

METAL FLAGPOLES



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GUIDE SPECIFICATIONS FOR DESIGN OF METAL FLAGPOLES

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THE NATIONAL ASSOCIATION OF
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INTRODUCTION

The design of safe flagpoles requires knowledge of the loads to which they will be subjected. The principal loads acting on flagpoles are the wind loads, and it is these loads which must be most carefully determined. Maximum wind speeds to which flagpoles are exposed depend on the geographical location, whether or not it is in the center of a large city, the outskirts of a small town, the seashore at ground level or on the roof of a high rise building. Wind speeds are generally higher along coastal areas than inland. They are also higher in open country than in the center of cities, and wind speed increases with height above ground.

ASCE 7-05, page 300, third paragraph states "It is not the intent of this standard to exclude the use of other recognized literature for the design of special structures,..... For the design of flagpoles, see ANSI/NAAMM FP1001-97, 4th Ed., Guide Specifications for Design of Metal Flagpoles." This 5th Edition of the Guide follows the same design procedure as the 4th Edition.

The wind will exert a force on the pole itself as well as on the flag, and these two forces must be taken into consideration to determine the total load. Different size flags are flown from different poles, and it is important that flagpoles be selected which are capable of supporting the largest size flag intended to be flown under the highest speed wind to which it will be subjected. Loads on the flagpole are resisted by the mounting and the foundation or building structure (roof or wall) to which it is secured. The procedures used to determine wind loads on flagpoles are those set forth in the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. There is sufficient similarity between flagpoles and the poles used for signs, lights and signals to justify this approach. Furthermore, there has been a vast amount of knowledge and data accumulated by AASHTO on the requirements for pole design because of experience with many types of poles installed all across the country which are subjected to the wind conditions occurring in these varied geographical locations. NAAMM believes that the procedures developed by AASHTO over the years provide a sound basis for the determination of flagpole loadings without the flag flying

However, a flagpole's function is to fly flags, and hence this standard presents procedures for determining the loads applied to poles as a result of the wind loads on flags. The original procedures set forth in the first edition of this standard in 1983 were developed by NAAMM as a result of a laboratory test program conducted in the fall of 1979 in which flags attached to a flagpole were subjected to winds generated by an aircraft engine and propeller. There were limitations to flag sizes and wind speeds in this program. Recognizing the limitations of the laboratory test program, NAAMM initiated a program of actual flight testing of flags in sizes ranging from 5 ft x 8 ft (1.5 m x 2.4 m) through 20 ft x 30 ft (6.1 m x 9.1 m) and at air speeds from 60 mph (27 m/s) up to 110 mph (49 m/s). This flight test program, completed in the fall of 1984, yielded the most complete and reliable data obtained to date on the loading of flags under high speed wind conditions. The results of this test program provided the basis for the development of the flag drag formulas given in the later editions of these guide specifications.

In the determination of the pole design, the inclusion of the wind load on the flag with the wind load on the pole, provides an added degree of safety for the flagless pole. Flags are not always lowered when a high speed wind occurs. Under such a circumstance the flag can be ripped off of the pole. Some flags are made of materials such as nylon which are very strong and resist the tendency to rip away as flags in years past were prone to do. NAAMM recommends that flagpole designers consider both pole and flag loads when selecting a flagpole design. Building codes that do not take into account the load caused by the flag drag do not require a design as safe as that required by this standard. Nevertheless, the designer shall check to be certain that his design meets or exceeds the requirements of the governing building code.

This 5th edition of the standard has replaced the basic wind speed map found in the previous editions with the new wind speed map in ASCE 7-05 which is based on 3-second gust speeds.

GUIDE SPECIFICATIONS

1. SCOPE

- 1.1 These specifications set forth the procedures for determining the design loads for metal flagpoles of hollow circular cross section.
- 1.2 The method for determining the wind speed and resulting wind load on the pole is part of these specifications.
- 1.3 The method for determining the wind load on the flag and the resulting load imposed on the pole is part of these specifications also.
- 1.4 Methods of analysis are given with sample calculations for a typical flagpole.
- 1.5 Minimum properties of materials typically used in the design of flagpoles are included.

2. APPLICABLE DOCUMENTS

The publications listed in this section form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only. When a more recent standard is available, the specifier should verify its applicability to this Guide prior to its inclusion.

- 2.1 *Aluminum Design Manual, 8th Edition, 2005*
The Aluminum Association
1525 Wilson Boulevard, Suite 600
Arlington, Virginia 22209
www.aluminum.org
- 2.2 *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 4th Edition 2001, Interim Revisions 2002, 2003 and 2006*
American Association of State Highway and Transportation Officials
444 North Capitol Street, NW, Suite 249
Washington, DC 20001
- 2.3 **ASCE/SEI 7-05. Minimum Design Loads for Buildings and Other Structures**
American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, Virginia 20191-4400
www.asce.org
- 2.4 **ASTM Standards**
ASTM International
100 Barr Harbor Drive
West Conshohocken, Pennsylvania 19428
www.astm.org

3. FLAGPOLE LOADS

- 3.1 **Dead Load.** The dead load shall consist of the weight of the flagpole plus the fittings, accessories and flag.
- 3.2 **Wind Load.** The wind load shall be the pressure of the wind on the flagpole and the load created by the wind drag on the flag. For nautical flagpoles, the pressure of the wind on the yardarms and gaffs plus the load created by the wind drag of the flags flying from these members shall be included to obtain the total wind load. Equations with a suffix of "M" indicate a metric formula.
- 3.2.1 **Wind Pressure.** Wind pressure shall be computed by the following formula:

$$P = 0.00256 \times V^2 \times C_d \times C_h \times G$$
$$(0.613 \times V^2 \times C_d \times C_h \times G)$$

Equation 1

Equation 1 M

Where:

- P = Wind pressure in pounds per square foot (Newtons per square meter)
- V = 3-sec gust wind speed in miles per hour (meters per second) Figure 3.2.2
- C_d = Drag Coefficient (Table 3.2.4)
- C_h = Coefficient for height above ground for wind pressure (Table 3.2.3A)
- G = Gust Effect Factor. Use minimum value of 1.14.
- z = Height above grade.

3.2.2 Wind Speed. Wind speeds based on a 50-year mean recurrence interval shall be used for the design of flagpoles. Figure 3.2.2 shows the 3-second gust speed at 33 ft (10 m) above the ground associated with an annual probability of 0.02 of being equaled or exceeded (50-year mean recurrence level). Select the appropriate wind speed for the geographical area in which the flagpole will be located. Use this value in Equation 1 (1M) to compute the wind pressure.

3.2.3 Coefficient of Height. The coefficient of height, C_h, to be used in computing the wind pressure on an area at a given height above grade can be determined using the following formulae:

$$C_h = 2.01 (z/900)^{(2/9.5)} \quad \text{for } 16.4 \text{ ft} < z \leq 900 \text{ ft} \quad \text{Equation 2}$$

$$C_h = 2.01 (z/274)^{(2/9.5)} \quad \text{for } 5 \text{ m} < z \leq 274 \text{ m} \quad \text{Equation 2M}$$

$$\text{For } z \leq 16.4 \text{ (5m)} \quad C_h = 0.86$$

The coefficients of height to be used in calculating wind pressure for a given height above ground are shown in Table 3.2.3 A.

3.2.4 Wind Force. The wind force is calculated from the wind pressure at increasing heights above ground. To find the wind force, W_p, on the segment multiply the design wind pressure, P, by the projected area, A, of the segment and by the drag coefficient C_d, as specified in Section 5.1.1, using Equation 3.

$$W_p = P \times A \times C_d \quad \text{Equation 3}$$

Where:

A is in square feet (square meters)

For heights up to 300 ft (91.4m) and wind speeds from 85 mph (38m/s) to 150 mph (67m/s), wind pressures given in Table 3.2.3B (3.2.3B[M]) have been computed from Equation 1 (1M) using the coefficients of height from Table 3.2.3A, a drag coefficient (C_d = 1), and a gust effect factor of 1.14. To compute the design wind pressure for any segment of the flagpole, find the wind pressure from Table 3.2.3B (3.2.3B[M]) corresponding to the height of the segment and the wind speed, and multiply this value by the appropriate drag coefficient from Table 3.2.4.

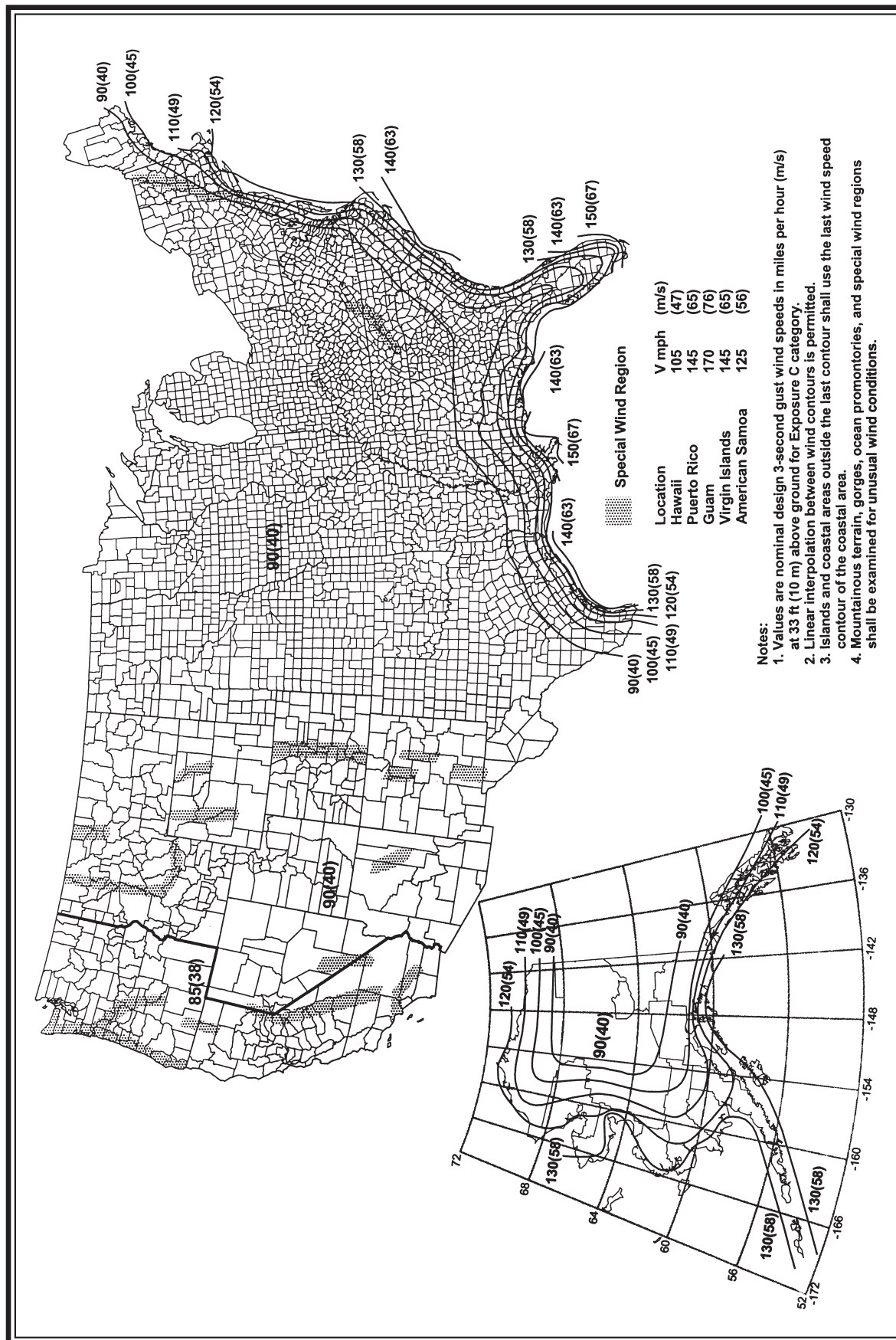


Figure 3.2.2
 Basic Wind Speed

TABLE 3.2.3A

Height Above Ground Level, z		Coefficient of Height, C_h for Wind Pressure
ft	(m)	
0-16.4		
	(0-5)	0.86
20	(6.1)	0.90
25	(7.6)	0.94
30	(9.1)	0.98
40	(12.2)	1.04
50	(15.2)	1.09
60	(18.3)	1.14
70	(21.3)	1.17
80	(24.4)	1.21
90	(27.4)	1.24
100	(30.5)	1.27
120	(36.6)	1.32
140	(42.7)	1.36
160	(48.8)	1.39
180	(54.9)	1.43
200	(61.0)	1.46
250	(76.2)	1.53
300	(91.4)	1.59

Note: Linear interpolation for intermediate values of height z is acceptable.

TABLE 3.2.3B

WIND PRESSURE ON FLAGPOLES (for $C_d = 1$ and $G = 1.14$)								
Height Above Ground Level, z, ft	Pressure, psf, for indicated wind speed, mph							
	85	90	100	110	120	130	140	150
0-16.4	18	20	25	31	36	43	49	57
20	19	21	26	32	38	44	52	59
25	20	22	28	33	40	47	54	62
30	21	23	29	35	41	48	56	64
40	22	25	30	37	44	51	60	69
50	23	26	32	39	46	54	63	72
60	24	27	33	40	48	56	65	75
70	25	28	34	41	49	58	67	77
80	25	29	35	43	51	60	69	79
90	26	29	36	44	52	61	71	81
100	27	30	37	45	53	62	72	83
120	28	31	38	46	55	65	75	86
140	29	32	40	48	57	67	78	89
160	29	33	41	49	59	69	80	92
180	30	34	42	51	60	71	82	94
200	31	35	43	52	62	72	84	96
250	32	36	45	54	65	76	88	101
300	34	38	47	58	67	79	91	105

Note: Linear interpolation for intermediate values of height z is acceptable.