4

METEOROLOGY

METEOROLOGICAL TERMS

Anabatic

This term refers to the upward movement of air due to convection. An anabatic wind ascends a hillside or blows up a valley.

Anemometer

This is an instrument used to register and determine the velocity of the wind.

Aneroid Barometer

A dry mechanical instrument for measuring changes of pressure in the atmosphere.

Anti-cyclone

An area of high pressure, with clockwise circulation of air in the northern hemisphere, and anti-clockwise in the southern hemisphere, defines an anti-cyclone. Winds are generally light to moderate.

Aurora

This shimmering area of light is caused by an electrical discharge in the atmosphere over high northern and southern latitudes. The Northern Lights are called the Aurora Borealis, and the Southern Lights the Aurora Australis.

Backing

This means a change in the direction of the wind in an anti-clockwise sense, e.g. from north through west to south and then east. This is the opposite of veering, which occurs when the wind direction changes in a clockwise direction.

Bar

An international unit of atmospheric pressure, at sea level a bar is equal to the pressure of a column of mercury 29.53 in. high at a temperature of 32°F at latitude 45°.

Barograph

This instrument provides a permanent record, in graphical form, of the continuous changes in atmospheric pressure. It may be described as a continuous recording aneroid barometer.

Barometer

This is an instrument for measuring barometric pressure. Corrections are made to the readings for latitude, temperature, and height above sea level. The instrument will also carry an index error, which may be found on its certificate.

Barometric Tendency

The change in barometric pressure indicated during the three hours preceding observation is the barometric tendency. It shows the rise or fall of atmospheric pressure.

Cold Front

Cold air travelling over the earth's surface can sometimes lodge itself under warmer air. A sloping separation between the layers of warm and cold air is defined as a 'cold front'.

Condensation

This is the process of converting a vapour into liquid.

Conduction

Heat transfer through a body from places of higher temperature to those having a lower temperature is called conduction.

Convection

This is a process of heat transfer being carried out in a fluid, when the heat is carried by the motion of the hot fluid itself.

Corona

Faint blue rings about the moon, brought about by diffraction of and interference with light by water droplets in the atmosphere.

Cyclone

Often referred to as a depression or just as simply a low, this is an area of low pressure about which the air moves in an anti-clockwise direction in the northern hemisphere and vice-versa in the southern hemisphere. It is also the term given to violent revolving tropical storms.

Dew

An accumulation of water droplets on objects cooler than the temperature of the air.

Dewpoint

This is the temperature to which air can be cooled without condensation taking place.

Diffraction

Light is diffracted when light waves pass through narrow apertures or between bodies forming narrow apertures. See 'Corona'.

Doldrums

This area of calm, variable winds lies between the NE and SE Trades. Occasional squalls and torrential rain may be encountered within the area.

Etesian

A northerly wind encountered among the Greek islands, the Etesian is of katabatic origin. See 'Katabatic wind'.

Evaporation

In this process water or ice are converted into an aqueous vapour.

Fog

It is defined as visible water vapour at the earth's surface. Mist may be similarly defined, except that mist tends not to impede navigation to the same degree as fog. A state of fog exists when visibility is less than 1000 yd (914.4 m).

Gale

A strong wind in excess of 40 knots and represented by forces 8 and 9 on the Beaufort Wind Scale constitutes a gale. Cone-shaped signals exhibited by coastal stations give warning of the approach and direction of a gale.

Gulf Stream

This warm water current flows from the Gulf of Mexico up the east coast of the United States and then moves in an easterly direction, as the North Atlantic Drift Current, towards the European continent.

Hail

A hard ice pellet, which generally falls from cumulo-nimbus cloud, hail is usually associated with thunderstorms. Hailstones vary in size. They are built up by concentric layers of ice forming on top of each other. One theory is that the nucleus is a particle of dust which attracts moisture, and the moisture subsequently freezes.

Halo

A circle of light caused by refraction, which forms about the sun or moon.

Haze

A reduction of visibility caused by dust or smoke in the atmosphere, limiting the range to about 1.25 miles (2 km), haze is not to be confused with mist, which is brought about by condensed water particles.

Horse Latitudes

This term is given to the area of calm and light, variable winds between the 30th and 40th parallels. In general, they lie between the trade winds and the prevailing westerly winds.

Humidity

The amount of moisture in the air is the humidity.

Hurricane

This is an exceptionally strong wind, measuring force 12 on the Beaufort Wind Scale. A tropical cyclone, not uncommon in the North Atlantic and the Caribbean Sea, is a hurricane. Its counterpart in the Indian Ocean and the Far East is known as a typhoon, from the Chinese word *Tai-fung*.

Hydrometer

An instrument for obtaining the relative density of a fluid, it is used extensively to obtain the dock water allowance and test boiler water.

Hygrometer

An instrument for obtaining the relative humidity of the air, it comprises two thermometers, one a wet bulb and the other a dry bulb. The thermometers are usually contained in a box known as a Stevenson's screen which allows the passage of air currents.

Ice

Ice is frozen water. For types of ice, see 'Ice terminology', p. 78.

Isobars

These are lines drawn on a weather map to connect areas of the same barometric pressure.

Isotherms

These are lines drawn on a weather map to connect areas of the same temperature, and they may also be used to express the sea or air temperatures.

Katabatic Wind

This is the name given to a wind produced by a downward current, which is especially prevalent in high coastal areas. The wind 'runs' down the hillside, its velocity increasing with gravity, and it can expect to meet the sea often with great violence.

Land and Sea Breezes

Evening temperatures over land and sea tend to be reasonably equal, but at night the temperature over the land falls and the pressure increases, the state of equilibrium is upset, and a current of air moves towards the sea. The opposite phenomenon takes place in morning.

Lightning

A discharge of electricity between two clouds, or between a cloud and the earth.

Mirage

Abnormal refraction and reflection of light rays may cause a false horizon in the lower layers of the atmosphere because of the differing densities of the layers. When mirage is seen over water, distant ships may appear, sometimes upside down.

Monsoon

This seasonal wind blows over much of SE Asia, sometimes from the land and sometimes from the sea. In fact, it may be compared to the definition for land and sea breezes above, except that the occurrence is seasonal rather than daily, and over a much larger area.

Phosphorescence

This luminous effect on the surface of the water, showing bluish points of light, has never been explained satisafctorily.

Polar Front

This is the line of demarcation between a cold polar air mass and warmer air from more temperate latitudes.

Precipitation

The conversion of water vapour into visible rain, snow, sleet, hail, dew etc. is called precipitation.

Radiation

This is the process of heat being transferred by wave energy.

Rain

This comprises water droplets, formed by the condensation of water vapour. The maximum size of each droplet will not exceed 5.5 mm, and its maximum velocity, depending on size, when falling will not exceed 17.9 mph (29 kmph).

Rainbow

An arc formed by refracted and reflected light from water droplets in the atomsphere, it can only be seen when the observer is looking into a rain clould or shower of rain with the sun at his back.

Recurvature of Storm

Often referred to as the vertex of the path of the storm, the recurvature represents that point which is as far west as the centre of the tropical storm will reach. Also known as the 'cod'.

Refraction

This is the bending of a ray of light when passing from one medium to another of different density.

Ridge

The term may be applied to a 'ridge of high pressure', indicating a bulge or extension of a high pressure area between two lows.

Sleet

A mixture of rain and snow or partially melted snow becomes sleet.

Snow

Light ice crystals fall as snow.

Squall

This is a sudden change in wind velocity, often increasing considerably over a short period of time, with little warning. It can consequently cause serious damage, especially to small craft.

Stratosphere

This is the region of the atmosphere above the troposphere in which the lapse rate is about zero and in which the phenomena comprising 'weather' do not occur. The stratosphere begins at a height of some 11 miles at the equator.

Temperature

A condition which determines heat transfer from a hot to a colder body. Temperature may be expressed in degrees Fahrenheit (°F), Celsius (°C), Kelvin (°K) or Absolute (°A).

Thunder

This is a violent report caused by the expansion of air as it becomes heated along the path of a lightning flash.

Rumbling thunder is experienced at a distance from the lightning, and may be accentuated by echoes. As sound travels through the air at 1100 ft per second, and light travels at the rate of 186,000 miles per second, there is always a delay after a lightning flash before the observer hears the sound of thunder.

Tornado

A violent whirlwind about an area of low pressure, the tornado is most common in the United States, where they have been known to create considerable damage. The diameter of the whirlwind area is small, usually 50–200 m, but wind speeds may be in excess of 200 knots about the centre. Actual wind speed in the centre is zero, but updraft may lift objects into the air.

Trade Winds

Permanent winds which blow towards the equator, trade winds usually measure between 3 and 5 on the Beaufort Scale. They are generally referred to as NE Trades when they blow over the North Atlantic and North Pacific from below latitude 30°N towards the equator, and SE Trades when they blow from latitude 30°S towards the equator over areas of the South Atlantic and the South Pacific.

Trough

This is an extension of low pressure from a low-pressure centre. It is the opposite to a ridge, which is the outward extension from a high pressure centre.

Twilight

A period of reduced light which occurs after the sun dips below the horizon, it is caused by the rays of sunlight being refracted in the atmosphere towards the earth.

Veering

See 'Backing'.

Vertex

The turning point in the path of a tropical revolving storm, the vertex is the position in which the path of the storm moves to an easterly from a westerly direction in the northern hemisphere.

Visibility

This is the maximum range at which an object is discernible. The state of visibility may be assessed by using the length of the ship when in dense or thick fog conditions. It may similarly be assessed when in poor visibility by noting the time taken for an approaching vessel to become visible, making due allowance for the respective speeds of the two ships. When assessing good visibility, it is not good practice to use the range of the visible horizon, owing to the possibility of distortion by refraction, especially in misty or hazy conditions. Excellent visibility may be ascertained when heavenly bodies are seen to be coming over or dropping under the horizon when rising and setting.

Warm Front

This is a line of demarkation between advancing warm air and a mass of cold air, over which the warm air is rising.

Waterspout

Caused by an extension, usually from a nimbus cloud, it will extend to the surface of the sea, causing agitation of the water, which effectively turns to a spout. The result is a column of water vapour, which may last for up to half an hour. Shipping is advised to give it a wide berth.

Wave

A disturbance of the surface of the sea, a wave is caused by the wind. Waves will vary in size and height. When a wave breaks on the coast line, it is referred to as a 'breaker'.

Wedge

A ridge of relatively high pressure, situated between two low pressure areas, it is often roughly wedge-shaped.

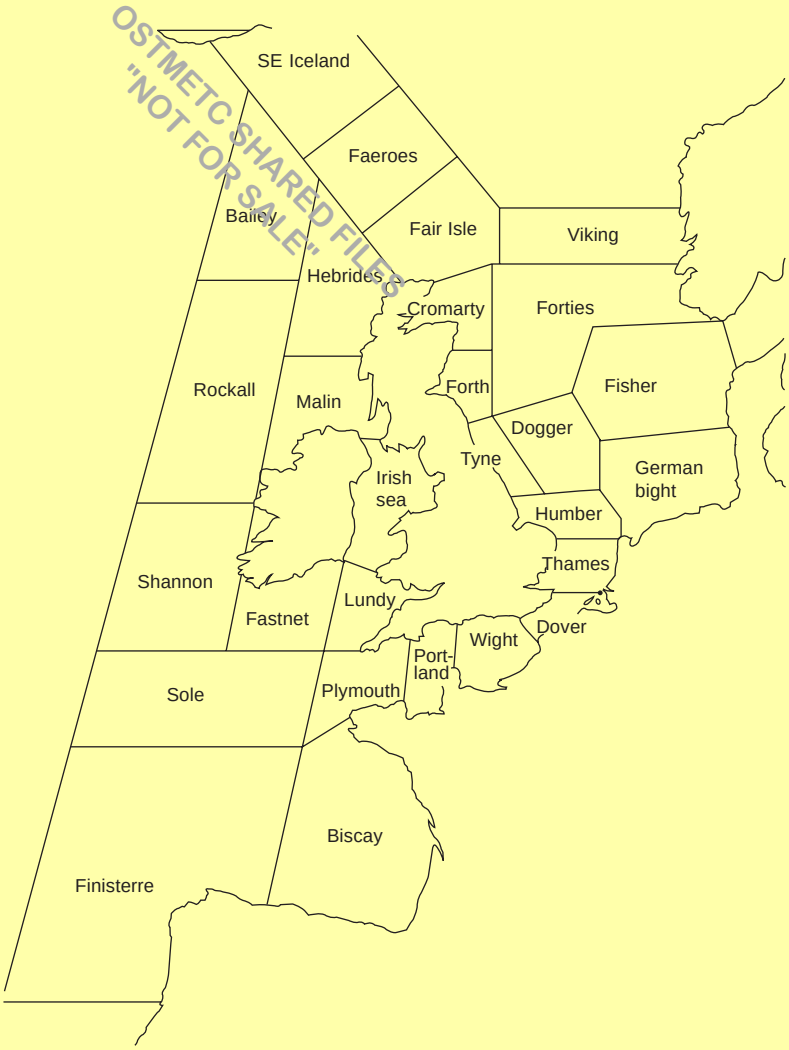


Figure 4.1 UK coastal forecast areas.

Wind

The movement of air parallel or nearly parallel to the surface of the earth, the wind is named after the direction from which it comes.

FORECAST AREAS

Figures 4.1 and 4.2 map the UK coastal forecast areas and the weather reporting stations respectively, and Figure 4.3 the North Atlantic areas.

WEATHER SCALES

Tables 4.1 to 4.3 cover the Beaufort Wind Scale and weather notation, fog and visibility scale, and wave scale.

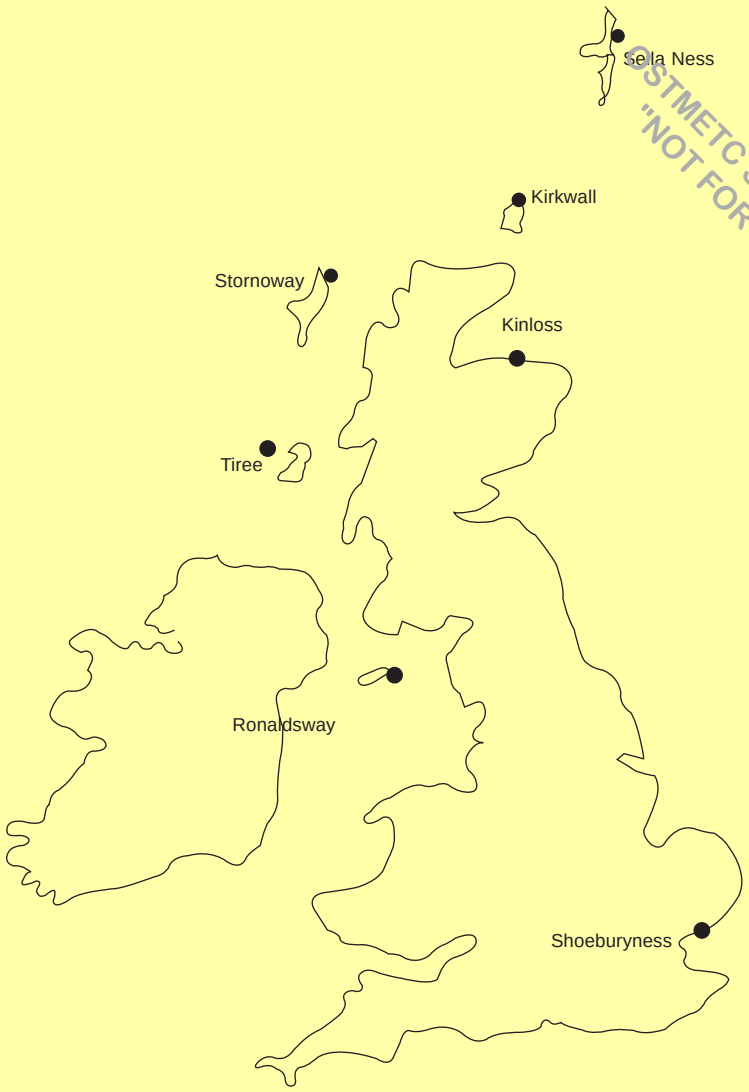


Figure 4.2 Present weather – UK Coastal. Ships requiring actual weather conditions around the coastline of the British Isles can obtain such reports from any of the Met Stations shown. However, the stations may only be manned during office hours or in the event of a casualty risk being present. Sella Ness has limited opening times.

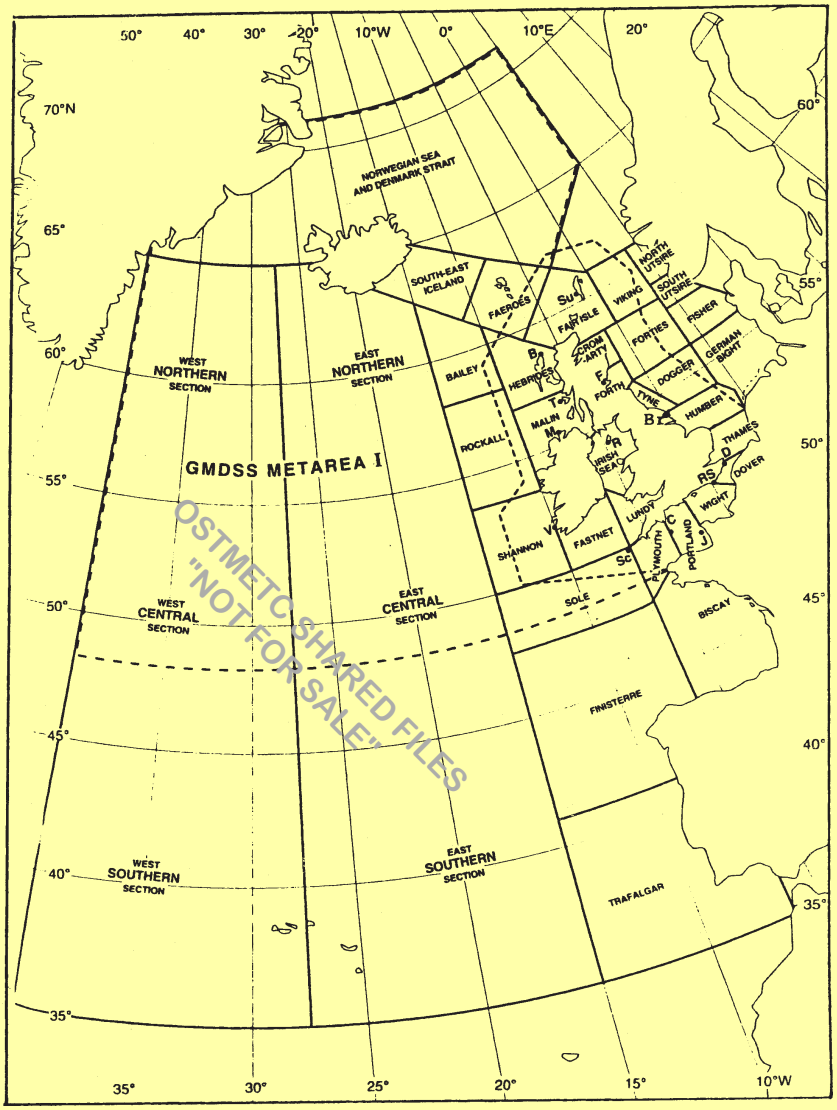


Figure 4.3 Sea areas and associated marine communication areas effective under the GMDSS operation.

CONSTRUCTION AND INTERPRETATION OF SYNOPTIC CHART

Meteorological offices around the world in many participating countries collect and collate weather reports and related information for the benefit of safe navigation. Weather reporting vessels, together with aircraft and satellite pictures, provide reasonable forecasts for all major shipping areas.

The reports from all sources allow a comprehensive weather chart to be produced. Symbols used are shown in Figure 4.4a.

The following information is typical of the normal weather report:

1. Position of reporting station, latitude and longitude.
2. Speed of reporting station (knots). Course of vessel.
3. Barometric pressure, correct for sea level. Indication of movement.
4. Weather description in Beaufort Scale notation (letter).

TABLE 4.1 Beaufort Wind Scale

Beaufort Scale number	*Wind description*	*Wave description*	*Height of sea in ft*	*Knots in nautical mph*
0	Calm	Flat calm, mirror smooth	–	0–1
1	Light airs	Small wavelets, without crests	0.25	1–3
2	Light breeze	Small wavelets, crests glassy but not breaking	0.5	4–6
3	Light breeze	Large wavelets, crests beginning to break	2.0	7–10
4	Moderate breeze	Small waves, becoming longer, crests breaking frequently	3.5	11–16
5	Fresh breeze	Moderate waves, longer with crests breaking	6.0	17–21
6	Strong breeze	Large waves, forming, crests breaking more frequently	9.5	22–27
7	Strong wind	Large waves, streaky foam	13.5	28–33
8	Gale	High waves, increasing in length, continuous streaking of crests	18.0	34–40
9	Strong gale	High waves, crests rolling over, dense streaking	23.0	41–47
10	Storm	Very high waves, overhanging crests, surface white with foam	29.0	48–55
11	Violent storm	Exceptionally high waves, surface completely covered with foam	37.0	56–65
12	Hurricane	Air filled with spray, visibility impaired	–	over 65

5. Air temperature.
6. Wind force and direction.
7. Sea state. Description of any swell.
8. Ice accretion.
9. Cloud cover and description.
10. Date and time of observation.

For ease of transmission, reports are coded by use of the *Code and De-Code Booklet*, issued by the Meteorological Office and obtainable from Her Majesty's Stationery Office.

Once all the coded reports from stations in the area have been received, decoding takes place, and the lowest barometric pressure is marked on the weather chart at its point of observation. Due allowance is made for the station's course and speed from the time of observation to the moment of reception. The term LOW is then recorded on the chart, and isobars, joining places of equal barometric pressure, are sketched in lightly.

Arrows are then added to indicate wind direction. The mariner should bear in mind that the arrows will generally cross the isobars in the direction of the LOW. Speed of the wind in knots is indicated, together with barometric pressure in numerical form. Wind speed used to be indicated by the number of feathers attached to the drawn arrows, to represent wind speed under the Beaufort Scale, but this practice is no longer as popular as in the past.

TABLE 4.2 Beaufort weather notation

Symbol	*Meaning*
b	Blue sky with clear or hazy atmosphere, with less than one quarter of the sky area clouded
c	Cloudy with detached opening cloud, where more than three-quarters of the sky area is clouded
bc	Sky area clouded over between one-quarter and three-quarters of the total area
d	Drizzle or fine rain
e	Wet air with no rain falling
f	Fog
fe	Wet fog
g	Gloomy
h	Hail
kq	Line squall
l	Lightning
m	Mist
o	Overcast sky
p	Passing showers
q	Squalls
r	Rain
rs	Sleet
s	Snow
t	Thunder
tl	Thunderstorm
u	Ugly threatening sky
v	Unusual visibility
w	Dew
z	Dust haze

TABLE 4.3 Wave scale

State of sea	*Height in metres*
Calm – glassy	0
Calm – rippled	0–0.1
Smooth wavelets	0.1–0.5
Slight	0.5–1.25
Moderate	1.25–2.5
Rough	2.5–4.0
Very rough	4.0–6.0
High	6.0–9.0
Very high	9.0–14.0
Phenomenal	over 14.0

Length of swell	*Length in metres*
Short	0–100
Average	100–200
Long	over 200

Height of swell	*Height in metres*
Low	0–2.0
Moderate	2.0–4.0
Heavy	over 4.0

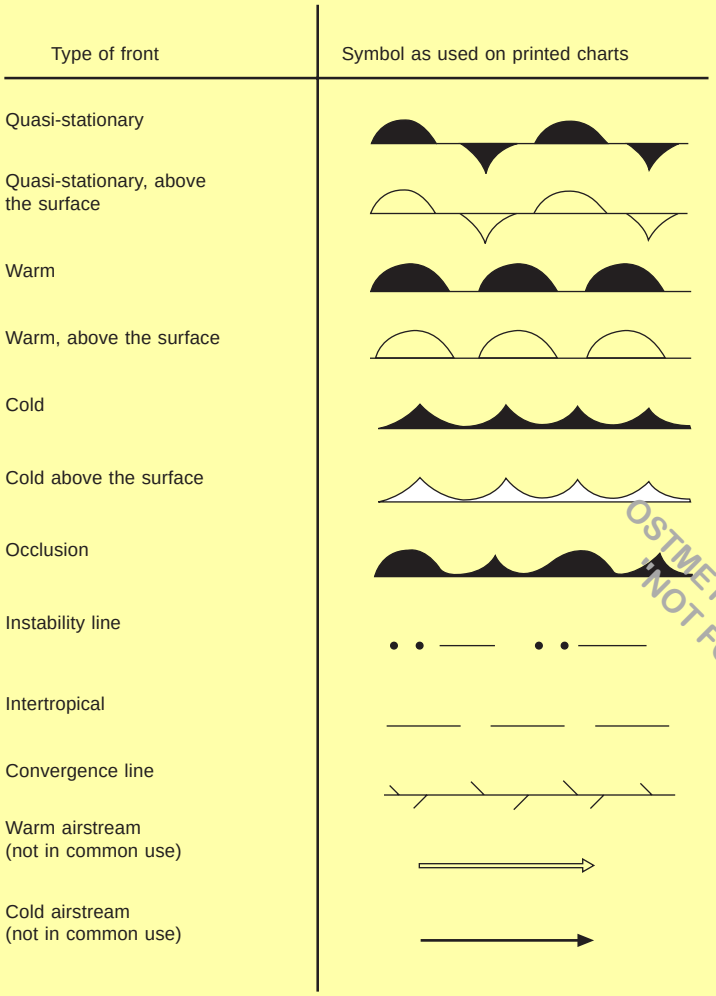


Figure 4.4(a) Symbols for fronts, as plotted on a synoptic weather chart.

The letters of the Beaufort notation are added to describe the apparent weather condition around the observer's area, together with any relevant information regarding storms, ice, fog etc. (see Figure 4.5).

CONTINGENCY PLANS FOR HEAVY WEATHER

1. Verify vessel's position. Investigate safe port options.
2. Obtain up-to-date weather forecasts and expected weather predictions, for surrounding areas.
3. Warn all departments of impending heavy weather.
4. Rig lifelines fore and aft.
5. Check following: anchors and securing, lifeboats and lashings, watertight doors, and general cargo stowage and securing, especially deck cargo lashings.
6. Close up ventilation, removing cowls where appropriate.

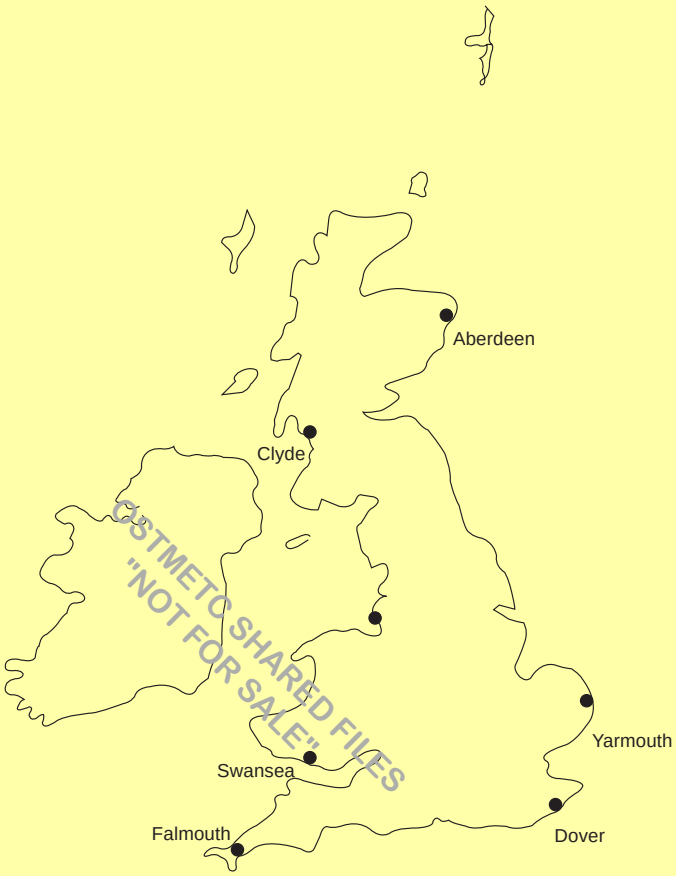


Figure 4.4(b) Maritime Rescue Co-ordination Centres (MRCCs) are continuously manned around the United Kingdom, together with fifteen Maritime Rescue Sub-Centres (MRSCs). All these stations may respond to local weather conditions but such information given would be only applicable to present weather in the vicinity of the station and would include forecasts for other areas.

7. Check stability – no slack tanks.
8. Note preparations in log books.
9. Contact shore station, passing position and obtain constant plotting of storm's track.
10. Secure derricks/cranes and hatch covers.
11. Clear surplus gear from decks.
12. Close down deadlights.
13. Slacken off signal halyards and other relevant cordage.
14. Drain swimming pool.
15. Reduce manpower on deck by operating heavy weather work routine.
16. Take down awnings.
17. Secure bridge for excessive pitching and rolling motion.
18. Warn engine room in plenty of time to reduce revolutions.
19. Check distress rockets and LSA gear.
20. Organise meal reliefs before bad weather arrives.

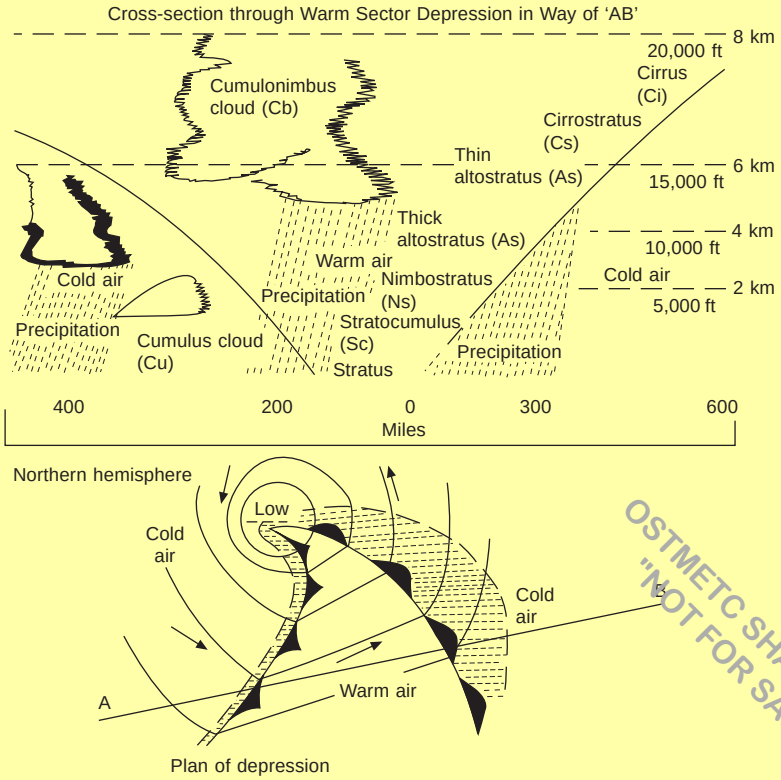


Figure 4.5 Interpretation of a synoptic weather chart.

EFFECTS OF HEAVY WEATHER ON VESSEL AT SEA

To describe the behaviour of any vessel in a heavy sea the mariner should first be aware that every vessel, depending on her build, GM, state of loading etc. will perform differently.

Stiff and Tender

A large GM will render a vessel stiff, i.e. give her a short period of roll, and subsequent damage may be sustained by rapid rolling. A small GM will render the vessel tender, i.e. she will have a long slow roll motion. These two conditions, usually brought about by incorrect loading or ballasting, should be avoided, so that unnecessary stress in the structure of the vessel when in a seaway is avoided also.

Periods of Roll and Encounter

Period of roll may be defined as that time taken by a ship to roll from port to starboard, or vice-versa, and back again. The 'period of roll' will be to a great extent controlled by the GM of the vessel and by the disposition of weights away from the fore and aft line.

Period of encounter may be defined as that time between the passage of two successive wave crests under the ship.

If we consider the behaviour of a vessel with a short period of roll compared to the period of encounter, then the vessel will tend to lie

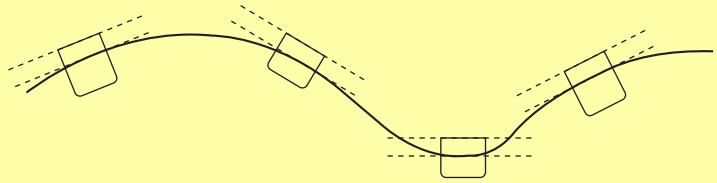


Figure 4.6 Vessel with short period of roll compared to period of encounter.

Figure 4.7 Vessel with long period of roll compared to period of encounter.

with her decks parallel to the water surface or wave slope. The ship will probably suffer violent and heavy rolling and may suffer damage because of this. However, she will not generally ship a lot of water in this condition (see Figure 4.6).

If we consider the behaviour of a vessel with a long period of roll compared to the period of encounter, then the vessel may be expected to roll somewhat slowly and independently of the waves. The vessel will probably experience only moderate angles of roll, and the waves may be expected to break near the ship's side (see Figure 4.7).

Synchronism

This is most dangerous and highly undesirable condition for a vessel to experience and occurs when the period of roll is equal, or nearly equal, to the half period of the waves. Successive waves tend to increase the angle of roll of the vessel, producing the possible danger of capsize. It is imperative that the watch officer should recognise the condition immediately, especially in a small vessel, or when the range of stability is small. An immediate alteration of the vessel's course will effectively change the period of encounter and eliminate the condition, which is probably at its most dangerous when a beam sea is experienced and the ship reaches a greater maximum inclination at each crest and hollow. Cargo is liable to shift and the vessel will most certainly be damaged if the condition is left uncorrected for any length of time.

Synchronised pitching – when the period of encounter is similar to the vessel's period of pitch – may also occur. This situation can be alleviated by an alteration of speed, preferably a reduction, as an increase may cause the vessel to 'pound'. A vessel which has suffered engine failure is most vunerable to synchronised rolling and efforts to bring the vessel's head into the wind should be made while she still has headway (headreach).

GENERAL BEHAVIOUR OF VESSELS IN HEAVY WEATHER

The options available to a vessel running into heavy weather can be restricted to five main categories:

1. Head to sea, or with wind and sea fine on the bow, running at reduced speed.

2. Stern to sea, at reduced speed, running before the wind.
3. Heaving to, preferably in the lee of a land mass, to allow the weather to pass.
4. Anchoring, depending on depth of water.
5. Altering course in plenty of time to take evasive action away from adverse weather conditions.

It has been pointed out that the successful handling of any ship will be dependent on the circumstances at the time and the characteristics of the ship in question. Draught, state of loading, superstructure, turning circles etc. will all influence decisions taken for the safety of the vessel.

Head to Sea (or with wind and sea fine on the bow)

This is probably the most favoured position for a deep-draughted vessel. Leeward drift is minimised, but the vessel is liable to sustain considerable punishment, owing to continual pounding. Should a vessel be designed with increased scantlings, as for ice navigation, the concern might not be as great as in, say, a vessel with no additional strengthening built in.

The object is to head the vessel into the weather, with the idea of letting the weather pass over her. To this end, the speed of the vessel is considerably reduced, which will affect the period of encounter of the on-coming wave formations and subsequently reduce any pounding that the vessel is experiencing. It may become necessary to stop the ship's engines on the approach of extremely heavy seas, effectively reducing all headway. Courses and speed should be altered to remove the possibility of hogging or sagging, and to prevent synchronism.

This situation can be a most uncomfortable one, with the vessel pitching violently at times. Violent pitching may result in 'racing propellers', which in turn puts excessive stress on engines. Absolute control of rudder and power is essential. As a rule of thumb, power should be reduced to the minimum necessary to maintain steerage way and avoid undue stress on machinery. Two steering motors should be operational, if fitted, and any zone of critical revolutions should be avoided.

Stern to Sea

Bad weather may often overtake the vessel at sea and she will effectively find herself running before the wind. It is usual to take up a course with the wind on the quarter rather than dead astern, this action tending to make things more comfortable on board for all concerned. If the wind and sea are acting directly from astern, then a vessel will run the risk of a surf effect, as waves build up under the stern. In addition, vessels with a low freeboard will run the risk of 'pooping'.

Pooping occurs when a vessel falls into the trough of a wave and does not rise with the wave, or if the vessel falls as the wave is rising and allows the wave to break over her stern or poop deck area. Hence the name 'pooping', which may cause considerable damage in the stern area.

The mariner should consider the speed of the vessel in all conditions of heavy weather, and what the effects of an increase or decrease would

be on the periods of encounter and the effective wave impact; but generally the vessel's speed should be eased down until she is handling comfortably.

Generally speaking, the vessel with a following sea will not move as violently as a vessel head to sea. Trial and error will determine an optimum speed and minimise adverse motions of the ship. Speed adjustment, together with the long peroid of encounter, will probably reduce wave impact without any great delay to a ship's schedule.

The main concern for a vessel with the wind and sea abaft the beam arises if and when the vessel is required to turn. A distinct danger of attempting to turn across the wave front is that the vessel may 'broach to'.

A following sea reduces the flow of water past the rudder, so that steering may become difficult, and prevent the vessel's head coming up to wind. With reduced rudder effect, the vessel may be caught in an undesirable beam sea and may 'broach to', being unable to come into the wind and sea.

Heaving to

The prudent Master, after due consideration of all the circumstances, might be well advised to take what may at first appear to be the easy option. This may prove to be just that, with the wind blowing itself out in a very short time. However, this is not always the case, and a Master may encounter problems associated with crew fatigue or the spoiling of cargo through heaving to for a lengthy period of time.

Obviously, circumstances must dictate the actions in every case, but if it is possible to take advantage of a lee caused by some land mass, then this can often be the answer to the immediate problem. This practice is employed frequently in the coastal trades, especially with vessels carrying cargoes liable to shift, e.g. roll on–roff off, grain etc.

If general heavy weather is encountered at sea, well away from coastlines, the action taken by the Master will depend on the type and form of the vessel. A reduction of speed will probably be one of the early actions to reduce the motions of the vessel and eliminate the possibility of cargo shift. Such reductions in the vessel's speed should be limited, to permit correct steerage under the adverse weather conditions. Power should not be reduced to such an extent that stalling of the main machinery occurs, nor should revolutions be allowed to oscillate about any critical zone of revolutions for that type of main engine.

Another alternative under the heading of heaving to, is when it is decided to stop main engines altogether. This action could result in considerable drifting of the ship and sufficient sea room should be available before the operation is begun. Heavy rolling can be expected, with the ever present risk of synchronism and the real problem of shifting cargoes.

For this alternative to be successful, a vessel needs to have good watertight integrity, together with an adequate GM. The use of storm oil may become a necessity, once the vessel has taken up her own position. Oil should only be used to maintain the safety of the vessel

and/or life. It should be distributed on the windward side of the vessel, in an amount sufficient to reduce the immediate hazards.

Spreading vegetable or animal oil on heavy seas will prevent wave crests from breaking over the vessel but will have little or no effect on the swell waves about the hull area. The use of mineral oils should be avoided, especially if people are in the water. Lubricating oils are a possible alternative but heavy fuel oils should be avoided at all costs.

The oil may be spread via the hawse pipes forward or by the scuppers and/or toilet overboard discharges. Distribution via the hawse pipes is particularly useful to any vessel engaged in a towing operation, for not only will the tow gain the benefit of the oil but also the vessel towing.

Smaller craft, such as fishing boats and supply vessels, may need to use oil in order to prevent the sea waves breaking over the vessel and 'icing-up' taking place in the colder latitudes. Oil may require warming or thinning down in very cold climates, and a suitable spirit may assist its flow and distribution.

Should a decision be taken to use oil, then only enough to achieve the objective should be employed. It should be remembered that large waves which break and surf will effectively reduce and destroy the oil film.

Use of Anchors

One of the greatest fears of any Master is that of being blown down on to a lee shore. Many shipwrecks caused in this way could have been avoided by anchoring in deep water, say 25–50 fathoms.

If the vessel is in shallow water, consideration should be given to the use of two anchors, and the expected strain on cable(s). Many vessels founder on a lee shore because they become disabled, loss of power resulting in subsequent grounding, or insufficient power preventing them from 'beating out' to seaward. The process of anchoring with or without engine power will reduce the rate of the vessel's drift to leeward. The possibility of the anchors holding is a real one. Even if grounding is not prevented, then refloating may very well be assisted by heaving on cables.

Use of Sea Anchors

The idea of rigging an efficient sea anchor to keep the vessel head to wind is feasible for a small vessel, if a sea anchor can be constructed easily, but it is doubtful if any Master of a super tanker or even just a large vessel would consider the idea. To be effective, the sea anchor would have to be of an unmanageable size, even if the ship were equipped with the necessary lifting gear and materials to make one, which is highly unlikely.

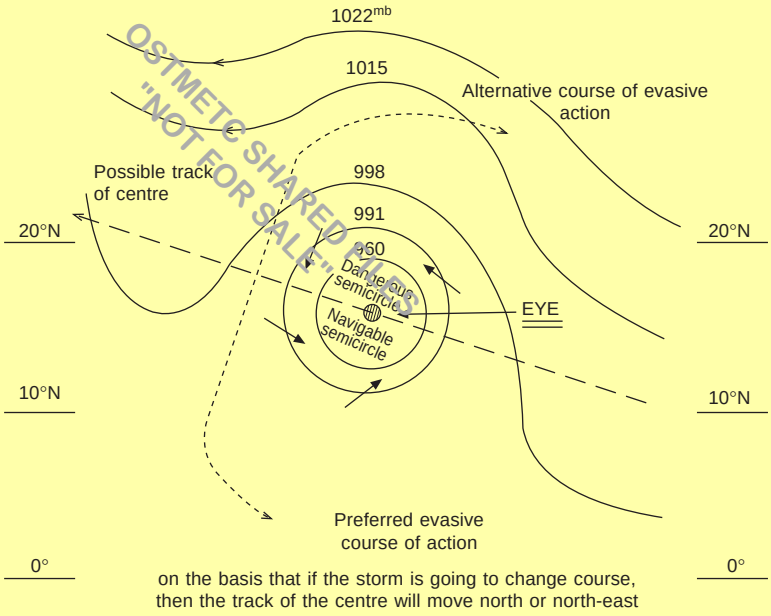
For small craft such as coasters and large yachts, a sea anchor will reduce the lee drift, and keep the boat head to wind, but for the majority of vessels it is a non-starter and they should consider other possibilities. Any floating object that will offer reasonable resistance to the drift of the ship will behave as a sea anchor, and mooring lines paid out over the

bow will sometimes be useful. Large ships, especially those having high freeboard, would probably need outside help, such as a tug, in dangerous situations.

The situation may be more appreciated if the mariner considered a VLCC or ULCC ship, with small crew and little in the way of suitable equipments for jury rigging.

TROPICAL REVOLVING STORM

The tropical revolving storm (TRS) normally forms in low latitudes, usually between 7° and 15° north or south of the equator. It cannot form in very low latitudes, or for that matter near land masses. These storms are often called hurricanes, typhoons or cyclones, but to seafarers they are all tropical revolving storms (see Figure 4.8).



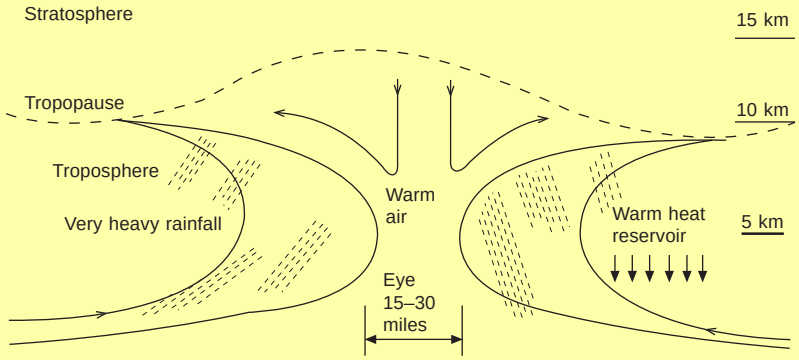


Figure 4.8 Tropical storms.

A storm will develop over open seas where the temperature and humidity are high, and some form of trigger action is available to set off the violent convection. The storm is made up of intense asymmetrical line squalls, which spiral inwards towards a central point, known as the 'eye'. The eye of the storm will vary in size but is generally 15–30 miles in diameter. This area is known to be a comparatively calm area, of warm air from the sea surface, right up to the stratosphere.

Wind speeds are in excess of 64 knots and may reach as high as 200 knots, with gale force winds extending from the eye up to a range of 300 miles. The barometric pressure will be exceptionally low and may fall below 900 mbs. A very high humidity level will be experienced, together with very heavy rainfall in the area.

A tropical storm may take up to 5 days to form and reach a mature stage, but once this stage is reached, it may take several weeks before it dissipates. However, the normal period for a tropical storm's life is between one and two weeks. Should the storm move inland, the associated violent weather can be expected to diminish within 48 hours of crossing the coastline.

The general movement of a tropical storm will probably be in a westerly direction, either in the northern or southern hemispheres. Speed of movement will vary but the average is about 10 knots. Once clear of the tropical latitudes, it is not uncommon for the track to move north or north-east, or south or south-east, in the northern and southern hemispheres, respectively.

Evasive Action

It is the duty of the Master of any vessel to report the position and movement of any tropical storm if it has not already come to the attention of the authorities. The eye of the storm should be plotted, together with its rate of movement and probable path. Other dangers to the vessel's navigation should also be plotted in relation to the storm's path.

The Master of any vessel should ascertain at the earliest possible moment his own vessel's position and which 'semi-circle' he is in or entering. By full consideration of all the facts, a course of evasive action should be taken as quickly as possible to avoid crossing the path of the storm. Prudent use of the vessel's full speed should be quickly made, as it may become necessary to reduce speed later to avoid pounding and damage to the vessel.

Obviously any Master faced with a tropical storm must make his decisions on the particular case. It may become a practical proposition to take up a satisfactory position and ride the storm out, letting the bad weather move past the vessel. When making the decision on the type of evasive action to take, Masters should bear in mind that tropical storms have a general tendency to move towards the pole of whichever hemisphere the vessel is navigating in. This, of course, is not inevitable, and a storm has been known to double back on itself more than once.

Setting an evasive course towards the equator when on the predicted track of the storm would seem to be the soundest action, provided that the storm maintains its predicted movements.

ICE TERMINOLOGY

Anchor Ice

Submerged ice attached or secured to the bottom is known as anchor ice.

Bare Ice

Ice without any snow covering.

Bergy Bit

A large piece of floating ice, this is between 1 m and 5 m above the surface of the water.

Brash Ice

An accumulation of broken, floating ice, this contains pieces up to approximately 2 m across.

Compact Pack Ice

A heavy concentration of pack ice, when no water is visible.

Compacted Ice Edge

A clear cut ice edge, this is generally found on the windward side of an area of pack ice, compacted by the action of wind or current.

Concentration

A ratio expressing the density of ice accumulation, concentration is expressed in tenths or oktas of the total area.

Consolidated Pack Ice

A concentration of 10/10, where the ice floes are frozen together.

Crack

This is a split or fracture in the ice surface, which has not parted.

Difficult Area

A general term used to describe the area as difficult for purpose of navigation.

Easy Area

A general term used to describe the area as not too difficult for the purpose of navigation.

Fast Ice

This is sea ice which has become 'fast' to the shore, ice wall or other similar surface. It may be formed by the freezing of sea water close

inshore or by pack ice freezing to the shore or other surfaces. Should its height extend more than 2 m, it would be referred to as an 'ice shelf'.

First Year Ice

A term derived from young ice, being sea ice of not more than one winter's growth, this ice is between 30 cm and 2 m thick.

Flaw

A narrow dividing section between the pack ice and fast ice, a flaw is formed by the shearing of the former from the latter.

Floating Ice

This general term is also used with regard to grounded or stranded ice.

Floe

This is a flat piece of ice more than 20 m across. Floes are sub-divided according to size as giant, vast, big, medium and small.

Floeberg

A massive piece of sea ice, a floeberg made up of one or more hummocks frozen together, the whole being separated from any other surrounding ice.

Fracture

This general term is used to describe any fracture/break of unspecified length. The width of the break is called:

large when over 500 m,
medium when 200–500 m,
small when 50–200 m, and
very small when less than 50 m.

Glacier

A continuously moving mass of snow and ice, a glacier moves from high to lower ground or, when afloat, its mass is continuously spreading.

Glacierberg

An iceberg of irregular shape is given this name.

Grey Ice

Young ice up to 15 cm in thickness, grey ice has a tendency to break up in a swell and will be seen to 'raft' under pressure.

Grounded Ice

Large or small pieces of ice gone aground/ashore in shoal water.

17. Small iceberg in open water of North Atlantic (1984).

Growler

This piece of ice shows less than 1 m above the surface of the water. Its volume is less than that of a 'berg, bit', and it usually has an area of approximately 20 sq. m. As a growler makes a very poor radar target, it is often very dangerous to navigation.

Hummock

A build-up of ice forced up by pressure is called a hummock, and a similar build-up of broken ice forced downwards by pressure is referred to as a 'bummock'.

Ice Belt

A long pack ice feature, an ice belt is longer than it is wide. Length will vary from about half a mile (1 km approx.) to more than 62 miles (100 km).

Ice Bound

When navigation in or out of a harbour is restricted by an accumulation of ice, the harbour is said to be 'ice bound'.

Ice Cake

A flat piece or cake of sea ice, less than 20 m across.

Ice Edge

This may be described as the dividing line between the open sea and the limit of sea ice (ice boundary).

Ice Field

Pack ice, composed of various sized floes in close proximity over an unspecified distance greater than 10 km across (6.2 miles), is called an ice field.

Ice-Free

Open water, clear of any ice, is ice-free.

Ice Patch

A quantity of pack ice, less than 10 km across (6.2 miles), is an ice patch.

Ice Shelf

This is a very thick layer of ice. An ice shelf could be up to 50 m above the surface of the water, and of any length. The seaward edge is termed an ice front.

Ice Tongue

A major ice projection from the coastline, this comprises several icebergs joined by 'fast ice'. Some or all of the icebergs may be grounded.

Iceberg

An enormous piece of ice more than 5 m in height above the surface of the water, an iceberg originates from a glacier and may be afloat or aground. When afloat, the greatest volume of the iceberg is beneath the surface.

Lead

This is a visible fracture or passage which is navigable by surface craft through the ice regions.

Level Ice

Flat sea ice unaffected by deformation is called level ice.

Multi-year Ice

This is ice which has survived for more than two summers without melting. Its thickness is variable but generally up to about 3 m. It is also practically salt-free.

New Ice

This term describes newly formed ice.

Nilas

A crust of thin ice approximately 10 cm in thickness, this often bends with the swell and wave motion on the surface. It may be sub-divided into dark nilas and light nilas.

Nip

The vessel is said to be nipped when ice under pressure is pressed into the ship's side; she is sometimes damaged in the process.

Open Pack Ice

This is a concentration of pack ice, of between four and six tenths coverage with extensive leads and floes not in contact with each other.

Open Water

This term describes clear water free of obstruction ice and navigable to surface craft, with ice concentration not exceeding one-tenth.

Pack Ice

A general term to include areas of sea ice, it does not include 'fast ice'.

Pancake Ice

Circular pieces of ice up to 3 m in diameter and about 10 cm in thickness, pancake ice curls up at the edges when pieces crash into each other.

Rafted Ice

This is deformed ice caused by layers riding on top of each other. Pressure changes cause the overriding, which is more often found in young ice.

Rotten Ice

This is ice in an advanced state of decomposition, usually consisting of light small pieces breaking up continuously.

Sea Ice

Ice formed from freezing sea water, found at sea, is called sea ice.

Stranded Ice

This is ice left ashore by a falling tide.

Tabular Berg

A flat-topped iceberg in the southern hemisphere.

Very Close Pack Ice

A concentration of pack ice between nine- and ten-tenths coverage is described by this term.

ICE NAVIGATION

In general, when a vessel has to advance through ice areas, the progress of the ship will be dependent on:

(*a*) The nature of the ice.
(*b*) The qualities of the vessel, scantlings, ice breaker bow construction, and motive power of machinery.
(*c*) Expertise and experience of the Master.
(*d*) Operational qualities of navigational instruments.
(*e*) Assistance of tugs or ice breaker vessels.
(*f*) Ice convoy facilities.

The Master of any vessel coming up to or approaching dangerous ice is obliged by the International Convention for the Safety of Lift at Sea, 1960, to report any dangerous ice formation sighted on or near his course. His ice report should contain the following information: type of ice encountered; position of this ice; and GMT and date of sighting the same. The Master is further obliged to proceed at a moderate speed or alter his course to pass clear of ice dangers.

Ice reports are despatched to the International Ice Patrol, operated by the United States Coast Guard throughout the ice season, usually beginning about February and ending about June/July.

The prime function of the Ice Patrol is to warn shipping of the extent of sea ice and icebergs which may affect vessels on the main shipping routes.

Ice reports from shipping, together with weather reports from shipping, assist the Ice Patrol to piece together any movement of ice, and allow the construction of a facsimile chart of conditions for general broadcast to all shipping within the area. Reports are made by the Ice Patrol twice daily, together with the despatch of the facsimile chart. Additional reports of ice sightings are broadcast whenever considered necessary. Transmitting stations, together with frequencies and channels, are as described in the *Admiralty List of Radio Signals* (see p. 10). Mariners should be aware that this service is provided for them, and is greatly enhanced by their own co-operation. Reports of actual sightings help the flight planning of Ice Patrol aircraft and in designating patrol areas for surface craft.

Operating in Ice

Mariners entering ice regions should take early action to seek up-to-date ice reports from the Ice Patrol, as distributed by the US Naval Oceanographic Office. Ice limits should then be marked on to navigational charts, and any particular hazards, such as single icebergs, being plotted. Course and speed of the vessel can then be adjusted accordingly, circumstances dictating the safest route. A lookout is essential during daylight hours, even in so-called good visibility.

Vessels without operational radar should be prepared to stop during the hours of darkness if the concentration of dangerous ice warrants such action, and should at any time proceed only at a safe speed. Ice reports should be continually obtained and charts updated in accordance

with the vessel's progress. A combination of fog and ice is not only a dangerous combination but unfortunately a common occurrence.

Vessels attempting to negotiate ice regions should be equipped with reliable engines and steering gear. It is an advantage if the ship is ice-strengthened or longitudinally framed, with an ice-breaker bow.

It has been found by experience that ship-handling in ice can be achieved by observing one or two basic principles:

1. The vessel must endeavour to keep moving into the ice and making headway. Even if the movement is only very slight, it must be maintained.
2. It is best for the vessel to move with the ice, not against it.
3. Maintain freedom to move, bearing in mind that excessive speed lends itself to ice damage.
4. The mariner will require a great deal of patience.

Should the vessel become trapped in the ice and held, bear in mind that freedom of movement is lost and the ship will then only move with the ice, going wherever the ice is going. Should the forward motion of the vessel be impeded, a movement astern should be considered as an option, while searching for another 'lead' through the pack ice or ice field. Continuous movement astern should be avoided because of the very real danger to rudder and propeller. Continuous plotting of the ship's position in confined waters is essential at this stage in order to keep the vessel clear of shoals and to prevent disorientation. Regular checks on compasses and prominent landmarks must be considered essential.

The alternatives open to the Master are limited in the event of his vessel becoming 'ice bound'. Owners may decide to re-route the vessel to another port, but, failing this, one or more of the following actions are advised:

1. Assemble with other ships for movement in an ice convoy, usually escorted by ice-breaker vessels.
2. Follow the track of an ice-breaker vessel, or ice-strengthened vessel towards destination.
3. If equipped with an ice-breaker bow and also ice-strengthened, attempt passage independently.
4. Before leaving port, add ice strengthening to the forepart of your own vessel. (This can be done relatively quickly by building a framework in the forepeak tanks out of pit prop beams, and covering or filling the whole tank area with concrete. This construction may later become permanent ballast for the vessel, as it is unlikely that it could be easily removed without drydocking and cutting into the shell plate.)

Ice Damage

The extent of any damage will depend on the condition of the ice the vessel is passing through. The mariner should be prepared to accept some damage to the vessel, while limiting the amount as much as possible.

Severe wear of the outer shell plating will be experienced at the waterline level, and for some height and depth above this level, according to the thickness of the ice the ship is passing through. All paint work on superstructures can be expected to flake and become badly pitted, especially if the temperature is continuously below freezing for any period.

Denting of shell plates in the bow area must be anticipated. The stem will be stripped clean of all paint and protective covering. The rudder and propeller area is extremely susceptible to ice damage from large floes passing down the ship's side and colliding with the upper area of the rudder and the rudder securing to the stock.

Lifeboat water tanks should be part emptied to avoid fracture. Steam lines should be drained. Lagging on pipes should be regularly checked for expected deterioration. Ballast tanks and fresh-water tanks should be inspected daily to prevent freezing over.

18. Pack ice conditions.