BRITISH STANDARD

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Hydrometry — Direct depth sounding and suspension equipment

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BSI
British Standards

National foreword

This British Standard is the UK implementation of ISO 3454:2008. It supersedes BS 3680-8B:1983 which is withdrawn.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Hydrométrie — Matériel de sondage et de suspension pour le mesurage direct de la profondeur

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 3454 was prepared by Technical Committee ISO/TC 113, *Hydrometry*, Subcommittee SC 5, *Instruments, equipment and data management*.

This third edition cancels and replaces the second edition (ISO 3454:1983), which has been technically revised.

Introduction

The choice of suspension and sounding equipment depends on the depth of flow, the velocity of the current and the method of discharge measurement (by wading, from a boat, from a manned cableway or from a bridge).

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Hydrometry — Direct depth sounding and suspension equipment

1 Scope

This International Standard specifies the functional requirements of the equipment, excluding bankside cableway systems, used in the measurement of liquid flow in open channels for

a) sounding (by direct method), and

b) suspending the measuring equipment (for example, current-meter or sediment sampler) at the point of measurement.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 772, *Hydrometry — Vocabulary and symbols*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 772 apply.

4 Sounding equipment

4.1 General

To obtain the correct vertical depth of water from surface to bed, either a sounding-rod or a sounding line is used depending on the velocity and depth of flow. The sounding rod can also be a wading rod. For measurements by either sounding rod or wading rod, the rod shall be held in a vertical position. For measurements by sounding line, appropriate weights shall be attached to keep it as close as practicable to vertical. Sounding equipment can also be employed as suspension equipment. Requirements for the deployment of suspension equipment, as described in Clause 5, also apply to sounding equipment.

4.2 Sounding rod, wading rod and sounding line

A sounding rod is a graduated rigid rod with a base plate; it is used for measurement of depths up to 5 m to 6 m in medium velocities (up to 2 m/s). For smaller depths and velocities, a wading rod is used; for greater depths, a sounding line is used.

5 Suspension equipment

5.1 Basic requirements

The basic requirements for making observations in flowing water with the help of meter-suspension equipment are as follows.

a) Measuring equipment shall be placed at the point of measurement in such a way that it does not cause appreciable disturbances, irrespective of the depth of water and velocity of flow.

b) Supporting devices, such as cableways, bridges and boats or wading rods, shall be appropriate to the measuring equipment suspended from them and capable of supporting the safe working load of the equipment with a suitable factor of safety.

c) The method of deployment shall be in accordance with local health and safety regulations.

5.2 Types of suspension

5.2.1 General

Several types of suspension equipment have been developed to suit the basic requirements in 5.1. These can be classified into two broad categories:

a) rigid-rod suspension equipment;

b) cable suspension equipment.

5.2.2 Rigid-rod suspension equipment

5.2.2.1 General

This type of equipment has the merit that the current-meter or sediment sampler can be placed at the point of measurement without any appreciable deflection from the vertical at which the observations are being made.

Rigid-rod suspension equipment includes:

a) hand-operated suspension equipment, such as a wading rod;

b) mechanically operated rigid-rod suspension equipment such as a rack-and-pinion arrangement.

5.2.2.2 Hand-held suspension equipment

Hand-held suspension equipment is simple to operate, can be manufactured from local resources, and can be used in water of depths up to approximately 3 m and velocities of 2 m/s. In the case of wading rods, the limits for the depth and velocity are approximately 1 m and 1 m/s, respectively.

5.2.2.3 Mechanically operated suspension equipment

Mechanically operated rigid-rod equipment is preferable because of the accuracy with which the instrument can be placed at the point of measurement, but it is heavier and requires very careful installation with suitable stabilizing counter-weights. This type of equipment can be used in water of depths up to approximately 6 m and velocities up to approximately 3 m/s. Limitations on the use of the equipment shall be clearly established and attached to the equipment so that safe working limits are not exceeded. Special care is needed in the presence of overhead power cables.

5.2.3 Cable suspension equipment

Cable suspension equipment is generally used in measurement of deep streams where rigid-rod suspension equipment cannot be used. Cableway systems for stream gauging are specified in ISO 4375.

Depending on the depth and velocity encountered, suitable weights are attached to the cable suspension to keep the cable as vertical as possible. Guidance on the selection of sounding weights is given in Annex A. If, with the maximum permissible sinker attached, the current-meter and weight are carried downstream, the measured depth will be greater than the true depth and will therefore require correction. In such situations where large vertical angles are induced, two separate corrections are required. These corrections are an "air-line" correction for that part of the cable which is between the point of suspension and the surface of water, and a "wet-line" correction for that portion of the cable which is in the water (see Annex B). To prevent large vertical angles, it may be necessary to use weights of several hundred kilograms to keep the cable as vertical as possible. Hand-operated or power-driven gauging-reels and cranes should handle such weights with an appropriate safe working load.

Cable suspension equipment includes:

a) hand-line suspension;

b) crane and gauging reel.

A hand-line suspension is operated by hand, is simple in design, and can be manufactured from local resources. Its application shall be limited to use with weights up to 15 kg and velocities up to 2 m/s. Gauging-reel suspension can be used under most conditions of flow. This type of equipment shall include an automatic brake and a means of overload protection.

6 Performance requirements

6.1 Rigid rods for sounding and suspension

6.1.1 Sounding rod

The sounding rod shall comply with the following requirements.

a) It shall be straight and remain vertical during use.

b) It shall be made as lightweight as possible, but have sufficient strength to withstand the force due to flowing water without itself undergoing any significant deflection or vibration.

c) It shall not cause significant heading up of water due to its own obstruction.

d) The smallest graduation should preferably correspond to 10 mm.

e) It shall not penetrate into the bed of the channel.

6.1.2 Suspension rod

In addition to the requirements in 6.1.1 a) to e), the suspension rod shall have a suitable stabilizing arrangement to enable it to maintain proper orientation, especially when the immersed portion of the rod is long. Mechanically operated rigid-rod suspension equipment (see 5.2.2.3) shall comply with the following additional requirements.

a) A load-activated brake shall be incorporated in the winding mechanism to prevent the winding handle from turning under the action of the load and to hold the suspension rod in the desired position. It shall not be possible for the sinker to be lowered except by the action of the handle.

b) The mechanical arrangement shall be such that the suspension rod can be raised or lowered without the application of excessive effort. Manual handling regulations may apply.

c) There shall be an arrangement for fixing it to a boat or any other structure.

d) There shall be sufficient counter-weights to ensure stability.

6.2 Cable suspension equipment

6.2.1 General

Cable suspension equipment shall comply with the requirements in 6.2.2, 6.2.3, 6.2.4 and 6.2.5.

6.2.2 Cable

The cable shall comply with the following requirements.

a) The current-meter suspension cable shall be corrosion resistant and preferably pre-formed and reverse-laid to inhibit spinning.

b) The cable shall have strength sufficient to support the current-meter and sounding weight with a factor of safety of five. Its elongation under load shall not exceed 0,5 %.

c) The cable shall be equipped with a suitable attachment for suspending the measuring equipment.

d) If the suspension cable serves for the transmission of the signals of the current-meter, it shall incorporate an insulated conducting core.

e) The cable shall be smooth and flexible, so that it can take turns without any permanent bends or twists, which would affect its usability and length.

f) When supplied for use as hand-line, the cable shall have a suitable covering to prevent discomfort or injury.

g) It shall have a diameter as small as possible consistent with the conditions stated in a) to f) in order to reduce the hydraulic drag to the minimum.

6.2.3 Gauging reel

6.2.3.1 General

The gauging reel shall comply with the following requirements.

a) There shall be a device incorporated into the winding mechanism to limit the load on the equipment in the event of the sounding line becoming overloaded. This device shall be capable of being preset to twice the maximum sinker weight specified for the gauging reel.

b) It shall be possible to fix the gauging reel securely to the supporting device used for discharge measurements (for example, a personnel carriage used on a cableway, a crane used on a bridge or on an A-frame used on boats, etc.). The fixings shall be able to withstand a load equal to five times the safe working load specified for the gauging reel.

c) There shall be a plug-and-socket arrangement to connect the gauging-reel to the current-meter controller or to any other instrument.

d) The diameter of the drum shall be not less than the minimum winding diameter recommended for the cable by the manufacturer.

e) The drum shall be able to accommodate the specified length of the cable either in a single layer, in which case the counter can be connected to the drum, or in several layers. In the latter case, the unwinding of the cable itself shall directly operate the counter, and in addition, there shall be an arrangement for obtaining the correct winding of the cable on the drum.

6.2.3.2 Hand wound reels

There shall be a load-activated brake incorporated in the winding mechanism to prevent the winding handle from turning under the action of the load and to hold the equipment at any desired position. It shall not be possible to lower the load other than by winding the handle, or, in the case of large reels, by the action of a controlling brake, provided it is not possible for the winding handle to be driven by the load in an uncontrolled manner.

It shall be possible to lower or raise the measuring equipment and weights attached by hand without the application of excessive effort. The cranking effort should be less than 10 kg.

6.2.3.3 Motorized reels

It shall not be possible for the load to over-run the motor drive system.

The motor drive train shall be able to withstand a load applied to the sounding line equal to the load limited setting.

Motor controls shall be designed to revert to the “off” position when controls are released.

6.2.4 Vehicle- and boat-mounted cranes

The following requirements and recommendations apply to vehicle- and boat-mounted cranes.

a) The crane shall be of adequate strength to support the gauging reel, the measuring equipment and the weights attached to keep the cable vertical. It shall have a safe working load equal to or greater than five times the safe working load of the gauging reel.

b) It shall be of proper design to enable the measuring equipment to be lowered or raised in a vertical plane sufficiently far enough from the structure to avoid fouling on parapets and to permit its movement from point to point when used on a bridge.

c) It shall have a protractor to measure the deviation of the cable from the vertical.

d) It shall have proper counter weights to ensure its stability while in use, up to the load limit setting of the reel.

e) Transportable, free-standing cranes should be collapsible so that they can be easily transported after use.

6.2.5 Sounding weights

A sounding (sinker) weight is provided:

a) to hold the meter in a steady position in the current while observations of velocity are being made;

b) to keep the suspension cable as vertical as possible under the point of support to ensure that the measurement of depth is accurate when sounding, and to ensure that the meter is held at the proper depth when velocity observations are being made;

c) in some cases, to protect the meter from driftwood or bed projections.

The shape of the weight assembly shall be such as to offer the least resistance to the flow of the water and to minimize its effect on the operating characteristics of the current-meter. The attachment of the sounding weight to the suspension cable shall be reduced or incorporated in the body of the sounding weight for the same reason. The weight may be equipped with a device to detect and signal the contact with the bed. The mass of the sinker or sounding weight shall not exceed the safe working load of the equipment in use.

Annex A
(informative)

Selection of sounding (sinker) weight

Sounding weights are added to keep the sounding line (or suspension cable) reasonably vertical. The higher the velocity and the greater the water depth, the heavier will be the sounding weight required. There is no general rule for the choice of the sounding weight to be added but, for guidance, the following approximate formula is suggested:

$$m = 5\overline{v}d$$

where

m is the mass of the sounding weight, in kilograms;

$\overline{v}$ is the mean velocity, in metres per second;

d is the depth, in metres.

The shape and size of the sounding weight assembly may have an appreciable effect on the normal flow conditions in the channel and, therefore, on the accuracy of flow measurements. It may also be limited by manual handling and safety considerations.

Annex B
(informative)

Corrections for length of sounding line when measuring depth with the line not normal to the surface

The following tables are based on *Measurement and computation of stream flow: Volume 1. Measurement of stage and discharge*, the United States Geological Survey Water-Supply Paper 2175[3].

A correction shall be made for the difference between the vertical length and the slant length of the sounding line above the water surface, the dry line correction. If the point of suspension of the sounding line is at a vertical distance x above the surface and the angle between the sounding line and vertical is α then the air correction k_{la} to be applied is given by the formula

$$k_{\text{la}} = (\sec\alpha - 1)\, x$$

The percentage correction $(k_{\text{la}} \cdot 100/x)$ to be deducted from the measured length of the sounding line, for angles up to 30° is given in Table B.1.

Table B.1 — Air-line correction

Vertical angle	Correction %	Vertical angle	Correction %
4°	0,24	18°	5,15
6°	0,55	20°	6,42
8°	0,98	22°	7,85
10°	1,54	24°	9,46
12°	2,23	26°	11,26
14°	3,06	28°	13,26
16°	4,03	30°	15,47

The wet-line correction, k_{lw}, also expressed as a percentage to be deducted from the measured length of the sounding line, is estimated on the assumptions that the horizontal drag pressure on the weight in the comparatively still water near the bottom can be neglected, that the velocity distribution in the vertical is normal, and that the sounding line and the weight are designed to offer little resistance to the water current.

The uncertainties in the estimation are such that significant errors may be introduced if the vertical angle is more than 30°.

Table B.2 — Wet-line correction

Vertical angle	Correction %	Vertical angle	Correction %
4°	0,06	18°	1,64
6°	0,16	20°	2,04
8°	0,32	22°	2,48
10°	0,50	24°	2,96
12°	0,72	26°	3,50
14°	0,98	28°	4,08
16°	1,28	30°	4,72

The corrections given in Table B.2 are percentages of the wet-line depth.

Bibliography

[1] ISO/TR 9209, *Measurement of liquid flow in open channels — Determination of the wetline correction*

[2] ISO 4375, *Hydrometric determinations — Cableway systems for stream gauging*

[3] RANTZ, S.E. et al. *Measurement and computation of stream flow: Volume 1. Measurement of stage and discharge*. United States Geological Survey Water-Supply Paper 2175, 1982

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