Federal Aviation Agency

ADVISORY CIRCULAR

AC NO: AC 150/5330-3	
AIRPORTS	
EFFECTIVE: 5/5/66	

SUBJECT: WIND EFFECT ON RUNWAY ORIENTATION

1. PURPOSE. This advisory circular provides guidance for evaluating wind conditions at an airport site and their effect on the orientation of runways.

2. CANCELLATIONS.

   a. Chapter II, paragraph under Wind on pages 3, 4, and part of 5 of Airport Design, 1961, including Supplement No. 1, 1962.

   b. Airport Engineering Data Sheet Item No. 38, Wind Data Analysis.

3. GENERAL.

   a. Wind conditions are of prime importance in determining runway orientation. This circular pertains particularly to this factor.

   b. There are other factors which should also be considered in determining runway orientation. These factors are discussed briefly in paragraph 7.

4. RUNWAY ORIENTATION AS INFLUENCED BY THE WIND.

   a. For the certification of airplanes, there is a requirement that there be no uncontrollable ground or water looping tendency in 90 degree crosswinds up to a wind velocity of 0.2 V_{so} (stall speed in landing configuration) at any speed at which the airplane may be expected to operate on the ground or water. Recognizing this and also the fact that less runway is required when landing or taking off into the wind, runways are oriented to minimize crosswind effects and a limiting value of crosswind velocity is established for design purposes. This value is 15 miles per hour (13 knots) for all airports except those built to the VFR Airports (AC 150/5300-1) standards. For VFR airports, this value is 11.5 miles per hour (10 knots). The crosswind value or velocity for any runway orientation is the component of the surface wind which acts at 90 degrees to the runway centerline.

b. Where prevailing winds are consistently from one direction, runways would best be oriented in that direction. In many cases, however, a high degree of consistency of wind direction is not found. This situation may then require more than one runway orientation to obtain an acceptable wind coverage. The measure of the time that a runway is usable under local wind conditions is expressed in relation to a specified crosswind component.

c. At a single-runway airport, the runway should be oriented with respect to prevailing winds so that at least 95 percent of the time the crosswind component affecting the runway does not exceed the values given in paragraph 4a.

d. Where a single runway does not provide a usability factor of at least 95 percent, the system of runways at the airport should provide at least 95 percent usability with crosswind components that do not exceed the values given in paragraph 4a.

5. DATA NEEDED FOR MAKING WIND ANALYSIS. The most accurate and long-term wind data possible should be acquired for making an analysis to determine runway orientation. The more reliable the data are in picturing prevailing wind conditions, the greater will be the usability of the runway oriented with relation to the data. It is desirable to have wind data covering a period of at least five years.

a. The U.S. Weather Bureau has a network of stations which record wind data at many locations. Where one of these stations is at or in the vicinity of the airport site, weather data recorded at the station should be used. Statistical data on wind conditions at a station may be acquired from the National Weather Records Center (NWRC) located at Asheville, North Carolina.

b. Where wind data for a specific airport site are not available, the data from two or more of the nearest recording stations can be used to indicate the wind characteristics for the site. If the terrain between the recording station and the airport site is level or slightly rolling, composite wind data derived from the data on the adjacent stations are usually acceptable. Where intervening terrain is hilly or mountainous, composite wind data have limited value.

c. Where no recorded data are available either for the specific site or from recording stations near enough to be significant, an evaluation should be made of the best local information. If local information does not firmly establish a wind pattern, it is desirable to collect wind data at the site. Data collected for a period of at least one year can be useful in conjunction with local information in the determination of runway orientation.

6. ANALYSIS OF WIND EFFECTS. The principal method of analyzing wind conditions at an airport as they relate to runway orientation is by using a wind rose as shown in Figure 1 of Attachment 1. This is a convenient manner of plotting wind data for a particular location. While this method of analysis requires the graphical presentation of statistical data in the wind rose format, it provides ready visualization of logical runway orientation. Wind roses can be used to analyze individual runway orientation as well as the combined wind coverage of a system of runways. Wind data are represented on the wind rose in terms of the percentage of time winds of different velocities blow from various compass directions.

a. The concentric circles on the wind rose indicate wind velocity in miles per hour or knots. Wind division breakdowns of 12, 18, 24, 31, and 38 miles per hour (10, 16, 21, 27, and 33 knots) are used since these wind intensity divisions are compatible with the periodic reports of the U.S. Weather Bureau.

b. The radial lines on the wind rose define the various compass directions from which the winds originate. Wind data collected by the Weather Bureau may be recorded for the sixteen principal compass points (N, NNE, NE, etc.) or for 36 directions (10-degree segments). The radials on the wind rose are drawn to fit the summarized available wind data. The numbers within the segments are the percentages of time the wind blows from that direction within the indicated velocity ranges.

c. An example of the application of this method of wind analysis, with step-by-step procedures, is shown in Attachment 1.

7. OTHER FACTORS IN DETERMINING RUNWAY ORIENTATION. Several other considerations affecting runway orientation and affecting the adequacy of a site for a proposed airport, over and above wind coverage, are as follows:

a. Neighboring Airports. Existing and potential holding and other traffic patterns of airports in the area should be studied and adequate separation between these patterns should be provided to avoid air traffic conflicts.

b. Built-Up Areas. Airport sites and runway alignment should be selected and operational procedures adopted which will be the least objectionable to inhabitants of the area.

c. Restricted Areas. Restricted areas are shown on sectional and local aeronautical charts. Runways should be so oriented that their approach-departure paths and traffic patterns do not encroach on the restricted areas.

d. Obstructions. A specific airport site and proposed runway layout must be known before a detailed survey can be made of obstructions which affect aircraft operations. Runways should be so oriented that approaches necessary for the ultimate development of the airport are free of all obstructions.

e. Topography. Features such as hills and streams have a substantial effect on the amount of grading and drainage work in constructing a runway. The costs of such work should be considered in deciding on runway orientation.

f. Bird Hazards. The relative locations of bird sanctuaries or other areas which might be attractive to assembly of large numbers of birds and create bird hazards to aviation should be considered in orienting runways.

8. HOW TO OBTAIN THIS PUBLICATION. Additional copies of this circular may be obtained from the Federal Aviation Agency, Printing Branch, HQ-438, Washington, D.C. 20553. Identify the circular by number and title and indicate number of copies needed.

Chester G. Bowers
for Cole Morrow, Director
Airports Service

ATTACHMENT 1. WIND ROSE ANALYSIS PROCEDURE

1. Figures 1 and 2 present a plot on a wind rose diagram of wind data obtained from the U.S. Weather Bureau except for the division at 15 miles per hour (13 knots). Normally, no wind data are presented for 15 miles per hour (13 knots). For runway orientation to provide for the 15 miles per hour (13 knots) allowable crosswind value, 40 percent of the wind intensity presented for 13 to 18 miles per hour (11 to 15 knots) rounded to the nearest tenth is considered as occurring in the sector below 15 miles per hour (13 knots). The remaining 60 percent is considered as being between 15 and 18 miles per hour (13 and 15 knots).

2. In performing a graphical wind analysis, the procedure is to use a transparent template on which three parallel and equally spaced lines have been plotted. The middle line represents the runway centerline; the distance between it and each of the outside lines plotted to the wind-velocity scale of the wind rose represents the allowable crosswind components (see paragraph 4a) with the template placed on the center of the wind rose. The segments and portions of segments of the wind rose appearing between the two outside lines on the template enclose all acceptable wind velocities and directions.

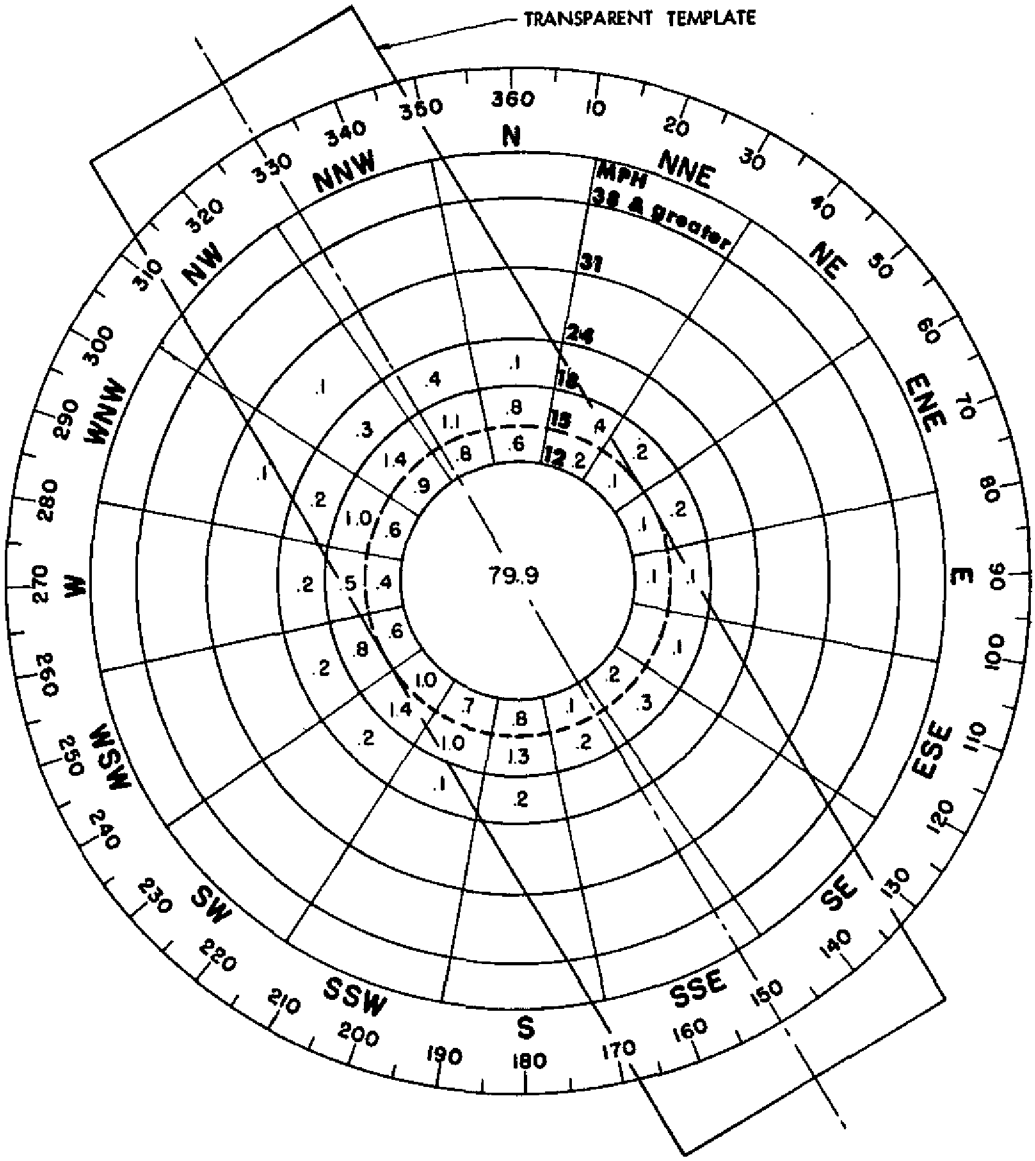
3. The quickest and simplest way to determine the wind coverage for any orientation is to find the wind values not covered by the template and subtract these from 100 percent.

4. Using the center of the wind rose as a pivot, the template is rotated until the sum of the percentages appearing between the outside lines becomes maximum. The percentage shown in each segment of the wind rose is assumed to be equally distributed over the area of the segment. When one of the outside lines on the template cuts through a segment, the fractional part of the percentage appearing in that segment within the outside lines is to be used in the summation of the percentages contributing to the wind coverage. Fractional areas are determined visually and tabulated to the nearest tenth of a percent.

5. Figure 1 illustrates a typical wind rose with the template representing a runway oriented 150/330 degrees. This orientation resulted from rotating the template about the center point of the wind rose until it enclosed the greatest percentage of the wind values shown. The percent of the time that the wind exceeds the acceptable 15 miles per hour (13 knots) crosswind limitation, i.e., outside the template, is 3.5 percent. Therefore, the runway orientation of 150/330 degrees provides for a wind coverage of 96.5 percent.

6. Figure 2 illustrates another wind rose with the runways oriented 180/360 and 090/270 degrees. By adding the wind intensity percentages outside the template oriented 180/360 degrees, it is apparent that the coverage is less than 95 percent. The coverage for this single orientation (180/360 degrees) is 90.8 percent. Using both orientations, the system of runways would yield 99.5 percent wind coverage.

7. A blank wind rose (Figure 3) is added for the convenience of airport planners and designers in the determination of runway orientation.



PERCENTAGE OUTSIDE PARALLEL LINES

NNE	.1	SW	1.3
NE	.2	WSW	.9
ENE	.2	W	.4
SSW	.3	WNW	.1

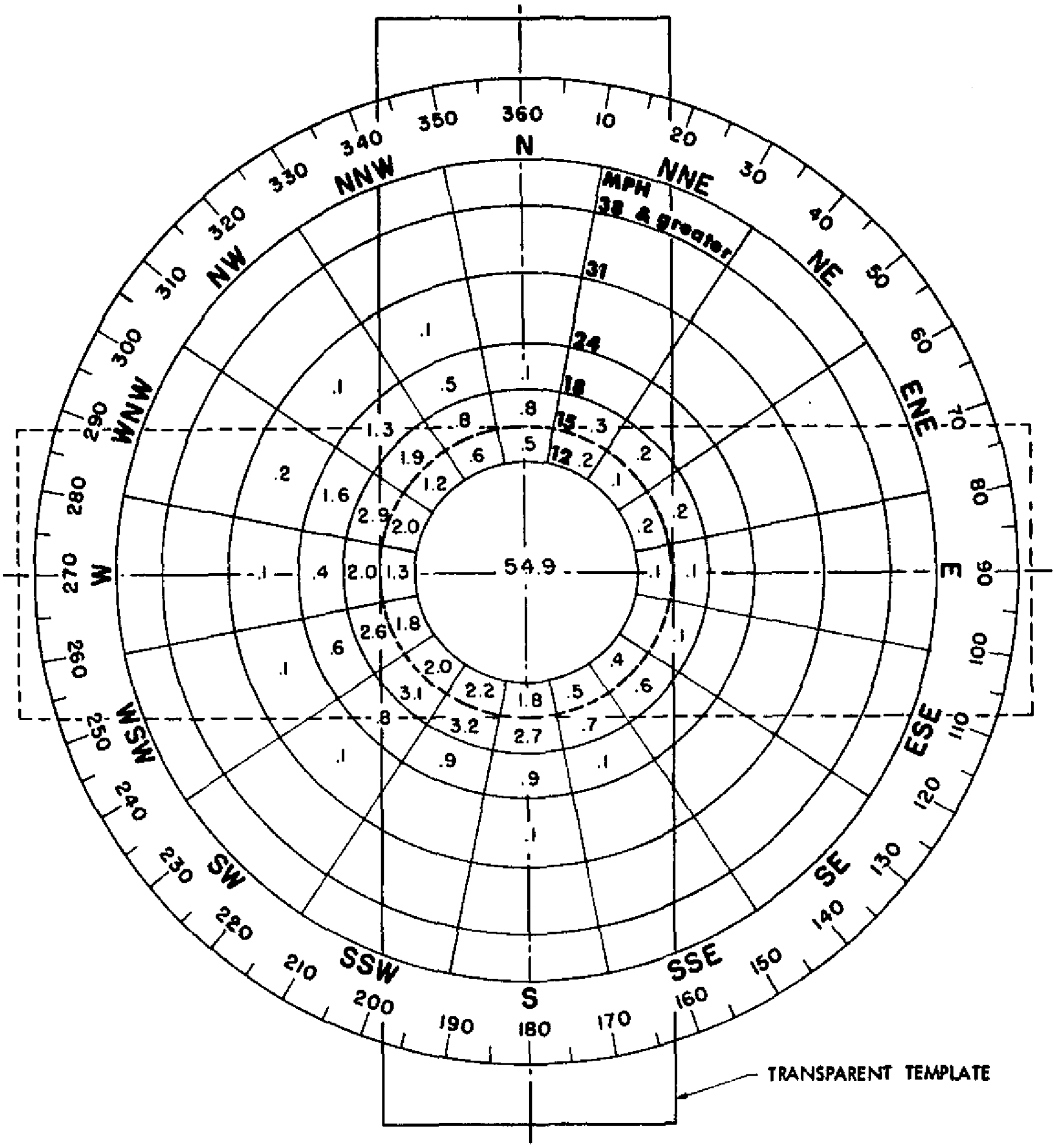
TOTAL 3.5%

PERCENTAGE OF WIND COVERAGE

100 - 3.5 = 96.5

WIND DATA PERIOD:
JANUARY 1, 1960-DECEMBER 31, 1964

FIGURE 1. TYPICAL 15 MPH (13 KTS) WIND ROSE - ONE RUNWAY

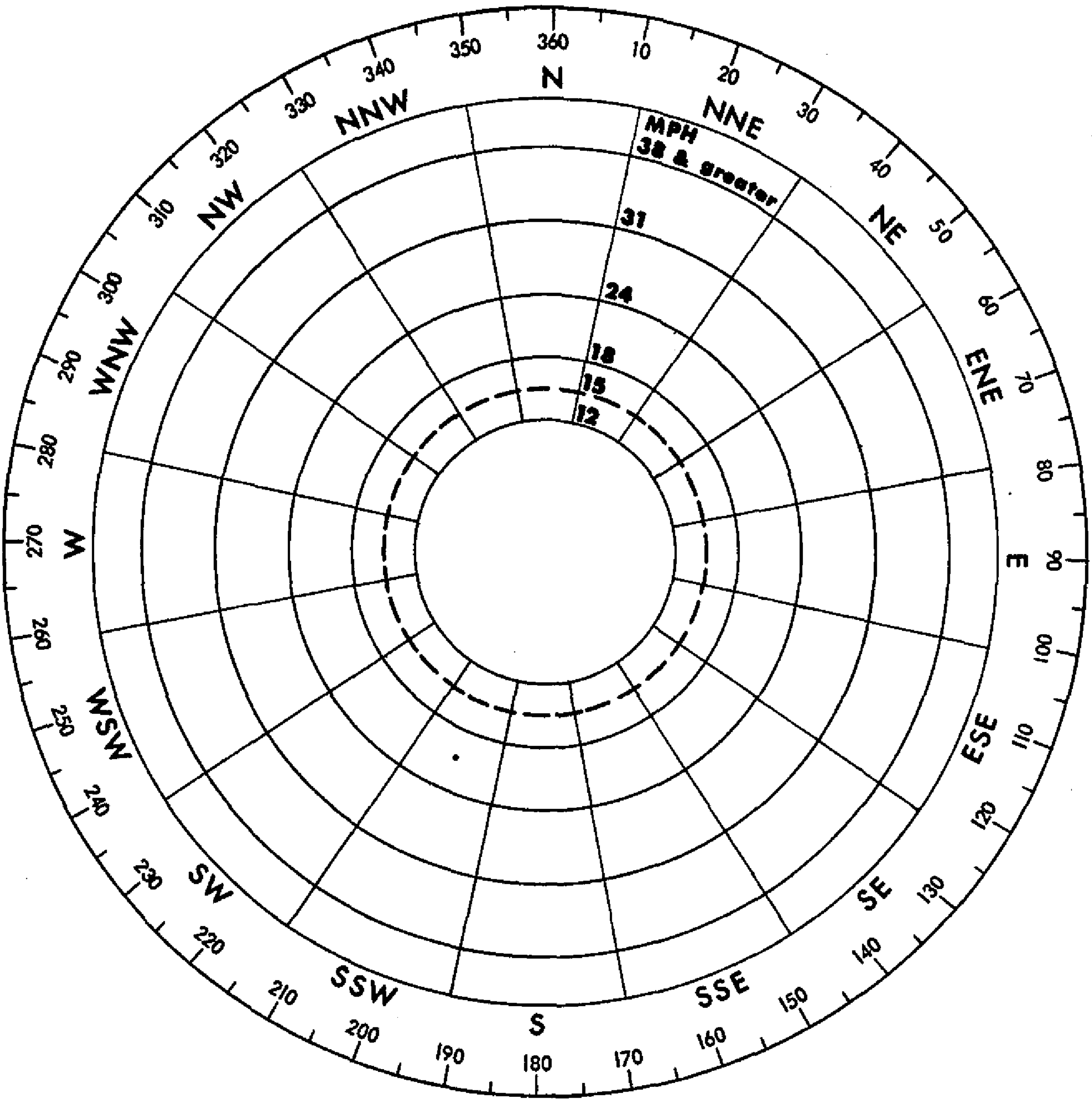


ONE RUNWAY 180°/360° 100-9.2 = 90.8% COVERAGE

TWO RUNWAYS 180°/360°, 090°/270° 100-0.5 = 99.5% COVERAGE

WIND DATA PERIOD:
JANUARY 1, 1960-DECEMBER 31, 1965

FIGURE 2. TYPICAL 15 MPH (13 KTS) WIND ROSE - TWO RUNWAYS



WIND DATA PERIOD:

FIGURE 3. BLANK WIND ROSE