SLOVENSKI STANDARD

SIST EN ISO 748:2001

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Merjenje pretoka tekoḷ in v odprtih kanalih - Metode hitrost-povrġina (ISO 748:1997)

Measurement of liquid flow in open channels - Velocity-area methods (ISO 748:1997)

Durchflußmessung in offenen Gerinnen - Geschwindigkeitsflächen-Verfahren (ISO 748:1997)

Mesure de débit des liquides dans les canaux découverts - Méthodes d'exploration du champ des vitesses (ISO 748:1997)

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17.120.20 Pretok v odprtih kanalih Flow in open channels

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EUROPEAN STANDARD

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English version

Measurement of liquid flow in open channels - Velocity-area methods (ISO 748:1997)

Mesure de débit des liquides dans les canaux découverts - Méthodes d'exploration du champ des vitesses (ISO 748:1997)

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Foreword

The text of the International Standard from Technical Committee ISO/TC 113 "Hydrometric determinations" of the International Organization for Standardization (ISO) has been taken over as an European Standard by Technical Committee CEN/TC 318 "Hydrometry", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2000, and conflicting national standards shall be withdrawn at the latest by July 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of the International Standard ISO 748:1997 has been approved by CEN as a European Standard without any modification.

INTERNATIONAL STANDARD

ISO 748

Third edition
1997-08-01

Measurement of liquid flow in open channels — Velocity-area methods

Mesure de débit des liquides dans les canaux découverts — Méthodes d'exploration du champ des vitesses

Reference number
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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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.

International Standard ISO 748 was prepared by Technical Committee ISO/TC 113, *Hydrometric determinations*, Subcommittee SC 1, *Velocity area methods*.

This third edition cancels and replaces the second edition (ISO 748:1979), which has been technically revised.

Annexes A to G of this International Standard are for information only.

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Measurement of liquid flow in open channels — Velocity-area methods

1 Scope

This International Standard specifies methods for determining the velocity and cross-sectional area of water flowing in open channels without ice cover, and for computing the discharge therefrom.

It covers methods of employing current-meters and floats to measure the velocities. Although, in most cases, these measurements are intended to determine the stage-discharge relation of a gauging station, this International Standard deals only with single measurements of the discharge; the continuous recording of discharges over a period of time is covered in ISO 1100-1 and ISO 1100-2.

NOTE The methods for determining the velocity and cross-sectional area of water flowing in open channels with ice cover are specified in ISO 9196.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 772:1996, *Hydrometric determinations — Vocabulary and symbols.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 772 and the following definition apply.

3.1 unit-width discharge
discharge through a unit width of a section at a given vertical

4 Principle of the methods of measurements

4.1 The principle of these methods consists of measuring velocity and cross-sectional area. A measuring site is chosen conforming to the specified requirements; the width, depending on its magnitude, is measured either by means of steel tape or by some other surveying method, and the depth is measured at a number of points across the width, sufficient to determine the shape and area of the cross-section.

Velocity observations are made at each vertical preferably at the same time as measurement of depth, especially in the case of unstable beds. They are made by any one of the standard methods using current-meters. If unit width discharge is required, it is generally computed from the individual observations.

In the integration method, the mean velocity is obtained directly.

Under certain circumstances, velocity observations can also be made using surface floats or velocity-rods. Other methods consist of measuring the velocity along one or several horizontal lines of the section (e.g. moving-boat and ultrasonic methods.)

4.2 The discharge is computed either arithmetically or graphically by summing the products of the velocity and corresponding area for a series of observations in a cross-section.

5 Selection and demarcation of site

5.1 Selection of site

The site selected should comply as far as possible with the following requirements:

a) The channel at the measuring site should be straight and of uniform cross-section and slope in order to minimize abnormal velocity distribution.

NOTE When the length of the channel is restricted, it is recommended for current-meter measurements, or other velocity-meter measurements, that the straight length upstream should be at least twice that downstream.

b) Flow directions for all points on any vertical across the width should be parallel to one another and at right angles to the measurement section.

c) The bed and margins of the channels should be stable and well defined at all stages of flow in order to facilitate accurate measurement of the cross section and ensure uniformity of conditions during and between discharge measurements.

d) The curves of the distribution of velocities should be regular in the vertical and horizontal planes of measurement.

e) Conditions at the section and in its vicinity should also be such as to preclude changes taking place in the velocity distribution during the period of measurement.

f) Sites displaying vortices, reverse flow or dead water should be avoided.

g) The measurement section should be clearly visible across its width and unobstructed by trees, aquatic growth or other obstacles. When gauging from a bridge with divide piers, each section of the channel should be treated accordingly.

h) The depth of water at the section should be sufficient at all stages to provide for the effective immersion of the current-meter or float, whichever is to be used.

i) The site should be easily accessible at all times with all necessary measurement equipment.

j) The section should be sited away from pumps, sluices and outfalls, if their operation during a measurement is likely to create flow conditions inconsistent with the natural stage-discharge relationship for the station.

k) Sites where there is converging or diverging flow should be avoided.

l) In those instances where it is necessary to make measurements in the vicinity of a bridge, it is preferable that the measuring site be upstream of the bridge. However in special cases and where accumulation of ice, logs or debris is liable to occur, it is acceptable that the measuring site be downstream of the bridge. Particular care should be taken in determining the velocity distribution when bridge apertures are surcharged.

m) The measurement of flow under ice cover is dealt with in ISO 9196 but for streams subject to formation of ice cover, requirements of measurement specified in this International Standard can be used during the free water season.

n) It may, at certain states of river flow or level, prove necessary to carry out current-meter measurements on sections other than that selected for the station. This is quite acceptable if there are no substantial ungauged losses or gains to the river in the intervening reach and so long as all flow measurements are related to levels recorded at the principal reference section.

5.2 Demarcation of site

NOTE If the site is to be established as a permanent station or likely to be used for future measurement, it should be provided with means for demarcation of the cross-section and for determination of stage.

5.2.1 The position of each cross-section, normal to the mean direction of flow, shall be defined on the two banks by clearly visible and readily identifiable markers. Where a site is subject to considerable snow cover, the section line-markers may be referenced to other objects such as rock cairns.

5.2.2 The stage shall be read from a gauge at intervals throughout the period of measurement and the gauge datum shall be related by precise levelling to a standard datum.

5.2.3 An auxiliary gauge on the opposite bank shall be installed where there is likelihood of a difference in the level of water surface between the two banks. This is particularly important in the case of very wide rivers. The mean of the measurements taken from the two gauges shall be used as the mean level of the water surface and as a base for the cross-sectional profile of the stream.

6 Measurement of cross-sectional area

6.1 General

The cross-sectional profile of the open channel at the gauging-site shall be determined at a sufficient number of points to establish the shape of the bed.

The location of each point is determined by measuring its horizontal distance to a fixed reference point on one bank of the channel, in line with the cross-section. This in turn allows calculation of the area of individual segments separating successive verticals where velocities are measured.

6.2 Measurement of width

Measurement of the width of the channel and the width of the individual segments may be obtained by measuring the horizontal distance from or to a fixed reference point which shall be in the same plane as the cross-section at the measuring site.

6.2.1 Where the width of the channel permits, these horizontal distances shall be measured by direct means, for example a graduated tape or suitable marked wire, care being taken to apply the necessary corrections given in annex A. The intervals between the verticals, i.e. the widths of the segments, shall be similarly measured.

6.2.2 Where the channel is too wide for the above methods of measurement, the horizontal distance shall be determined by optical or electronic distance-meters, or by one of the surveying methods given in annex B.

6.3 Measurement of depth

6.3.1 Measurement of depth shall be made at intervals close enough to define the cross-sectional profile accurately. In general, the intervals shall not be greater than 1/20 of the width.

NOTE 1 For small channels with a regular bed profile, the number of intervals may be reduced. This may, however, affect the accuracy of the determination of the bed profile (see 7.1.3 and clause 9).

NOTE 2 Accuracy of measurement of discharge is increased by decreasing the spacing between verticals.

6.3.2 The depth shall be measured by employing either sounding-rods or sounding-lines or other suitable devices. Where the channel is of sufficient depth, an echo-sounder may be used. If the velocity is high and the channel is sufficiently deep, it is preferable to use an echo-sounder or other device which will not require large corrections.

6.3.3 When a sounding-rod or sounding-line is used, it is desirable that at least two readings be taken at each point and the mean value adopted for calculations, unless the difference between the two values is more than 5 %, in which case two further readings shall be taken. If these are within 5 %, they shall be accepted for the measurement and the two earlier readings discarded. If they are again different by more than 5%, no further readings shall be taken but the average of all four readings shall be adopted for the measurement, noting that the accuracy of this measurement is reduced.

When an echo-sounder is used, the average of several readings shall always be taken at each point. Regular calibrations of the instrument shall be carried out under the same conditions of salinity and temperature of the water to be measured.

NOTE Where it is impracticable to take more than one reading of the depth, the uncertainty in measurement may be increased (see clause 9).

6.3.4 Where measurements of the depths are made separately from the velocity measurements and the water level is not steady, the water level shall be observed at the time of each measurement of the depth. When this is not possible, the water level shall be observed at intervals of 15 min and the value of the level at the time of each determination of depth shall be obtained by interpolation.

NOTE 1 When, during the measurement of discharge, the bed profile changes appreciably, depth measurements should be carried out by taking one depth reading at each point at the beginning and one at the end of the velocity measurement at each vertical, and the mean value of these two measurements shall be taken as the effective depth. Care should be exercised when taking repeated soundings to avoid disturbance of the bed.

NOTE 2 Inaccuracies in soundings are most likely to occur owing to:

a) the departure from the vertical of the sounding-rod or line, particularly in deep water, when the velocity is high;

b) the penetration of the bed by the sounding-weight or -rod;

c) the nature of the bed when an echo-sounder is used.

Errors due to a) may be minimized by the use, where practicable, of an echo-sounder, or pressure-measuring device. The effect of drag on a sounding-line may be reduced by using a streamlined lead weight at the end of a fine wire. A correction shall be applied to the wetted length of wire if the wire is not normal to the water-surface. It is recommended that the angle of departure from the vertical of the sounding line should not be greater than 300 in view of the inaccuracies involved. Methods of applying the correction are given in annex C.

Errors due to b) may be reduced by fitting a baseplate to the lower end of the sounding-rod, or by fastening a disk to the end of the sounding-line, provided they will not cause additional scour of fine bed material due to high velocities.

Errors due to c) may be reduced by selecting an echo-sounder frequency that most adequately depicts the bed-water interface.

NOTE 3 In certain cases, for example floods, it may be impossible to determine an adequate profile of cross-section during the measurement. For those cases, the full profile shall be determined by surveying methods, either before or after the measurement. However, it should be recognized that this method is subject to errors due to possible erosion or deposition in the cross-section between the time the profile is determined and the time of discharge measurement.

7 Measurement of velocity

7.1 Measurement of velocity using current-meters

7.1.1 Rotating-element current-meters

Rotating-element current-meters should be constructed, calibrated and maintained according to ISO 2537 and ISO 3455.They should be used only within their calibrated range and fitted on suspension equipment similar to that used during calibration.

In the vicinity of the minimum speed of response, the uncertainty in determining the velocity is high. Care should be exercised when measuring velocities near the minimum speed of response.

For high velocities, the propeller, in the case of propeller-type current-meters, or the reduction ratio where available, shall be chosen in order that the maximum speed of rotation can be correctly measured by the revolution counter.

No rotating-element current-meter shall be selected for use in water where the mean depth is less than 4 times the diameter of the impeller that is to be used, or of the body of the meter itself, whichever is the greater. No part of the meter shall break the surface of the water.

7.1.2 Electromagnetic current-meters

Electromagnetic current-meters are acceptable for making measurements of point velocity. These current-meters have the advantage that they have no moving parts and thereby eliminate all friction and resistance. They should be calibrated throughout the range of velocity for which they are to be used, and should meet accuracy requirements similar to rotating-element current-meters. They should not be used outside the range of calibration. Electromagnetic current-meters are capable of operation in shallow depths and of detecting and measuring flow reversal. No electromagnetic current-meter shall be selected for use in water whose mean depth is less than 3 times the vertical dimension of the probe.

The control box of the electromagnetic meter should be splashproof and provide a digital readout of velocity instantaneously or averaged over preset time periods.

The sensor of the electromagnetic meter should have a moulded epoxy resin pod with no protrusions, containing an electromagnetic sensor and solid-state encapsulated circuitry. It shall be relatively immune to fouling or damage, simple to clean and maintain and be readily interchangeable.

7.1.3 Measurement procedure

Velocity observations are normally made at the same time as measurements of the depth. This method shall be used in the case of unstable beds. Where, however, the two measurements are made at different times, the velocity observations shall be taken at a sufficient number of places, and the horizontal distance between observations shall be measured as described in 6.2.1 and 6.2.2.

In judging the specific number n of verticals that are to be defined for the purpose of gauging flow at a particular location, the following criteria shall be applied.

Channel width > 0 and < 0,5 m	n = 3 to 4
Channel width > 0,5 m and < 1 m	n = 4 to 5
Channel width > 1 m and < 3 m	n = 5 to 8
Channel width > 3 m and < 5 m	n = 8 to 10
Channel width > 5 m and < 10 m	n = 10 to 20
Channel width >10 m	$n \geqslant 20$

In all instances, measurements of depth or velocity made at the water's edge are additional to the above.

It is further recommended that the location of the verticals be selected after a previous cross-section survey. When the channel is sufficiently uniform it may be possible to reduce the number of verticals and to allocate equal distance spacing between the verticals without conflicting with the above requirement.

The verticals should be chosen so that the discharge in each segment is less than 5 % of the total, insofar as possible, and that in no case should it exceed 10 %.