus cloud. Tornadoes are often accompanied by thunder, lightening and/or hailstones.

Waterspouts are tornadoes which have passed over water. When sighted they appear as a column of water which joins the cloud to the sea surface. The column will be caused to bend as the upper and lower sections move at different speeds, eventually breaking to disintegrate.

Large shipping tend to give a wide berth to waterspouts as loose articles on deck would be swept clear with possible associated damage. However, small craft should be aware of the acute danger of navigating too close to them and alter the course away in ample time.

Generally speaking they move at about 15 knots in a mainly easterly direction and may only last for a short period (approximately up to 1 hour). Certain areas of the world are more susceptible than others, for example the United Kingdom experience on average 1 every 2 years, whereas the USA has around 150 per year.

Where a tornado effects the coastline, extensive damage is usually the end product. House roofs are torn away and trees often uprooted with its ferocity. Mariners are advised to alter the course away and avoid the immediate areas of waterspouts. Good 'house keeping' by having clean and clear decks, with all parcels of cargo well secured will, go a long way to eliminating serious damage in the event of a tornado effecting the ships position.

Tidal Bores

A body of water with a wall like front which may be seen to surge up rivers. Notable examples are encountered in Hangchow Bay in China, and the River Severn in England. They are

generated because river estuaries act as a funnel causing a rise in the height of water as it flows upstream. Maximum height approx. 8 metres, observed in the North Amazon River.

Speed of tidal bore will be related to its height and the water depth ahead of it. Where a river has an outflow current then the velocity of the bore would be correspondingly reduced. Mariners should note that dangerous bores are well noted in sailing directions, and small vessels are advised to navigate with extreme caution in and around noted estuaries.

Tidal Waves (*Tsunamis*)

Tidal wave is a common misnomer for what should be correctly called 'Tsunamis'. They are caused by underwater landslides, earthquakes, and volcanic eruptions. When encountered at sea their height rarely exceeds one metre, but their length is often between 50 to 250 miles. Consequently they do not tend to pose a hazard for ships. However, they do travel very fast. An example of the speed of travel was observed from an earthquake in the Aleutian Trench in the North Pacific in 1946. A 'Tsunamis' generated from the disturbance took 4 hours 34 minutes to reach Honolulu. The distance was 2000 nautical miles so the speed of travel was approximately 438 m.p.h. The results of this wave were such that 25 million dollars of damage was caused and 173 persons killed when the wave struck Honolulu.

International co-operation has now caused a 'Tsunamis warning service' to be established, based in Honolulu, and supported by the countries which border on the Pacific Ocean. In the case of an alert mariners are strongly advised to head for open sea conditions and clear of shallows. Alerts being activated by seismograph equipment, but generally the intensity of the 'Tsunamis' cannot be reliably forecast. Anchorages, buoy moorings, or even tied up alongside cannot be considered as a reliable position. Dangerous encounters and collision with floating debris during the passing phase of a Tsunamis is a common hazard.

Storm Surge — (see tropical revolving storms)

Chapter Nine

S.A.R. NAVIGATION AND GMDSS

Introduction

With any search and rescue operation within the marine environment there are bound to be defined 'key players'. Without doubt the Master of a vessel engaged in a search mode will be a major influence on the success or failure of the operation. The Navigating Officer of a search vessel will also carry a high level of responsibility from the time that any distress message is received.

Other major participants will be involved as and when location is achieved, bearing in mind that the term 'location' is not the same thing as 'recovery'. The coxswain of a rescue boat, or the 'aircrew' from a helicopter will become positive players at a later stage of recovering survivors.

In order to provide a comprehensive appreciation of all the activity which will concern itself in a successful rescue, certain elements of general seamanship have been introduced with the navigational aspects. The author makes no apology for this in the belief that the two topics overlap considerably.

Action on Receipt of a Distress Message

1. Immediate Action:

   (a) Master must acknowledge the distress message
   (b) Obtain radio bearing of distress transmitter (if possible)
   (c) Establish plain language communication as soon as possible. (Obtain identity, position, course and speed and ETA)
   (d) Maintain continuous radio communication watch.
   (e) Maintain continuous radar watch (double watches)
   (f) Post extra look-outs at high vantage points
   (g) Obtain target definition

2. Subsequent Action:

   (a) Contact Rescue Co-ordination Centre (RCC) via coast radio.
   (b) Order navigator to plot positions and establish a course to rendezvous and update ETA.
   (c) Relay distress message on other frequencies if appropriate.
   (d) Plot other vessels within the search vicinity together with their respective movements.
   (e) Update distress information, i.e. weather at distress site, numbers of casualties, total number of persons at scene, number and type of survival craft and if any emergency location aids.
   (f) Bridge team at alert status and manual steering engaged.

3. Vessel Preparation:

   (a) Prepare ship's hospital to receive casualties.
   (b) Turn out rescue boat ready for immediate launch
   (c) Gear up rescue boat's crew (immersion suits and lifejackets)
   (d) Rig, guest warp, accommodation ladder, scrambling nets and a derrick/crane if required.

   (e) Test and trim search lights
   (f) Check that line throwing apparatus is readily available
   (g) Test communications systems to rescue boat/bridge
   (h) Order 'stand by engines' but remain at maximum sea speed.

4. (a) Establish a co-ordinator surface search (CSS)
   (If no specialised craft, eg. warship/military plane is available the most suitable merchant ship will assume this role)

The role of CSS

Any vessel accepting the role of CSS should carry out the following:

1. Display international code flags 'FR' by day and/or a distinctive signal by night.
2. Select a suitable search pattern appropriate to the conditions.
3. Plot the 'datum'. (Most probable position of target).
4. Maintain and control inter ship communications
5. Estimate drift rate and hence total drift
6. Adjust search pattern in the light of weather conditions (i.e. visibility, and with the input from additional search units).
7. Establish search pattern track space for the prevailing conditions.
8. Identify the 'datum' by dropping a marker buoy.

Commence search pattern and maintain relevant communications.

During all the above proceedings the officer of the watch should maintain an accurate record of the ship's movements and make specific statements in the log book. These will later be required for quoting periods of 'deviation'. The limits of any searched areas, together with the positive or negative results, should also be entered in the log.

The Role of Bridge Team

Duties of the Master

In any search and rescue operation the role of the Ship's Master has to be that of 'conning' the vessel. This in itself is of major consideration in the fact that many other operational units could be active in the area and the risk of collision is greatly increased. The proximity of navigational hazards is always present and the need for immediate and positive response is often not just desirable but necessary.

The management of the bridge team and the direct control of associated operations will fall to the Master's authority. This is especially so where junior officers lack experience and are seeking operational guidance. There will be a need for the Master to oversee all communications and become directly involved with any search pattern and the respective movements of the vessel. Shipboard facilities such as recovery methods, medical treatment of survivors and communications analysis will be essential in order to achieve a successful outcome.

Navigation Officer

The duties of the navigator will be tremendous in a MERSAR operation. He should be considered as the Master's right hand man. Not only will the 'search area' be required to be plotted, but also any alteration of course points required by the search pattern. In the case of the co-ordinator surface search (CSS) all areas being searched by other units will also be required to be plotted to formulate an overall picture of the operational area.

It will be necessary for the navigator to note and record searched areas. He will also need to project ETA's as and when applicable and co-ordinate surface movements with possible aircraft activity. The ship's speed and fuel resources may also become a factor for consideration, depending on the size of vessel and general circumstances at the time.

The navigator will need to consider the possibility of sudden changes from recognised search patterns, in the light of updated information. Casualty sightings, poor visibility, and/or internal shipboard problems may make deviations from expected performance a requirement. Rendezvous calculations with other units can also be expected.

Officer of the Watch

In addition to the navigator, the watch officer will be required to monitor the ship's performance, namely, position, speed, course etc. A continuous radar watch, especially in active areas must be considered essential, and Masters should consider "doubling watches" to facilitate the search vessel's requirements.

Watchkeeping duties will be ongoing, and will encompass such special duties as:

The display of special signals, monitoring weather conditions, maintaining and updating communications, traffic avoidance, effective and constant lookout and conning the vessel in the absence of the Master. Consideration towards fellow watchkeepers, by way of meal reliefs and the avoidance of fatigue should also be assumed as part and parcel of the duty officer's tasks.

Radio/Communications Officer

With the recent introduction of GMDSS, many watch officers will assume the role of communications officer. However, it will be some time, in the author's opinion, before radio officers are no longer carried. Passenger vessels and warships will probably retain radio operators for some time to come. With this in mind Masters should establish and maintain regular communications with the Rescue Co-ordination Centre and/or other search units. To do this effectively continuous guarding of alarm and working frequencies will be required by Radio/ communication officers.

Transmission/reception contents should include: —

Updated weather reports, results of searched areas, position reports of ship, position reports of all sightings of wreckage/ survivors, updates of information received from survivors (following debrief), status reports relayed from other search units, operational changes (such as change of track space), changes in visibility inside search area, equipment or resource requirements, identity and homing signals, pollution reports and navigational hazards as appropriate.

With any operation of this nature the vital link from the Master to the Rescue Co-ordination Centre is effective and reliable communications. It is essential that early communications are established and retained by the on scene commander, the co-ordinator surface search and individual search units.

Engine Room

It may be disputed that the engine room is part of the bridge team. Mariners should remember that control of the vessel is only possible while you retain engine power. It is therefore prudent for Masters to encourage and develop involved links between the navigational bridge and the engine control room. The outdated thinking of 'oil and water' between deck and engine room, does not breed efficiency, they must be seen to mix, in the interest of the casualty.

Watch officers should therefore endeavour to keep the engine room informed of surface activities. Early warning on 'standbys' or 'engine movements' are appreciated whenever possible and response times can be improved. Teamwork will without doubt, complement a ship's overall performance.

MERSAR SEARCH PATTERNS

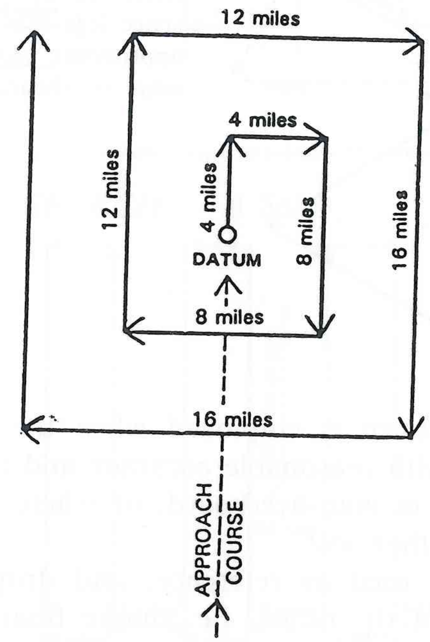
Many different types of search patterns are available to SAR units and in conjunction with the Co-ordinator Surface Search

(CSS) an appropriate pattern to suit the conditions would be put into operation. Most of the following examples are suitable for either air or surface units, but in all cases the navigator of the search craft will play a 'key' role.

The majority of searches take place within defined limits, depending on the target's capability and endurance. Individual search units are usually designated a specific area and the navigator will need to plot these extreme boundaries before instigation of the pattern.

Obviously the type of pattern and track space employed should reflect the nature and size of target as well as taking into account the prevailing weather conditions, especially the state of visibility. Where more search units are employed the accuracy is generally increased and/or the area of coverage is increased.

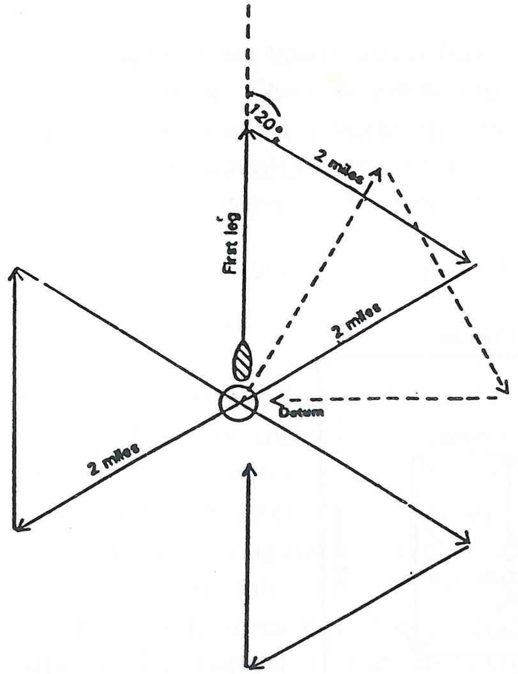
EXPANDING SQUARE SEARCH PATTERN — 1 Ship



The expanding square search pattern can be employed by either surface vessels or aircraft search units. Where more than one aircraft is involved, they would fly at different heights and on headings 45 ° off the original.

The CSP begins at the probable location of the target and expands outward in concentric squares. Accurate navigation is required to monitor the ship's position towards course alteration points.
(All course alterations being 90 °)
The track spacing which will vary depending on visibility and sea conditions relative to the type of target.

SECTOR SEARCH — 1 Ship



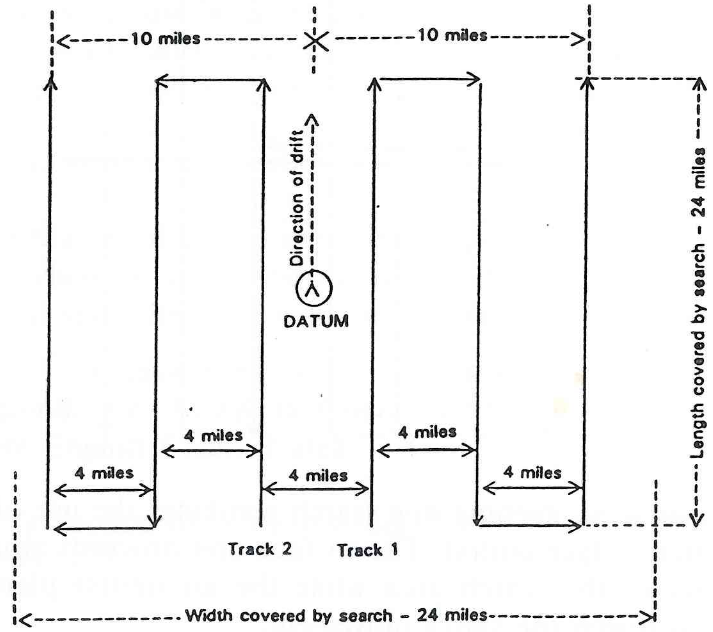
The use of time instead of miles for determining track space/legs may be more appropriate especially for a man overboard incident.

The sector search pattern is employed when the position of the target is known with reasonable accuracy and the search is over a small area, as in man-overboard, or where the casualty has been sighted and then lost.
A suitable marker is used as reference, and dropped at the most likely position of the target, i.e. smoke float or beacon. All turns are 120 ° to starboard. Start pattern at datum. This pattern gives a very high probability of detection close to datum and spreads the search over the probable area quickly.
Upon completion of the first search, re-orientate the pattern 30 ° to the right and re-search as shown by the dashed line.

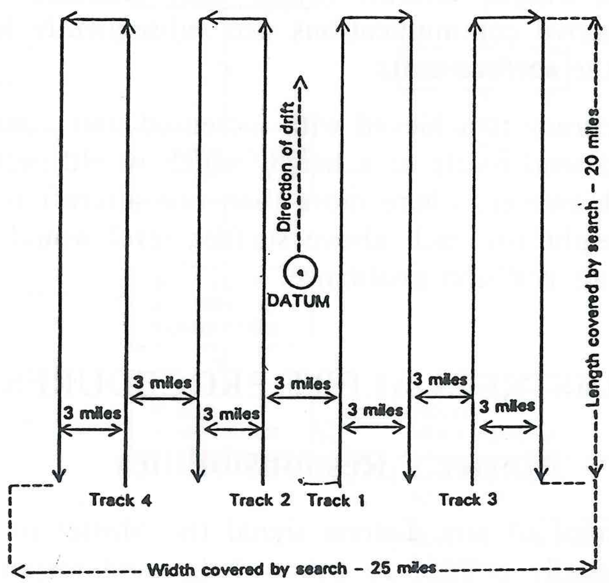
PARALLEL SEARCH PATTERN

Used when the search area is large or where only the approximate location is known and uniform coverage is necessary.

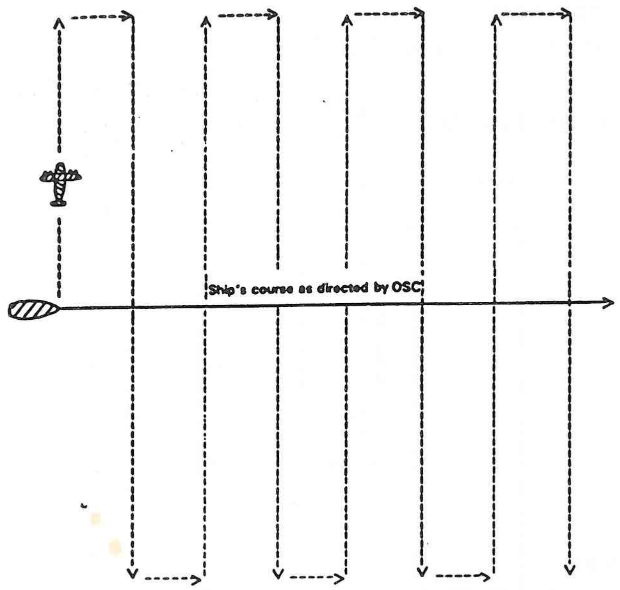
PARALLEL SEARCH — 2 Ships



PARALLEL SEARCH — 4 Ships



CO-ORDINATED CREEPING LINE SEARCH — 1 Ship and 1 Aircraft



The co-ordinated creeping line search combines the use of both aircraft and surface unit(s). The surface unit proceeds along the major axis of the search area while the air unit(s) plan their advance to match the ship's movement.

NB: Fixed winged aircraft (other than seaplanes) can only locate, effective communications can subsequently lead to recovery by the surface units.

Greater accuracy is achieved with increased unit numbers. Aircraft would tend to fly at a height which would permit visible detection. However, where more than one aircraft is employed a varied height for each above surface level would be in the interest of air collision avoidance.

DISTRESS ALERT PROCEDURES

Distress – Master's Responsibilities

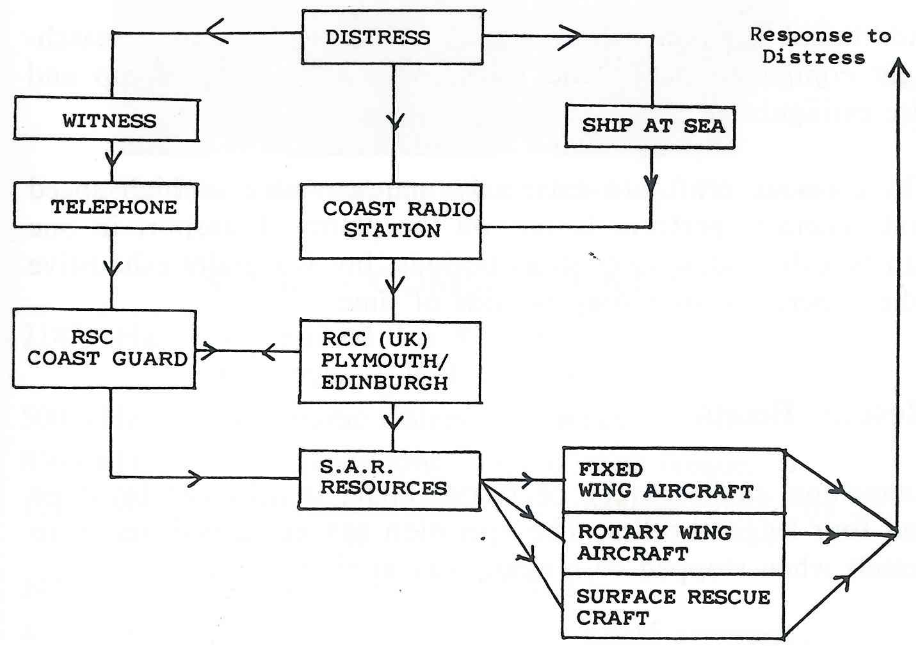
On the receipt of any distress signal the Master or officer in charge is legally obliged to acknowledge and respond to that

signal. In the event that the distress signal is not in the immediate area then it would be considered normal practice for a potential rescue vessel to wait a short interval to allow other vessels, closer to the scene to respond.

The obligation to render assistance to a vessel or aircraft in distress at sea must be considered with the highest priority. No communication can take precedence over a distress message and the Master of another vessel so called must respond. It should however be noted that a vessel may be relieved of this duty to assist a distressed vessel when:

1. The Master of a ship is unable to positively respond possibly when he might be in distress himself, or the action would stand his own vessel in immediate danger, or
2. When circumstances make it unreasonable for him to respond, e.g. Vessel in China Sea receives distress signal from English Channel area.

Following receipt of a distress signal the 'alert machinery' is as follows: —



FAST RESCUE CRAFT

Many of the current rescue authorities around the world operate fast rescue type craft of a semi-rigid inflatable type. Both the Royal National Lifeboat Institution and the U.K. Coast Guard have these craft available in the event of them being required.

The craft, depending on size and engine power, have speeds in excess of thirty knots. With this potential power and shallow draft, they have a fast response time, often into shallow and difficult areas. It is common practice for operators of such craft to move out from their base under high speed and arrive very quickly at the scene of an incident. The return rate of speed will often be reduced to ease the comfort of casualties and will depend on the circumstances of the case in hand.

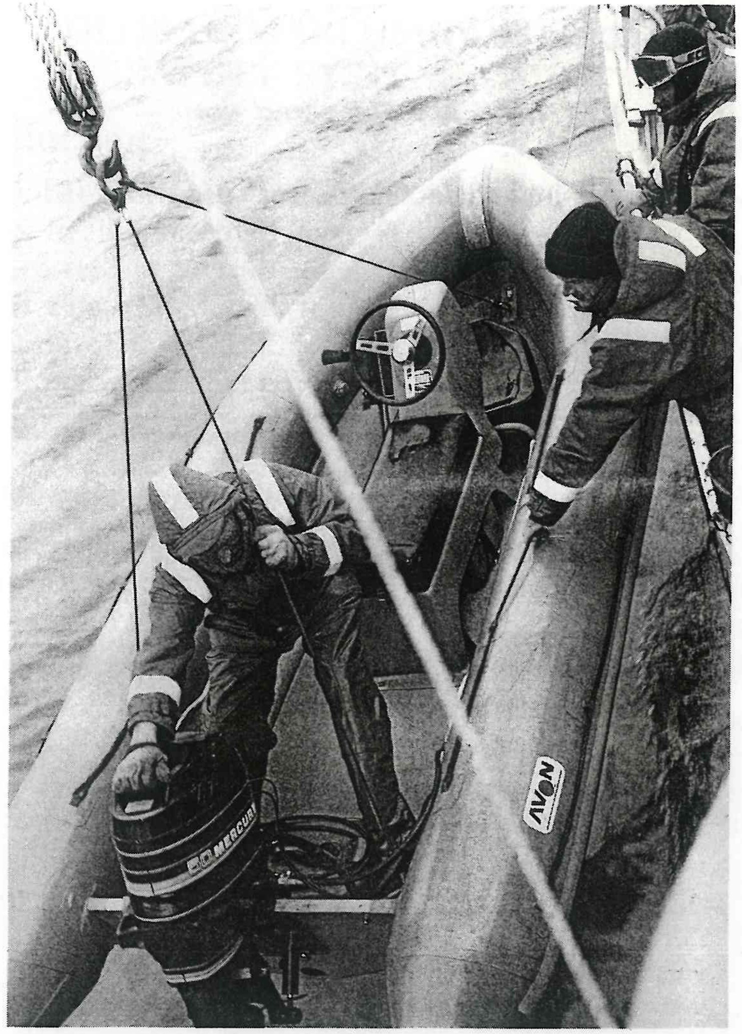
They are normally crewed by two or three men, again depending on the size of the craft. First coxswain, second coxswain and/or an observer/swimmer. Standard equipment would include: external lifelines, paddles, navigation lights, bellows, internal grablines and repair kit.

Additional equipment may include: First aid kit, radio, searchlight compass, anchor and warp, boat hook, bilge pump and fire extinguisher.

These rescue craft are extremely manoeuvrable at high speed and generally perform better 'on the plane'. Transport in one can be exhilarating over short periods, but is equally exhaustive when operating over long periods of time.

Rescue Boats

Launching and recovery of rescue boats is achieved by three and four legged bridles. The operation can be carried out from vessels when stopped or making way at slow speed.



Use of three legged bridle for launch and recovery of rescue boats.

S.A.R – COMMUNICATIONS

2182 kHz	Designated S.A.R aircraft. Compulsory R/T distress frequency.
500 kHz	Automatic distress frequency
8364 kHz	Emergency long range distress frequency
121.5 MHz	Aeronautical distress frequencies carried by all designated
243 MHz	S.A.R aircraft E.P.I.R.B.'s
406 MHz	E.P.I.R.B, Satellite alert world coverage.

156.8 Hz (Ch. 16)	Desirable VHF
3023 kHz 5680 kHz	R/T for S.A.R 'on scene' use.
123.1 MHz	Air and surface 'on scene' use.

Fast recovery craft, FRC, operating at speed in excess of 30 knots.

GLOBAL MARITIME DISTRESS & SAFETY SYSTEM (GMDSS)

Introduction

The Global Maritime Distress and Safety System has been developed by the International Maritime Organization. It is expected to replace the present marine distress and safety systems and has been included in the amendments to the SOLAS 1974 convention. The GMDSS will involve considerable automation and will make use of the Inmarsat's satellites to provide reliable communications.

Compliance with the System

1. Ships which are constructed before 1st February 1995 must either comply with GMDSS, or comply with the old chapter IV of SOLAS 1974.
2. Ships which are constructed after 1st February 1995 must comply with GMDSS.
3. Every ship must comply with NAVTEX and satellite EPIRB's not later than 1st August, 1993.
4. All ships must comply with GMDSS by 1st February 1999.

Types of Vessels Affected

The GMDSS requirements will affect all passenger ships and all cargo ships of 300 grt. or over.

Equipment Carriage Requirements

Ships will require specific items of equipment, based on the sea area in which the vessel operates. There are four designated sea-areas and these are defined in the tabulated carriage requirements.

At present two types of terminals are available, namely:

Inmarsat-A	offers the use of voice, data, facsimile and telex based communications.
Inmarsat-C	this is smaller and offers text and data messaging at lower speeds.

Both terminals provide worldwide coverage with the exception of the extreme polar regions.

GMDSS Functional Requirements

The equipment provided has been identified by the IMO as being suitable to carry out the following operations:

- Ship to shore distress alerting
- Shore to ship distress alerting
- Ship to ship distress alerting
- Search and rescue co-ordination
- On scene communication
- Transmission and receipt of locating signal
- Transmission and receipt of maritime safety information
- General radio communications
- Bridge to bridge communications

DEPARTMENT OF TRANSPORT

MERCHANT SHIPPING NOTICE No. M.1454

Guidance on the Carriage of Radio Life-Saving Appliances having regard to Radiocommunications for the Global Maritime Distress and Safety System (GMDSS)

Notice to Owners of Merchant Ships, Operators, Builders, Masters and Officers

Introduction

1. The development of radiocommunications provisions for the GMDSS has resulted in changes to international requirements, so far only partially implemented, concerning the carriage of radio life-saving appliances. In order to complete implementation, having regard to the GMDSS (particularly recommendations of the GMDSS Conference), future regulations will contain certain equipment choices and give rise to particular exemptions.

2. The purpose of this "M" Notice is to give advance notification of revised requirements concerning radio life-saving appliances, and also consequential exemptions, in order that unnecessary changes and duplication of equipment are minimised.

3. It is intended that the revised international requirements for survival craft and ship radio life-saving appliances will be implemented through amendments to the existing regulations on life-saving appliances and on radio installations.

Regulations

4. The current LSA Regulations, based on Chapter III of the SOLAS Convention, apply also to many classes of non-Convention cargo ships; tankers and tugs of less than 500 tons and additionally passenger ships not engaged in international voyages.

5. The LSA Regulations have required ships, built on or after 1 July 1986, to carry portable/fixed radio equipment, radiotelephone sets and 121.5/243 MHz Emergency Position-Indicating Radio Beacons (EPIRBs) for use in survival craft. From 1 July 1991, the regulations will be amended to require the above equipment on ships constructed before 1 July 1986. However, to improve safety, to give effect to GMDSS recommendations and avoid unnecessary changes/duplication of equipment, the amended LSA Regulations will allow ships to opt for early compliance with GMDSS, ie:—

(a) to carry, in lieu of the 121.5/243 MHz EPIRBs, the combination of a 406 MHz (or 1.6 GHz) satellite EPIRB and 9 GHz radar transponder(s); and

(b) to dispense with the portable/fixed lifeboat radio equipment if meeting the optional arrangements in (a) above.

6. The MS (Radio Installations) Regulations, which have traditionally reflected the ship classification in Chapter IV of SOLAS, do not apply to cargo ships, tankers and tugs of less than 300 tons.

7. The MS (Radio Installations) Regulations 1980 will be revised to implement the GMDSS from 1 February 1992. These regulations will cover radio life-saving appliances required for the ship, as distinct from those for use in survival craft, and will also necessitate the carriage of a 406 MHz (or 1.6 GHz) satellite EPIRB. They will also require the carriage of a ship's 9 GHz radar transponder which may be one of those required by the LSA Regulations.

8. In summary, it is intended that there will be two sets of regulations requiring ships to carry, either by option or by requirement, a 406 MHz (or 1.6 GHz) satellite EPIRB and 9 GHz radar transponder(s). The LSA Regulations will apply to all Convention ships and to many non-Convention ships including those of less than 500 tons, while the MS (Radio Installations) Regulations will apply to all passenger ships and, additionally, to all other ships of 300 tons and above.

9. For ships which do not opt for early compliance with GMDSS provisions, the carriage of the satellite EPIRB and radar transponder(s) will, in any case, become mandatory (under both the LSA and Radio

Installations Regulations) from 1 August 1993 and 1 February 1995, respectively. In view of these dates, compliance with the optional arrangements in paragraph 5(a) above is recommended at an early date. Certain exemptions will be permitted. Guidance on the carriage requirements and related exemptions stemming from regulations concerning radio life-saving appliances follow:

Carriage Requirements

10. The following guidance applies to ships built either on or before 1 February 1992, in the course of construction or which will comply with the GMDSS provisions from 1 February 1992 onwards:—

(i) *Satellite EPIRB*

If this EPIRB is carried in lieu of the survival craft EPIRBs, it must be of the 406 MHz type (but see also paragraph 11(i) below). It should be capable of floating free and of being automatically activated when afloat. The EPIRB must be capable of manual release and able to be carried by one person to a survival craft.

EPIRBs should be registered with the Department of Transport, Marine Directorate, Surveyor General's Organisation, Sunley House, Room 1/32, 90/93 High Holborn, London WC1 6LP. When EPIRBs are purchased, the purchaser will be given a registration card by the retailer/manufacturer.

The registration card should be completed and returned to the above address. This record will facilitate the positive identification of ships in the event of an emergency. It is important that EPIRB purchasers promptly inform the Department of any changes affecting the registered information (eg change of vessel or owner, or loss or theft of the EPIRB).

(ii) *Radar Transponders* (see also paragraph 11(i) below)

On passenger ships and on cargo ships of 500 tons gross tonnage and upwards, at least one transponder should be carried on each side of the vessel and should be located so they can be rapidly placed in any survival craft (other than the forward or aft liferaft required on some cargo ships).

On cargo ships of less than 500 tons gross tonnage, at least one transponder should be carried and located so it can be rapidly placed in any survival craft.

Alternatively, one transponder should be stowed in each survival craft on passenger ships and cargo ships (other than the forward or aft liferaft required on some cargo ships).

(iii) *Two-way VHF Radiotelephones*

On passenger ships and on cargo ships of 500 tons gross tonnage and above at least three waterproofed portable radiotelephones should be provided.

On cargo ships of less than 500 tons gross tonnage at least two waterproofed portable radiotelephones should be provided.

The radiotelephones must include Channel 16 and may be those used for general onboard communications which might not be waterproofed but have, for example, plastic waterproof covers.

In either case arrangements should be made to ensure that a fully charged battery is available for emergency use of these radiotelephones.

Not later than 1 February 1999, the radiotelephones should comply with the IMO performance standard for fully waterproofed equipment and with the relevant DTI performance specification.

Exemptions

11. The following exemptions will be permitted:—

(i) *Radar Transponders*

Until a type-approved device is available, a 121.5 MHz EPIRB will be acceptable in lieu. This device may be separate from, or combined with, the 406 MHz device described in paragraph 10(i) above.

(ii) *General*

Ships currently exempted from the carriage of the existing portable radio apparatus for survival craft will be expected to comply fully with the guidance in paragraph 10 by 1 February 1995 after which date the exemption will be withdrawn.

Department of Transport
Marine Directorate
London WC1V 6LP
1991

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FREQUENCIES FOR DISTRESS AND SAFETY COMMUNICATIONS FOR GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM

TYPE OF COMMUNICATION		DISTRESS AND SAFETY FREQUENCIES	NOTES ON PARTICULAR FREQUENCIES
NAVTEX	NBDP	518kHz	
	NBDP	4209.5kHz	
	NBDP	490kHz	AFTER FULL IMPLEMENTATION OF GMDSS
R/T	MF/HF	2182kHz	ALSO GENERAL CALLING
		3023kHz	AERONAUTICAL SAR
		4125kHz	ALSO AERONAUTICAL SAR
		5680kHz	AERONAUTICAL SAR
		6215kHz	
		8291kHz	
		12290kHz	
		16420kHz	
	VHF	156.8MHz	ALSO GENERAL CALLING CH 16
		156.650MHz	INTERSHIP SAFETY CH 13
		156.3MHz	AERONAUTICAL SAR, CH 6 INTER-SHIP
DSC		2187.5kHz	
		4207.5kHz	
		6312kHz	
		8414.5kHz	
		12577kHz	
		16804.5kHz	
TELEX	NBDP	2174.5kHz	
		4177.5kHz	
		4210kHz	SAFETY ONLY
		6268kHz	
		6314kHz	SAFETY ONLY
		8376.5kHz	
		8416.5kHz	SAFETY ONLY
		12520kHz	
		12579kHz	SAFETY ONLY
		16695kHz	
		16806.5kHz	SAFETY ONLY
		19680.5kHz	SAFETY ONLY
		22376kHz	SAFETY ONLY
		26100.5kHz	SAFETY ONLY
EPIRB		121.5MHz	ALSO AERONAUTICAL EMERGENCY
		123.1MHz	AUXILIARY TO 121.5 FOR SAR (NOT EPIRB)
		406MHz	LOW POLAR ORBIT SATELLITE EPIRB
		1645.5–1646.5MHz	GEOSTATIONARY SATELLITE EPIRB
SATELLITE		1626.5–1645.5MHz	
RADAR		9200–9500MHz	SART (SEARCH AND RESCUE RADAR TRANSPONDER)

SHIP CARRIAGE REQUIREMENTS FOR GMDSS

All ships to which the amended 1974 SOLAS convention applies are required to carry the GMDSS radio equipment, depending on the sea areas in which they operate.

One of the basic principles on which the GMDSS carriage requirement is based is that a functional requirement is that a vessel has the capability of transmitting ship to shore distress alerts by at least two separate and independent means. The requirements are such that other communications are also required and these regulate the specific carriage requirements by ships in accord with their respective sea area of operation.

Summary of requirements for GMDSS radio equipment are as follows:

a) Sea Area A1 ships will carry VHF equipment and either a satellite EPIRB or a VHF EPIRB.
b) Sea Area A2 ships will carry VHF and MF equipment and a satellite EPIRB.
c) Sea Area A3 ships will carry VHF, MF, a satellite EPIRB and either HF or satellite communications equipment.
d) Sea Area A4 ships will carry VHF, MF, and HF equipment and a satellite EPIRB.

Additionally all ships will carry equipment for receiving MSI broadcasts.

The Solas Convention as amènded 1988, stipulates a time scale when installations are expected to meet GMDSS requirements:

All ships constructed after 1st February, 1992 to be fitted with radar transponder and two way VHF radio telephone apparatus for survival craft.

All ships to be fitted with a NAVTEX receiver and satellite EPIRB by 1st August, 1993.

All ships constructed before 1st February 1992 to be fitted with radar transponder and two way VHF R/T apparatus for survival craft by 1st February 1995.

All ships constructed after 1st February 1995 to comply with appropriate regulations for GMDSS,

All ships to be fitted with at least one radar capable of operating in the 9 GHz band by 1st February 1995.

All ships to comply with GMDSS requirements by 1st February 1999.

The new system of GMDSS will greatly enhance marine communications over and above the old system. The present system has several disadvantages that will be overcome by GMDSS. Currently ship to ship service depends on the vessels being within an appropriate range (under 250 kilometres) and reception difficulties are also present. The need also exists to maintain a continuous radio listening watch. The new system is expected to eliminate these problems and provide a safe and efficient radiocommunications link worldwide.

Every ship which falls within GMDSS will be provided with minimum standards of equipment in order to carry out the functional requirements for specific sea areas of trading:

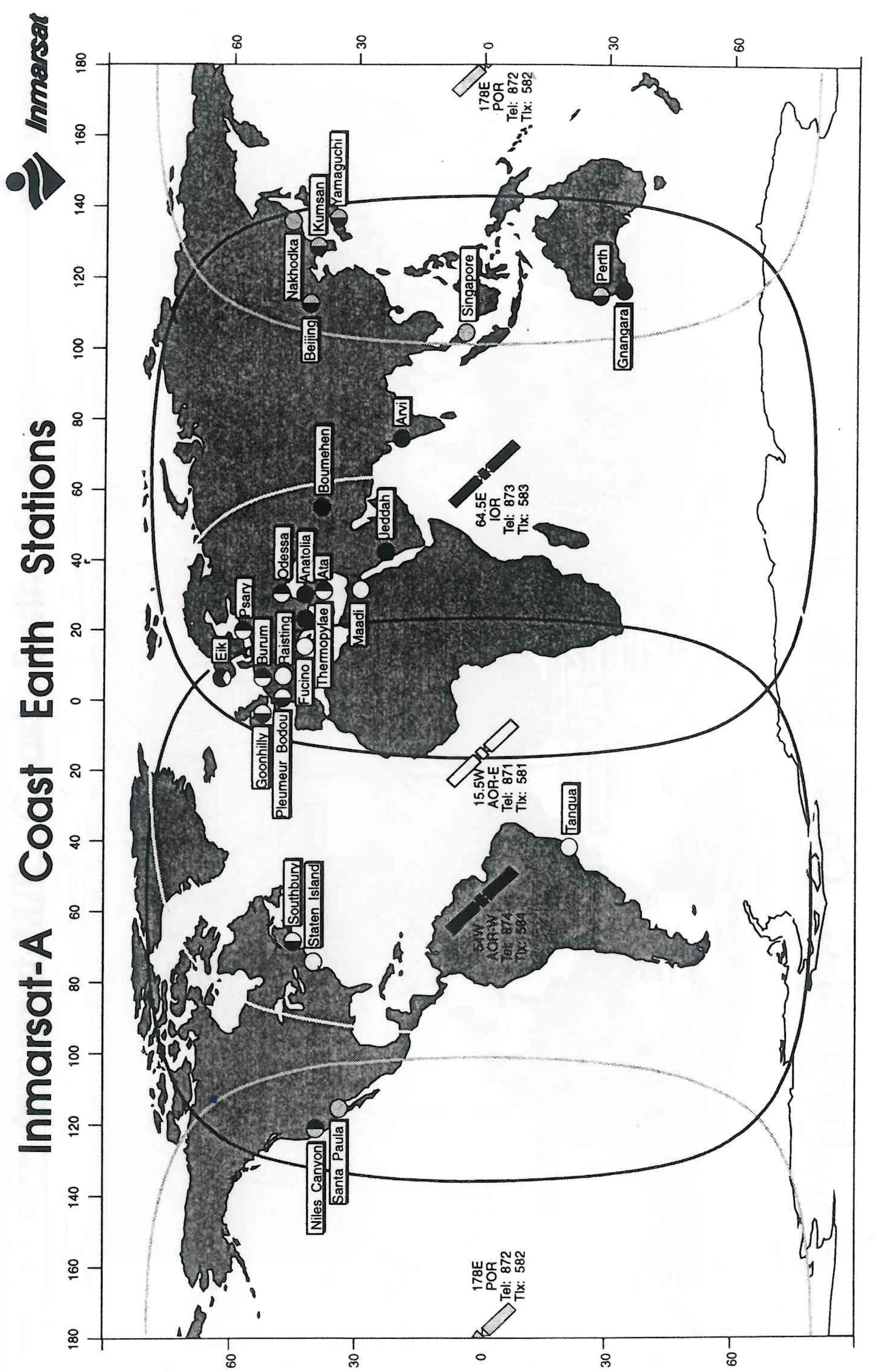
1. A VHF installation with the capability of transmitting and receiving DSC on channel 70 and radio telephony on channels 6, 13 and 16.
2. Equipment which allows a continuous DSC watch to be maintained on VHF channel 70.
3. Radar transponder (SART) operating in the 9 GHz band.
4. The capability to receive the International NAVTEX service broadcasts when operating in any area where NAVTEX is provided.
5. An on-board facility for the reception of Marine Safety Information (MSI) by the Inmarsat's Enhanced Group Call system (EGC) when engaged on voyages where NAVTEX coverage is not provided.

6. Satellite Emergency Position Indicating Radio Beacon (EPIRB) capable of being manually activated and with float free facility and automatic activation.

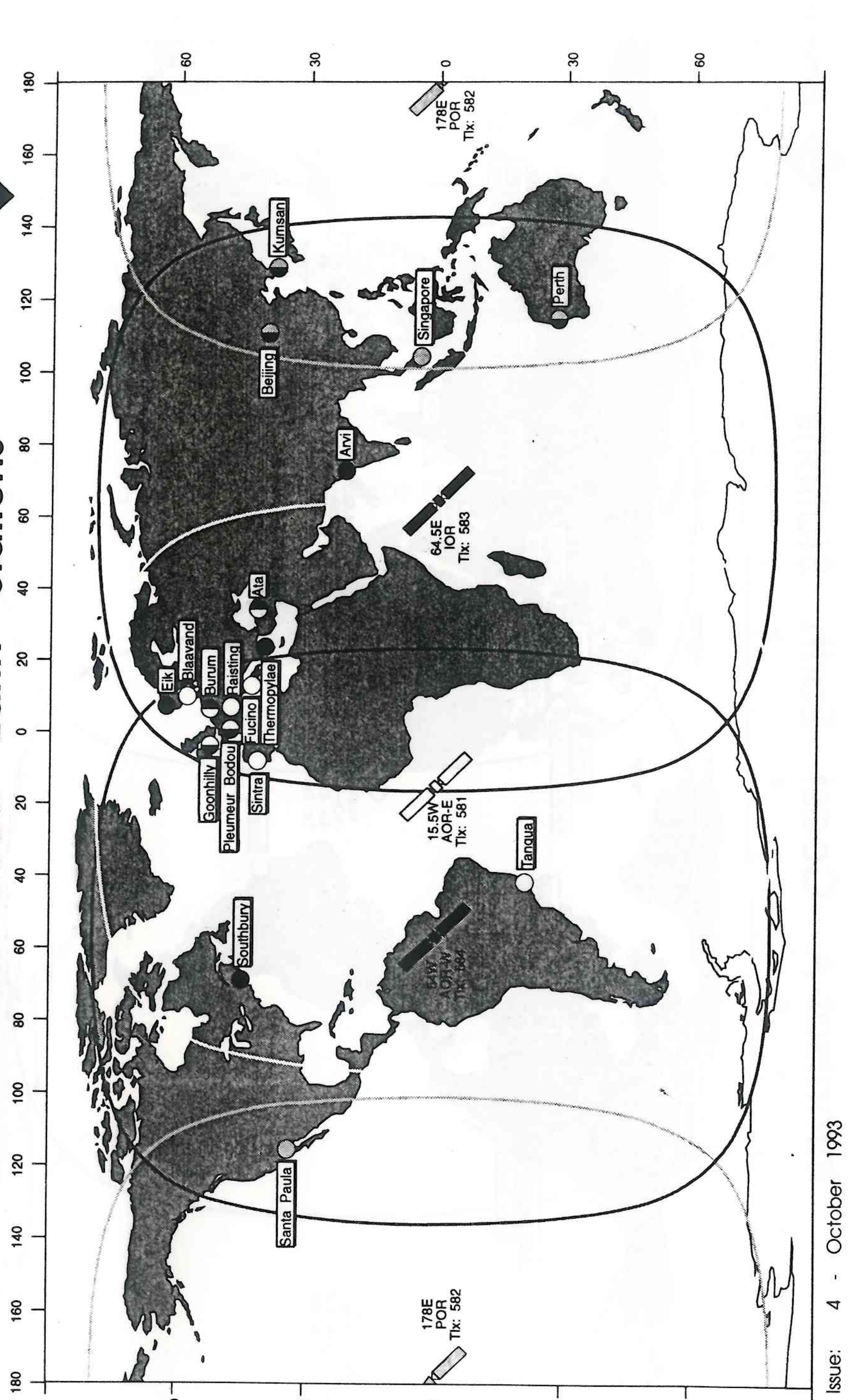
Personnel

Designated GMDSS vessels will be required to carry personnel qualified in distress and safety radiocommunication procedures. These persons will be certificated personnel who satisfy the radio regulations and the administering authority.

During a distress incident these persons will be designated as having primary responsibility for radio communications.



Inmarsat-C Coast Earth Stations



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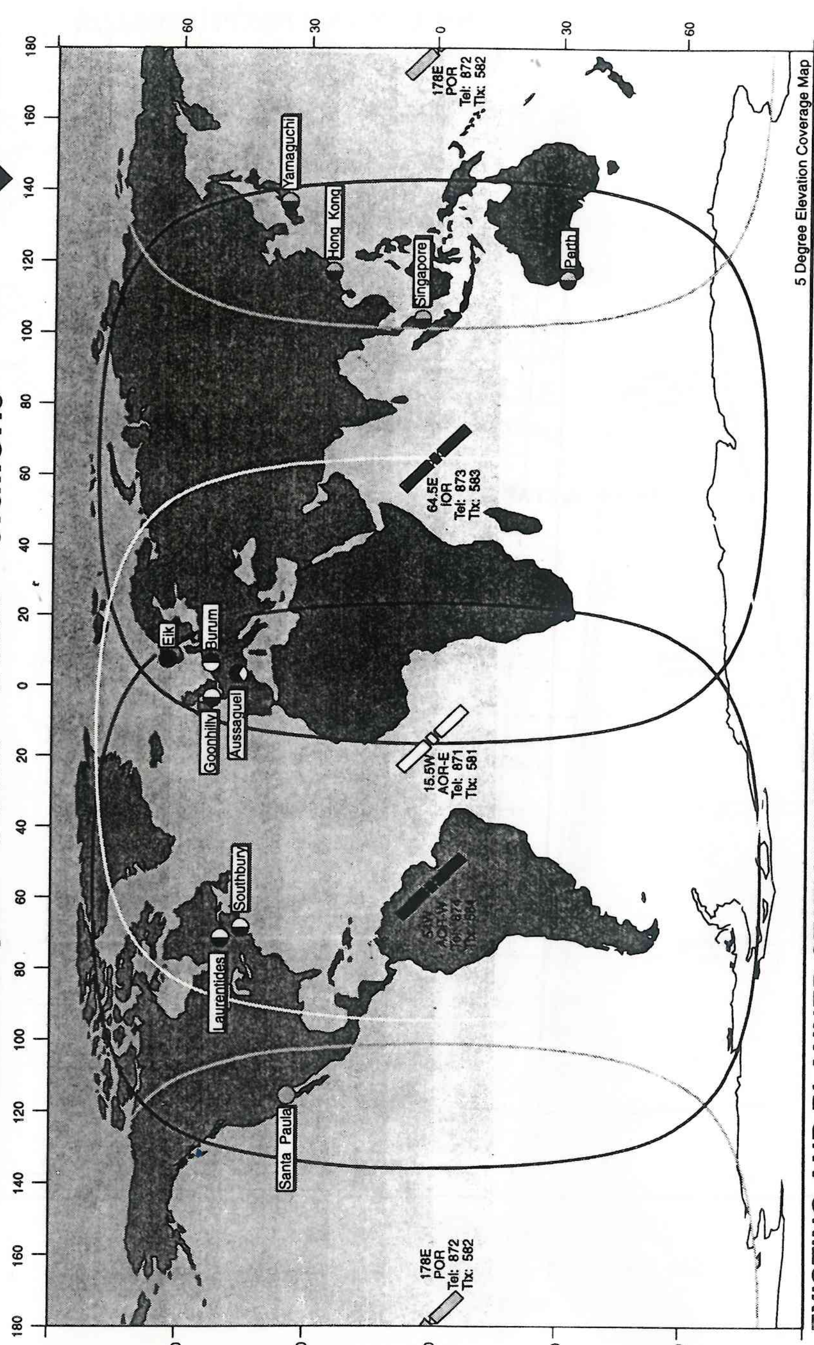
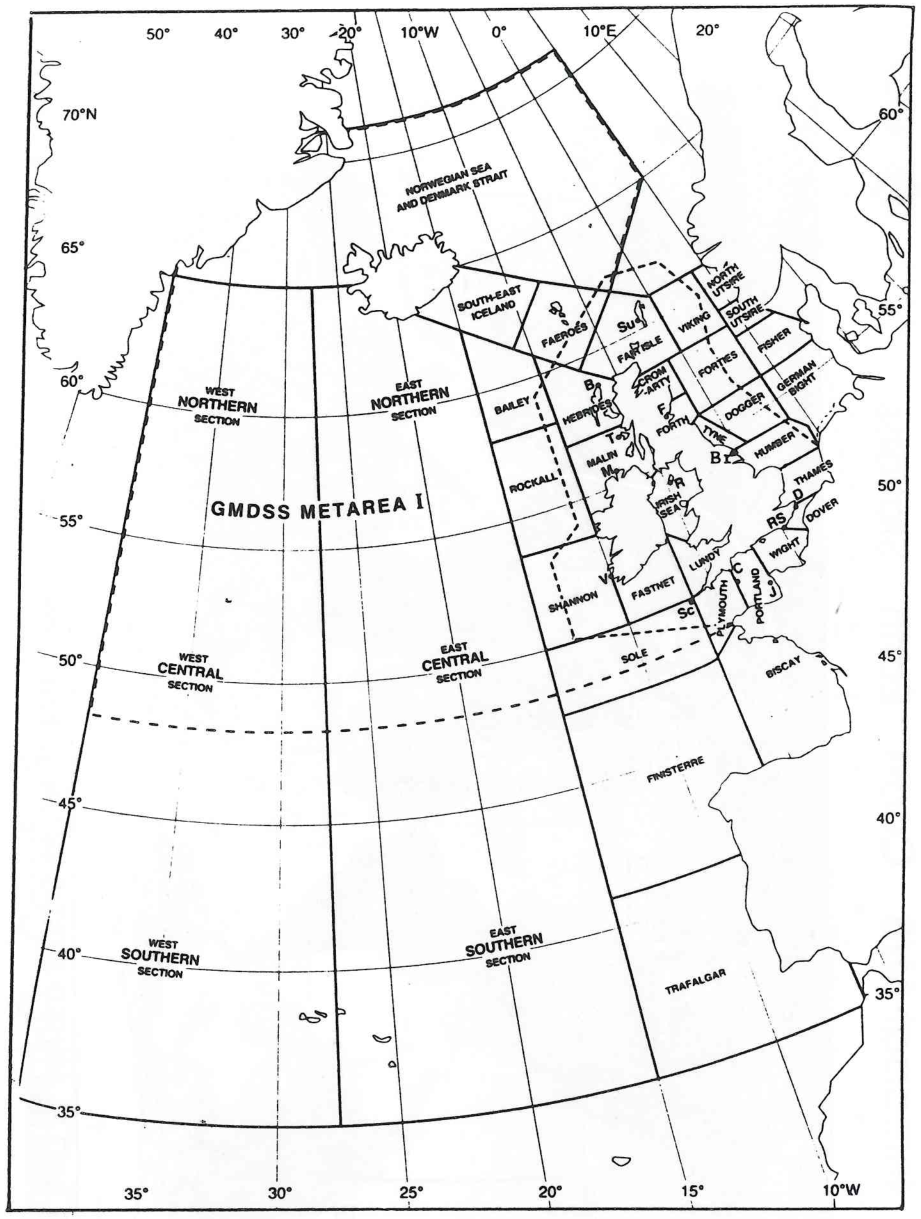
Inmarsat-M/B Coast Earth Stations



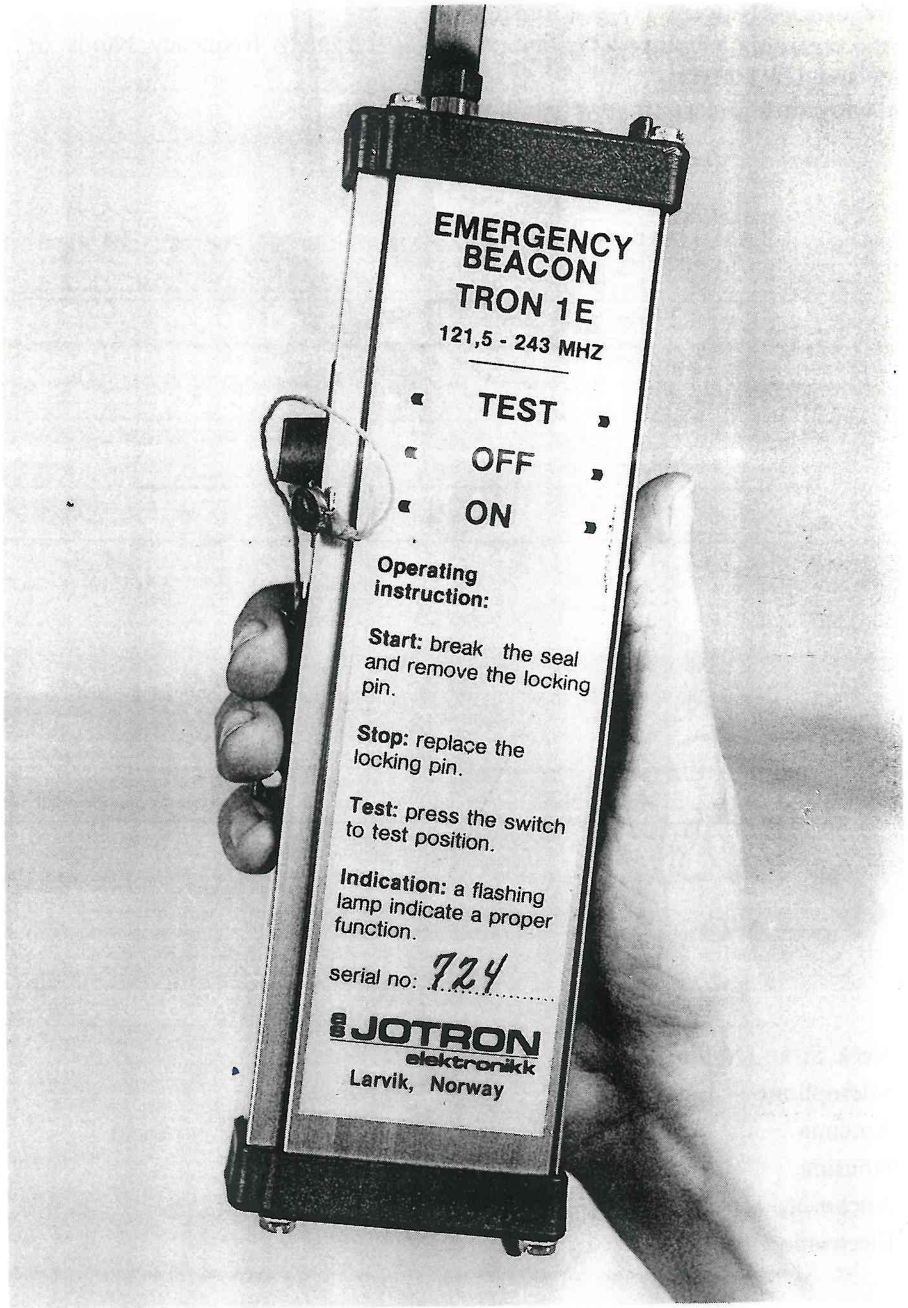
EXISTING AND PLANNED STATIONS UNTIL END 1994

Issue: 2 - October 1993



G.M.D.S.S. Sea Area
Sea areas and associated Marine Communication areas for G.M.D.S.S.

EMERGENCY POSITION INDICATING RADIO BEACONS (E.P.I.R.B.'s)



TRON 1E Type EPIRB manufactured by 'Jotron' Electronics AS operates on 121.5 and 243 MHz. Hand held and simple to activate. Battery operated and fitted with test facility