

Measurement of total discharge in open channels — Electromagnetic method using a full-channel-width coil

ICS 17.120.20

National foreword

This British Standard reproduces verbatim ISO 9213:2004 and implements it as the UK national standard. It supersedes BS 3680-3H:1993 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee CPI/113, Hydrometry, to Subcommittee CPI/113/1, Velocity-area methods, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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

Cross-references

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

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Summary of pages

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Measurement of total discharge in open channels — Electromagnetic method using a full-channel-width coil

*Mesurage du débit total dans les canaux découverts — Méthode
électromagnétique à l'aide d'une bobine d'induction couvrant toute la
largeur du chenal*



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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.

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 9213 was prepared by Technical Committee ISO/TC 113, *Hydrometry*, Subcommittee SC 1, *Velocity area methods*.

This second edition cancels and replaces the first edition (ISO 9213:1992), which has been technically revised.

Measurement of total discharge in open channels — Electromagnetic method using a full-channel-width coil

1 Scope

This International Standard specifies procedures for the establishment and operation of a gauging station, equipped with an electromagnetic flow meter, in an open channel or a closed conduit with a free water surface.

This International Standard is applicable to configurations where an artificial magnetic field is generated through which the entire body of water flows. The induced voltage is sensed in such a way that all elements of the moving water contribute. The equipment described normally requires an electrical mains power supply.

This International Standard is not applicable to devices sampling only part of the flowing body of water (e.g. velocity meters) or to flow meters which operate by using the Earth's magnetic field.

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

ISO 772, *Hydrometric determinations — Vocabulary and symbols*

ISO 1100-2, *Measurement of liquid flow in open channels — Part 2: Determination of the stage-discharge relation*

ISO 5168:—¹⁾, *Measurement of fluid flow — Evaluation of uncertainties*

ISO/TR 7066-1, *Assessment of uncertainty in calibration and use of flow measurement devices — Part 1: Linear calibration relationships*

3 Terms and definitions

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

4 Principles of operation and practice

4.1 This is a velocity-area method of discharge determination. The electromagnetic gauge operates on Faraday's principle of electromagnetic induction. If a length of conductor moves through a magnetic field, a voltage is generated between the ends of the conductor. In the electromagnetic gauge, a vertical magnetic field is generated by means of an insulated coil which is located either above or beneath the channel. The conductor is formed by the water which moves through the magnetic field; the ends of the conductor are represented by the channel walls or riverbanks. The voltage generated is sensed by electrodes on the channel extremities and these are connected to the input of a sensitive voltage-measuring device. The faster the velocity of the water, the greater is the voltage which is generated.

¹⁾ To be published. (Revision of ISO/TR 5168:1998)

4.2 The principle is widely applied to flow meters in circular pipes running full and in this case approximate formulae may be generated theoretically and refinement made by calibration through factory produced models.

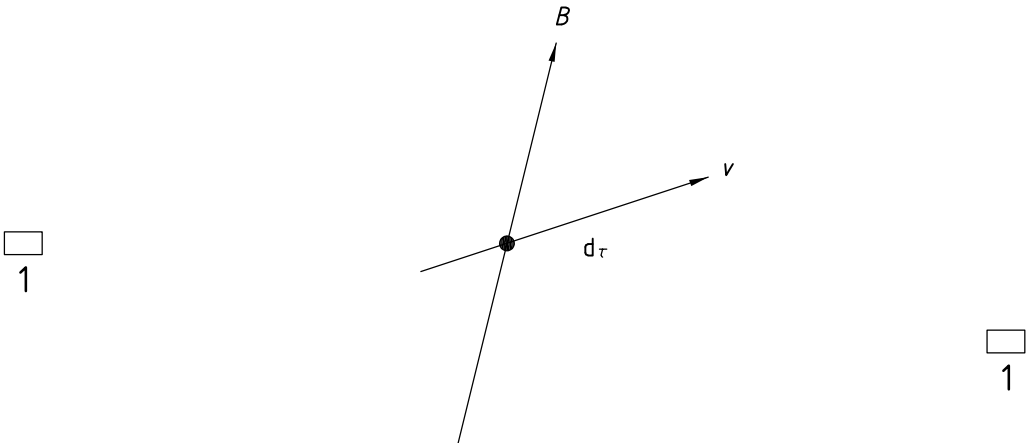
The open channel flow meter however does not lend itself to such treatment and hence *in situ* calibration is always necessary.

4.3 Bevir's formula for the potential generated between electrodes placed in a body of conducting fluid moving in a magnetic field is given by Equation (1) and illustrated in Figure 1.

$$E = \int B \times j \times v \times d\tau \tag{1}$$

where

- E is the potential between the electrodes;
- B is the vector magnetic induction;
- j is the vector virtual current between the electrodes;
- v is the vector velocity function;
- $d\tau$ is an element of volume.



Key
1 electrode

Figure 1 — Illustration of Bevir's formula

This involves integration between the electrodes over the entire space occupied by the fluid. In practice, the general case is not solvable since the spatial functions are unknown or difficult to determine. In the simple case of a rectangular horizontal channel of width w , expressed in metres, with water flowing with a mean velocity v , expressed in metres per second, in a uniform vertical magnetic field H , expressed in amperes per metre, the induced potential E , expressed in microvolts, is measured at electrodes at the sides and is calculated using Equation (2).

$$E \propto v \times w \times H \tag{2}$$