AS 3778.6.3—1992
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Australian Standard®

Measurement of water flow in open channels

Part 6.3: Measuring devices, instruments and equipment—Calibration of rotating element current-meters in straight open tanks

[ISO title: Liquid flow measurement in open channels—Calibration of rotating element current-meters in straight open tanks]

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Engineering and Water Supply Department of South Australia

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Water Board, Sydney — Illawarra — Blue Mountains

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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 3455:1976, *Liquid flow measurement in open channels — Calibration of rotating element current-meters in straight open tanks*.

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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*
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*
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:	*Measuring devices*
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* (this Standard)
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:

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

(ii) Wherever the word 'fluid' appears, it should be read as 'water'.

(iii) Substitute a full point (.) for a comma (,) as a decimal marker.

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

Reference to International Standard or other Publication		*Australian Standard*	
ISO		AS	
		3778	Measurement of water flow in open channels
772	Liquid flow measurement in open channels—Vocabulary and symbols	3778.1	Part 1: Vocabulary and symbols

CONTENTS

Measurement of water flow in open channels—

Part 6.3:
Measuring devices, instruments and equipment— Calibration of rotating element current-meters in straight open tanks

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies the procedure to be used for the calibration of current-meters, i.e. for the experimental determination of the relationship between liquid velocity and rate of revolution of the rotating element. It also specifies the type of tank and equipment to be used and the method of presenting the results.

The procedure does not take into account any possible difference existing between the behaviour of a current-meter moving in motionless water and that of a fixed current-meter in turbulent flow.

2 DEFINITIONS

For the purpose of this International Standard, the definitions given in ISO 772, *Liquid flow measurement in open channels — Vocabulary and symbols*, shall apply.

3 PRINCIPLE OF CALIBRATION PROCEDURE

The current-meter is drawn through still water contained in a straight tank of uniform cross-section at a number of steady velocities. Measurements are made of the speed of the towing carriage and of the rate of revolution of the rotor of the meter. The two sets of values are related by one or more equations of which the limits of application are stated.

4 DESIGN CRITERIA FOR CALIBRATION STATIONS

4.1 Dimensions of calibration tank

The dimensions of the tank and the number and relative position of current-meters in the tank cross-section may affect the test results.

4.1.1 *Length*

The length of a calibration tank may be considered as comprising accelerating, stabilizing, measuring and braking sections.

The length of the accelerating and braking sections depends on the design of the carriage and on the maximum speed at which it is to be towed along the tank. The length required for the braking section must take account of safety requirements.

The length of the measuring section shall be such that the calibration error, which is composed of inaccuracies in the measurement of time, distance covered and rate of revolution, does not exceed the desired tolerance at any velocity. The required length will, therefore, depend on the type of current-meter being calibrated, the way the signals are produced and transmitted and the method of calibration.

For example, if measured times both for distance covered by the carriage and for the revolutions counted are accurate to 0,01 s in order to limit the error in time measurement to 0,1 % at the 95 % confidence level, the duration of the test shall be at least 10 s at maximum speed. If the maximum speed is 6 m/s, then the measuring section of the tank would be 60 m long. The total length of the tank would be about 100 m of which about 20 m would be for acceleration and stabilizing and 20 m for braking.

4.1.2 *Depth and width*

The depth of the tank may have an influence on the test results which cannot be regarded as negligible, more particularly when the towing speed coincides with the velocity of propogation of the surface wave. The dependence of this critical velocity v_c on tank depth is given by the equation.

$$v_c = \sqrt{gd}$$

where

g is the acceleration due to gravity;

d is the depth of water.

The wave crest produced by the current-meter and its means of suspension, which moves forward with the instrument, causes an increase in the height of the wetted cross-section and thus, in accordance with the continuity equation, a reduction of the relative velocity. This phenomenon, known as the Epper effect, may cause an error in calibration within a narrow band in the velocity range from 0,5 v_c to 1,5 v_c. The magnitude of the Epper effect depends on the size of the current-meter(s) and suspension equipment, relative to the cross-sectional area of the tank. It may be negligible when a very small current-meter is calibrated.

The depth of the tank must therefore be chosen to suit the maximum velocity limits of the instruments to be calibrated. Care shall be taken to ensure either that the