Designation: D5413 – 93 (Reapproved 2013)

Standard Test Methods for Measurement of Water Levels in Open-Water Bodies[1]

This standard is issued under the fixed designation D5413; 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 These test methods cover equipment and procedures used in obtaining water levels of rivers, lakes, and reservoirs or other water bodies. Three types of equipment are available as follows:

Test Method A—Nonrecording water-level measurement devices
Test Method B—Recording water-level measurement devices
Test Method C—Remote-interrogation water-level measurement devices

1.2 The procedures detailed in these test methods are widely used by those responsible for investigations of streams, lakes, reservoirs, and estuaries, for example, the U.S. Agricultural Research Service, the U.S. Army Corp of Engineers, and the U.S. Geological Survey.[2] The referenced ISO standard also furnishes useful information.

1.3 It is the responsibility of the user of these test methods to determine the acceptability of a specific device or procedure to meet operational requirements. Compatibility between sensors, recorders, retrieval equipment, and operational systems is necessary, and data requirements and environmental operating conditions must be considered in equipment selection.

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *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:*[3]
D1129 Terminology Relating to Water
D1941 Test Method for Open Channel Flow Measurement of Water with the Parshall Flume
D2777 Practice for Determination of Precision and Bias of Applicable Test Methods of Committee D19 on Water
D5242 Test Method for Open-Channel Flow Measurement of Water with Thin-Plate Weirs
2.2 *ISO Standard:*[4]
ISO 4373 Measurement of Liquid Flow in Open Channels—Water Level Measuring Devices

3. Terminology

3.1 *Definitions*—For definitions of terms used in these test methods, refer to Terminology

3.2 *Definitions of Terms Specific to This Standard:*
3.2.1 *elevation*—the vertical distance from a datum to a point.

3.2.2 *datum*—a level plane that represents a zero or some defined elevation.

3.2.3 *gauge*—a generic term that includes water level measuring devices.

3.2.4 *gauge datum*—a datum whose surface is at the zero elevation of all the gauges at a gauging station; this datum is often at a known elevation referenced to National Geodetic Vertical Datum of 1929 (NGVD).

3.2.5 *gauge height*—the height of a water surface above an established or arbitrary datum at a particular gauging station; also termed stage.

3.2.6 *gauging station*—a particular site on a stream, canal, lake, or reservoir where systematic observations of hydrologic data are obtained.

[1] These test methods are 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.

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[2] Buchanan, T. J., and Somers, W. P., "Stage Measurement at Gauging Stations," Techniques of Water Resources Investigations, Book 3, Chapter A-7, U.S. Geological Survey, 1968.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

3.2.7 *National Geodetic Vertical Datum of 1929 (NGVD)*—prior to 1973 known as mean sea level datum; a spheroidal datum in the conterminous United States and Canada that approximates mean sea level but does not necessarily agree with sea level at a specific location.

4. Significance and Use

4.1 These test methods are used to determine the gauge height or elevation of a river or other body of water above a given datum.

4.2 Water level data can serve as an easily recorded parameter, and through use of a stage-discharge relation provide an indirect value of stream discharge, often at a gauging station.

4.3 These test methods can be used in conjunction with other determinations of biological, physical, or chemical properties of waters.

TEST METHOD A—NONRECORDING WATER-LEVEL MEASUREMENT DEVICES

5. Summary of Test Method

5.1 These test methods are usually applicable to conditions where continuous records of water level or discharge are not required. However, in some situations, daily or twice daily observations from a nonrecording water-level device can provide a satisfactory record of daily water levels or discharge. Water levels obtained by the nonrecording devices described in these test methods can be used to calibrate recording water-level devices described in Test Methods B and C.

5.2 Devices included in these test methods are of two general types: those that are read directly, such as a staff gauge; and those that are read by measurement to the water surface from a fixed point, such as wire-weight, float-tape, electric-tape, point and hook gauges.

5.2.1 Staff, wire-weight, and chain gauges are commonly used as both outside auxiliary and reference gauges. Vertical- and inclined-staff, float-tape, electric-tape, hook and point gauges are commonly used as inside auxiliary and reference gauges.

5.3 Documentation of observations must be manually recorded.

6. Apparatus

6.1 *Staff Gauges:*

6.1.1 *Vertical Staff Gauges*—Staff gauges are usually graduated porcelain-enameled plates attached to wooden piers or pilings, bridge piers, or other hydraulic structures. They may also be installed on the inside of gauging station stilling wells as inside reference gauges. They are precisely graduated, usually to 0.02 ft or 2 mm, although other markings may be used for specific applications (see Fig. 1).

6.1.2 *Inclined Staff Gauges*—Inclined staff gauges usually consist of markings on heavy timbers, steel beams, or occasionally concrete beams built partially embedded into the natural streambed slope. Since they are essentially flush with the adjoining streambed, floating debris and ice are less likely to cause damage than for a vertical staff gauge. Individual graduation and marking of the installed gauges by engineering levels are required due to the variability of bank slope.

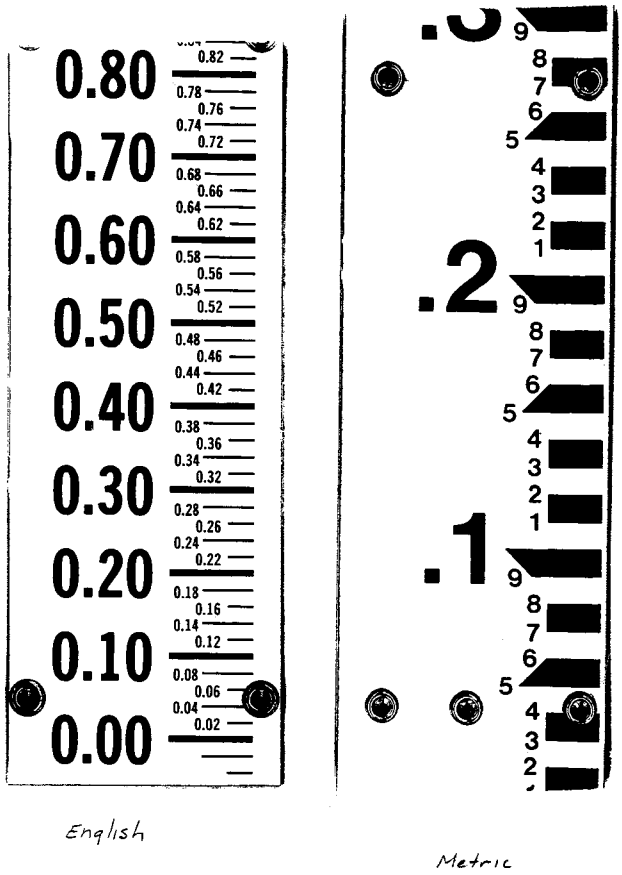

FIG. 1 Staff Gauges

6.2 *Wire-Weight Gauge*—An instrument that is mounted on a bridge or other structure above a water body. Water levels are obtained by direct measurement of the distances between the device and the water surface. A wire-weight gauge consists of a drum wound with a single layer of cable, a bronze weight attached to the end of the cable, a graduated disk, a counter, and a check bar, all contained within a protective housing (see Fig. 2). The disk is graduated and is permanently connected to the counter and the shaft of the drum. The cable is guided to its position on the drum by a threading sheave. The reel is equipped with a pawl and ratchet for holding the weight at any desired elevation. A horizontally mounted check bar is mounted at the lower edge of the instrument. Differential levels are run to the check bar. When the weight is lowered to touch the check bar, readings of the counter are compared to its known elevation as a calibration procedure. The gauge is set so that when the bottom of the weight is at the water surface, the gauge height is indicated by the combined readings of the counter and the graduated disk.

6.3 *Needle Gauges*—Frequently referred to as point or hook gauges. A needle gauge consists of a vertically-mounted pointed metallic, small-diameter rod, which can be lowered until an exact contact is made with the water surface. A vernier or graduated scale is read to indicate a gauge height. A

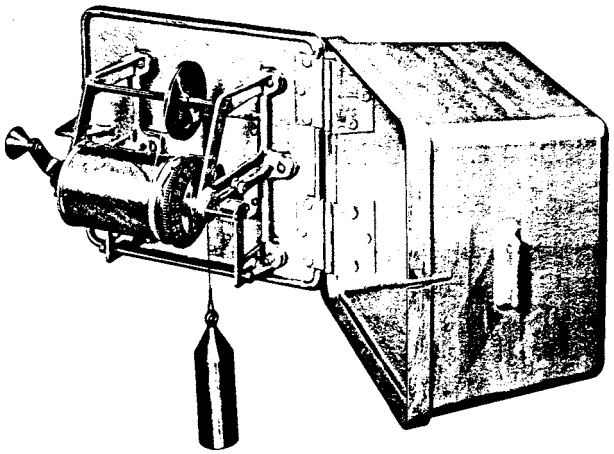

FIG. 2 Type A Wire-Weight Gauge

needle-type gauge offers high measurement accuracy, but requires some skill and good visibility (light conditions) in lowering and raising the device to a position where the point just pierces the water surface. These gauges are most commonly used in applications where the water surface is calm.

6.3.1 *Point Gauge*—A form of needle gauge where the tip or point approaches the water surface from above.

6.3.2 *Hook Gauge*—A form of needle gauge made in the shape of a hook, where the tip or point approaches the water surface from below (see Fig. 3). The hook gauge is easier to use in a stilling well application. As the point contacts the water surface, overhead light will reflect from a dimple on the water surface.

6.4 *Float-Tape Gauge*—Consists of a float attached to a stainless steel graduated tape that passes over a suitable pulley with a counterweight to maintain tension. A pointer or other index is frequently fabricated as an integral part of the pulley assembly (see Fig. 4). Float-tape gauges frequently are combined with water-level recorders in a manner whereby the pulley is the stage drive wheel for the recorder.

6.5 *Electric-Tape Gauge*—Consists of a graduated steel tape and weight attached to a combined tape reel, voltmeter, datum index and electrical circuit, powered by a 4½ to 6 volt battery (see Fig. 5). The gauge frame is mounted on a shelf or bracket over the water surface, usually in a stilling well. The weight is lowered until the weight touches the water surface closing the electrical circuit that is indicated by the voltmeter. The gauge height is read on the tape at the index.

6.6 A reference point is frequently selected on a stable member of a bridge, stilling well, or other structure from which distance vertical measurements to the water surface are made by steel tape and weight. The reference point is a clearly defined location, frequently a file mark or paint mark to ensure that all readings are from the same location.

7. Calibration

7.1 Establish a datum. The datum may be a recognized datum such as National Geodetic Vertical Datum of 1929 (NGVD), a datum referenced to a recognized datum such as

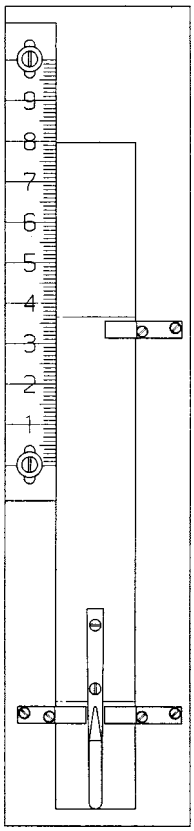

FIG. 3 Hook Gauge

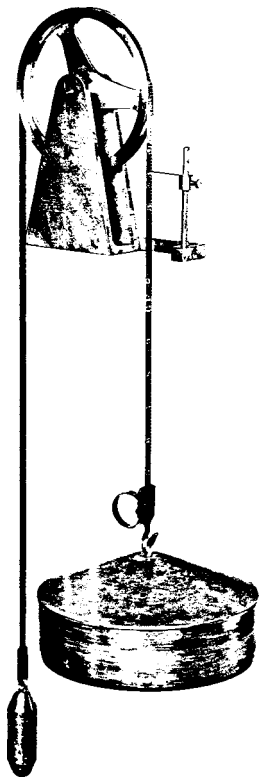

FIG. 4 Float-Type Gauge