AS 2360.7.2—1993
ISO 7066-2:1988
Reconfirmed 2019

Australian Standard®

Measurement of fluid flow in closed conduits

Part 7.2: Assessment of uncertainty in the calibration and use of flow measurement devices—Non-linear calibration relationships

[ISO title: Assessment of uncertainty in the calibration and use of flow measurement devices—Part 2: Non-linear calibration relationships]

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 3 August 1993 and published on 20 December 1993.

The following interests are represented on Committee CE/24:

Association of Consulting Engineers of Australia
Department of Water Resources, New South Wales
Engineering and Water Supply Department, South Australia
Forestry Commission of New South Wales
Institute of Instrumentation and Control, Australia
Melbourne Water
Monash University
Snowy Mountains Engineering Corporation
University of New South Wales
University of Queensland
Water Authority of Western Australia
Water Board, Sydney — Illawarra — Blue Mountains
Water Resources Commission, Queensland

Review of Australian Standards. *To keep abreast of progress in industry, Australian Standards are subject to periodic review and are kept up to date by the issue of amendments or new editions as necessary. It is important therefore that Standards users ensure that they are in possession of the latest edition, and any amendments thereto.*

Full details of all Australian Standards and related publications will be found in the Standards Australia Catalogue of Publications; this information is supplemented each month by the magazine 'The Australian Standard', which subscribing members receive, and which gives details of new publications, new editions and amendments, and of withdrawn Standards.

Suggestions for improvements to Australian Standards, addressed to the head office of Standards Australia, are welcomed. Notification of any inaccuracy or ambiguity found in an Australian Standard should be made without delay in order that the matter may be investigated and appropriate action taken.

STANDARDS AUSTRALIA

RECONFIRMATION

OF
AS 2360.7.2—1993
Measurement of fluid flow in closed conduits
Part 7.2: Assessment of uncertainty in the calibration and use of flow measurement devices—Non-linear calibration relationships

RECONFIRMATION NOTICE

Technical Committee CE-024 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

Certain documents referenced in the publication may have been superseded since the original date of publication. Users are advised to ensure that they are using the latest versions of such documents as appropriate, unless advised otherwise in this Reconfirmation Notice.

Approved for reconfirmation in accordance with Standards Australia procedures for reconfirmation on 28 November 2019.

The following are represented on Technical Committee CE-024:

Australian Bureau of Meteorology
Australian Hydrographers Association
Australian Industry Group
Institute of Instrumentation, Control & Automation
Irrigation Australia Limited
National Measurement Institute
Office of Finance & Services (NSW)

NOTES

Australian Standard®

Measurement of fluid flow in closed conduits

Part 7.2: Assessment of uncertainty in the calibration and use of flow measurement devices—Non-linear calibration relationships

First published as AS 2360.7.2—1993.

PUBLISHED BY STANDARDS AUSTRALIA
(STANDARDS ASSOCIATION OF AUSTRALIA)
1 THE CRESCENT, HOMEBUSH, NSW 2140

ISBN 0 7262 8500 5

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 7066-2:1988, *Assessment of uncertainty in the calibration and use of flow measurement devices*, Part 2: *Non-linear calibration relationships*.

Under arrangements made between Standards Australia and the international Standards bodies, ISO and IEC, as well as certain other Standards organizations, users of this Australian Standard are advised of the following:

(a) Copyright is vested in Standards Australia.

(b) The number of this Standard is not reproduced on each page; its identity is shown only on the cover and title pages.

(c) There may be occasional dual language sections, but English is always one of the languages reproduced.

(d) Where any cross-references to page numbers appear within the text, these relate to page numbering in the international Standard and are to be disregarded.

This Standard is one of a series, to be published progressively, which deals with methods of measurement of fluid flow in closed conduits. The following Parts were published concurrently with this Part:

AS		
2360		Measurement of fluid flow in closed circuits
2360.0	Part 0:	Vocabulary and symbols
2360.1.1	Part 1.1:	Pressure differential methods—Measurement using orifice plates, nozzles or Venturi tubes—Conduits with diameters from 50 mm to 1200 mm
2360.1.2	Part 1.2:	Pressure differential methods—Measurement using orifice plates or nozzles—Conduits with diameters less than 50 mm
2360.1.3	Part 1.3:	Pressure differential methods—Measurement using orifice plates, nozzles or Venturi tubes—Guide to the use of methods specified in Parts 1.1 and 1.2
2360.1.4	Part 1.4:	Pressure differential methods—Measurement using orifice plates, nozzles or Venturi tubes—Guide to the effect of departure from the conditions specified in Part 1.1
2360.1.5	Part 1.5:	Pressure differential methods—Measurement using orifice plates, nozzles or Venturi tubes—Pulsating flow, in particular sinusoidal or square wave intermittent periodic-type fluctuations
2360.6.1	Part 6.1:	Volumetric methods—By mass
2360.6.2	Part 6.2:	Volumetric methods—By volume
2360.7.1	Part 7.1:	Assessment of uncertainty in the calibration and use of flow measurement devices—Linear calibration relationships
2360.7.2	Part 7.2:	Assessment of uncertainty in the calibration and use of flow measurement devices—Non-linear calibration relationships (*this Standard*)

At the date of publication of this Part the following Parts, with the numbers of the parent international Standards in parenthesis, had not been published:

Pressure differential methods—Measurement using orifice plates, nozzles or Venturi tubes—Connections for pressure signal transmissions between primary and secondary elements (ISO 2186)

Pitot static tube methods—Measurement of velocity at a point of the cross-section of a conduit (ISO 7145)

Pitot static tube methods—Measurement using Pitot-static tubes (ISO 3966)

Pitot static tube methods—Measurement in swirling or asymmetric flow conditions using ISO 3966 or ISO 3354 (ISO 7194)

Current meters method—Measurement of clean water in full conduits and under regular flow conditions using current meters (ISO 3354)

Non-radioactive tracer methods—Review of alternative methods (ISO 2975.1)

Non-radioactive tracer methods—Measurement using constant rate injection (ISO 2975.2)

Non-radioactive tracer methods—Measurement using transit time (ISO 2975.6)

Weighing methods—Verification of static type (ISO 9368.1)

Weighing methods—Verification of dynamic type (ISO 9368.2, not published)

When published, the details for the above unpublished Australian Standards will be listed in the Catalogue of Australian Standards and Other Products.

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

(i) Wherever the words 'International Standard' appear, referring to this Standard, they should be read as 'Australian Standard'.

(ii) Substitute a full stop (.) for a comma (,) as a decimal marker.

(iii) The references to other publications should be replaced by references to Australian Standards as follows:

Reference to International Standard		*Australian Standard*	
ISO		AS	
5168	Measurement of fluid flow—Estimation of uncertainty of a flow-rate measurement	3778	Measurement of water flow in open channels
		3778.2.4	Part 2.4: General—Estimation of uncertainty of a flow-rate measurement
7066	Assessment of uncertainty in the calibration and use of flow measurement devices	2360	Measurement of fluid flow in closed conduits
7066-1	Part 1: Linear calibration relationships	2360.7.1	Part 7.1: Assessment of uncertainty in the calibration and use of flow measurement devices—Linear calibration relationships

CONTENTS

Measurement of fluid flow in closed conduits

Part 7.2:
Assessment of uncertainty in the calibration and use of flow measurement devices—Non-linear calibration relationships

0 Introduction

The method of fitting a straight line to flow measurement calibration data and of assessing the uncertainty in the calibration are dealt with in ISO 7066-1. ISO 7066-2 deals with the case where a straight line is inadequate for representing the calibration data.

1 Scope and field of application

This part of ISO 7066 describes the procedures for fitting a quadratic, cubic or higher degree polynomial expression to a non-linear[1] set of calibration data, using the least-squares criterion, and of assessing the uncertainty associated with the resulting calibration curve. It considers only the use of polynomials with powers which are integers.

Because it is generally not practicable to carry out this type of curve fitting and assessment of uncertainty without using a computer, it is assumed in this part of ISO 7066 that the user has access to one. In many cases it will be possible to use standard routines available on most computers; as an alternative the FORTRAN program listed in annex C may be used.

Examples of the use of these methods are given in annex D.

Extrapolation beyond the range of the data is not permitted.

Annexes A, B, C, D and E do not form integral parts of this part of ISO 7066.

2 References

ISO 5168, *Measurement of fluid flow — Estimation of uncertainty of a flow-rate measurement.* [2]

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

3 Definitions

For the purposes of this part of ISO 7066, the following definitions apply.

3.1 method of least squares: Technique used to compute the coefficients of a particular form of an equation which is chosen for fitting a curve to data. The principle of least squares is the minimization of the sum of squares of deviations of the data from the curve.

3.2 polynomial (function): For a variable x, a series of terms with increasing integer powers of x.

3.3 regression analysis: The process of quantifying the dependence of one variable on one or more other variables.

NOTE — Many of the available computer programs suitable for curve fitting have the word "regression" in the title. For the purposes of this part of ISO 7066, the terms regression and least squares may be regarded as interchangeable.

3.4 standard deviation: The positive square root of the variance.

3.5 variance: A measure of dispersion based on the mean of the squares of deviations of values of a variable from its expected value.

4 Symbols and abbreviations

b_j coefficient of x_j

C_{jb} element of the inverse matrix

1) These procedures are also suitable for a linear set of calibration data.

2) At present at the stage of draft. (Revision of ISO 5168 : 1978.)

3) At present at the stage of draft.