



Standard Test Method for Open-Channel Flow Measurement by Acoustic Velocity Meter Systems¹

This standard is issued under the fixed designation D 5389; 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 covers the measurement of flow rate of water in open channels, streams, and closed conduits with a free water surface.

1.2 The test method covers the use of acoustic transmissions to measure the average water velocity along a line between one or more opposing sets of transducers—by the time difference or frequency difference techniques.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 *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.* Specific precautionary statements are given in Section 6.

2. Referenced Documents

2.1 ASTM Standards:

D 1129 Terminology Relating to Water²

D 2777 Practice for Determination of Precision and Bias of Applicable Methods of Committee D19 on Water²

D 3858 Test Method for Open-Channel Flow Measurement of Water by Velocity-Area Method²

2.2 ISO Standard:

ISO 6416 Liquid Flow Measurements in Open Channels—Measurement of Discharge by the Ultrasonic (Acoustic) Method³

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology D 1129.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *acoustic path*—the straight line between the centers of two acoustic transducers.

3.2.2 *acoustic path length*—the face-to-face distance between transducers on an acoustic path.

3.2.3 *acoustic transducer*—a device that is used to generate acoustic signals when driven by an electric voltage, and conversely, a device that is used to generate an electric voltage when excited by an acoustic signal.

3.2.4 *acoustic travel time*—the time required for an acoustic signal to propagate along an acoustic path, either upstream or downstream.

3.2.5 *discharge*—the rate of flow expressed in units of volume of water per unit of time. The discharge includes any sediment or other materials that may be dissolved or mixed with it.

3.2.6 *line velocity*—the downstream component of water velocity averaged over an acoustic path.

3.2.7 *measurement plane*—the plane formed by two or more parallel acoustic paths of different elevations.

3.2.8 *path velocity*—the water velocity averaged over the acoustic path.

3.2.9 *stage*—the height of a water surface above an established (or arbitrary) datum plane; also gage height.

3.2.10 *velocity sampling*—means of obtaining line velocities in a measurement plane that are suitable for determining flow rate by a velocity-area integration.

4. Summary of Test Method

4.1 Acoustic velocity meter (AVM) systems, also known as ultrasonic velocity meter (UVM) systems, operate on the principle that the point-to-point upstream traveltime of an acoustic pulse is longer than the downstream traveltime and that this difference in travel time can be accurately measured by electronic devices.

4.2 Most commercial AVM systems that measure streamflow use the time-of-travel method to determine velocity along an acoustic path set diagonal to the flow. This test method⁴ describes the general formula for determining line velocity defined as (Fig. 1 and Fig. 2):

$$V_L = \frac{B}{2 \cos \theta} \left[\frac{1}{t_{CA}} - \frac{1}{t_{AC}} \right] \quad (1)$$

¹ This test method is under the jurisdiction of ASTM Committee D19 on Water and is the direct responsibility of Subcommittee D19.07 on Sediments, Geomorphology, and Open-Channel Flow.

Current edition approved April 15, 1993. Published June 1993.

² Annual Book of ASTM Standards, Vol 11.01.

³ Available from the American National Standards Institute, 11 W. 42nd Street, 13th Floor, New York, NY 10036.

⁴ Laenen, A., and Smith, W., "Acoustic Systems for the Measurement of Streamflow," *U.S. Geological Survey Water Supply Paper* 2213, 1983.