INTERNATIONAL

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Standard Practice for ~~The~~ Selection of Maximum Transit-Rate Ratios and Depths for the U.S. Series of Isokinetic Suspended-Sediment Samplers[1]

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1. Scope

1.1 This practice covers the maximum transit-rate ratios and depths for selected suspended-sediment sampler-nozzle-container configurations.

1.2 This practice explains the reasons for limiting the transit-rate ratio and depths that suspended-sediment samplers can be correctly used.

1.3 This practice give maximum transit-rate ratios and depths for selected isokinetic suspended-sediment sampler/nozzle/container size for samplers developed by the Federal Interagency Sedimentation Project.

1.4 Throughout this practice, a samplers lowering rate is assumed to be equal to its raising rate.

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~~ safety, health, and ~~health~~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
D4410 Terminology for Fluvial Sediment
D4411 Guide for Sampling Fluvial Sediment in Motion

[1] This practice is under the jurisdiction of ASTM Committee D19 on Water and 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. Terminology

3.1 ~~Definitions—~~*Definitions:*

3.1.1 For definitions of terms used in this practice, refer to Terminology D1129 and Terminology D4410.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *approach ~~angle—~~angle, n—*the angle between the velocity vector of the approaching flow and the centerline of the nozzle.

3.2.2 *approaching ~~flow—~~flow, n—*flow immediately upstream of a nozzles entrance.

3.2.3 *bag ~~sampler—~~sampler, n—*a suspended-sediment sampler that uses a flexible collapsible bag as a sample container.

3.2.4 *compression ~~rate—~~rate, n—*the rate at which the air is compressed in the sample container and is a function of the speed at which the sampler is lowered in the sampling vertical.

3.2.5 *~~isokinetic—~~isokinetic, adj—*the conditions under which the direction and speed of the flowing water/sediment mixture are unchanged upon entering the nozzle of a suspended-sediment sampler.

3.2.6 *maximum transit ~~rate—~~rate, n—*the maximum speed at which the sampler can be lowered and raised in the sampling vertical and still have the sample collected isokinetically.

3.2.7 *transit ~~rate—~~rate, n—*the speed at which the suspended sediment sampler is lowered and raised in the sampling vertical.

3.2.8 *transit-rate ~~ratio—~~ratio, n—*the ratio computed by dividing the transit rate by the mean stream velocity in the vertical being sampled.

4. Summary of Practice

4.1 This practice describes the maximum transit-rate ratios and depths that can be used for selected isokinetic suspended-sediment sampler/nozzle/container configurations to ensure isokinetic sampling. (Manufacturing differences in the production of sediment samplers may result in some samplers not collecting a sample isokinetically. It is the users responsibility to ensure through calibration that the sampler does collect a sample isokinetically. Guide D4411 describes a process for checking calibration of suspended-sediment samplers.)

5. Significance and Use

5.1 This practice describes the maximum transit-rate ratios and depths that can be used for selected isokinetic suspended-sediment sampler/nozzle/container configurations in order to insure isokinetic sampling.

5.2 This practice is designed to be used by field personnel collecting whole-water samples from open channel flow.

6. Background

6.1 The distribution of velocity and sediment concentration in a sampling vertical is very complex. The velocity of the flow will generally decrease with depth while the suspended-sediment concentration will normally increase with depth in a vertical. For a sediment sampler to collect a representative volume, the water-sediment mixture must enter the nozzle without undergoing a change in direction or speed. Ideally, the water must enter the nozzle at the same velocity as the approaching flow. When the velocity is unchanged upon entering the nozzle, the condition is termed isokinetic. Depth- and point-integrating samplers sample isokinetically only if their nozzles point directly into the flow and the samplers are used within certain ranges of depths. Depth-integrating samplers also operate isokinetically only when their vertical transit rate is within a given range.

6.2 If the velocity of the water-sediment mixture entering the nozzle exceeds that of the approach velocity, the sample sediment concentration is smaller than the concentration of the approaching flow. Decreasing the velocity in the nozzle compared to the approach velocity will cause the sample sediment concentration to be greater than that of the approaching flow. The magnitude of the difference between nozzle and approach velocity is related to the degree of increase or decrease in concentration. The concentration shift is also related to the sizes of the grains in suspension. The larger the grain size, the larger the potential shift in concentrations will be.

6.3 The sampler will not operate properly if the transit rate is too fast, the sampling depth is too great, or both. See Guide D4411 for more details on proper use of depth integrating suspended sediment samplers.

6.4 Two factors control the maximum transit rate for a sampler: approach angle and the compression rate.

6.4.1 At a given sample vertical, as the transit rate increases, the approach angle increases. If the transit-rate exceeds 0.4 times the mean flow velocity in the vertical, the intake velocity undergoes a significant acceleration due to changes in flow direction. The maximum vertical transit rate for a depth-integrating sampler or point-integrating sampler used for depth integrating, should not exceed 0.4 times the mean stream velocity of the section.

6.4.2 The compression rate, which is related to the compression limit, may restrict the vertical transit rate to less than 0.4 times the mean stream velocity when a rigid sample container is used. As the sampler is lowered through the water, the increasing water pressure compresses the air in the sampler container. If the sampler is lowered slowly, the volume of the incoming water exceeds the volume lost, the displaced air exits through the sampler's exhaust vent. If the sampler is lowered rapidly, the volume of the incoming water is less than the volume lost to compression. Pressure inside the sampler container is less than the hydrostatic pressure outside the sampler. The self regulating properties of the sampler lose control. The intake velocity increases above the stream velocity. In severe cases, water enters the sampler through the air-exhaust vent. If the sampler is raised too rapidly, the air inside the bottle expands and, if not relieved by venting, will not escape fast enough through the air-exhaust vent. The pressure unbalance causes the intake velocity to be less than the approach velocity. The compression-rate limit is a function of the diameter of the nozzle, volume of the sample container, and altitude. For large bottles with small nozzles it can limit the vertical transit rate to less than 3 % of the mean stream velocity. Table 1 lists the maximum transit-rates ratios for commonly used combinations of sampler nozzle and container sizes.

6.4.3 Because no air is contained inside of the bag, the compression rate limit does not apply to bag samplers.

6.5 Edwards and Glysson[3] discuss the proper use of the samplers and transit-rate ratios for some of the more common combinations used by the US Geological Survey (USGS). Because of difficulties in maintaining a slow transit rate, the USGS does not recommend using the USD-77 sampler.

6.6 Based on compression, isokinetic inflow rates, and limits on sample volumes to prevent ~~overfilling,~~overfilling (see Note 1), the maximum depth that any rigid container can be lowered to is about 15 ft (4.572 m) (FISP).[4] If the sampler is lowered below the maximum depth limit, the bottle overfills. As shown in Table 1, the maximum depth depend on sampler, nozzle, and container size. Depending on the maximum percentage of useful volume, depth limit also varies with sample container size and volume of the pressure compensating chamber for point-integrating samplers. The values given in Table 1 are for sea level conditions. The maximum depth decreases about 1 ft (0.3048 m) for every 1000-ft (304.8-m) increase in elevation.

NOTE 1—Maximum sample volume to prevent over filling is assumed to be approximately ⅔ the sample container volume.

6.6.1 The maximum depth that a bag sampler may collect a sample ~~isokineticly~~isokinetically is limited by the nozzle and bag size. See Table 1.

6.7 For additional information about isokinetic suspended-sediment samplers, see Footnote 6.[5]

7. Procedure

7.1 Table 1 lists the most commonly use suspended-sediment samplers in he United States. A "D" in the name indicates that it is a depth-integrating sampler, a "P" indicates that it is a point-integrating sampler.

[3] Edwards, T.K., and Glysson, G.D., "Field Methods for Measurement of Fluvial Sediment," *U.S. Geological Survey, Techniques of Water Resource Investigations*, Book 3, Chapter C2, 1998.

[4] FISP, Federal Interagency Sediment Project Report No. 6, 1952, *The Design of Improved Types of Suspended-Sediment Samplers*.

[5] Contact the Project Chief, Federal Interagency Sedimentation Project, Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199.

TABLE 1 Maximum Transit-Rate Ratios and Depths for Sampler/Container/Nozzle Configurations

Sampler US	Nozzle Size, in. (mm)	Nozzle Color	Container Size	Maximum Depth, ft (m)	Max ratio Rt/Vm[A]
DH-48	1/4 (6.35)	Yellow	Pint	9 (2.74)	0.4
DH-48	3/16 (4.76)	Yellow	Pint	15 (4.57)	0.4
DH-75P	3/16 (4.76)	White	Pint	15 (4.57)	0.4
DH-75Q	3/16 (4.76)	White	Quart	15 (4.57)	0.2
DH-75H	3/16 (4.76)	White	2 L	15 (4.57)	0.1
DH-59	1/8 (3.17)	Red	Pint	15 (4.57)	0.2
DH-59	3/16 (4.76)	Red	Pint	15 (4.57)	0.4
DH-59	1/4 (6.35)	Red	Pint	9 (2.74)	0.4
DH-76	1/8 (3.17)	Red	Quart	15 (4.57)	0.1
DH-76	3/16 (4.76)	Red	Quart	15 (4.57)	0.2
DH-76	1/4 (6.35)	Red	Quart	15 (4.57)	0.4
DH-81	1/8 (3.17)	White	Pint	15 (4.57)	0.2
DH-81	3/16 (4.76)	White	Pint	15 (4.57)	0.4
DH-81	1/4 (6.35)	White	Pint	9 (2.74)	0.4
DH-81	5/16 (7.93)	White	Pint	6 (1.83)	0.4
DH-81	1/8 (3.17)	White	Quart	15 (4.57)	0.1
DH-81	3/16 (4.76)	White	Quart	15 (4.57)	0.2
DH-81	1/4 (6.35)	White	Quart	15 (4.57)	0.4
DH-81	5/16 (7.93)	White	Quart	10 (3.05)	0.4
D-49/D-74	1/8 (3.17)	Green	Pint	15 (4.57)	0.2
D-49/D-74	3/16 (4.76)	Green	Pint	15 (4.57)	0.4
D-49/D-74	1/4 (6.35)	Green	Pint	9 (2.74)	0.4
D-74	1/8 (3.17)	Green	Quart	15 (4.57)	0.1
D-74	3/16 (4.76)	Green	Quart	15 (4.57)	0.2
D-74	1/4 (6.35)	Green	Quart	15 (4.57)	0.4
DH-95	3/16 (4.76)	White	1 L	15 (4.57)	0.2
DH-95	1/4 (6.35)	White	1 L	15 (4.57)	0.3
DH-95	5/16 (7.93)	White	1 L	13 (3.96)	0.4
D-95	3/16 (4.76)	White	1 L	15 (4.57)	0.2
D-95	1/4 (6.35)	White	1 L	15 (4.57)	0.3
D-95	5/16 (7.93)	White	1 L	13 (3.96)	0.4
D-96/D-96Al	3/16 (4.76)	White	3L - bag	110 (33.4)	0.4
D-96/D-96Al	1/4 (6.35)	White	3L - bag	60 (18.3)	0.4
D-96/D-96Al	5/16 (7.93)	White	3L - bag	39 (11.9)	0.4
D-99	3/16 (4.76)	White	3L - bag	110 (33.4)	0.4
D-99	1/4 (6.35)	White	3L - bag	60 (18.3)	0.4
D-99	5/16 (7.93)	White	3L - bag	39 (11.9)	0.4
D-99	3/16 (4.76)	White	6L - bag	220 (67.0)	0.4
D-99	1/4 (6.35)	White	6L - bag	120 (36.6)	0.4
D-99	5/16 (7.93)	White	6L - bag	78 (23.8)	0.4
DH-2	3/16 (4.76)	White	1 L - bag	35 (11.0)	0.4
DH-2	1/4 (6.35)	White	1 L - bag	20 (6.09)	0.4
DH-2	5/16 (7.93)	White	1 L - bag	13 (3.96)	0.4

[A] Rt = transit rate; Vm = mean stream velocity in the vertical being sampled.

7.2 To determine the maximum depth for a sampler, find the nozzle size and container size and then read across to the maximum depth.

7.3 To determine the maximum transit-rate, find the sampler/nozzle/container to be used and read across to the maximum ratio (Rt/Vm). Then multiply this ratio by the mean stream velocity in the vertical to be sampled.

7.3.1 The maximum transit rate determined in 7.3 should be used as a practice, the actual transit rate can be and in most cases should be less than the maximum rate computed.