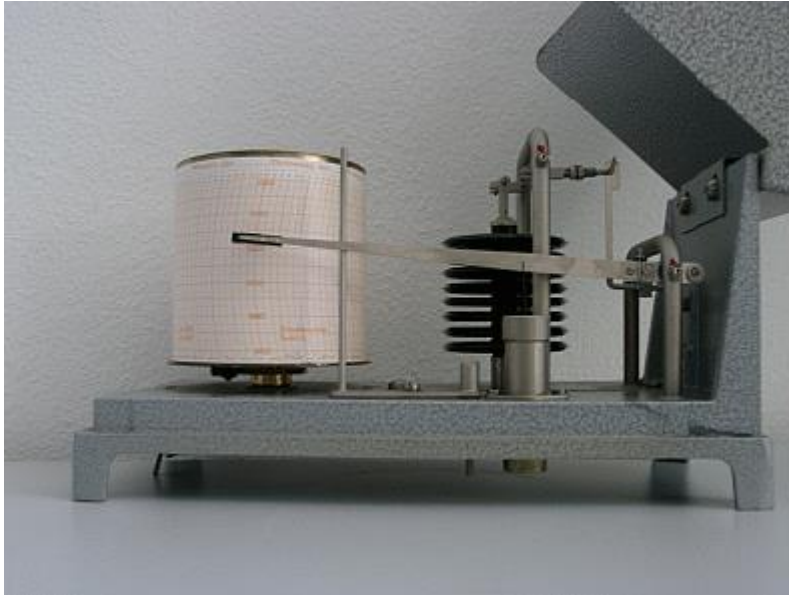


Barograph reading



marine barograph (photo Deutscher Wetterdienst)

The amount of the pressure tendency and characteristic of the pressure tendency in the past three hours is obtained from a marine barograph, preferably an open-scale instrument graduated in divisions of 1 hPa, or from an integrated electronic barometer-barograph with a digital output.

Barograph check

Barometers and barographs should be checked as frequently as possible against standard instruments on shore at least once every three months. A permanent record of all such checks should, if possible, be attached to the instrument, and should include such information as the date of the check, temperature and pressure at which the check was made. It is particularly important that barometers and barographs be checked as frequently as possible, because of possible zero drift, especially when the instruments are new.

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A typical barograph is shown in Figure 7. It is constructed on exactly the same principle as the aneroid barometer, but records its readings by the movement of a pen over a suitable chart.

To increase the movement through which the pen travels in response to pressure changes, the vacuum chamber takes the form of either a number of individual capsules or one large chamber with corrugated walls. The bottom of this vacuum chamber is anchored to the pen arm through a series of levers which still further magnify the movement by pressure changes and which can be arranged to compensate for temperature changes. The variation of volume of the vacuum chamber is thus translated into a vertical movement of the pen arm. This pen arm carries a patented felt stylus or pen and pressure changes are presented as a mark on a chart attached to a clockwork-operated drum. This pressure is recorded as a

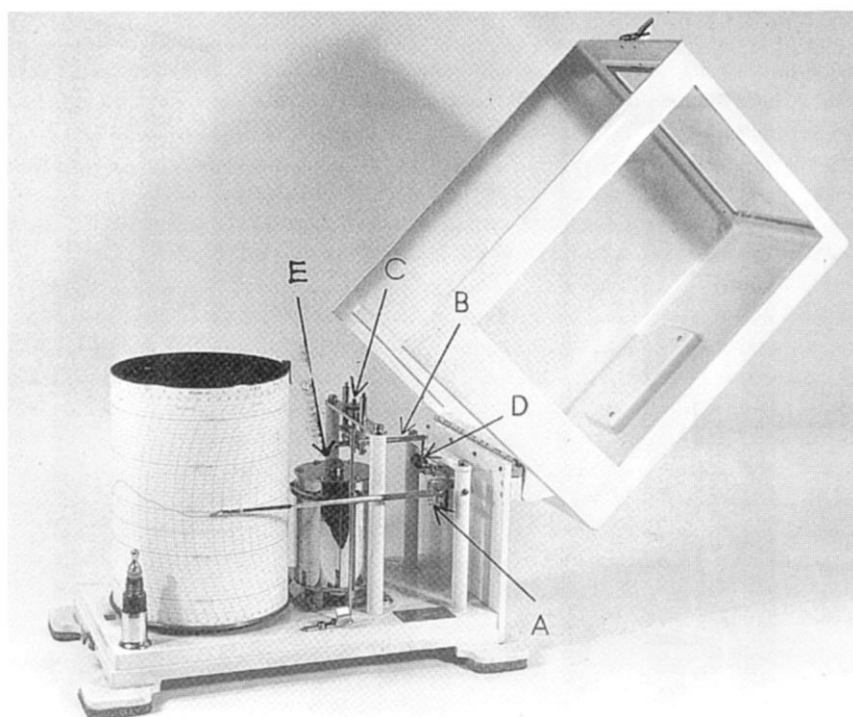


Figure 7. The marine open-scale barograph.

continuous line whose height at any point represents the pressure at the time it was recorded. This record is known as a barogram.

The barograph is a valuable adjunct to the barometer aboard ship in providing a continuous record of atmospheric pressure between the times at which the barometer was read. The barograph is not a precision instrument and should never be used as an alternative to the barometer for measuring atmospheric pressure at fixed times. Its advantage is that it provides a graphical record of fluctuations of pressure, together with the times at which they occur, such as the moment of passing of a line squall and its readings are valuable to the meteorologist and to the mariner for various practical purposes.

The open-scale barograph. Barographs may be made in various scales of size, the smaller being more convenient when space is limited. In such smaller instruments the vacuum chamber and the

clock drum are themselves smaller, and the pressure changes recorded on the chart are of a correspondingly reduced scale. To report barometric tendencies with the accuracy required for synoptic meteorological observations, it is desirable that larger, and hence more open-scaled barographs are used. Records from such barographs, when carried on board ships may, however, be unsatisfactory because, due to their greater sensitivity, the trace is not a fine line but a ribbon of appreciable width, resulting from vibration, pressure changes from gusts of wind and from the movement of the ship. Because of this, an oil-damped open-scale barograph (Met. Office Marine Mk. 2) is used on board UK Selected Ships. In this instrument the vacuum chamber is contained in a brass cylinder filled with silicone oil which, to compensate for changes of volume of the vacuum chamber, must pass through a small orifice. In this way short time-period changes are damped out and only the major persistent changes shown on the chart. As a further precaution against vibration the instrument is mounted on rubber pads.

Care of the barograph. The barograph is a delicate instrument and must be handled carefully. Friction between the working parts of the apparatus must be avoided as far as possible. The bearings should be cleaned occasionally and oiled with good clock oil, care being taken to remove excess clock oil.

Friction occurs between the pen and the paper on which it writes. The pressure of the pen on the paper should be reduced to the minimum consistent with a continuous trace; this pressure should be tested from time to time.

In the open-scale barograph the pen arm which carries the pen is suspended like a gate and it is so arranged that the slope of the gate bearings is adjustable. It is thus possible to regulate the pressure of the pen on the chart. In Figure 7, A denotes the gate suspension which is suitably adjusted before issue. The barograph, when used on board ship, should be located in a position where it will be least affected by concussion, vibration or movement of the ship.

Setting of the barograph. The barograph is set to give the correct mean-sea-level reading by comparison with the reading of the precision aneroid barometer after it has been corrected to give mean-sea-level pressure.

In the type of barograph shown in Figure 7, the setting is made by adjusting the height of the fulcrum of the principle lever B by means of the milled head screw C on the central bridge.

Standardizing the barograph. Like the aneroid barometer, and for the same reason (the possibility of changes in the elasticity of the metal of which the vacuum boxes are composed), the readings of the barograph should be compared at least once a week with those of a barometer, duly corrected. The most suitable time is when the weekly chart is changed, and the reading of the barometer, together with the date and UTC, should be entered on the chart.

Adjustments to the barograph should not be made too frequently, but only if its readings become appreciably different from those of the barometer, and a note of the adjustment should be made on the chart, giving date and time. If, after initial installation, the barograph trace appears to be erratic when compared with barometer readings, first check if the brass plug on top of the oil cylinder has been unscrewed and raised on its spindle (see 'Carriage of barograph' below). If this appears to be in order and the barograph is still erratic, the error must be reported to a Port Met. Officer or the responsible Met. Office.

Whenever it appears that the pen may be about to go above or below the barogram in extremes of high or low pressure, the position of the pen arm may be temporarily adjusted, by 10 millibars for instance, as described above and a note made on the chart to this effect. In this way extremes of pressure would be recorded instead of being lost beyond the top or bottom edges of the chart. After passage of the extremes the pen arm should be reset and compared again with the barometer for accuracy of setting.

The barograph clock and chart. The barograph may be fitted with various clocks which will rotate a drum quickly or slowly as desired, round which the chart is fixed. For many applications a rotation in 24 hours will be necessary to show up the small-scale features of pressure changes but, for use at sea, the clock chosen will rotate the drum once per week. The chart must therefore be changed weekly, the clock being wound at the same time. Before removing the chart from a small barograph the pen arm must first be moved away from the chart by means of the lever provided. On open-scale barographs the pen arm automatically lifts off the chart when the lid is lifted. Before the new chart is put on the drum, the date and time should be entered on it. Time marks should be made each day at 1200 UTC and just before the chart is removed, the times being entered on the chart, for the purpose of correcting the time scale should the barograph clock run fast or slow. The barograph should be kept to UTC throughout the voyage. For the purpose of making time marks, barographs have a small button on the outer case which, when depressed, acts on a rubber roller (D in Figure 7) which slightly moves the pen arm vertically.

Before fixing the chart on the drum, the latter must first be lifted from the clock by removing the key and unscrewing the milled nut which holds the drum in place. The chart is then placed round the drum where it is held in position by two short spring clips that hold its top and bottom edges. When fixing the chart on the drum, care must be taken that the horizontal lines printed on the chart are parallel to the flange at the base of the drum. As the length of the chart is slightly greater than the circumference of the drum, there is some overlap when the chart is put on the drum. The last portion of the chart should come on top of the first portion, so that if the chart is not changed at the end of seven days, the pen will not catch on the edge of the chart and tear it, or damage itself.

The drum is then replaced on the clock and the whole is rotated until the pen records the correct UTC. In order to avoid time errors that might be caused by backlash in the teeth of the clock gears, the final movement of the drum, when setting it, should be opposite to the normal direction of rotation.

Carriage of barograph. Before removing the barograph from its position on board ship, the brass plug on top of the oil cylinder (E in Figure 7) should be pushed down its spindle and screwed in place tightly to prevent leakage of the silicone damping oil in transit. Oil leakage will seriously damage the barograph mechanism. The pen arm should be attached to the pen lifter. The reverse procedure applies when a barograph is installed.

THE CHANGE OR TENDENCY OF THE BAROMETER

The change or tendency of the barometer, always a valuable observation to seamen, is also of considerable value to the forecaster.

The barometric tendency, by international usage, is defined as the change in the barometric pressure in the last three hours. It is required in radio weather messages and is read off from the barograph. The position of the pen on the chart at the time of observation, and the reading of the trace three hours earlier, should be noted, if possible to the tenth of a millibar. The difference between these two readings will give the tendency. It should not be taken as the difference between two readings on the barometer, but should always be read off from the barograph, since the barograph method is less liable to error, and anyway the barometer is not customarily read every three hours at sea. Also, mistakes in reading a barograph are more likely to be detected, owing to the continuous availability of the trace.

It is essential that the barograph trace should be fine and sensitive, with the instrument free from mechanical faults such as sticking, and as far as possible not vitiated by the effects of vibration, or of unequal heating due to sunshine or nearby sources of heat.

Allowance for course and speed

To estimate the true tendency of the barometer reported from a ship under way, a meteorological service needs to allow for course and speed, and, therefore, in a ship's weather report provision is made for reporting the course and speed of the ship. The allowance for the course and speed of the ship should not be made by the observer on board ship when reporting tendency in a weather message. This allowance can be readily made at the meteorological office ashore when the observations are studied by forecasters or processed by computers.

The characteristic of the barometric tendency

This is the name given to the coded description of the nature of the changes the pressure has undergone in the last three hours. It is required in ships' weather reports, and is read off from the barograph trace. The codes to be used in reporting the barometric tendency and characteristic are given, with other codes, in the *Ships' Code and Decode Book* (Met.O.509) and in the *Admiralty List of Radio signals*, Volume 3.

The diurnal variation in the pressure

Superposed upon its irregular variations due to changes in the weather, the barometric pressure has a regular rise and fall twice a day, the maximum values occurring at about 10 and 22 hours and the minimum values at about 04 and 16 hours, local time. In temperate regions the amplitude of these diurnal variations is comparatively small, so that they are usually lost in the much greater irregular variations of these regions, but nearer the tropics, the amplitude of the diurnal variation increases and

the magnitude of other changes in general decreases, so that the diurnal variations become very marked and can be clearly seen, day after day, on a barograph chart. In these regions, therefore, barometric changes do not indicate changes in the weather, unless they remain considerable after the diurnal variation has been discounted.

Tables have been prepared for the Atlantic, Pacific and Indian Oceans, between latitudes and 20° N or S, showing the corrections for diurnal variation to be applied to the observed pressure to reduce it to the mean for the day. and the average values of the barometric change in an hour, throughout the day, due to the diurnal variation. These tables are given in the meteorological text of the appropriate Admiralty Sailing Directions. Corresponding figures do not differ greatly from one ocean to another or between north and south latitudes and have been averaged in this handbook to give values that will be approximately correct in any ocean for the two bands of latitude 0° - 10° N or S, and 10° - 20° N or S. These values are shown in Tables 2 and 3, also Figure 9. In the tropics, should the barometer, after correction for diurnal variation (Table 2), be as much as 3 millibars below the monthly normal for the locality, the mariner should be on the alert, as there is a distinct possibility that a tropical cyclone has formed, or is forming. A comparison of subsequent hourly changes in his barometer with the corresponding figures in Table 3 will show whether these changes indicate a real further fall in pressure and, if so, its amount.

When the observer on board ship is reporting barometric tendency, or entering it up in his log, he should not correct it for changes due to normal diurnal variation. This correction, like the correction for course and speed of the ship, is made, if necessary, as a matter of routine by the meteorological office receiving the observations.

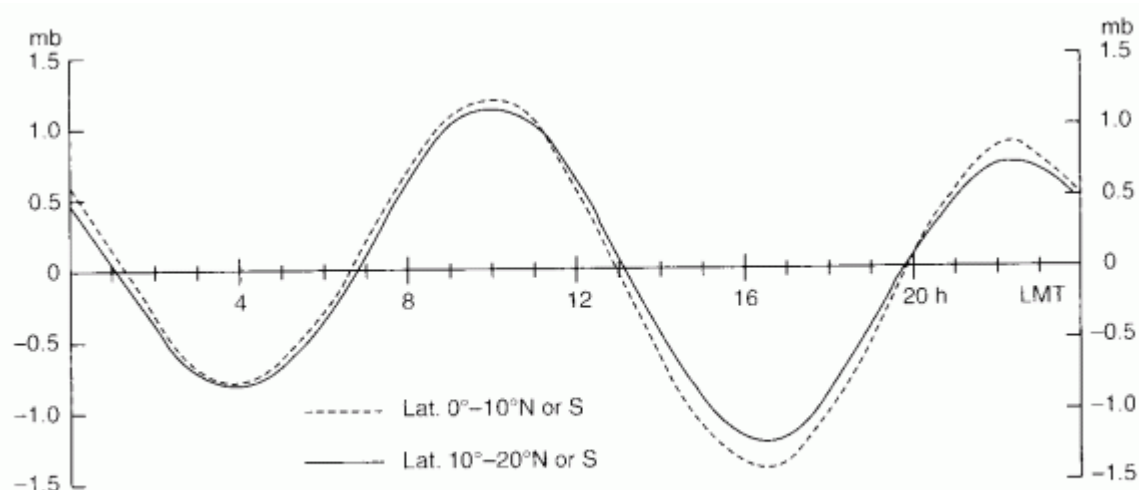


Figure 9. Mean diurnal variation of pressure.

THE DIURNAL VARIATION OF BAROMETRIC PRESSURE IN THE ZONES OF LATITUDE 0—10° AND 10-20°, N OR S

TABLE 2— *Correction to be applied to the observed pressure for diurnal variation*

Local Time	0-10° N or S	10-20° N or S
	<i>mb</i>	<i>mb</i>
0	-0.6	-0.5
1	-0.1	-0.1
2	+0.3	+0.3
3	+0.7	+0.7
4	+0.8	+0.8
5	+0.6	+0.6
6	+0.2	+0.2
7	-0.4	-0.3
8	-0.9	-0.8
9	-1.3	-1.1
10	-1.4	-1.2
11	-1.1	-1.0
12	-0.6	-0.5
13	+0.1	+0.1
14	+0.7	+0.7
15	+1.3	+1.1
16	+1.5	+1.3
17	+1.4	+1.2
18	+1.0	+0.9
19	+0.5	+0.3
20	-0.1	-0.2
21	-0.6	-0.6
22	-0.9	-0.8
23	-0.9	-0.8
24	-0.6	-0.5

TABLE 3— *Average values of barometric change in an hour due to diurnal variation*

Local Time	0-10° N or S	10-20° N or S
	<i>mb</i>	<i>mb</i>
0-1	-0.5	-0.4
1-2	-0.4	-0.4
2-3	-0.4	-0.4
3-4	-0.1	-0.1
4-5	+0.2	+0.2
5-6	+0.4	+0.4
6-7	+0.6	+0.5
7-8	+0.5	+0.5
8-9	+0.4	+0.3
9-10	+0.1	+0.1
10-11	-0.3	-0.2
11-12	-0.5	-0.5
12-13	-0.7	-0.6
13-14	-0.6	-0.6
14-15	-0.6	-0.4
15-16	-0.2	-0.2
16-17	+0.1	+0.1
17-18	+0.4	+0.3
18-19	+0.5	+0.6
19-20	+0.6	+0.5
20-21	+0.5	+0.4
21-22	+0.3	+0.2
22-23	0	0
23-24	-0.3	-0.3

These tables are based on observations made in British ships, at the hours 0000, 0400, 0800, 1200, 1600, 2000 local time, between the years 1919-1938.

In the tropics, should the barometer, after correction for diurnal variation (Table 2), be as much as 3 millibars below the monthly normal for the locality, as shown on meteorological charts, the mariner should be on the alert, as there is a distinct possibility that a tropical storm has formed, or is forming. A comparison of subsequent hourly changes in his barometer with the corresponding figures in Table 3 will show whether these changes indicate a real further fall in pressure and, if so, its amount.

Caution. When entering a barometric pressure in the log the correction for diurnal variation must not be applied.