

Australian Standard[®]

**Measurement of water flow in
open channels**

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

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Engineering and Water Supply Department of South Australia
Forestry Commission, NSW
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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 weir 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.

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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 |
| $s_{\bar{Y}}$ | Estimate of the standard error of the mean of n independent measurements |
| t | Student's t |
| Y | Any variable |
| \bar{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 sub-clause.

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.