EXTRACTS AND REVIEWS.

THE WIND ACCORDING TO THE BEAUFORT SCALE AND ITS VELOCITY

by

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Originally the seaman calculated the force of the wind according to its action on the sails; later he introduced the Beaufort Scale with 12 divisions. It scarcely entered his head to consider the velocity in metres per second (m/s) or in kilometres per hour (km/h) (*); rather, for purposes of comparison, he reached the stage of converting wind force into knots (nautical miles per hour) for it was and is still by this measure that he gives his speed.

Both in climatology and in civil meteorology the indication of the force of the wind in Beaufort numbers (F) has been introduced generally. But it is different in oceanography, where currents are given in knots (nautical miles per hour), and in aerology as well as in aeronautics, where the air-currents are given m/s and in km/h. In passing, it should be noted that, for sporting purposes where accurate measures are required, the metric system only is used.

As the two measures, metre and Beaufort Scale, have taken a firm footing in their respective spheres of application and have stood the test therein, it is evident how absolutely necessary it is to establish a strong and simple bridge to connect them.

It may be said with truth that, for the theorist, it is immaterial in which type of measure the velocity data are given for he can convert them by means of his formulas and, the more complicated these conversions, the more he is in his element. For the practical man, and particularly for the seaman and the airman, it is a different matter. He has not the time to make such calculations onboard. Should it happen, however, that he has to make a conversion it is a sine qua non that the system of conversion — even at the expense of accuracy — should be as simple as possible and that the rule for doing it should be easily memorised.

I will give below a rule of this sort for the conversion of the two most frequent data in wind-observations—velocity in metres per second and force by the Beaufort Scale. I venture to, and must in the circumstance, start on the hypothesis that tenths of m/s are not considered, seeing that they are merely imaginary for, in all data as to wind-force on the Beaufort Scale, it is merely a case of estimated value encumbered with personal errors.

The simple mnemonical rule reads thus :– Write the 12 figures of the Beaufort Scale in consecutive order in a horizontal line, under the first half of them write the first six odd numbers — 1, 3, 5, 7, 9 & 11. This second line is in arithmetical progression with D = + 2. To complete this line the difference at each step in the progression should be increased by 0.5; viz :– + 2.5 = 13.5, + 3.0 = 16.5, + 3.5 = 20, + 4.0 = 24.0, + 4.5 = 28.5 and + 5.0 = 33.5. The figures thus entered on the second line represent the desired velocities in m/s corresponding to the 12 forces of the Beaufort Scale. This gives the three first lines of figures, which are not easily forgotten, of the following table :

(*) *The abbreviations used here were laid down in the* Meteorol. Zeitsch. 1934, *p.* 310.

Comparative Table of Wind Velocity and the Beaufort Scale in Metres, Kilometres, Nautical Miles and English as well as Wind Pressure. (*)

1. Beaufort Scale (F)	1	2	3	4	5	6	7	8	9	10	11	12
2. Velocity in m/s.....	1	3	5	7	9	11	13,5	16,5	20	24	28,5	33,5
3. Easily remembered differences.....	2	2	2	2	2	2,5	3	3,5	4	4,5	5	
4. Kilometres per hour.....	4	11	18	25	32	40	49	59	72	86	103	121
5. Knots ..... (1 NM = 1,852 km)	2	6	10	14	17	21	26	32	39	47	55	65
6. English Miles per hour... (1 Eng. M. = 1,609 km)	2	7	11	16	20	25	30	37	45	54	54	75
7. Extreme velocities in m/s internationally approved (corresponding to the Beaufort Scale numbers above).....	0,6 to 1,7	1,8 to 3,5	3,4 to 5,2	5,3 to 7,4	7,5 to 9,8	9,9 to 12,4	12,5 to 15,2	15,3 to 18,2	18,3 to 21,5	21,6 to 25,1	25,2 to 29,0	more than 29,0
8. Means of line 7, not fixed internationally.....	1,1	2,5	4,3	6,3	8,6	11,1	13,8	16,7	19,9	23,3	27,1	—
9. Pressure of Wind (P) in kg/m² (approximately).	0,2	0,9	2,0	3,6 to 4,0	6,8 to 8,5	10 to 12	14 to 19	20 to 28	29 to 40	40 to 53	60 to 75	more than 80

In order that other comparisons may be made I have added lines 4,5 and 6 which give the corresponding values in km/h, nM/h and Eng.M/h. These figures (rounded off) naturally cannot be memorised.

Further, in line 7, I have given the extreme velocities fixed by the International Meteorological Conference, from which it may be seen what a wide margin, in m/s, the various forces of the Beaufort Scale represent. So far, no figures for converting from the Beaufort Scale into m/s have been adopted internationally, but the means of the extreme values, i.e. $\frac{\text{max.} + \text{min.}}{2}$, give approximately the conversion values which are frequently required in practice. These mean values of the figures in line 7 are given in line 8. These last mean values (8), which are not easy to remember, differ but slightly from the fixed conversion figures of line 2 proposed by me, all of which fall within the extreme values internationally adopted and thus satisfy the requirements established internationally. As my figures are retained easily in the mind, even when calculated once only, they are the most suitable, in my opinion, as the basic international link between m/s and the Beaufort Scale. This is supported by the graphic representation of different international series of conversion figures. I constructed this graph in the *Meteorologische Zeitschrift* 1927, page 457 so I merely note it here.

The justification for giving fixed figures of conversion between m/s and Beaufort — as opposed to the international freedom which has prevailed to date — arises from the following consideration :– The development (and I referred to this at the beginning of this paper) was that, at first and for a long time, the wind was merely estimated. It was not until the invention of instruments that anemometers and anemographs were installed. Thereafter a definite reading on the anemometer corresponded to each estimate and mean values were taken which could be taken as fundamental values for all later estimations. All new estimates of force are thus no longer made freely and anyhow as before, but are fixed mathematically and with no ambiguity as figures on the anemometers, i.e. in extreme values and in average figures. To the forces 1 to 12 of the Beaufort Scale there are corresponding figures of velocity in the various series of our table published in the *Meteorologische Zeitschrift.* All estimates of the wind should, henceforth, be based on observations and, on the other hand, can be checked thereby. This in no

(*) *The Editor of* Hansa, *Hamburg* 11, *Steinhoft* 3, *can supply extract prints of this table.*

way implies an amendment of the system used for wind, but merely introduces, as required by development and progress, a uniform scale for checking and educating observers in estimating. In addition, the non-initiated are given an accurate numerical measure by which they can train themselves in estimating the wind even without personal assistance or apprenticeship.

If we ever wish to reach a definite practical result in this so important and so frequently raised question we can, and wish. to, take a stand by saying :– Estimates of wind of force 1, 2, 3 to 12 are correct when they agree with the velocity figures of 1, 3, 5 to 33 m/s (line 2). If the m/s refer to the movement of the air at the estimated position (height), we thus become independent of the configuration of the ground and the height above it. We lay down even that :– The Beaufort Scale, line 1, is equal to line 2 in m/s, and all estimates of force — particularly since the invention and use of the anemograph — should be based thereon.

Seamen afloat and meteorological observers on land, by their estimates of wind force during centuries, have provided the bases for this standardisation and these valuable bases should be preserved to them and their posterity in observations and records in such a way that neither time nor generations shall change them. By thus faithfully preserving them in mathematically accurate measurements, of great value to international intercourse, we would best pay homage to the experience and work of all the old observers and seamen.

To make the table more complete I have added the pressure, in kg/m^2, exerted by wind of various velocities on a fixed object. These pressure data, line 9, however, are not standard values.

Generally speaking, it is only in building work that the maximum values of wind pressure are of importance; the old official values of wind pressure of 100 kg/m^2 and 150 kg/m^2 respectively, according to height above ground, are still valid as such.

There are no specifications as to the form of the surface acted upon by wind but, Ministerialrat (retired) BUSCH, an expert, informs me that, at present efforts are being made to determine a change in the old specifications in order to adapt them to recent advances in the knowledge of this subject. According to this, the static pressure should be taken as :–

$$q = \delta \frac{v^2}{2} \quad \text{or} \quad q = \frac{1}{16} v^2,$$

if the density of the air δ be assumed to be 1/8; the maximum values of this static pressure would probably be from 800 to 1000 kg/m^2 in practice. Account would be taken of the shapes of the buildings by multiplication by the coefficients determined by observations of models in wind-tunnels.

MAPS VERSUS CHARTS.

(Extract from *The Military Engineer*, Washington, D.C., Sept.-Oct. 1935, page 400).

There has been confusion in the minds of some map users concerning the designations "maps" and "charts". To some the name "map" is synonymous with "chart". To others there appears to be a difference but they find it hard to define. Perhaps comparatively few have given the matter any thought whatsoever, accepting a map or a chart for their purpose at its worth.

In order to clear up doubts concerning differences between maps and charts, the following article by Thoburn C. LYON, of the Coast and Geodetic Survey, published in a recent number of *Air Commerce Bulletin*, may be of interest. The title of the article is "Airway maps now called Aeronautical Charts".

"Probably all pilots are familiar with the sectional airway maps published by the Coast and Geodetic Survey for the Bureau of Air Commerce. Recently the designation of this series was changed to sectional aeronautical charts, and some of the reasons for this change may lead to a better understanding of their nature and purpose.