Designation: D5906 – 21

Standard Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths[1]

This standard is issued under the fixed designation D5906; 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 guide covers the selection of procedures commonly used to establish a measurement of horizontal position during investigations of surface water bodies that are as follows:

	Sections
Procedure A—Manual Measurement	7 to 12
Procedure B—Optical Measurement	13 to 17
Procedure C—Electronic Measurement	18 to 27

1.1.1 The narrative specifies horizontal positioning terminology and describes manual, optical, and electronic measuring equipment and techniques.

1.2 The references cited contain information that may help in the design of a high quality measurement program.

1.3 The information provided on horizontal positioning is descriptive in nature and not intended to endorse any particular item of manufactured equipment or procedure.

1.4 This guide pertains to determining horizontal position of a depth measurement in quiescent or low velocity flow.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1129 Terminology Relating to Water

D3858 Test Method for Open-Channel Flow Measurement of Water by Velocity-Area Method

D4410 Terminology for Fluvial Sediment

D4581 Guide for Measurement of Morphologic Characteristics of Surface Water Bodies (Withdrawn 2013)[3]

D5073 Practice for Depth Measurement of Surface Water

D5173 Guide for On-Line Monitoring of Total Organic Carbon in Water by Oxidation and Detection of Resulting Carbon Dioxide

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this guide, refer to Terminology D1129.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *accuracy*—refers to how close a measurement is to the true or actual value. (See Terminology D1129.)

3.2.2 *baseline, n*—the primary reference line for use in measuring azimuth angles and positioning distances.

3.2.3 *continuous wave system, n*—an electronic positioning system in which the signal transmitted between the transmitter and responder stations travels as a wave having constant frequency and amplitude.

3.2.4 *electronic distance measurement (EDM), n*—the measurement of distance using pulsing or phase comparison systems.

3.2.5 *electronic positioning system (EPS), n*—a system that receives two or more EDM to obtain a position.

3.2.6 *global positioning system (GPS), n*—a global positioning system (GPS) is a satellite-based EDM system used in determining Cartesian coordinates (x, y, z) of a position by means of radio signals from NAVSTAR satellites.

[1] This guide 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.

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[2] 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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

3.2.7 *horizontal control, n*—a series of connected lines whose azimuths and lengths have been determined by triangulation, trilateration, and traversing.

3.2.8 *line of position (LOP), n*—the locus of points established along a rangeline.

3.2.9 *precision, n*—the agreement among or reproduciblity of multiple measurements. (See Terminology D1129.)

3.2.10 *pulsed wave system, n*—an electronic positioning system in which the signal from the transmitting station to the reflecting station travels in an electromagnetic wave pulse.

3.2.11 *range, n*—the distance to a point measured by physical, optical, or electronic means.

3.2.12 *range line, n*—an imaginary, straight line extending across a body of water between fixed shore markings.

3.2.13 *range line markers, n*—site poles or other identifiable objects used for positioning alignment on a range line.

3.2.14 *shore markings, n*—any object, natural or artificial, that can be used as a reference for maintaining boat alignment or establishing the boats position as it moves along it course. Examples include range line markers, sight poles, trees, power poles, land surface features, structures, and etc.

3.2.15 *site poles, n*—metal or wood poles used as a sighting rod.

3.2.16 *stadia, n*—telescopic instrument equipment with horizontal hairs and used for measuring the vertical intercept on a graduated vertical rod held vertically and at some distance to and in front of the instrument.

3.2.17 *total station, n*—an electronic surveying instrument which digitally measures and displays horizontal distances and vertical angles to a distant object.

4. Summary of Guide

4.1 This guide includes three general procedures for determining the location or horizontal position in surveying of surface water bodies. The first determines position by a manual procedure. The equipment to perform this procedure may be most readily available and most practical under certain conditions.

4.2 The second determines position by a optical procedure.

4.3 The third determines position by a electronic procedure.

4.4 Horizontal control stations shall be in accordance with Third Order, Class I, Federal Geodetic Control Committee Classification (FGCC) Standards,[4] with traverses for such controls beginning and ending at existing first- or second-order stations (**1**).[5]

5. Significance and Use

5.1 This guide is intended to provide instructions for the selection of horizontal positioning equipment under a wide range of conditions encountered in measurement of water depth in surface water bodies. These conditions, that include physical conditions at the measuring site, the quality of data required, the availability of appropriate measuring equipment, and the distances over which the measurements are to be made (including cost considerations), that govern the selection process. A step-by-step procedure for obtaining horizontal position is not discussed. This guide is to be used in conjunction with standard guide on measurement of surface water depth (such as standard Practice D5173.)

6. Horizontal Positioning Criteria

6.1 The level of accuracy required in horizontal positioning can be defined in three general classes:

6.1.1 Class One pertains to precise positioning demanding a high degree of repeatability.

6.1.2 Class Two is for medium accuracy requirements typical of project condition studies or offshore/river hydraulic investigations, or both.

6.1.3 Class Three is for general reconnaissance investigations requiring only approximate measurements of positions.

6.1.4 Table 1 provides an estimate of the suitability by Class for the different horizontal positioning discussed within this guide (**2**).

PROCEDURE A—MANUAL MEASUREMENT

7. Scope

7.1 This procedure explains the measurement of horizontal position using manual techniques and equipment. These include use of tagline positioning techniques and application of shore marks.

7.2 Description of techniques and equipment are general in nature and may need to be modified for use in specific field conditions.

8. Significance and Use

8.1 Prior to the development of optical and electronic positioning equipment, manual equipment and techniques were the only means of measuring horizontal position. These techniques and equipment are still widely used where precise controlled measurements may be required (for example, taut cable method), or where limitations in equipment availability, site conditions and cost considerations prohibit use of more modern equipment.

TABLE 1 Allowable Horizontal Positioning System Error (7)

System	Estimated Positional Accuracy				
	±1 ft RMS	(±1 m) (RMS)	Suitable for Survey Class		
			1	2	3
Visual range intersection	10 to 66	(3 to 20)	No	No	Yes
Sextant angle resection	7 to 30	(2 to 10)	No	Yes	Yes
Transit/theodolite angle intersection	3 to 16	(1 to 5)	Yes	Yes	Yes
Range-azimuth intersection	1.6 to 10	(0.5 to 3)	Yes	Yes	Yes
Tagline high frequency EPS	3 to 13	(1 to 4)	Yes	Yes	Yes

[4] Available from National Oceanic and Atmospheric Administration (NOAA), 14th St. and Constitution Ave., NW, Room 6217, Washington, DC 20230, http://www.noaa.gov.

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

9. Tagline Positioning Techniques

9.1 Tagline positioning techniques makes use of a measuring line having markings at fixed intervals along its length to indicate distance. These can be either a taut cable in which the line is anchored firmly at opposite banks and stretched taut, or a boat mounted cable in which one end of the line is firmly anchored at the bank and the other is attached to a boat with the line fed out as the boat proceeds along its course. Both methods are frequently used low cost positioning techniques. The taut cable is most commonly used for obtaining streamflow measurements and sediment sampling data at non-bridge locations on rivers and streams, but is equally applicable for controlled boat positioning when obtaining river or lake bed profiles for other purposes. In this regard it has proven especially useful for positioning on small lakes or reservoirs, usually where distances involved are less than 1000 ft (305 m), and where sheer walls exist at both ends of the range, or where the presence of dense vegetation along the shoreline precludes use of optical or electronic positioning methods. The boat mounted tagline, in contrast, is much easier to set up and use since only one end of the line is anchored at the shore, but this method can be considerably less accurate due to the increased possibility of misalignment errors.

9.1.1 *Taut Cable Method (Manual Procedure):*

9.1.1.1 For the taut cable method (see Fig. 1), firmly anchor the ends of the cable on both banks (see 9.1.1.2 for installation) and the line then pulled as taut as possible without pulling the anchors out of the bank. This method of positioning is recognized as accurate for use on streams where the flow velocity does not exceed more than a few feet per second so that the drag induced by the flow, on any boat or other attachment, does not substantially deflect the line. The taut cable method is time consuming when compared to other more modern optical and electronic positioning equipment and techniques; take this into consideration when deciding on which equipment and techniques best apply **(3)**.

9.1.1.2 Installation of the taut cable should be done either in one of two ways: either securely anchor the cable to one bank and the line fed from a boat mounted reel as the boat proceeds across the body of water; or securely anchor the reel to one bank near the water's edge with the loose end towed across. Shore markings can be used for visual alignment, but the normal procedure is to place a transit or theodolite on line for this purpose. The transmit person, equipped with a two-way radio, relays alignment directions to the boat operator (also equipped with a two-way radio), as the line is transported to the opposite bank. A power or hand winch or hand cranked reel, skid mounted on locally fabricated support assemblies, can be attached to a tree or other firm support on shore and used to take slack out of the line and to minimize sag associated errors in distance. For safety, the reel should come equipped with a spring-loaded pin lock brake assembly. Buoys may be placed at optimum locations along the line to help reduce sag as well as provide an indicator of boat alinement.

9.1.1.3 Taglines for the taut cable method are commonly stainless steel or galvanized 7 by 7 cable, although a fiber line is increasingly being used. The stainless steel lines generally come pre-beaded at 2 ft intervals for the first 50 ft, at 5 ft for the next 100 ft (30 m), and at 10-ft intervals for to the end of the line. Sizes vary in diameter with the length of the cable used. For a length less than 400 ft (122 m), a 1⁄32 in. (0.79 mm) diameter line is recommended; for lengths up to 800 ft (244 m), a 1⁄16 in. (1.59 mm) diameter is recommended; for greater lengths, the diameter should be at least 1⁄8 in. (3.18 mm). The fiber line is normally 3⁄16 in. (4.76 mm) diameter, is normally yellow with black markings and generally comes available in any length up to 1000 ft (305 m). It is usually pre-marked with one mark every 10 ft (3 m) and two marks every 100 ft (30 m). To prevent damage when attaching the tagline to a tree, connect the free end of the tagline (the end not connected to a reel), to a 30 ft length of 3⁄32-in. (2.37 mm) diameter cable. One end of this cable should have a harness snap and the other should have a pelican hook. The free end of the tagline should be equipped with a sleeve and thimble, of size matching the tagline diameter **(4)**.

9.1.1.4 Attachments for holding the boat in position at a fixed location along the tag line will vary depending on the specific needs of the data collection effort. Normally the attachment is some form of clamp arrangement. If velocity measurements or sediment sampling is being done along with the water depth measurements, the standard procedure is to equip the boat with a crosspiece (I-beam), normally a little longer than the width of the boat, and set perpendicular to the boat's centerline. The crosspiece is either clamped or bolted in

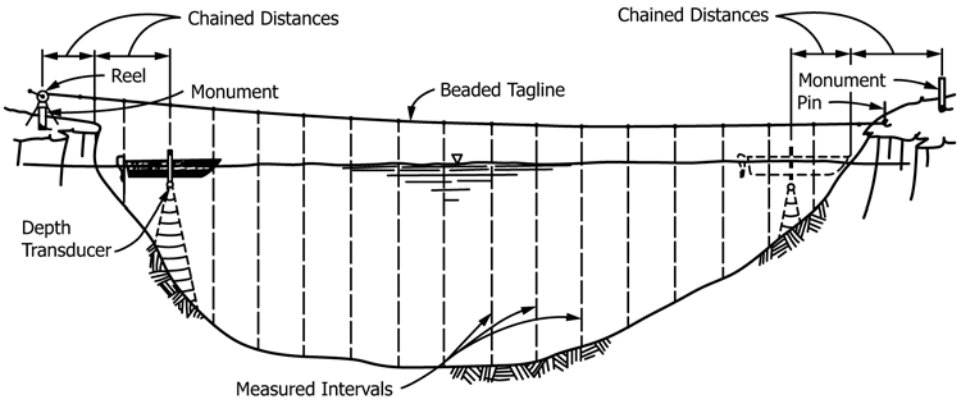

FIG. 1 Taut Cable Method