

Australian Standard[®]

**Measurement of water flow in
open channels**

**Part 3: Velocity-area methods
Method 3.5: Investigation of total
error**

This Australian Standard was prepared by Committee CE/24, Measurement of Water Flow in Open Channels and Closed Conduits. It was approved on behalf of the Council of Standards Australia on 9 April 1990 and published on 10 December 1990.

The following interests are represented on Committee CE/24:

Association of Consulting Engineers of Australia
Australian Water and Wastewater Association
Board of Works, Melbourne
Department of Water Resources, NSW
Engineering and Water Supply Department of South Australia
Forestry Commission, NSW
Institute of Instrumentation and Control
Monash University
Public Works Department, NSW
Snowy Mountains Engineering Corporation
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University of Queensland
Water Authority of Western Australia
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PREFACE

This Standard was prepared by the Standards Australia Committee on Measurement of Water Flow in Open Channels and Closed Conduits. It is identical with and has been reproduced from ISO TR 7178—1983, *Liquid flow measurement in open channels—Velocity-area methods—Investigation of total error*.

This Standard is one of a series which deals with methods of measurement of water flow in open channels. The series when complete will consist of the following parts:

- Part 1: Vocabulary and symbols
- Part 2.1: General—Guidelines for the selection of methods of measurement
- Part 2.2: General—Establishment and operation of a gauging station
- Part 2.3: General—Determination of the stage-discharge relation
- Part 2.4: General—Estimation of uncertainty of a flow-rate measurement
- Part 2.5: General—Guidelines for the selection of flow gauging structures
- Part 3: Velocity-area methods—
 - Method 3.1: Measurement by current-meters and floats
 - Method 3.2: Measurement by moving-boat method
 - Method 3.3: Measurement by slope-area method
 - Method 3.4: Collection and processing of data for determination of errors in measurement
 - Method 3.5: Investigation of total error (this Standard)
 - Method 3.6: Measurement of flow in tidal channels
 - Method 3.7: Measurement by ultrasonic (acoustic) method
 - Method 3.8: Electromagnetic method using a full-channel-width coil
- Part 4: Measurement structure methods—
 - Method 4.1: Thin-plate weirs
 - Method 4.2: Rectangular broad-crested weirs
 - Method 4.3: Round-nose horizontal broad-crested weirs
 - Method 4.4: V-shaped broad-crested weirs
 - Method 4.5: Triangular profile weirs
 - Method 4.6: Flat-V weirs
 - Method 4.7: Rectangular, trapezoidal and U-shaped flumes
 - Method 4.8: Trapezoidal profile weirs for free discharge
 - Method 4.9: Parshall and Saniiri flumes
 - Method 4.10: End-depth method for estimation of flow in rectangular channels with a free overfall
 - Method 4.11: End-depth method for estimation of flow in non-rectangular channels with a free overfall (approximate method)
- Part 5: Dilution methods—
 - Method 5.1: Constant-rate injection method for the measurement of steady flow
 - Method 5.2: Integration method for the measurement of steady flow
- Part 6.1: Measuring devices, instruments and equipment—Rotating element current-meters
- Part 6.2: Measuring devices, instruments and equipment—Direct depth sounding and suspension equipment
- Part 6.3: Measuring devices, instruments and equipment—Calibration of rotating element current-meters in straight open tanks
- Part 6.4: Measuring devices, instruments and equipment—Echo sounders for water depth measurements
- Part 6.5: Measuring devices, instruments and equipment—Water level measuring devices
- Part 6.6: Measuring devices, instruments and equipment—Cableway system for stream gauging
- Part 6.7: Measuring devices, instruments and equipment—Ultrasonic (acoustic) velocity meters
- Part 6.8: Measuring devices, instruments and equipment—Position fixing equipment for hydrometric boats

For the purposes of this Australian Standard, the ISO text should be modified as follows:

- (a) Wherever the words 'International Standard' appear, referring to this Standard, they should be read as 'Australian Standard'.
- (b) Wherever the word 'fluid' appears, it should be read as 'water'.
- (c) Substitute a point (.) for a comma (,) as a decimal marker.
- (d) The references to other publications should be replaced by references to Australian Standards.

<i>Reference to International Standard</i>	<i>Australian Standard</i>
ISO	AS
	3778 Measurement of water flow in open channels
748 Liquid flow measurement in open channels—Velocity-area methods	3778.3.1 Part 3: Velocity-area methods—Method 3.1: Measurement by current-meters and floats

- 1088 Liquid flow measurement in open channels—Velocity-area methods—Collection and processing of errors in measurement
- 3778.3.4 Part 3: Velocity-area methods—Method 3.4: Collection and processing of data for determination of errors in measurement

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Measurement of water flow in open channels

Part 3: Velocity-area methods

Method 3.5: Investigation of total error

0 Introduction

All measurements of physical quantities are subject to uncertainties, which may be due to bias errors in the equipment used for calibration and measurement, or to random scatter caused by a lack of sensitivity of the equipment used for the measurements, etc.

During the preparation of ISO 748^[1], much discussion was given over to the question of the magnitude of errors in measurements, and it was concluded that recommendations could only be formulated on the basis of an analysis of sufficient data. Moreover, it was recognized that to be able to analyse such data statistically, it was essential that the data be collected and recorded on a standardized basis and in a systematic manner, and this recognition led to the preparation of ISO 1088^[2].

On the basis of the procedures given in these two International Standards, data were subsequently collected and processed from the following rivers (see annex A for the characteristics of the rivers):

- a) rivers Ganga, Jalangi, Yamuna, and Visvesvaraya Canal, in India;
- b) river IJssel, in the Netherlands;
- c) rivers Derwent, Eden, Lambourn, Ouse, Tyne and Usk, in the United Kingdom;
- d) rivers Columbia and Mississippi, in the USA.

Further data obtained on the rivers Ganga and Krishna, in India, and the Spey, Tay, Tweed, Tyne, Gala Water, Yarrow Water, Ettrick Water and the Clyde, in the United Kingdom, were received later, but could not be included in the processing exercise.

1 Scope and field of application

This Technical Report summarizes the results of investigations of the total error in measurements of flow by velocity-area methods. It describes the procedure used and types of errors (section one), and gives recommendation for the collection of data for investigations of errors (section two) with a view to supplementing the information given in ISO 1088.

2 Symbols

a = coefficient of linear regression

b = coefficient of linear regression

b_i = unobservable true width of section i

d_i = unobservable true depth in vertical of section i

h_{rel} = relative depth, measured from the surface

i = number of series of measurements (error types II and III)

j = number of measurements per series (error type II)

k = time displacement autocorrelation function (of time interval, etc.)