NBS BUILDING SCIENCE SERIES 160

Directional Extreme Wind Speed Data for the Design of Buildings and Other Structures
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Directional Extreme Wind Speed Data for the Design of Buildings and Other Structures

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ABSTRACT

The purpose of this report is to provide largest yearly fastest-mile wind speed data corresponding to winds blowing from each octant at 37 airport stations in the United States. Four sets of data are presented. The first set consists of largest yearly fastest-mile wind speeds at 24 stations as extracted from original records. The second set consists of largest yearly fastest-mile wind speeds at 13 stations as extracted from Local Climatological Data (LCD) summaries. The third and fourth sets consist of the data from the first and second sets reduced to a height of 10 m above ground. The report also provides information on possible differences between extreme data extracted from original records on the one hand and from LCD summaries on the other hand. Procedures for estimating extreme wind effects that take into account the directional characteristics of the extreme wind climate and of the aerodynamic behavior of the structure are briefly reviewed, and it is noted that additional research on sampling errors in the estimation of extreme wind effects appears to be warranted.

Key words: aerodynamics; climatology; directionality; reliability; structural engineering; wind engineering; wind speeds.
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1. INTRODUCTION

It is widely recognized that, owing to both aerodynamic and climatological factors, wind direction can have an important effect on the design of wind-sensitive structures. For this reason, modern wind tunnel tests provide extensive information on the dependence of aerodynamic loads upon direction. However, in current design practice this information is in many instances not integrated in a consistent manner with data concerning the extreme wind climate. This can lead to the estimation of design wind loads that, depending upon the extreme wind climate and the aerodynamic properties of the structure, can differ significantly for any given mean recurrence interval from the actual loads.

In recent years various procedures for estimating design wind loads have been developed that take into account both aerodynamic and climatological directional effects. Procedures applicable to structures in hurricane-prone regions have been proposed by references 1 and 2. Procedures developed for structures in regions with well-behaved wind climates are described in references 3 to 6. The procedure of references 3 and 4 depends for the characterization of the extreme wind climate upon continuous wind velocity records (or similar types of records, e.g., wind velocities recorded at 1-hour or 3-hour intervals). The procedures of references 5 and 6 utilize records of largest yearly wind speeds for each of the eight (or sixteen) directions of the compass.

It has been shown in reference 7 that continuous velocity records may reflect predominantly the presence of weak winds, such as, for example, morning breezes, which do not belong to the same family of meteorological phenomena as the strong winds of interest in structural design. For this reason, the use of such records may lead to systematically incorrect inferences concerning effects of strong winds.

Records of largest yearly wind speeds provide a more dependable basis for such inferences. However, a major obstacle to the implementation of procedures that utilize such records is the absence of readily available directional extreme wind data. The main purpose of this report is to provide such data at a number of airport stations in the United States.

The report consists of four sections and four appendices. Following this introduction, section 2 includes a brief review of recent research results reported in references 2, 5, and 6 concerning wind directionality effects in well-behaved wind climates and in hurricane-prone regions. Section 3 discusses the differences between directional extreme wind speed data as obtained at various stations from the original records on the one hand, and from Local Climatological Data (LCD) summaries issued by the National Climatic Data Center on the other hand. Section 4 describes the procedure used in this report for reducing the wind speed data to a common elevation.

Appendix I includes directional extreme fastest-mile wind speed data obtained from the original records at 24 stations. Some of these data differ from those obtained from LCD summaries, for reasons explained in section 3. In those instances where such differences exist, the fastest-mile wind speed data
obtained at 21 of these 24 stations from LCD summaries are also listed under the heading "Published Data." Appendix II includes directional extreme fastest-mile wind speed data at 13 stations, as obtained from LCD summaries only. The data listed in appendices I and II were recorded at a variety of elevations. For statistical analysis and structural design purposes it is necessary that the data be reduced to a common anemometer height. This is done, as shown in section 4, in appendices III and IV, which include extreme fastest-mile wind speed data reduced to a 10 m height for the stations listed in appendices I and II, respectively. Also included in appendices III and IV are sample statistics (sample mean, \( \bar{v} \), sample standard deviation, \( s(v) \), sample maximum, \( v_{\text{max}} \), and sample minimum, \( v_{\text{min}} \)) of largest yearly fastest-mile speeds for winds blowing from each octant, and for largest yearly fastest-mile speeds for winds blowing from any direction. Such statistics are calculated for the entire period of record, as well as for the first and for the second half of the record. These three sets of statistics are presented in order to provide some insight into the dependence of the statistics upon the data sample, both in the case of winds blowing from each octant and in the case of winds blowing from any direction.
2. WIND DIRECTIONALITY EFFECTS ON CLADDING AND STRUCTURAL LOADS

In this section a brief review is presented of results reported in references 2, 5, and 6. These results are applicable to cladding and structural members not subjected to resonant or aeroelastic effects under the assumption that the only random dependence of the loading upon time is that associated with wind loads.

2.1 EXTREME WIND LOADS

Let the direction-dependent loading be defined by the expression

\[ Q(\alpha_j, \theta_1) = \frac{1}{2} \rho E C_p(\alpha_j, \theta_1)v^2(\alpha_j) \]  \hspace{1cm} (2.1.1)

where \( \rho \) = air density, \( E \) = exposure factor converting the square of speed \( v(\alpha_j) \) recorded under standard micrometeorological conditions into the square of the mean speed at reference elevation over the building site, and \( C_p(\alpha_j, \theta_1) \) = aero-dynamic coefficient corresponding to wind direction, \( \alpha_j \), given that the angle of orientation of the building is \( \theta_1 \). We assume for the time being that the building has a specified orientation, i.e., that the angle \( \theta_1 \) is fixed.

Let the largest wind speeds blowing from the directions \( \alpha_j \) during a specified period be denoted by \( v(\alpha_j) \). The largest wind load to which the member under consideration will be subjected during that period is:

\[ Q(\theta_1) = \frac{1}{2} \rho E \max_j \left[ C_p(\alpha_j, \theta_1)v^2(\alpha_j) \right] \]  \hspace{1cm} (2.1.2)

2.2 WELL-BEHAVED WIND CLIMATES

Let now \( v(\alpha_j) \) represent the set of largest yearly wind speeds corresponding to the directions \( \alpha_j \). \( Q(\theta_1) \) is then the largest yearly wind load acting on the member to which Eq. 2.1.1 applies. In well-behaved wind climates, where sets of largest yearly wind speed data, \( v(\alpha_j) \), are available for a sufficient number of consecutive years, largest yearly wind loads corresponding to these data can be calculated by Eq. 2.1.2. The requisite statistics of \( Q(\theta_1) \) can be estimated from these calculated loads. The advantage of using this procedure is that it does not require any explicit assumptions concerning the joint probability distribution of wind speed and direction, for which no validated model is available to date.

In practice it is computationally convenient to estimate statistics of a variate \( v_{eq}(\theta_1) \) which is proportional to \( [Q(\theta_1)/\rho]^{1/2} \) and is referred to as the equivalent wind speed. The requisite information concerning \( Q(\theta_1) \) can then be obtained from the statistics of \( v_{eq}(\theta_1) \).

2.3 HURRICANE-PRONE REGIONS

In hurricane-prone regions the design loads are influenced by winds associated with both hurricanes (tropical cyclones) and non-hurricane storms. Let the
cumulative distribution functions fitted to the hurricane and the non-hurricane equivalent wind speeds, \( v_{H,eq} \) and \( v_{NH,eq} \), be denoted by \( F_{H}[v_{H,eq}(\theta_1) < v] \) and \( F_{NH}[v_{NH,eq}(\theta_1) < v] \), respectively. The probability distribution of the equivalent wind speeds is obtained from the relation

\[
F_{v_{eq}}[v_{eq}(\theta_1) < v] = F_{H}[v_{H,eq}(\theta_1) < v] F_{NH}[v_{NH,eq}(\theta_1) < v]
\]

(2.3.1)

The reference period for the distributions of Eq. 2.3.1 is one year. However, the sample of hurricane equivalent wind speeds to which the distribution \( F_H \) is fitted are not yearly values. Rather, they are associated with hurricanes whose irregular occurrence is characterized by the mean rate of occurrence, \( \nu \). The approach used in this case is the following [2]. A large number, \( m \), of hurricanes is generated by Monte Carlo simulation on the basis of climatological data pertaining to hurricane storms. The corresponding largest speeds, \( v(\alpha_j) \), corresponding to the directions, \( \alpha_j \), are calculated for each of these hurricanes. These speeds are then used in Eq. 2.1.2. A number of largest hurricane-induced loads, \( Q_k(\theta_1) \), is thus obtained [k = 1, 2, ..., \( m \), and \( \theta_1(\theta_1) < \theta_2(\theta_1) < ... \theta_m(\theta_1) \)]. It can be shown [8] that the mean recurrence interval of the load, \( Q_k(\theta_1) \), is

\[
N = \frac{1}{1 - e^{-\nu(1 - \frac{k}{m})}}
\]

(2.3.2)

The probability distribution and various statistics of \( v_{H,eq} \) can then be obtained as needed. Hurricane wind speed data, \( v(\alpha_j) \), for \( m = 1,000 \) hurricanes generated as shown in reference 8 are recorded on tape for 56 stations along the Gulf and Atlantic coasts [9].

The sample of non-hurricane wind speeds from which the distribution of the equivalent speeds, \( v_{NH,eq} \), is estimated consists of the set of largest yearly non-hurricane wind speeds recorded for each octant over a sufficient number of consecutive years. In practice, data recorded at a station in a hurricane-prone region also include hurricane wind speeds—if hurricanes happen to have occurred at that station during the period of record. To estimate the distribution of \( v_{NH,eq} \) the set of largest yearly wind speed data at that station must therefore, be corrected, i.e., the wind speeds associated with tropical cyclones must be excluded from the set (e.g., using information on the occurrence dates of tropical cyclones available in references 10 or 11) and replaced by largest yearly non-hurricane wind speeds (e.g., obtained from Local Climatological Data sheets). Note that appendices I through IV include data sets at the following stations in hurricane-prone regions: Corpus Christi, Texas; Jacksonville, Florida; and Cape Hatteras, North Carolina. Wind speeds associated with tropical cyclones, if any, were not replaced in these sets by largest yearly nonhurricane wind speeds.
Local Climatological Data (LCD) monthly summaries include fastest-mile wind speed data* and the corresponding direction. On the date of this fastest-mile, another (lower and unpublished) value could have occurred from a different direction and actually exceeded the published annual extreme for that different direction. Since that value would not appear in the LCD summaries, it is referred to as a "hidden value".

The 24 stations for which data are included in appendix I have been corrected for possible "hidden values" by examining the original records. "Hidden values" discovered as a result of this search are indicated by an asterisk adjacent to the date of occurrence of the wind speed and the corresponding published values are listed, for 21 of the 24 stations of appendix I.

A comparison of the "hidden values" with the corresponding published values shows that in most cases the wind load statistics would be only modestly affected if the published values were used in the calculations. The reader can verify that in the case of such stations as, e.g., Great Falls, Montana; Portland, Oregon; and Tucson, Arizona, using the "hidden values" instead of the published values would result in differences in the design wind loads of the order of 1 percent. At some stations such differences are somewhat larger.

Examples of relatively large differences, Δ, between "hidden" and published values are shown in table 1.

Table 1. Examples of "Hidden" Versus Published Values of Extreme Wind Speeds

<table>
<thead>
<tr>
<th>Station</th>
<th>Year</th>
<th>Direction</th>
<th>&quot;Hidden&quot; Value (mph) [m/sec]</th>
<th>Published Value (mph) [m/sec]</th>
<th>Δ %</th>
</tr>
</thead>
</table>

* The fastest-mile wind speed is the speed averaged over an interval equal to the time required for the passage over the anemometer of a volume of air with a horizontal length of one mile.
However, even at these stations the effect of such differences is small from a structural design viewpoint. This is the case because differences such as those listed in table I occur only for a small number of observations so that their effect upon the wind load statistics is strongly mitigated. The data of appendix I thus suggest that the use of extreme yearly directional wind speed data extracted from monthly Local Climatological Data summaries is acceptable not only for preliminary design purposes but, in most cases, for final designs as well.
4. REDUCTION OF WIND SPEED DATA TO A COMMON ELEVATION

To ensure the micrometeorological homogeneity of the data at any given station, it is necessary to reduce all the wind speeds recorded at that station to a common elevation. The elevation chosen for this purpose is 10 m above ground.

The mean wind profile near the ground in homogeneous terrain is given by the well-known logarithmic law, which may be written in the form:

$$v(z) = \frac{\ln \frac{z}{z_0}}{\ln \frac{10}{z_0}} v(10)$$

(4.1)

where \(z\) = height above ground and \(z_0\) = roughness length, both expressed in meters. In open terrain, \(z_0\) may vary from, say, 0.03 m to 0.10 m. In this report the reduction of the data to a height of 10 m is based on the assumption \(z_0 = 0.05\) m. It can be verified that the errors inherent in the assumption \(z_0 = 0.05\) m — if in fact the values \(z_0 = 0.03\) m or \(z_0 = 0.10\) m were correct — are small (of the order of 1 percent or 2 percent).

An approximation to Eq. 4.1 is given by the power law

$$v(z) = \frac{(z_0)}{10}^{a} v(10)$$

(4.2)

where, for open terrain conditions, it is generally assumed that \(a = 1/7\). It is noted that Eq. 4.1, and therefore its approximate equivalent given by Eq. 4.2, is valid for mean wind speeds averaged over a relatively long time interval, e.g., one hour. The question thus arises of expressing the variation with height of the fastest-mile wind speed, which is averaged over a relatively short time (30 to 90s or so).

To obtain an approximate expression for the fastest-mile wind profile, it may be assumed, approximately,

$$\frac{V_{pk} - V_{fm}}{V_{pk} - \bar{v}} = \frac{1}{2}$$

(4.3)

where \(V_{pk}\) = peak wind speed, \(V_{fm}\) = fastest-mile speed, and \(\bar{v}\) = hourly mean speed (see, e.g., reference 13, p. 62). The expression for \(V_{pk}\) can, in open terrain, be written as

$$V_{pk}(z) = \sqrt{v(z)} + 3 \sqrt{v'_{z}^2}^{1/2}$$

(4.4)

where \(v'_{z}^2 = r.m.s.\ of\ longitudinal\ velocity\ fluctuations,\ and
\[
\frac{v^{1/2}}{v'2} = \frac{\bar{v}(10)}{\ln \frac{10}{z_0}}
\] (4.5)

where \(z_0\) is expressed in meters (see reference 13, pp. 45 and 54).

It can be verified by using Eqs. 4.1, 4.3, 4.4 and 4.5 that, within the anemometer elevation range of interest in this report, it is possible to write approximately

\[
\frac{V_{fm}(10)}{V_{fm}(z)} = \frac{\bar{v}(10)}{\bar{v}(z)} (1 + \frac{z-10}{10} 0.02)
\] (4.6)

where \(z\) is expressed in meters. The errors inherent in Eq. 4.6 are of the order of -1 to 3 percent, the higher errors being on the conservative side (i.e., yielding slightly higher fastest-mile values at 10 m above ground than would be obtained by a more "exact" expression). Eq. 4.6, also used in reference 14, has been employed in this report to obtain the corrected speeds at 10 m above ground.

Note that Eq. 4.6 is based on the assumption that the atmospheric stratification is neutral. As shown in reference 15, this assumption is acceptable for wind speeds of the order of 20 mph (8.9 m/sec) or more at 10 m above ground. The use of Eq. 4.6 for lower speeds entails errors which may become significant if the speeds are of the order of 10 mph (4.5 m/sec) at 10 m above ground.

Since these errors affect only the lower wind speeds, which generally do not control the structural design, their practical effect is not significant. For this reason, no corrections for these errors have been attempted in this report.
5. REFERENCES


APPENDIX I

LARGEST YEARLY FASTEST-MILE WIND SPEEDS EXTRACTED FROM ORIGINAL RECORDS (IN MILES PER HOUR).

Notes:

1. For all stations listed in this appendix the data have been extracted from the original records. These data may in certain instances differ from data published in Local Climatological Data (LCD) summaries. This is the case because the LCD data consist of the daily fastest mile and its associated direction; on the date of the fastest mile another (lower and unpublished) value could occur from a different direction and actually exceed the annual extreme for this direction published in the LCD's. Dates when such "hidden" values were noted are indicated by an asterisk, and the corresponding data published in LCD summaries are listed at the end of the data set for all stations except Huron, Sheridan, and Toledo.

2. Dates of occurrence of the wind speeds, and anemometer heights for each station are also included in this appendix.
### Tucson, Arizona (1950-1979)

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1966 NE None
1973 NE None
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Anemometer Height: 58', 71', 20'

Begin Date: 9/18/50, 9/19/50, 5/7/60

End Date: 9/21/79, 9/19/50, 5/6/60
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(*) Published Values

- 1951 W 42
- 1952 NW 40
- 1957 NW 36
- 1968 NW 35
- 1971 NW 32
- 1974 W 36
Portland, Maine (1950-1979)

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1957 SW 32
1959 W 33
1960 S 33
1963 NW 37
1966 N 25
1975 NW 34
1976 N 29
### Detroit, Michigan (1950-1979)

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### Wind Direction

- **Anemometer Height**: 77', 82', 20'  
- **Begin Date**: 4/17/52, 4/20/66  
- **End Date**: 4/16/52, 4/19/66  

- **Tri**: These entries correspond to three entries for each year, indicating the wind direction data is split into three segments.
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1954  N  30, SE 22
1955  W  42
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1957  E  26, NW 38
1958  S  23
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1978  W  39

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Anemometer Height
75'
22'

Begin Date
8/1/59
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**Wind Direction**

**Anemometer Height**  
68'  
74'  
20'

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9/1/54  
4/1/63

**End Date**  
8/31/54  
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1962 W 41
1964 NW 32
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Charlotte, North Carolina (1952-1978)

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1975 SW 30
1978 W 40
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**Wind Direction**

**Anemometer Height**  
- 66'  
- 20'  
**Begin Date**  
- 11/8/58  
**End Date**  
- 11/7/58  

**Note:** Dates of occurrence of "hidden" values and values published in LCD's not shown for this station.
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### Anemometer Height
- 61'
- 39'
- 23'

### Begin Date
- 2/24/56
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### End Date
- 8/28/62
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Portland, Oregon (1950-1979)

Anemometer Height: 55' 20'
Begin Date: 10/6/64 10/5/64

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- 22' End Date: 12/19/61
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Note: Dates of occurrence of "hidden" values and values published in LCD's not shown for this station.
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(*) Published Values

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- 1953 SW 50
- 1958 NE 34
- 1959 E 26
- 1960 SW 36
- 1963 NE 35
- 1965 NW 35
- 1971 E 26
- 1975 NE 35
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- 23': 9/19/60

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- 8/ 7/60
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- 8/ 7/60
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Salt Lake City, Utah (1950-1979)
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(*) Published Values

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- 1978 NE 23
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**Anemometer Height**

- 40'  Begin Date  End Date
- 45'  8/21/52  1/31/58
- 38'  2/1/58  10/26/58
- 21'  10/27/59  ---

**Madison, Wisconsin (1950-1979)**
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(*) Published Values

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1960  S  29
1965  S  26
1967  SE 26
1975  S  26
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**Note:** Dates of occurrence of "hidden" values and values published in LCD's not shown for this station.
APPENDIX II

LARGEST YEARLY FASTEST-MILE WIND SPEEDS OBTAINED FROM LOCAL CLIMATOLOGICAL DATA (LCD) SUMMARIES (IN MILES PER HOUR).

Notes:

1. The data listed in this appendix have not been corrected for "hidden values" (see note 1, appendix I). Values are listed as published in Local Climatological Data (LCD) summaries.

2. Dates of occurrence of the wind speed, and anemometer elevations for each station are also included in this appendix.
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Anemometer Height  Begin Date  End Date
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90'  4/28/55  5/26/60
78'  5/27/60  7/10/63
22'  7/11/63  ---

## Wind Direction

- **N**: North
- **NE**: Northeast
- **E**: East
- **SE**: Southeast
- **S**: South
- **SW**: Southwest
- **W**: West
- **NW**: Northwest

### Notes
- The table provides wind direction data for Kansas City, Missouri, from 1950 to 1979.
- The data includes the year, quarter, and wind direction.
- The data is useful for understanding wind patterns and can be used for various applications such as weather forecasting, construction planning, and environmental studies.
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St. Louis, Missouri (1959–1979)
Anemometer Height
82’
20’

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**Anemometer Height**
- 83'
- 20'

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- 4/12/62

**End Date**
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Cape Hatteras, North Carolina (1917-1956)

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50'
47'
56'

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- 20'  

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APPENDIX III

LARGEST YEARLY FASTEST-MILE WIND SPEEDS AT 10 METERS ABOVE GROUND CORRESPONDING TO DATA EXTRACTED FROM ORIGINAL RECORDS (IN MILES PER HOUR).

Notes:

1. Also included in this appendix are the following sample statistics:
   - $\bar{v}$ = sample mean
   - $s(v)$ = sample standard deviation
   - $v_{\text{max}}$ = sample maximum
   - $v_{\text{min}}$ = sample minimum

   Sample statistics are provided for the entire record as well as for the first and the second half of the record.
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Jacksonville, Florida (1950-1979)

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92
## Jackson, Mississippi (1950-1962, 1965-1975)

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Great Falls, Montana (1950-1979)

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Period $v$

| 1979 $v_{max}$ | 56 | 40 | 36 | 52 | 51 | 75 | 62 | 51 | 75 |
| $v_{min}$ | 21 | 19 | 16 | 14 | 16 | 47 | 32 | 32 | 50 |

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$\bar{v}$

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Omaha, Nebraska (1950-1976)

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Charlotte, North Carolina (1952-1978)

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### Period $\bar{v}$

- **1952-54** $s(v)$: 6.2, 7.8, 6.9, 4.7, 6.1, 5.6, 9.4, 7.3
- **1978 $v_{\max}$**: 48, 51, 37, 39, 56, 43, 66, 66
- **1978 $v_{\min}$**: 23, 19, 13, 18, 17, 35, 14, 27

### Period $\bar{u}$

- **1952-54** $s(v)$: 7.7, 9.4, 5.7, 6.6, 5.6, 7.2, 11.0, 8.0
- **1964 $v_{\max}$**: 48, 51, 31, 39, 54, 43, 66, 66
- **1964 $v_{\min}$**: 23, 19, 13, 18, 17, 35, 14, 28

### Period $\bar{v}

- **1965-78** $s(v)$: 4.0, 4.1, 5.9, 5.3, 3.8, 6.5, 3.7, 6.4
- **1978 $v_{\max}$**: 38, 36, 37, 34, 56, 38, 50, 56
- **1978 $v_{\min}$**: 24, 21, 16, 19, 23, 38, 27, 27

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Toledo, Ohio (1959-1977)

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Max. Winds from all Directions

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| $1978 v_{max}$ | 49 | 50 | 46 | 51 | 51 | 53 | 49 | 55 | 55 |
| $v_{min}$ | 30 | 25 | 18 | 17 | 29 | 17 | 27 | 30 | 32 |

| Period $\bar{v}$ | 38.3 | 34.6 | 31.0 | 30.6 | 34.6 | 36.6 | 34.9 | 38.5 | 45.3 |
| $1950-8(v)$ | 6.6 | 3.7 | 8.0 | 7.4 | 4.9 | 7.5 | 6.3 | 7.2 | 5.6 |
| $1963 v_{max}$ | 49 | 41 | 46 | 49 | 46 | 48 | 49 | 55 | 55 |
| $v_{min}$ | 30 | 30 | 22 | 17 | 29 | 17 | 28 | 30 | 36 |

| Period $\bar{v}$ | 36.5 | 34.2 | 31.0 | 39.3 | 42.9 | 41.2 | 36.5 | 38.2 | 45.7 |
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| $1978 v_{max}$ | 42 | 50 | 43 | 51 | 51 | 53 | 47 | 53 | 53 |
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Portland, Oregon (1950-1979)

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Period \( \overline{v} \)

| 1950-79 | 20.0 | 21.1 | 35.3 | 34.0 | 45.4 | 40.2 | 30.5 | 26.9 | 50.3 |
| 1979 | 5.9 | 8.3 | 7.9 | 9.0 | 12.3 | 6.5 | 6.4 | 5.1 | 9.7 |
| \( v_{\text{max}} \) | 31 | 39 | 51 | 64 | 79 | 55 | 46 | 38 | 79 |
| \( v_{\text{min}} \) | 9 | 7 | 22 | 22 | 26 | 31 | 17 | 20 | 38 |

Period \( \overline{v} \)

| 1950-79 | 16.5 | 17.8 | 29.4 | 32.3 | 47.2 | 39.3 | 28.0 | 22.9 | 49.3 |
| 1964 | 3.8 | 6.5 | 5.0 | 7.8 | 11.1 | 7.1 | 6.5 | 2.8 | 10.0 |
| \( v_{\text{max}} \) | 24 | 34 | 39 | 50 | 79 | 55 | 44 | 30 | 79 |
| \( v_{\text{min}} \) | 9 | 7 | 22 | 22 | 31 | 31 | 17 | 20 | 38 |

Period \( \overline{v} \)

| 1965-79 | 23.5 | 24.5 | 41.3 | 35.7 | 43.7 | 41.1 | 33.0 | 30.9 | 51.3 |
| 1979 | 5.6 | 8.9 | 5.3 | 10.0 | 13.5 | 5.9 | 5.3 | 3.5 | 9.6 |
| \( v_{\text{max}} \) | 31 | 39 | 51 | 64 | 78 | 53 | 46 | 38 | 78 |
| \( v_{\text{min}} \) | 9 | 9 | 33 | 26 | 26 | 33 | 26 | 26 | 40 |
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Huron, South Dakota (1958-1977)

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Period $v$ $s(v)$ $v_{\text{max}}$ $v_{\text{min}}$
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1968 56 52 52 63 52 63 67 72 72

Period $v$ $s(v)$ $v_{\text{max}}$ $v_{\text{min}}$
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103
Abilene, Texas (1950-1979)

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APPENDIX IV

LARGEST YEARLY FASTEST-MILE WIND SPEEDS AT 10 METERS ABOVE GROUND CORRESPONDING TO DATA EXTRACTED FROM LOCAL CLIMATOLOGICAL DATA (LCD) SUMMARIES (IN MILES PER HOUR).

Notes:

1. The data listed in the appendix have not been corrected for "hidden" values (see note 1, appendix I).

2. Also included in this appendix are the following sample statistics:
   \[ \bar{v} = \text{sample mean} \]
   \[ s(v) = \text{sample standard deviation} \]
   \[ v_{\text{max}} = \text{sample maximum} \]
   \[ v_{\text{min}} = \text{sample minimum} \]

Sample statistics are provided for the entire record as well as for the first and the second half of the record.
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Peoria, Illinois (1950-1979)

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Minneapolis, Minnesota (1950-1979)

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Cape Hatteras, North Carolina (1917-1956)

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| 118 |
Cleveland, Ohio (1950-1976)

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1950-$s(v)$ | 7.6 | 6.6 | 4.5 | 5.7 | 4.9 | 5.2 | 7.6 | 9.7 | 8.2 |
1974 $v_{\text{max}}$ | 48 | 37 | 31 | 40 | 44 | 44 | 58 | 69 | 69 |
1974 $v_{\text{min}}$ | 19 | 15 | 13 | 20 | 25 | 26 | 26 | 32 | 38 |

Period $\bar{v}$ | 32.9 | 22.2 | 20.3 | 28.3 | 31.8 | 32.2 | 41.9 | 44.6 | 49.7 |
1950-$s(v)$ | 7.6 | 5.0 | 5.2 | 5.5 | 4.9 | 5.0 | 7.9 | 11.7 | 10.3 |
1961 $v_{\text{max}}$ | 48 | 30 | 31 | 40 | 40 | 41 | 58 | 69 | 69 |
1961 $v_{\text{min}}$ | 21 | 15 | 13 | 20 | 25 | 26 | 32 | 32 | 40 |

Period $\bar{v}$ | 26.3 | 29.5 | 18.0 | 32.5 | 35.5 | 38.5 | 35.5 | 41.5 | 44.7 |
1962-$s(v)$ | 6.2 | 6.0 | 3.7 | 5.2 | 4.4 | 3.4 | 6.1 | 7.6 | 5.0 |
1974 $v_{\text{max}}$ | 39 | 37 | 23 | 40 | 44 | 44 | 46 | 53 | 53 |
1974 $v_{\text{min}}$ | 19 | 20 | 13 | 22 | 26 | 32 | 26 | 32 | 38 |
Richmond, Virginia (1951-1979)

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122
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Max. Winds from all Directions

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123
Directional Extreme Wind Speed Data for the Design of Buildings and Other Structures

Michael J. Changery, Eugene J. Dumitriu-Valcea, Emil Simiu

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

National Science Foundation
Washington, DC 20550

Library of Congress Catalog Card Number: 84-601008

Document describes a computer program; SF-185, FIPS Software Summary, is attached.

The purpose of this report is to provide largest yearly fastest-mile wind speed data corresponding to winds blowing from each octant at 37 airport stations in the United States. Four sets of data are presented. The first set consists of largest yearly fastest-mile wind speeds at 24 stations as extracted from original records. The second set consists of largest yearly fastest-mile wind speeds at 13 stations as extracted from Local Climatological Data (LCD) summaries. The third and fourth sets consist of the data from the first and second sets reduced to a height of 10 m above ground. The report also provides information on possible differences between extreme data extracted from original records on the one hand and from LCD summaries on the other hand. Procedures for estimating extreme wind effects that take into account the directional characteristics of the extreme wind climate and of the aerodynamic behavior of the structure are briefly reviewed, and it is noted that additional research on sampling errors in the estimation of extreme wind effects appears to be warranted.

aerodynamics; climatology; directionality; reliability; structural engineering; wind engineering; wind speeds.
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