Get the Most From Your Windspeed Observation*

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Surface windspeed is often the most critical weather element affecting fire behavior and fire danger. It is also the most variable and, consequently, the hardest to evaluate.

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What Is Gustiness?

Air moving across the surface of land is constantly changing speed and direction. Standing still, one observes a series of gusts and lulls. Because of gusts, trying to measure windspeed is much like trying to measure the speed of a car on a winding mountain road. It slows on the turns, speeds up on the straightaways, and slows to a crawl on bumpy stretches. To obtain a reliable average speed, one must determine the time required to travel at least 2 miles (3.2 km). And the rougher and more crooked the road, the longer is the distance required to obtain a reliable average. This same principle applies to wind measurements. The greater the gustiness (the ratio between the range in momentary windspeeds and the average speed), the longer it takes to determine a reliable windspeed.

Peak windspeeds that persist for 1 minute can affect gross fire behavior, including rate of spread and fire intensity. For example, a surface fire in pine litter spreading at 10 chains (660 feet [201 m]) per hour with the wind averaging 5 miles per hour (8 km/h) would spread 11 feet (3.3 m) farther than expected during a minute when the wind was blowing at 9 miles per hour (14 km/h). During that minute it would burn with twice its average intensity and would be nearly three times as likely to jump a prepared fireline.

Momentary gusts have little effect on the overall rate of fire spread and intensity, but they do produce large fluctuations in flame height and can easily trigger crowning or throw showers of sparks across the fireline when other weather factors are in critical balance. Gusts will usually be close to the average value and will rarely exceed the maximum value.

Gustiness is caused by mechanical and thermal turbulence.

Mechanical turbulence is produced by friction as the air flows over the ground surface. Its magnitude depends on the height above the ground where measurements are made, the roughness of the ground surface, and the windspeed. The maximum mechanical turbulence is found close to the surface in rough topography on windy days.

Thermal turbulence occurs when horizontal wind meets convective currents produced by unequal heating or cooling at the ground. Its magnitude depends mostly on topography, ground cover, solar radiation, and atmospheric stability. The maximum thermal turbulence occurs above rough topography with patchy ground cover during sunny afternoons in unstable air.

Gustiness Problem

Gustiness is a serious problem for both fire researchers and fire-control planners. Because of gustiness, wind measurements at two locations cannot be compared unless they are taken at the same height above the ground and for the same length of time. For maximum comparability, measurements should be taken as high above the ground as possible and for as long as possible. But high towers and long observations are expensive. Therefore, for fire-danger rating we have established a standard anemometer height of 20 feet (6.1 m) and a standard observation time of 10 minutes.

While these standards are fine for fire-danger rating, they often confuse the firefighter on the ground. Rapid changes in fire behavior are determined by rapid changes in the wind blowing on the burning fuel, and not by changes in the long-

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term average windspeed 20 feet (6.1 m) above ground. Often the firefighter loses confidence in his meteorologist or his weather station, or both, because he is told to expect a 16-mile-per-hour (26-km/h) wind and found the fire fanned by 35-mile-per-hour (56-km) gusts. He often must estimate the variations in windspeed that may be expected for the average speed that is reported.

Tool for Estimating Gustiness

To help firefighters estimate gustiness, we determined the 10-minute average speed, the probable fastest 1-minute average speeds, and the probable average and highest momentary speed or gust during the fastest 1-minute speed (table 1). The table values were determined from several hundred noon and afternoon observations made at Salem, Missouri, during fire seasons. They were taken when gustiness was likely to be greatest, as it often is on difficult fires. Thus, the estimates are most accurate when they are needed the most.

It is difficult to convert windspeeds taken by firefighters to the standard windspeed. In preparing spot forecasts for project fires, wind measurements are often made with a hand-held anemometer. This instrument indicates gust speed accurately, but it is almost impossible to accurately determine average speed with it. Consequently, the windspeed reported from the fireline almost invariably is the average gust speed rather than the accepted 20-foot (6.1-m), 10- minute standard. Therefore, another table was

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Table 1—*Wind gust estimating table.*

Standard 10-minute average		*Probable maximum 1-minute speed*		*Probable momentary gust speed*			
				Average		*Maximum*	
mph	*km/h*	*mph*	*km/h*	*mph*	*km/h*	*mph*	*km/h*
1	1.6	3	4.8	6	9.7	9	14.5
2	3.2	5	8.0	8	12.9	12	19.3
3	4.8	6	9.7	11	17.7	15	24.1
4	6.4	8	12.9	13	20.9	17	27.4
5	8.0	9	14.5	15	24.1	18	29.0
6	9.7	10	16.1	16	25.7	20	32.2
7	11.3	11	17.7	17	25.7	21	33.8
8	12.9	12	19.3	19	30.6	23	37.0
9	14.5	13	20.9	20	32.2	24	38.6
10	16.1	14	22.5	22	35.4	26	41.8
11	17.7	15	24.1	23	37.0	27	43.5
12	19.3	17	27.4	25	40.2	29	46.7
13	20.9	18	29.0	26	41.8	30	48.3
14	22.5	19	30.6	28	45.1	32	51.5
15	24.1	20	32.2	29	46.7	33	53.1
16	25.7	21	33.8	30	48.3	35	56.3
17	27.4	22	35.4	32	51.5	36	57.9
18	29.0	23	37.0	33	53.1	38	61.2
19	30.6	24	38.6	34	54.7	39	62.8
20	32.2	25	40.2	35	56.3	40	64.4
21	33.8	26	41.8	37	59.5	42	67.6
22	35.4	27	43.5	38	61.2	43	69.2
23	37.0	28	45.1	39	62.8	44	70.8
24	38.6	29	46.7	40	64.4	46	74.0
25	40.2	30	48.3	41	66.0	47	75.6
26	41.8	31	49.9	43	69.2	49	78.9
27	43.5	32	51.5	44	70.8	50	80.5
28	45.1	33	53.1	45	72.4	51	82.1
29	46.7	34	54.7	46	74.0	53	85.3
30	48.3	35	56.3	47	75.6	54	86.9

Note: All readings were taken in the afternoon 20 feet (6.1 m) above the ground.

Table 2—*Standard windspeed estimates based on maximum gusts* [a]

Fastest gust observed on hand-held anemometer [b]		Standard windspeed when atmospheric condition is:					
		Stable [c]		Neutral [d]		Unstable [e]	
mph	km/h	mph	km/h	mph	km/h	mph	km/h
0–3	0–4.8	0	0	0	0	0	0
4–6	6.4–9.7	1	1.6	1	1.6	1	1.6
7	11.3	2	3.2	1	1.6	1	1.6
8	12.9	2	3.2	2	3.2	1	1.6
9	14.5	3	4.8	2	3.2	2	3.2
10	16.1	4	6.4	3	4.8	3	4.8
12	19.3	6	9.7	4	6.4	4	6.4
14	22.5	8	12.9	6	9.7	5	8.0
16	25.7	10	16.1	8	12.9	7	11.3
18	29.0	12	19.3	9	14.5	8	12.9
20	32.2	15	24.1	11	17.7	10	16.1
22	35.4	17	27.4	13	20.9	12	19.3
24	38.6	19	30.6	15	24.1	14	22.5
26	41.8	22	35.4	17	27.4	16	25.7
28	45.1	24	38.6	19	30.6	18	29.0
30	48.3	27	43.5	21	33.8	20	32.2
32	51.5	29	46.7	23	37.0	22	35.4
34	54.7	32	51.5	25	40.2	23	37.0
36	57.9	34	54.7	27	43.5	25	40.2
38	61.2	37	59.5	29	46.7	27	43.5
40	64.4	39	62.8	31	49.9	29	46.7

a. Standard windspeed is 10-minute average speed 20 feet (6.1 m) above the ground
b. Readings were taken 5 feet (1.5 m) above ground. For best results observations should be made for several minutes.
c. This column usually should be used for observations between 8 p.m. and 8 a.m.
d. This column usually should be used for observations between 8 a.m. and noon, and between noon and 8 p.m. on overcast days.
e. This column usually should be used between noon and 8 p.m. on clear or partly cloudy days.

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developed to convert gust speed 5 feet (1.5 m) above the ground to the standard 20-foot (6.1-m), 10-minute speed for stable, neutral, and unstable conditions (table 2). This conversion should be used when fire-danger indexes are determined from fireline observations or when wind information consists of a mixture of hand-held and tower observations. ■

Russo and Schoemaker (1989) Decision Trap 4—
Overconfidence in Your Judgment:
Failing to collect key factual information because you are too sure of your assumptions and opinions.*

* See page 9.