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Australian Standard®

Measurement of water flow in open channels

Part 2.4: General—Estimation of uncertainty of a flow-rate measurement

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.

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Association of Consulting Engineers of Australia

Australian Water and Wastewater Association

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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

University of New South Wales

University of Queensland

Water Authority of Western Australia

Water Board, Sydney

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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 5168—1978, *Measurement of fluid flow—Estimation of uncertainty of a flow-rate measurement.*

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 (this Standard)
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
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 using flow gauging structures—
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.

Measurement of water flow in open channels

Part 2.4: General—Estimation of uncertainty of a flow-rate measurement

0 INTRODUCTION

0.1 Notation

Symbol	Description
a, b, c	Constants
$(E_R)_{95}$	Percentage random uncertainty at the 95% confidence level
E_s	Percentage systematic uncertainty
e_i	Uncertainty in the measurement of the quantity Y_i
$e_{i,j}$	Interdependent uncertainty due to dependence between the variables Y_i and Y_j
e_R	Random uncertainty
$(e_R)_{95}$	Random uncertainty at the 95% confidence level
e_s	Systematic uncertainty
M	Measured value
n	Number of measurements of the value of a variable
q	Flow-rate
R	The result of a measurement
s_Y	Estimate of the standard deviation of the variable Y
$s_{\overline{Y}}$	Estimate of the standard error of the mean of n independent measurements
t	Student's t
Y	Any variable
$\overline{Y}$	Arithmetic mean of the n measurements of the variable Y
δt	Systematic error
δq	Uncertainty in flow-rate measurement
θ_i	Dimensional sensitivity coefficient of the quantity Y_i
θ_i^*	Dimensionless sensitivity coefficient of the quantity Y_i
ν	Degrees of freedom
σ_Y	Standard deviation of the variable Y

0.2 Glossary

The majority of the definitions given here are taken from ISO 3534, *Statistics — Vocabulary and symbols.* Figure 1 is, however, given in order to assist in the understanding of some terms.

Where a term has been adequately defined in the main text, reference is made to the appropriate clause or subclause.

0.2.1 error : In a result, the difference between the measured and true values of the quantity measured.

0.2.2 random error : See 3.2.

0.2.3 systematic error : See 3.3.

0.2.4 spurious error : See 3.1.

0.2.5 constant systematic error : See 3.3.

0.2.6 variable systematic error : See 3.3.

0.2.7 true value : The value which characterizes a quantity perfectly defined in the conditions which exist at the moment when that quantity is observed (or the subject of a determination). It is an ideal value which is assumed to exist and which could be known only if all causes of error were eliminated.

0.2.8 confidence level : See clause 2.

0.2.9 confidence limits : Each of the lower and upper limits, T_1 and T_2, of the two-sided confidence interval. For a one-sided interval, the single limit T of this interval.

0.2.10 uncertainty : The interval within which the true value of a measured quantity can be expected to lie with a stated probability : it is given as $\pm ts_Y$, with the value of t equal to that corresponding to the chosen probability.