



Designation: D5096 – 02 (Reapproved 2017)

# Standard Test Method for Determining the Performance of a Cup Anemometer or Propeller Anemometer<sup>1</sup>

This standard is issued under the fixed designation D5096; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the determination of the *Starting Threshold*, *Distance Constant*, *Transfer Function*, and *Off-Axis Response* of a cup anemometer or propeller anemometer from direct measurement in a wind tunnel.

1.2 This test method provides for a measurement of cup anemometer or propeller anemometer performance in the environment of wind tunnel flow. Transference of values determined by these methods to atmospheric flow must be done with an understanding that there is a difference between the two flow systems.

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

## 2. Referenced Documents

2.1 *ASTM Standards*:<sup>2</sup>

**D1356 Terminology Relating to Sampling and Analysis of Atmospheres**

**D3631 Test Methods for Measuring Surface Atmospheric Pressure**

## 3. Terminology

3.1 For definitions of terms used in this standard, refer to Terminology **D1356**.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *starting threshold* ( $U_o$ , m/s)—the lowest wind speed at which a rotating anemometer starts and continues to turn and produce a measurable signal when mounted in its normal position. The normal position for cup anemometers is with the

axis of rotation vertical, and the normal position for propeller anemometers is with the axis of rotation aligned with the direction of flow. Note that if the anemometer axis is not aligned with the direction of flow, the calculated wind speed component parallel to the anemometer axis is used to determine starting threshold.

3.2.2 *distance constant* ( $L$ ,  $m$ )—the distance the air flows past a rotating anemometer during the time it takes the cup wheel or propeller to reach  $(1 - 1/e)$  or 63 % of the equilibrium speed after a step change in wind speed (**1**).<sup>3</sup> The response of a rotating anemometer to a step change in which wind speed increases instantaneously from  $U = 0$  to  $U = U_f$  is (**2**):

$$U_t = U_f (1 - e^{(-t/\tau)}) \quad (1)$$

where:

$U_t$  = is the instantaneous indicated wind speed at time  $t$  in m/s,

$U_f$  = is the final indicated wind speed, or wind tunnel speed, in m/s,

$t$  = is the elapsed time in seconds after the step change occurs, and

$\tau$  = is the time constant of the instrument.

$$\text{Distance Constant is: } L = U_f \tau \quad (2)$$

3.2.3 *transfer function* ( $\hat{U}_f = a + bR$ , m/s)—the linear relationship between wind speed and the rate of rotation of the anemometer throughout the specified working range.  $\hat{U}_f$  is the predicted wind speed in m/s,  $a$  is a constant, commonly called zero offset, in m/s,  $b$  is a constant representing the wind passage in m/r for each revolution of the particular anemometer cup wheel or propeller, and  $R$  is the rate of rotation in r/s. It should be noted that zero offset is not the same as starting threshold. In some very sensitive anemometers the constant  $a$ , zero offset, may not be significantly greater than zero. The constants  $a$  and  $b$  must be determined by wind tunnel measurement for each type of anemometer (**3**).

3.2.4 *off-axis response* ( $U/(U_f \cos \theta)$ )—the ratio of the indicated wind speed ( $U$ ) at various angles of attack ( $\theta$ ) to the indicated wind speed at zero angle of attack ( $U_f$ ) multiplied by

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee **D22** on Air Quality and is the direct responsibility of Subcommittee **D22.11** on Meteorology.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The boldface numbers in parentheses refer to the list of references at the end of this standard.