



Designation: D 4480 – 93

AMERICAN SOCIETY FOR TESTING AND MATERIALS

1916 Race St. Philadelphia, Pa 19103

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Standard Test Method for Measuring Surface Wind by Means of Wind Vanes and Rotating Anemometers¹

This standard is issued under the fixed designation D 4480; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes the measurement of horizontal wind velocity by means of commercially available rotating anemometers and wind vanes attached to the earth's surface in the ambient atmosphere. Wind speeds can be measured in the range of 0.2 to 100 m/s using such anemometers. All wind directions may be measured by commercially available wind vanes within the operating speed range.

1.2 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Document

2.1 ASTM Standard:

D 5096 Test Method for Determining the Performance of a Cup Anemometer or Propeller Anemometer²

3. Terminology

3.1 Definitions:

3.1.1 *damped natural frequency* (Hz)—the frequency at which a damped second-order sensor (or recorder, etc.) oscillates after being disturbed.

3.1.2 *damped natural periods*—the period required by a damped second-order sensor to undergo one complete oscillation; also the reciprocal of damped natural frequency.

3.1.3 *damped natural wavelength*—the product of the speed of the wind past a wind vane and the damped natural period of the wind vane. At sea level in the U.S. standard atmosphere, damped natural wavelength is related to delay distance, D , and damping ratio by the approximate expression:

$$\lambda_d = \frac{D[6.0 - 2.4\epsilon]}{\sqrt{2 - \epsilon^2}} \quad (1)$$

3.1.4 *damping ratio*—the ratio of the actual damping coefficient to the critical damping coefficient. The damping ratio ϵ is determined by:

$$\epsilon = \frac{\ln(1/\Omega)}{\sqrt{\pi^2 + [\ln(1/\Omega)]^2}} \quad (2)$$

where Ω , the overshoot ratio, is readily measurable.

3.1.5 *delay distance*—the distance the air flowing past a wind vane moves while the wind vane is responding to 50 % of a step change in wind direction.

3.1.6 *distance constant* (m)—the distance the air flowing past an anemometer moves while the anemometer is responding to 63.2 % of a step increase or decrease in wind speed. This is determined by anemometer characteristics and fluid density and is not a function of wind speed.

3.1.7 *first-order sensor*—a sensor for which the equation of forces on the sensor is a first-order differential equation. Such sensors, if suddenly subjected to a step change in the variable they are measuring, will approach the new value asymptotically at a rate which is directly proportional to the difference between the new equilibrium value and the value being registered by the sensor. A first-order sensor does not overshoot the new equilibrium value.

3.1.8 *overshoot ratio*—the ratio of the amplitudes of two successive deflections of a second-order sensor as it oscillates about the equilibrium position. Because all deflections after the first to the side opposite the release point are small, the initial release point (that is, the $n = \text{zero}$ deflection) and the first deflection after release are used in practice in determining overshoot ratio. When using this equation to calculate Ω for a wind vane, θ_n should not exceed 10° . Overshoot ratio by a wind vane is expressed by the equation:

$$\Omega = \frac{\theta_{(n+1)}}{\theta_n} \quad (3)$$

where θ_n and $\theta_{(n+1)}$ are the amplitudes of the n and $(n + 1)$ deflections, respectively.

3.1.9 *second-order sensor*—a sensor for which the equation of forces on the sensor is a second-order differential equation. A second-order sensor will respond to a step change in the variable it is measuring by overshooting and then undergoing a damped harmonic oscillation about the new equilibrium position unless it is overdamped or critically damped. If it is overdamped or critically damped, it will approach the new equilibrium position asymptotically.

3.1.10 *sensor*—that part of an instrument which responds to the variable being measured.

3.1.11 *starting threshold* (m/s)—the wind speed at which an anemometer or vane first starts to perform within its specifications.

3.1.12 *synoptic—in meteorology*, the meteorological data observed simultaneously over a wide area for the purpose of

¹ This test method is under the jurisdiction of ASTM Committee D-22 on Sampling and Analysis of Atmospheres and is the direct responsibility of Subcommittee D22.11 on Meteorology.

Current edition approved Feb. 15, 1993. Published April 1993. Originally published as D 4480 – 85. Last previous edition D 4480 – 85.

² Annual Book of ASTM Standards, Vol 11.03.