



Designation: D 6011 – 96

Standard Test Method for Determining the Performance of a Sonic Anemometer/Thermometer¹

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1. Scope

1.1 This test method covers the determination of the dynamic performance of a sonic anemometer/thermometer which employs the inverse time measurement technique for velocity or speed of sound, or both. Performance criteria include: (a) acceptance angle, (b) acoustic pathlength, (c) system delay, (d) system delay mismatch, (e) thermal stability range, (f) shadow correction, (g) velocity calibration range, and (h) velocity resolution.

1.2 *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:

C 384 Test Method for Impedance and Absorption of Acoustical Materials by the Impedance Tube Method²

D 1356 Terminology Relating to Sampling and Analysis of Atmospheres³

D 5527 Practice for Measuring Surface Wind and Temperature by Acoustic Means³

E 380 Practice for Use of the International System of Units (SI) (the Modernized Metric System)⁴

3. Terminology

3.1 **Definitions**—For definitions of terms related to this test method, refer to Terminology D 1356.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 **axial attenuation coefficient**—a ratio of the free stream wind velocity (as defined in a wind tunnel) to velocity along an acoustic propagation path (v_t/v_d) (1).⁵

3.2.2 **critical Reynolds number (R_c)**—the Reynolds number

at which an abrupt decrease in an object's drag coefficient occurs (2).

3.2.2.1 **Discussion**—The transducer shadow corrections are no longer valid above the critical Reynolds number due to a discontinuity in the axial attenuation coefficient.

3.2.3 **Reynolds number (R_e)**—the ratio of inertial to viscous forces on an object immersed in a flowing fluid based on the object's characteristic dimension, the fluid velocity, and viscosity.

3.2.4 **shadow correction (v_{dm}/v_d)**—the ratio of the true along-axis velocity v_{dm} , as measured in a wind tunnel or by another accepted method, to the instrument along-axis wind measurement v_d .

3.2.4.1 **Discussion**—This correction compensates for flow shadowing effects of transducers and their supporting structures. The correction can take the form of an equation (3) or a lookup table (4).

3.2.5 **speed of sound (c , (m/s))**—the propagation rate of an adiabatic compression wave

$$c = (\gamma \partial P / \partial \rho)^{0.5} \quad (1)$$

where:

ρ = density,

γ = specific heat ratio, and

s = isentropic (adiabatic) process (6).

3.2.5.1 **Discussion**—The velocity of the compression wave defined along each axis of a Cartesian coordinate system is the sum of propagation speed c plus the motion of the gas along that axis. In a perfect gas (5):

$$c = (\gamma R^* T / M)^{0.5} \quad (2)$$

The approximation for propagation in air is:

$$c_{air} = [403 T (1 + 0.32 e/P)]^{0.5} = (403 T_s)^{0.5} \quad (3)$$

3.2.6 **system clock**—the clock used for timing acoustic wavefront travel between a transducer pair.

3.2.7 **system delay (δt , μs)**—the time delay through the transducer and electronic circuitry (7).

3.2.7.1 **Discussion**—Each path through every sonic array axis can have unique delay characteristics. Delay (on the order of 10 to 20 μs) can vary as a function of temperature and direction of signal travel through the transducers and electronic

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.

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² Annual Book of ASTM Standards, Vol 04.06.

³ Annual Book of ASTM Standards, Vol 11.03.

⁴ Annual Book of ASTM Standards, Vol 14.02.

⁵ The boldface numbers in parentheses refer to the list of references at the end of this standard.