

**Handling the vessel within the storm area.**—If, from the weather indications given above and such others as his experience has taught him, the navigator is led to believe that a tropical cyclone is approaching, he should at once—

First. Determine the bearing of the center.

Second. Estimate its distance.

Third. Plot its apparent path.

The first two of the above determinations will locate the approximate position of the center, which should be marked on the chart. The relation between the position of the ship and the position and prospective track of the center will indicate the proper course to pursue (*a*) to enable the vessel to keep out of or escape from the dangerous semicircle and to avoid the center of the storm; (*b*) to enable the vessel to ride out the storm in safety if unable to escape from it.

Should the ship be to the westward of the storm center before the path has recurved, it may be assumed that the latter will draw nearer more or less directly. It then becomes of the utmost importance to determine its path and so learn whether the vessel is in the right or left semicircle of the storm area.

The right and left semicircles lie on the right and left hands, respectively, of an observer standing on the storm track and facing in the direction the center is moving. *Prior to recurving*, the winds in that semicircle of the storm which is more remote from the equator (the right-hand semicircle in the Northern Hemisphere, the left-hand semicircle in the Southern) are liable to be more severe than those of the opposite semicircle. A vessel hove-to in the semicircle adjacent to the equator has also the advantage of immunity from becoming involved in the actual center itself, inasmuch as there is a distinct tendency of the storm to move away from the equator and to recurve. For these reasons the more remote semicircle (the right hand in the Northern Hemisphere, the left hand in the Southern Hemisphere) has been called the **dangerous**, while that semicircle adjacent to the equator (the left hand in the Northern Hemisphere, the right hand in the Southern Hemisphere) is called the **navigable**.

In order to determine the path of the storm and consequently in which semicircle the ship finds herself, it is necessary to wait until the wind shifts. When this occurs, plot a new position of the center 10 points ( $112^\circ$ ) to the right of the new direction of the wind as before, and the line joining these two positions will be the *probable* path of the storm. If the ship has not been stationary during the time between the two sets of observations (as will indeed never be the case unless at anchor), allowance must be made for the course and distance traveled in the interim.

Two bearings of the center with an interval between of from 2 to 3 hours will, in general, be sufficient to determine the course of the storm, provided an accurate account is kept of the ship's way, but if the storm be moving slowly a longer interval will be necessary.

Should the wind not shift, but continue to blow steadily with increasing force, and with a falling barometer, it may be assumed that the vessel is on or near the storm track. Owing to the slow advance of storms in the Tropics, a vessel might come within the disturbed area through overtaking the center. In such a case a slight decrease in speed would probably be all that would be necessary, but it should be borne in mind that the storm path is by no means constant either in speed or direction, and that it is particularly liable to recurve away from the equator.

A vessel hove-to in advance of a tropical cyclonic storm will experience a long heavy swell, a falling barometer with torrents of rain, and winds of steadily increasing force. The shifts of wind will depend upon the position of the vessel with respect to the track followed by the storm center. Immediately upon the track, the wind will hold steady in direction until the passage of the central calm, the "eye of the storm," after which the gale will renew itself, but from a direction opposite to that which it previously had. To the right of the track, or in the *right-hand semicircle* of the storm the wind, as the center advances and passes the vessel, will constantly shift to the right, the rate at which the successive shifts follow each other increasing with the proximity to the center; in this semicircle, then, in order that the wind shall draw aft with each shift, and the vessel not be taken aback, a *sailing vessel* must be hove-to

on the starboard tack; similarly, in the left-hand semicircle, the wind will constantly shift to the left, and here a *sailing vessel* must be hove-to on the port tack so as not to be taken aback. These two rules hold alike for both hemispheres and for *cyclonic* storms in all latitudes.

It must not be forgotten that the shifts of wind will only occur in the above order when the vessel is stationary. When the course and speed are such as to maintain a constant relative bearing between the ship and storm center, there will be no shift of wind. Should the vessel be outrunning the storm, the wind will indeed shift in the opposite direction to that given, and a navigator in the right semicircle, for

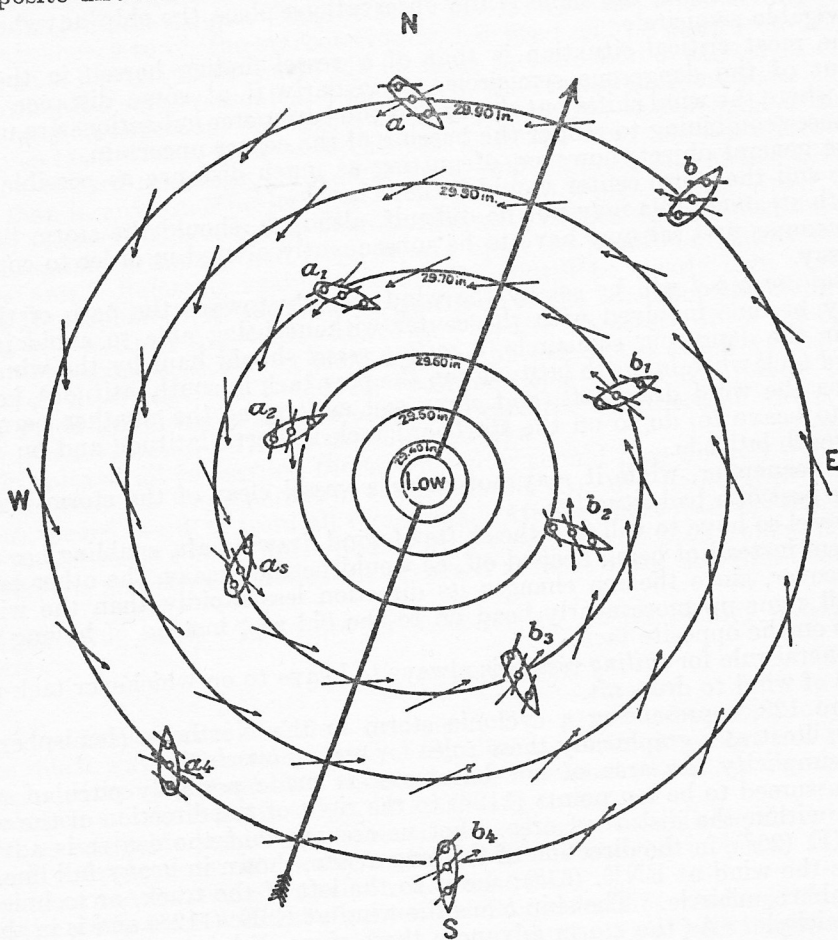


FIGURE 128.

instance, judging only by the shifts of wind without taking into account his own run, might imagine himself on the opposite side. In such a case the barometer must be the guide. If it falls, one is approaching the center; if it rises, one is receding.

An examination of figure 128 shows how this is. A vessel hove to at the position marked *b*, and being passed by the storm center, will occupy successive positions in regard to the center from *b* to *b4*, and will experience shifts of wind, as shown by the arrows, from East through South to SW. On the other hand, if the storm center be stationary or moving slowly and a vessel be overtaking it along the line from *b4* to *b*, the wind will back from SW. to East, and is likely to convey an entirely wrong impression as the location and movement of the center.

Hence it is recommended that a vessel suspecting the approach or proximity of a cyclonic storm should stop (if a sailing ship heave to on the starboard tack) for a while until the path of the center is located by observing the shifts of the wind and the behavior of the barometer.



If the wind remains steady in direction and increases in force in heavy squalls while the barometer falls rapidly, say, at a greater rate than 0.03 of an inch per hour, the vessel is probably on or near the track of the storm and in advance of the center.

In this position, with plenty of sea room, the proper course is to run with the wind well on the starboard quarter, if north of the equator, and on the port quarter if south. The vessel will thus be in the navigable semicircle and be constantly increasing her distance from the center. The wind will draw more forward as she recedes from the center, but the compass course first set should be adhered to until well clear.

The procedure is the same if the observations place the ship anywhere within the navigable semicircle.

The most critical situation is that of a vessel finding herself in the forward quadrant of the dangerous semicircle, particularly if at some distance from the center, where the wind shifts but slowly and the barometer indications are undecided, both causes combining to render the bearing of the center uncertain.

The general object, however, of putting as much distance as possible between the ship and the storm center should be kept in view.

With steamers this may not be difficult, although, should the storm be recurring, the course first set may have to be subsequently altered in order to continue to draw away.

A *sailing vessel* will be set by the wind directly toward the path of the storm and may become involved with the center without being able to avoid it. If so caught in the dangerous semicircle, a *sailing vessel* should haul by the wind on the starboard tack when in north latitude (on the port tack in south latitude), keep coming up as the wind draws aft, and carry sail as long as the weather permits. If obliged to heave to, do so on the starboard tack in north latitude and on the port tack in south latitude.

This maneuver, while it may not carry a vessel clear of the storm track, will make the best of a bad situation.

A vessel so hove to will find the shifts of wind drawing aft, enabling her to come up to them instead of being headed off, as would be the case on the other tack.

Moreover, since the sea changes its direction less rapidly than the wind, the vessel will come up more nearly head on to the old sea, instead of having it more abeam as on the opposite tack.

A general rule for *sailing vessels* is always to heave to on whichever tack permits the shifts of wind to draw aft.

Figure 128, representing a cyclonic storm in the Northern Hemisphere after recurring, illustrates graphically these rules for *sailing vessels*.

For simplicity the area of low barometer is made perfectly circular and the center is assumed to be ten points ( $112^\circ$ ) to the right of the direction of the wind at all points within the disturbed area. Let us assume that the center is advancing about NNE. ( $22^\circ$ ), in the direction of the long arrow, shown in heavy full line. The ship *a* has the wind at ENE. ( $67^\circ$ ); she is to the left of the track, or technically in the navigable semicircle. The ship *b* has the wind at ESE. ( $112^\circ$ ) and is in the dangerous semicircle. As the storm advances these ships, if lying to, *a* upon the port tack, *b* upon the starboard tack, as shown, take with regard to the storm center the successive positions  $a_1, a_2$ , etc.,  $b_1, b_2$ , etc., the wind of ship *a* shifting to the left, of ship *b* to the right, or in both cases drawing aft, and thus diminishing the probability of either ship being struck aback, with possible serious damage to spars and rigging, a danger to which a vessel lying to on the opposite tack (i. e., the starboard tack in the left-hand semicircle or the port tack in the right-hand semicircle) is constantly exposed, the wind in the latter case tending constantly to draw forward. This ship *b* is continually beaten by wind and sea toward the storm track. The ship *a* is drifted away from the track and should she be able to carry sail would soon find better weather by running off to the westward.

Should steamers find it necessary to heave to the method of doing so must depend upon the position within the storm area.

A steamer is concerned more with the damage resulting from heavy seas than from wind; furthermore a steamer is not dependent for the course upon the direction of the wind, but is free to maneuver to keep away from the storm center, where the



heaviest and most confused seas are found, unless other circumstances, such as proximity to the land, prevent.

If unable to escape from the storm, and this can be done only in low latitudes when the storm covers a comparatively limited area, the principal object of a steamer is to avoid the center of the storm.

Referring to figure 128, it is obvious that in the Northern Hemisphere if a steamer finding herself in the left-hand (**navigable**) semicircle at *a* or *a-1* should obey the rule for sailing vessels and heave to on the port tack, her head will lie *toward* the storm track and the greatest danger. On the other hand, under the same circumstances, if the steamer heaves to on the starboard tack, her head will lie *away* from the storm track and such headway as is made will all be in the direction of safety.

Following the same reasoning, a steamer in the Northern Hemisphere caught in the right-hand (**dangerous**) semicircle at *b*, *b-1* (fig. 128) and obliged to heave to should do so head to sea, because in this case both the wind and sea are constantly beating her toward the storm track, and then lying to, head to sea, less leeway will be made than in any other position.

Many steamers behave better when hove to with the sea astern, or on the quarter, but the adoption of this method must depend upon the position of the vessel within the storm area. Referring again to figure 128, it will be clearly seen that, in the Northern Hemisphere, if in the forward quadrant of the left-hand semicircle at positions *a*, *a-1*, a steamer may safely heave to with the sea astern or on the starboard quarter. This course, however, should never be attempted when in the forward quadrant of the right-hand semicircle (positions *b*, *b-1*) for the reason that any headway made would be, in all probability, toward the storm center where the high and confused seas would be likely to inflict damage.

If, in spite of all endeavors, the storm center should pass directly over a vessel she will experience a short period of calm, but the seas will be high, confused, and dangerous, being swept in from all directions. After a short interval the wind will burst with hurricane force from a point directly opposite to that from which it was blowing before, and the vessel must be prepared to meet it and to avoid being caught aback.

**Maneuvering rules.**—The rules for maneuvering, so far as they may be generalized, are:

#### NORTHERN HEMISPHERE

**Right or dangerous semicircle.**—Steamers: Bring the wind on the starboard bow, make as much way as possible, and if obliged to heave to, do so head to sea. Sailing vessels: Keep close-hauled on the starboard tack, make as much way as possible, and if obliged to heave to, do so on the starboard tack.

**Left or navigable semicircle.**—Steam and sailing vessels: Bring the wind on the starboard quarter, note the course and hold it. If obliged to heave to, steamers may do so stern to sea; sailing vessels on the port tack.

**On the storm track, in front of center.**—Steam and sailing vessels: Bring the wind two points (22°) on the starboard quarter, note the course and hold it, and run for the left semicircle, and when in that semicircle maneuver as above.

**On the storm track, in rear of center.**—Avoid the center by the best practicable route, having due regard to the tendency of cyclones to recurve to the northward and eastward.

#### SOUTHERN HEMISPHERE

**Left or dangerous semicircle.**—Steamers: Bring the wind on the port bow, make as much way as possible, and if obliged to heave to do so head to sea. Sailing vessels: Keep close-hauled on the port tack, make as much way as possible, and if obliged to heave to do so on the port tack.

**Right or navigable semicircle.**—Steam and sailing vessels: Bring the wind on the port quarter, note the course and hold it. If obliged to heave to, steamers may do so stern to sea; sailing vessels on the starboard tack.

**On the storm track, in front of center.**—Steam and sailing vessels: Bring the wind two points (22°) on the port quarter, note the course and hold it and run for the right semicircle, and when in that semicircle maneuver as above.