# Draft

## Australian Standard

Public Comment is invited for:

DR AS 4747.4:2024, Metering systems for non-urban water supply, Part 4: Installation and commissioning of metering systems

During their development process, Australian Standards are available in draft form during the public consultation period to allow any interests concerned with the application of the proposed Standard to review the draft and submit their comments.

This draft is liable to alteration. It is not to be regarded as an Australian Standard until finally issued as such by Standards Australia.

Upon successful conclusion of the Public Comment period it is proposed to publish this Standard as AS 4747.4:202X.



STANDARDS Australia

# Preface

This Standard was prepared by the Standards Australia Committee CE-024, Measurement Of Water Flow In Open Channels and Closed Conduits to supersede AS 4747.5—2013, *Meters for non-urban water supply, Part 5: Installation and commissioning of closed conduit meters fully charged* and AS 4747.6—2013, *Meters for non-urban water supply, Part 6: Installation and commissioning of open channel meters*.

The objective of this document is to set out the technical requirements for the installation and commissioning of non-urban metering systems.

This document forms part of the AS 4747 series covering the metering of non-urban water supply. A list of all parts in this series can be found in the Standards Australia online catalogue.

The major changes in this edition are as follows:

(a) The relevant terms and definitions from AS 4747.1 have been incorporated into this document. AS 4747.1 has been withdrawn.

(b) An Introduction section has been included to explain the relationship between this document and regulatory documents such as the Metrological Assurance Framework (MAF). AS 4747.8 has been withdrawn and the material previously contained in that document relating to in-service compliance is now covered by the MAF.

(c) Pseudo-regulatory requirements and validation/verification requirements have been removed.

(d) The content previously in AS 4747.5—2013 and AS 4747.6—2013 has been consolidated to create this single document related to installation and commissioning.

(e) The technical requirements have been clarified.

(f) The content about installation previously in AS 4747.2—2013 and AS 4747.3—2013 has been consolidated and included in this document.

(g) The term “metering system” replaces the use of other terms such as “modular metering system” and “self-contained meter”.

(h) A new clause and appendix are included to summarize how to demonstrate conformance with this document.

The terms “normative” and “informative” are used in Standards to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is for information and guidance only.

NOTE This document applies to areas subject to legislation. Refer to the relevant federal, state and territory authorities for the legal and regulatory requirements that apply in that jurisdiction.

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## Introduction

The National Water Initiative (NWI) (2004) was established to increase the productivity and efficiency of Australia's water use. The Commonwealth and all Australian states and territories agreed to the NWI. Clause 88 of the NWI refers to the development of the National Meter Specification, now known as AS 4747. This Australian Standard contributes to the outcomes of the NWI.

The requirements for non-urban water metering systems are described in the following documents:

(a) Parts 2, 3 and 4 of the AS 4747 series. Parts 2 and 3 describe the construction and technical requirements and Part 4 describes the installation and commissioning requirements for meters to conform to this series.

NOTE 1 AS 4747.1, which was a glossary of terms, has been withdrawn and the relevant terms and definitions are now included in Parts 2, 3 and 4.

NOTE 2 AS 4747.5 and AS 4747.6 have been withdrawn and the content combined to form AS 4747.4.

NOTE 3 AS 4747.8 has been withdrawn and replaced by the Metrological Assurance Framework (MAF).

(b) The National Measurement Institute (NMI) documents NMI M 10 and NMI M 11. These describe the requirements and test methods for the pattern approval and verification of non-urban water metering systems.

AS 4747 references the requirements and test procedures specified in the NMI documents. NMI M 10 and NMI M 11 are freely available from an Australian government website.

(c) The Metrological Assurance Framework 2 (MAF2). This describes —

(i) the nationally consistent compliance management approach for non-urban water meters in Australia; and

(ii) the rules and guidelines used to maintain compliance for non-urban water meters, including methods and practices for validation.

NOTE 4 Compliance is usually maintained by State and Territory regulators or irrigation infrastructure operators.

The MAF2 is freely available from an Australian government website.

Pattern approval and verification are regulatory requirements specified under the *National Measurement Act 1960*. This standard does not require meters to be pattern approved or verified. However, testing and evaluation performed for pattern approval purposes can also be used to demonstrate conformance to AS 4747. Pattern approval certificates for approved meters are available from an Australian government website.

At the time of publication, water meters with a maximum continuous flow rate ($Q^3$) greater than 16 kL/h are exempt from pattern approval and verification under the *National Measurement Act 1960*.

Verification and validation are separate and distinct requirements described in the above documentation. The requirements for verification are defined under the *National Measurement Act 1960*. The MAF2 describes practices for validation and verification.

NOTES

# Australian Standard®

## Metering systems for non-urban water supply

## Part 4: Installation and commissioning of metering systems

## Section 1 Scope and general

### 1.1 Scope

This document sets out the installation and commissioning requirements for non-urban metering systems in —

(a) closed conduit, fully charged applications; and

(b) open channel and partially filled conduit applications.

The document covers metering principally used for non-urban water supply.

NOTE 1 Technical requirements for metering systems are specified in AS 4747.2 (closed conduit) and AS 4747.3 (open channel).

The technical requirements in this document also cover closed conduit metering systems that will be used in open channel emplacements.

This document excludes the following:

(i) Validation and verification of metering systems.

(ii) Telemetry systems.

NOTE 2 Telemetry systems can be subject to regulatory requirements.

(iii) Meters covered by AS 3565.1.

### 1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1565, *Copper and copper alloys — Ingots and castings*

AS 2345, *Dezincification resistance of copper alloys*

AS 2738, *Copper and copper alloys — Composition and designations of refinery products, wrought products, ingots and castings*

AS 3600, *Concrete structures*

AS 4747.2, *Meters for non-urban water supply, Part 2: Technical requirements for closed conduit meters fully charged*

AS 4747.3, *Meters for non-urban water supply, Part 3: Technical requirements for open channel meters*

AS/NZS 1567, *Copper and copper alloys — Wrought rods, bars and sections*

AS ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ASTM A276, *Standard specification for stainless steel bars and shapes*

ASTM A480, *Standard specification for general requirements for flat-rolled stainless and heat-resisting steel plate, sheet and strip*

ASTM A743, *Standard specification for castings, iron-chromium, iron-chromium-nickel, corrosion resistant, for general application*

## 1.3 Terms and definitions

For the purposes of this document, the terms and definitions in the *International Vocabulary of Terms in Legal Metrology* (VIML), ISO/IEC Guide 99 (2007), AS 3778.1, and the following apply.

**1.3.1**
**accuracy (of measurement)**
closeness of the agreement between the measured quantity and a reference value

[SOURCE: ISO/IEC Guide 99: 2007, 2.13, modified]

**1.3.2**
**adjustment**
alteration of the measurement parameters of an instrument to bring them within the allowable maximum permissible errors (MPEs) for an instrument in use

**1.3.3**
**ancillary equipment**
**ancillary device**
device intended to perform a particular function, directly involved in elaborating, transmitting or displaying measurement results

Note 1 to entry: Note to entry: Ancillary devices can include —

(a) zero setting devices;

(b) repeating indicating devices;

(c) printing devices;

(d) memory devices;

(e) tariff control devices; and

(f) pre-setting devices.

[SOURCE: VIML: 2022, 5.06, modified]

**1.3.4**
**calibration**
set of operations which, under specified conditions, establish the relationship between the quantity values indicated by the measuring instrument and the corresponding reference quantity value with associated measurement uncertainties

Note 1 to entry: Note to entry: ISO IEC Guide 99:2007 (Clause 2.39) provides a more detailed definition of "calibration", but the definition provided above is suitable for the purposes of this document.

**1.3.5**
**can**
indicates the possibility of an option

**1.3.6**
**commissioning**
process to check that a metering system is installed according to relevant documents and is ready for service

Note 1 to entry: Relevant documents can include product documentation and certifications.

**1.3.7**
**competent person**
person who has acquired, through education, training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the task required

**1.3.8**
**configuration**
parameters specified in relevant product documentation that are entered into the metering system to enable correct operation

**1.3.9**
**error of indication**
indication minus a reference quantity value

[SOURCE: VIML:2022, 0.04]

**1.3.10**
**error (of measurement)**
measured quantity value minus a reference quantity value

[SOURCE: ISO/IEC Guide 99, 2.16]

**1.3.11**
**flow disturbance**
**disturbance**
change in upstream or downstream conditions that can cause an asymmetric flow

Note 1 to entry: An asymmetric flow can affect meter performance.

**1.3.12**
**flow rate**
**Q**
quotient of the actual volume of water passing a specified point and the time taken for this volume to pass that specified point

Note 1 to entry: Expressed in megalitres per day (ML/d), litres per second (L/s), cubic metres per hour or kilolitres per hour.

**1.3.13**
**fully charged**
pipe completely filled with water

**1.3.14**
**indicating device**
**display**
part of the metering system that displays the measurement results, either continuously or on demand

Note 1 to entry: A printing device that provides an indication at the end of the measurement is not an indicating device.

**1.3.15**
**in-service**
metering system that has been commissioned and is used to measure water for a defined purpose

Note 1 to entry: A defined purpose can include trade, water resource management and licensing compliance.

**1.3.16**
**IP rating**
coding system to indicate the degrees of protection provided by an enclosure against access to hazardous parts, ingress of solid foreign objects and water, and provide additional information in connection with such protection

**1.3.17**
**maximum permissible error**
**MPE**
extreme value of the measurement error of a metering system

Note 1 to entry: The value of maximum permissible error, as permitted by the AS 4747 series.

[SOURCE: VIML:2022, 0.05, modified]

**1.3.18**
**may**
indicates the existence of an option

**1.3.19**
**meter**
**water meter**
instrument intended to measure, memorize and display the volume of water passing through the measurement transducer at metering conditions

Note 1 to entry: A water meter includes at least a measurement transducer, a calculator (including adjustment or correction devices if present) and an indicating device. These three devices may be in different housings.

[SOURCE: ISO 4064-1:2014, 3.1.1]

**1.3.20**
**metering system**
device or group of associated devices that is intended to measure the quantity of water that passes a specified point

Note 1 to entry: The previous editions of this Standard included the terms “self-contained meter” and “modular metering systems”. This definition is intended to cover both of these terms.

Note 2 to entry: A metering system can include only a meter and no other associated devices.

Note 3 to entry: The devices comprising a metering system can include meters, sensors, physical structures (such as weirs, flumes and gates) and other electrical or mechanical equipment / interfaces associated with the metering system.

Note 4 to entry: Displays can be onsite or remote, and can be continuous or on-demand.

**1.3.21**
**nominal diameter**
**DN**
alphanumeric designation of size for components of a pipework system, which is used for reference purposes

Note 1 to entry: The designation comprises the letters DN followed by a dimensionless whole number that is directly related to the physical size of the bore (in millimetres) or outside diameter of the end connections.

Note 2 to entry: The number following the letters DN does not represent a measurable value and should not be used for calculation purposes except where specified in the relevant standards.

Note 3 to entry: In those standards which use the DN designation system, any relationship between DN and component dimensions should be given, e.g. DN/OD or DN/ID.

**1.3.22**
**open channel**
longitudinal boundary surface consisting of the bed and banks or sides within which water flows with a free surface

Note 1 to entry: Open channel includes partially-filled conduits or pipes.

[SOURCE: ISO 772, 3.19]

**1.3.23**
**open channel emplacement**
device or mechanism that allows a quantity of water flowing in an open channel to be measured by a closed conduit meter

[SOURCE: NMI M10, 2.4.15]

**1.3.24**
**pattern approval**
decision of legal relevance, based on the review of the type evaluation report, that the type of a measuring instrument complies with the relevant statutory requirements and results in the issuance of the type approval certificate

Note 1 to entry: This is a process whereby an impartial body examines the pattern of an instrument against a set of national or international metrological specifications, which determines whether an instrument can retain its calibration over a range of environmental and operating conditions and ensures that the instrument is not capable of facilitating fraud.

Note 2 to entry: Type approval is equivalent to pattern approval. "Type approval" is more commonly used internationally, whereas the term "pattern approval" is more commonly used in Australia.

[SOURCE: VIML:2022, 2.05]

**1.3.25**
**rated operating condition**
operating condition that must be fulfilled during measurement in order that a measuring instrument or measuring system performs as designed

Note 1 to entry: Rated operating conditions generally specify intervals of values for a quantity being measured and for any influence quantity.

[SOURCE: VIML:2022,0.08]

**1.3.26**
**shall**
indicates that a statement is mandatory

**1.3.27**
**should**
indicates a recommendation

**1.3.28**
**uncertainty (of measurement)**
non-negative parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used

Note 1 to entry: Measurement uncertainty includes components arising from systematic effects, such as components associated with corrections and the assigned quantity values of measurement standards, as well as the definitional uncertainty. Sometimes estimated systematic effects are not corrected for but, instead, associated measurement uncertainty components are incorporated.

Note 2 to entry: The parameter may be, for example, a standard deviation called standard measurement uncertainty (or a specified multiple of it), or the half-width of an interval, having a stated coverage probability.

Note 3 to entry: Measurement uncertainty comprises, in general, many components. Some of these may be evaluated by Type A evaluation of measurement uncertainty from the statistical distribution of the quantity values from series of measurements and can be characterized by standard deviations. The other components, which may be evaluated by Type B evaluation of measurement uncertainty, can also be characterized by standard deviations, evaluated from probability density functions based on experience or other information.

Note 4 to entry: In general, for a given set of information, it is understood that the measurement uncertainty is associated with a stated quantity value attributed to the measurand. A modification of this value results in a modification of the associated uncertainty.

[SOURCE: ISO/IEC Guide 99: 2007, 2.26]

**1.3.29**
**validation**
set of activities that includes inspecting the meter to check that it is installed in accordance with relevant Standards and maintained to an acceptable state of repair, which provides an acceptable level of confidence that the meter will operate within an acceptable range of error under normal operating conditions

Note 1 to entry: Validation is different to verification. The requirements for verification are defined under the *National Measurement Act 1960*.

## 1.4 Evaluation of product conformity

To claim that a metering system is installed and commissioned in accordance with this document, the metering system and its installation shall meet the conformity requirements in Appendix A.

# Section 2 Criteria for the design of metering installations

## 2.1 General

Metering systems installed in accordance with this document shall conform with the following:

(a) Closed conduit metering systems: NMI M10-1 and AS 4747.2.

(b) Open channel metering systems: AS 4747.3.

The metering installation design shall be in accordance with the installation conditions and requirements specified within the following documents:

(i) Relevant certifications.

(ii) Sections 3 and 4 of this document.

(iii) Product specifications.

If there are inconsistencies in the requirements between these documents, then the most stringent requirement shall be met.

## 2.2 Materials

Materials that are used in the fabrication of metering installations shall conform to the relevant Australian Standards. Materials shall be resistant to internal and external corrosion. For the purposes of this document, for most water chemistries, the following materials shall be deemed to be corrosion resistant:

(a) Copper alloys conforming to AS 1565, AS/NZS 1567 or AS 2345.

(b) Austenitic stainless steel conforming to ASTM A276 (grades to be suitable for the application).

(c) Stainless steel conforming to ASTM A480 or ASTM A743.

(d) Phosphor bronze conforming to AS 2738 alloy C 51800b.

(e) Copper nickel alloy conforming to AS 2738 alloy C 71500 or alloy C 70610.

(f) Aluminium grades 5083-H321, 5052-H34, 6351 T5, 6352 T5, 6353 T5, 6354 T5, 6355 T5, 6063 T6.

(g) Concrete conforming to AS 3600.

(h) Polymers in accordance with Clause 2.3 in AS 4747.2.

NOTE 1 Any history of corrosion should be taken into account when selecting the type and material composition of components.

NOTE 2 Other materials may be considered, based on demonstrated corrosion-resistance data.

NOTE 3 Combinations of materials can breach the resistance to corrosion requirement.

NOTE 4 High solute or aggressive waters can require site-specific design beyond the scope of this document.

NOTE 5 Stainless steel material likely to be affected by crevice corrosion should not be used for components in contact with water.

Consideration should be given to recyclability of components and the circular economy.

## 2.3 Performance

The metering system shall be installed such that it operates within the in-service maximum permissible error (MPE) of ±5 % while it is within its rated operating conditions.

The metering installation design, including the rated operating conditions of its components, shall be suitable for the expected environmental and water conditions during the product lifetime. Provision should be made for future in-service *in situ* testing.

## 2.4 Product documentation

Product documentation for the metering system and associated components is covered in AS 4747.2 (closed conduit installations) and AS 4747.3 (open channel installations).

Components of the installation design that are not part of the metering system shall conform to the relevant material product documentation and installation requirements for that component.

NOTE Components may include piping materials, valves, pressure transducers, flow conditioning devices and structural supports.

Instructions for electrically powered components shall include instructions for safe installation and safe operation.

## 2.5 Electrically powered metering systems

The metering system shall be installed in accordance with its documented power supply and telemetry.

The mains power supply of externally powered meters or sensors shall meet the product documentation and installation specifications for the metering system.

NOTE 1 Refer to AS/NZS 3000 (series) for electrical requirements.

The metering system and its installation shall support data retention in the event of power failure. This should include the last totalised volume measurement and a time stamp.

NOTE 2 Redundancy for power loss can include battery back-up, no data loss and alarm indicating that mains power has been lost.

# Section 3 Installation requirements

## 3.1 General

Metering systems shall be installed to meet the requirements in the following documents:

(a) Product certification.

(b) Product installation instructions.

(c) Design requirements.

If there are inconsistencies in the requirements between documents, then the metering installation shall meet the most stringent requirements of each document.

NOTE 1 Example for closed conduit installation: If the product certification specifies a minimum number of upstream (U)/downstream (D) straight lengths of pipe of 0U/0D, the product installation instructions specify 10U/5D and the design requirements specify 5U/10D, then 10U/10D would apply.

All dimensions and/or other physical quantities (such as structure dimensions, temperature, pressure) shall be measured using instruments calibrated by a laboratory that meets the requirements of AS ISO/IEC 17025.

The scope of the laboratory accreditation shall be in the relevant field of calibration and testing.

NOTE 2 Accreditation bodies which are signatories to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) for testing laboratories may be able to offer accreditation with the requirements of AS ISO/IEC 17025. A listing of ILAC signatories is available from the ILAC website (www.ilac.org). In Australia and New Zealand, the National Association of Testing Authorities (NATA), Joint Accreditation System of Australia and New Zealand (JAS-ANZ) and International Accreditation New Zealand (IANZ) are signatories to the ILAC MRA.

NOTE 3 Further information about specific meter types is included in ISO 20456 (electromagnetic meters) and ISO 12242 (ultrasonic meters).

The metering installation shall not present a safety or environmental hazard.

## 3.2 Bypass

There shall be no water that bypasses the metering system.

NOTE Water bypass includes leakage and overland flow.

## 3.3 Location

Metering systems shall be easily accessible for reading, for example, without the use of a mirror or a ladder.

NOTE 1 Viewing height, obstructions to the device, and environmental conditions, such as sunlight and temperature, should be considered.

Provision shall be made for maintenance, inspection, meter, and sensor removal and *in situ* dismantling of the installation so that all components can be inspected to ensure ongoing conformance. If a metering system or its components will be installed in a pit, then the pit shall be constructed in accordance with the relevant standards.

NOTE 2 Where possible, the metering system should not be installed in a pit as it may impede access to the system and its components.

NOTE 3 Relevant standards for safe work in confined spaces include AS 2865.

If a metering system component (such as the flow tube housing the transducer) needs to be directly buried, then the component shall be designed and specified for this type of installation.

NOTE 4 Directly burying the meter body can have implications for maintenance and inspection, and for demonstrating conformance with this document.

Remote-mounted devices and equipment should be easily accessible for reading and maintenance. The communication cable from the meter (or other component) to the display and/or control devices should be as short as practicable and in accordance with the product instructions. If required, cables should be protected in a suitable conduit, casing or duct and buried according to the design specifications.

## 3.4 Flow disturbances

### 3.4.1 General

Many types of metering systems are sensitive to upstream flow disturbances, which cause errors and premature wear. Likewise, though to a lesser extent, many metering systems are sensitive to downstream flow disturbances.

### 3.4.2 Straight lengths of pipe and flow disturbances (for closed conduit installations)

Metering systems shall be installed to minimize flow disturbances. The metering system shall be installed with at least the minimum number of straight lengths of pipe (with or without a flow straightener) according to requirements given in the documents listed in Clause 3.1.

Where practicable —

(a) measuring systems shall be installed with further straight lengths of pipe to improve flow performance; and

(b) components and associated fittings that can create flow disturbances should be either eliminated or installed downstream of the metering installation.

If internal pipe diameter transitions cannot be avoided, then —

(i) the opening angle should be no more than 16° included angle; and

(ii) the pipe diameter upstream of the meter (or the flow tube housing the sensors) should be larger than the meter (or flow tube).

NOTE 1 Methods for eliminating disturbances are given in Appendix B.

NOTE 2 Examples of flow disturbances and their impact are given in Appendix C.

### 3.4.3 Eliminating flow disturbances (for open channel installations)

Flow disturbances shall be mitigated to ensure the installation conforms to the requirements in Clause 3.1. The relevant Australian Standards or other documents shall be consulted for guidance on the elimination of flow disturbances.

NOTE 1 See AS 4747.3:202X, Table 3.1, for examples of relevant Australian Standards and other documents for different metering methodologies.

Disturbances include the following:

(a) Wave action.

(b) Distorted velocity profiles.

(c) Excessive approach velocities.

(d) Swirl.

(e) Algae/debris growth in the meter or in the metering system.

(f) Siltation/sediment build-up over time.

(g) Pipe/structure distortion due to movement above or below the ground.

(h) Backflow, backwater or ponding effects.

In some cases, it may be necessary to monitor conditions at the installation site before and/or after the metering system has been installed. Monitoring includes —

(i) water levels upstream and downstream of the site;

(ii) surface wave conditions at the site;

(iii) water velocity conditions in the vicinity of the site;

(iv) impact of silt build-up at the site; and

(v) any structure upstream or downstream that can affect the performance or metrology of the metering system.

NOTE 2 Guidance on the installation of other fittings close to the metering system should be sought from the product specification or a competent person.

| DRAFTING NOTE: AS 4747.3:202X is currently under development. |
| --- |

## 3.5 Meter system mounting

The orientation of the meter within the metering system shall be installed as specified for its type (see Clause 3.1).

NOTE The orientation is usually marked on the body of the meter.

Any limitations of use identified in the product specifications shall be addressed during the installation.

Precautions shall be taken to prevent damage to the metering system due to unfavourable flow conditions (such as cavitation, surging, siltation, waterborne debris) or adverse foundation conditions. The metering system shall be protected from damage due to shock or vibration induced by the surroundings (such as nearby pumps and machinery, pipes and fittings).

The metering system shall not be subjected to undue stresses caused by pipes, fittings and the installation method. The metering system shall be stable and supported on suitable foundations if necessary.

Consideration should be given to the installation method to allow servicing and removal of metering system components.

The following requirements apply to closed conduit installations:

(a) Water pipelines upstream and downstream shall be securely anchored to ensure that no part of the installation can be displaced under water thrust when the meter (or sensor) is removed or disconnected on one side.

(b) Pipelines either side of the meter (or sensor) shall be supported to allow easy removal.

## 3.6 External environment

The metering system shall have an IP rating suitable for the expected environmental conditions. If the metering system is mounted in pipework that forms a part of an electrical earthing circuit, there shall be a permanent shunt for the metering system and its associated fittings.

NOTE This will reduce the risk of electrocution.

The metering system shall be protected from risk of damage due to expected environmental conditions.

## 3.7 Air ingress and egress (for closed conduit installations)

The installation shall be designed such that the metering system always runs fully charged while in-service.

NOTE 1 Non-pressurized systems may require elbows or pipe elevation to meet this requirement.

Upstream pipework shall be sealed to prevent air ingress.

NOTE 2 Air ingress can cause negative pressures that affect metering system accuracy.

The installation shall be capable of expelling any entrained or entrapped air upstream of the metering system. The design should ensure an adequate grade on the installation to avoid air entrapment in the metering system. If there is a risk that air will enter the metering system, an upstream air-release valve (or similar) shall be incorporated and installed in accordance with the product specifications.

## 3.8 Associated fittings

### 3.8.1 Closed conduit installations

Fittings installed adjacent to the metering system can include the following:

(a) Isolation or flow control devices that indicate the direction of the valve operation.

(b) Diameter reduction or expansion of pipework.

(c) Flow conditioners.

(d) Strainers or screens.

(e) A means to seal the connection between the meter and the water supply line, in order to detect any unauthorized removal of the meter.

(f) Bends and other directional change.

(g) Pumps and other ancillary equipment capable of producing severe flow disturbances.

(h) Dismantling provisions to allow easy installation and removal of the metering system when the surrounding pipework is rigid.

(i) Devices including drain valves, which can be used for pressure measurement, sterilization, fertigation injection and water sampling.

(j) Check valves.

(k) Air-release devices.

If bolted flanges are used, then the correct bolt size, alignment and correct internal diameter sizing of flange shoulder and gaskets shall be selected according to the product specifications. A strainer or screen shall be fitted in the upstream pipeline if the metering system accuracy can be affected by the presence of solid particles in the water.

NOTE 1 Guidance for installing other fittings adjacent to the meter and adjoining pipework should be sought from the relevant manufacturer or from a competent person.

NOTE 2 Figure 3.1 shows an example of a metering system installation and associated fittings.

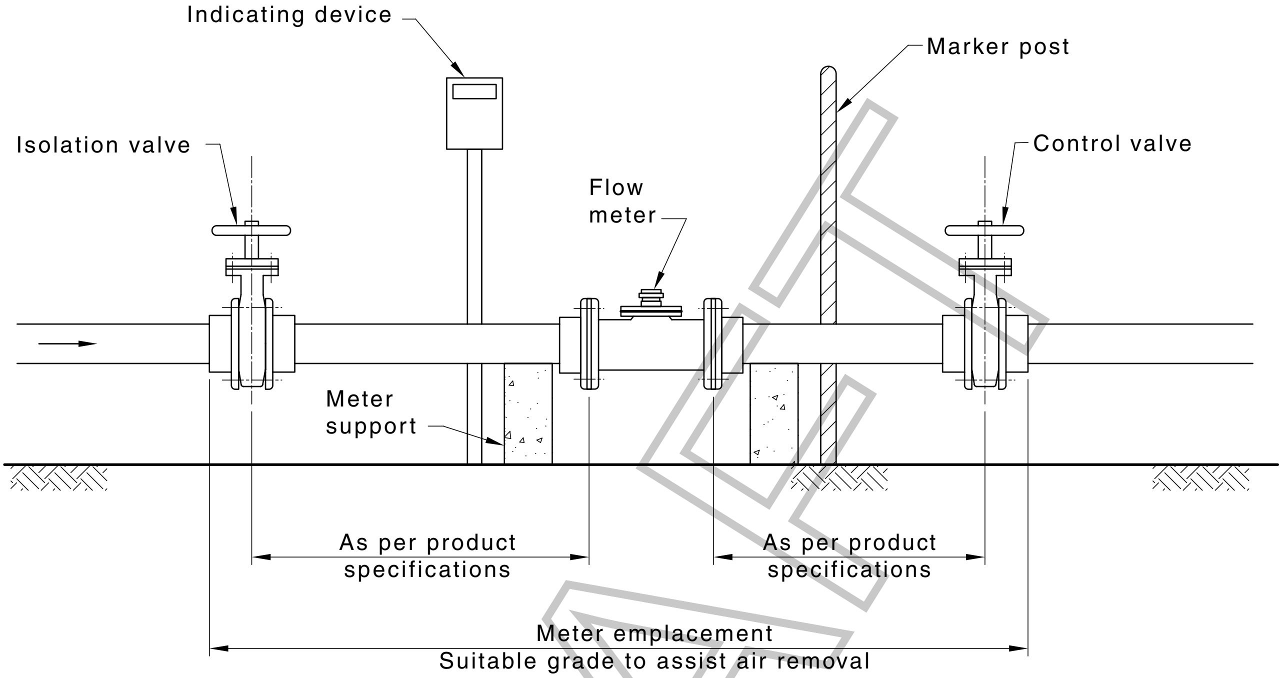



**Figure 3.1 — An example of a metering system installation and associated fittings**

### 3.8.2 Open channel installations

Fittings installed within or adjacent to the metering system can include the following:

(a) An isolation or flow control device.

(b) A flow-straightening device.

(c) A strainer or screen.

(d) A means to seal the connection between the logging device and the sensor to detect any tampering of the metering system.

(e) A culvert, pipe, flume or regulator (upstream and/or downstream).

(f) Devices or mechanisms to allow easy installation and removal of components.

Components shall not create flow disturbances that affect the measurement system performance. For more information, see Clause 3.4.

## 3.9 Security of operation

### 3.9.1 Sealing the meter installation

After a metering system has been installed correctly and inspected by a competent person, the installation shall be sealed to prevent tampering with the metrological performance.

NOTE Sealing the metering installation is important so that the meter or any adjacent components cannot be dismantled, altered, tampered with, or removed.

### 3.9.2 Data security

Settings, calibration and stored data shall be protected from non-authorized modification.

## 3.10 In-service testing

### 3.10.1 General

In-service testing is relevant to the installation process and maintaining metering system accuracy.

NOTE 1 For in-service testing requirements in the jurisdiction, refer to the relevant regulatory authority.

Where a metering system is tested *in situ* via direct volumetric comparison, the errors (of indication) shall not exceed ±5.0 % across the flow rate range ($Q_1 \leq Q \leq Q_4$) under the rated operating conditions.

The reference volume uncertainty measurement shall not be greater than one-third of the MPE of the metering system under test (i.e. ±1.67 %), with a coverage factor $k = 2$.

NOTE 2 If the one-third of the MPE cannot be practically met, then a lesser accuracy may be acceptable by the relevant regulatory authority in that jurisdiction.

NOTE 3 The *in situ* MPE of ±5.0 % is greater than the pre-service laboratory MPE of ±2.5 % (as given in AS 4747.2 and AS 4747.3) because there are environmental, installation and wear-based errors that are not present in new metering systems tested in controlled laboratory environments.

### 3.10.2 Laboratory in-service testing

When metering systems are removed from service and tested under laboratory conditions the MPE shall not exceed ±5 % when tested across the flow rate range ($Q_1 \leq Q \leq Q_4$) under rated operating conditions.

### 3.10.3 Direct volumetric comparison

Where direct volumetric comparison is used for metering system evaluation, performance shall be measured via a direct comparison with a reference device. This is undertaken by comparing the volumetric measurement of the metering system under test with the volumetric measurement of the reference device by passing the same volume of water through both.

The difference between the two measurements is defined as the error of indication of the metering system under test and is expressed as a percentage as follows:

$$\frac{(V_i - V_a)}{V_a} \times 100$$

where

$V_a$ = actual volume as determined by the reference equipment

$V_i$ = indicated volume of the metering system under test

Other recognized formulae may also be used, including those —

(a) published by Standards Australia;

(b) published by the International Standardization Organization; and

(c) specified in documentation provided by the manufacturer.

The reference device may be a direct volumetric measure, a gravimetric system, a calibrated reference meter or similar volumetric measuring device. The MPE for pre-service and in-service volumetric performance testing shall be the values given in Clauses 3.10.1 and 3.10.2. The reference volume method uncertainty shall be in accordance with Clause 3.10.1.

NOTE 1 For information on volumetric methods through closed conduits, refer to AS 2360.6.1 and AS 2360.6.2. For information on volumetric methods through open channel, refer to AS 3778.

NOTE 2 The reference device and corresponding methodology used by the test facility for volumetric comparisons will have an associated measurement uncertainty. The evaluation of this uncertainty is part of the facility's accreditation and is beyond the scope of this document.

### 3.10.4 Alternative test methods

Alternative test methods may be considered as part of in-service testing.

NOTE 1 An example of an alternative test method is self-diagnostic software.

NOTE 2 Alternative test methods can be subject to regulatory requirements.

## Section 4 Commissioning

Following installation, the metering system shall be commissioned by a competent person.

The commissioning process shall include the following:

(a) Check the installation conforms to Clause 3.

(b) Check the metering system integrity. This may include checking that tamper-evident seals are in place.

(c) Check that the correct version of software has been installed (where applicable).

(d) Measure the dimensions that define the structures used as constants in flow computations (where applicable).

(e) Program the flow computer with any required revised parameters (where applicable).

(f) Check the internal pipe diameter, pipe fittings, gasket protrusions (and any other relevant parameters) conform to the design requirements (where possible) (for closed conduit installations).

(g) Check the installation for leakage (where possible).

NOTE 1 A poor installation could unintentionally allow water to pass around the installation. If so, the metering system would not accurately record the total water flow. It is good practice during the commissioning process to identify potential causes of substantial errors, such as leakage. This will allow early correction of these errors.

(h) Record all measurement and configuration data used in the flow computer.

(i) Check that all necessary quality assurance documentation related to the installation has been completed.

For metering systems that require configuration after installation:

(A) Each sensor output shall be checked to confirm that the sensor accuracy conforms to the tolerances allowed as part of the metering system's MPE.

(B) All parameters used for flow computation shall be programmed with the values specific to the installation. Any subsequent alterations made to the values shall be recorded in a protected register.

NOTE 2 The flow computer parameters should be programmed by a competent person.

# Appendix A
(normative)

## Demonstration of conformance



Laboratories that perform the tests outlined in this document shall meet the requirements of AS ISO/IEC 17025.

NOTE 1 Accreditation bodies which are signatories to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA) for testing laboratories may be able to offer accreditation with the requirements of AS ISO/IEC 17025. A list of ILAC signatories is available from the ILAC website (www.ilac.org). In Australia and New Zealand, the National Association of Testing Authorities (NATA), Joint Accreditation System of Australia and New Zealand (JAS-ANZ) and International Accreditation New Zealand (IANZ) are signatories to the ILAC MRA.

NOTE 2 In Australia, the signatory to the International Accreditation Forum Multi-Lateral Recognition Arrangement (IAF MLA) accreditation body is JAS-ANZ.

Any changes to the installation design shall be evaluated in accordance with the requirements of this document. This is summarized in Table A.1. Re-evaluation, and re-testing if necessary, shall be undertaken to confirm installation conformity.

NOTE 3 Alternatives to re-testing or re-evaluation can be achieved by demonstrating process control, quality plans and/or documented procedures, as considered adequate by the certifying body.

NOTE 4 Installation changes may include changes to firmware or software, and changes to the hardware.

Installation evaluation and the need for retesting is the responsibility of the certification body.

NOTE 5 Statements of conformance to this document on product, packaging or promotional material related to that product should ensure that such conformance is capable of being verified.

Evaluation of conformity shall be performed by a competent person.

NOTE 6 A competent person may be defined by JAS-ANZ or by the regulatory authority in the relevant jurisdiction.

**Table A.1 — Summary of conformance requirements**

| Characteristics | Clause | Requirement | Method (closed conduit) | Method (open channel) |
|---|---|---|---|---|
| Material properties | 2.2 | Materials | Review materials parts list and compliance certificates | Review materials parts list and compliance certificates |
| | 2.4 | Product documentation | Review documentation | Review documentation |
| | 2.5 | Electrically powered metering systems | Review documentation and required compliance certificates | Review documentation and required compliance certificates |
| Installation requirements | 3 | Installation requirements | Review documentation<br><br>Onsite inspection | Review documentation<br><br>Onsite inspection |
| | 3.2 | Bypass | Onsite inspection | Onsite inspection |
| | 3.3 | Location | Onsite inspection against the design documentation | Onsite inspection against the design documentation |
| | 3.4 | Flow disturbances | Onsite inspection against the design documentation | Onsite inspection against the design documentation |

**Table A.1** *(continued)*

| Characteristics | Clause | Requirement | Method (closed conduit) | Method (open channel) |
|---|---|---|---|---|
| | 3.5 | Meter mounting | Onsite inspection against the design documentation | Onsite inspection against the design documentation |
| | 3.6 | External environment | Review documentation and required compliance certificates | Review documentation and required compliance certificates |
| | 3.7 | Air ingress and egress | Onsite inspection | n/a |
| | 3.8 | Associated fittings | Onsite inspection | Onsite inspection |
| | 3.9 | Security of operation | Onsite inspection | Onsite inspection |
| | 3.10 | In-service testing | Volumetric testing or an alternative method | Volumetric testing or an alternative method |
| Commissioning | 4 | Commissioning | Onsite inspection against the design documentation<br>Review documentation | Onsite inspection against the design documentation<br>Review documentation |
| NOTE Onsite inspections can include virtual inspections. | | | | |

# Appendix B
(informative)

# Best practice meter installation for closed conduit installations

## B.1 General

All non-urban metering systems should be accompanied by documentation that defines best practice installation specific to the metering system.

NOTE This can include installation manuals, product certificates, pattern approval certificates, relevant jurisdictional requirements and/or test data/reports.

## B.2 Flow disturbances

A metering system can be affected by flow disturbances in the upstream or downstream pipeline. A flow disturbance is any condition that causes turbulence in the flow profile of a fluid flowing through a conduit (e.g. due to the presence of bends, elbows, valves or pumps). NMI M 10-2 defines three types of standardised flow disturbance, which are used as part of the conformity testing process.

While Types 1, 2 and 3 are not the only disturbance conditions, these have been chosen because they represent common conditions that can be expected in meter installations (see Table B.1).

**Table B.1 — Disturbance types (from NMI M10-2)**

| Type | Description |
|---|---|
| 1 | Right hand swirl, usually found downstream of two 90° bends directly connected at right angles, or created by an axial flow pump |
| 2 | Left hand swirl, usually found downstream of two 90° bends directly connected at right angles, or created by an axial flow pump |
| 3 | Turbulence caused by a partially closed valve or other throttling devices, generally defined as “asymmetric velocity profiles” |

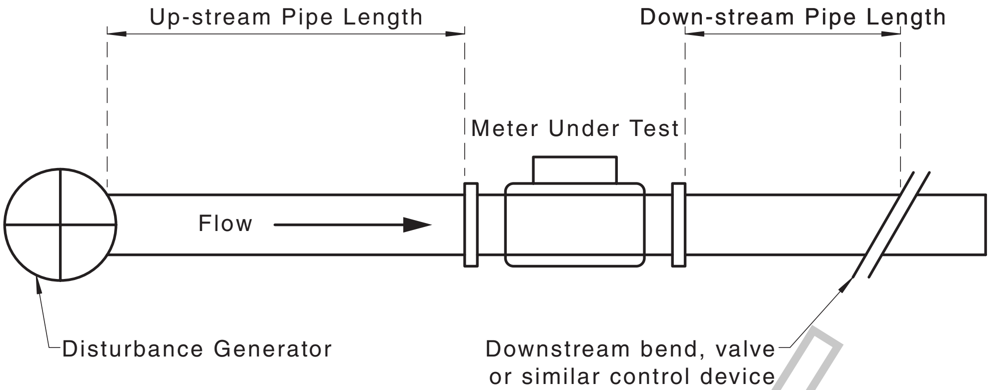
## B.3 Minimising the effects of flow disturbances

The circumstances leading to flow disturbances are by nature complex and too numerous to detail in this document. Where possible, potential causes should be identified and eliminated in preference to resorting to remedial devices such as flow straighteners.

Certifications and product specifications should provide guidance to support best practice in typical installations. The primary means of eliminating the effects of flow disturbances is to surround the metering system with straight lengths of pipe. Preference should be given to installation of longer straight section of pipe upstream of the metering system (for example, see Figure B.1). Where used, the product specifications should provide details of the required flow straightener upstream or downstream lengths.

NOTE 1 Special consideration should be given to bi-directional flow applications.

NOTE 2 Any device (such as a check-valve, orifice, flow or pressure regulator) can create a flow profile disturbance that will exist well after a length of 10 × DN of the pipe. Such devices should be installed downstream of the metering system, at the far end of the straight section.




[SOURCE: NMI M10-2]

NOTE The upstream and downstream are generally quoted as the number of pipe diameters of the meter (DN), for example 10 DN on a 150 mm pipe is 1 500 mm.

**Figure B.1 — Example of the specification of upstream and downstream lengths**

As noted above, Types 1, 2 and 3 represent standardised examples of flow disturbances. In practice, a metering system can be installed into a variety of different installation arrangements producing varying types of flow disturbance (an example of a typical installation is given in Figure 3.1).

Abrupt changes in pipe size should be avoided. Joint gaskets should be flush against internal surfaces and should not intrude into the internal pipe. Wherever possible, valves should be located downstream of the metering system. If this is not possible, then the installation should maximize the distance between the valve and the meter and/or sensor. Examples of best practice in the presence of flow disturbances are given in Figure B.2.

Feed lines should be located downstream of the metering system. If this is not possible, the installation of feed lines should minimize swirl effects. An example of how this can be achieved is shown in Figure B.3.

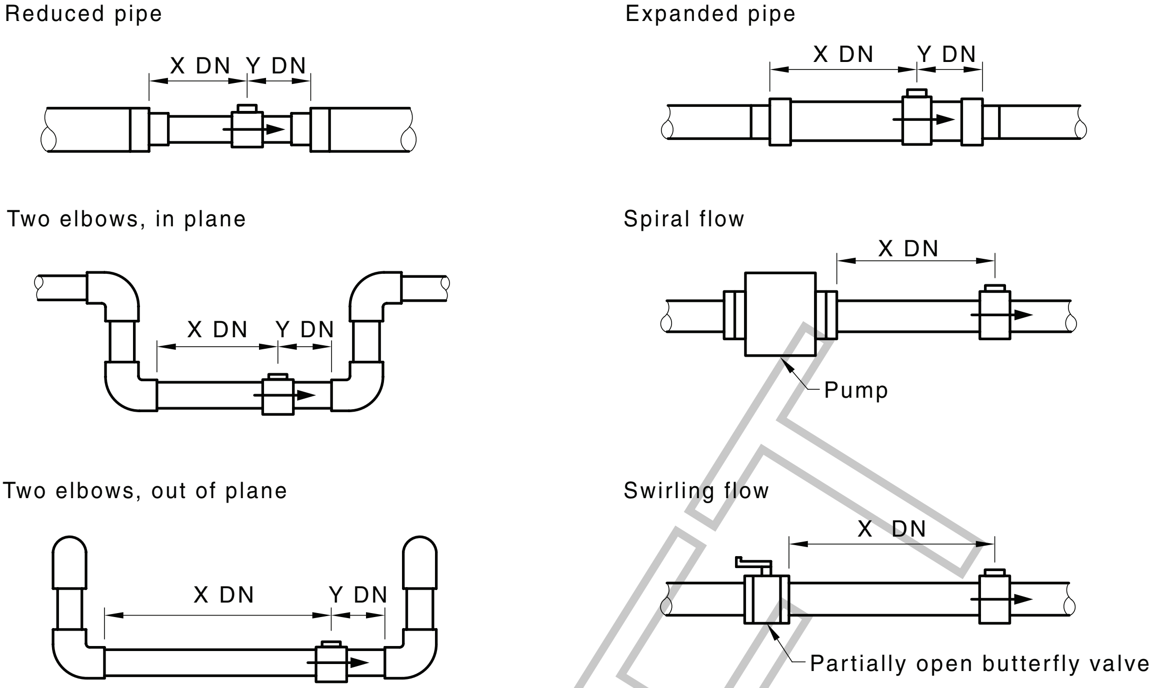
Where two or more bends in different planes exist, then these should be —

(a) installed downstream of the metering system; or

(b) moved as far as practicable from the metering system if located upstream.

In both cases, the bends should be separated as far as practicable from each other. An example of the effect on flow profile due to the presence of bends is shown in Figure B.4. A compatible flow-straightening device may be used upstream of a meter and/or sensor, provided its use does not conflict with the product installation instructions.

NOTE 3 Additional information about flow straightening devices can be found in AS ISO 5167.1.




NOTE X and Y refer to the multiplied distance that is applied to the nominal meter diameter (DN).

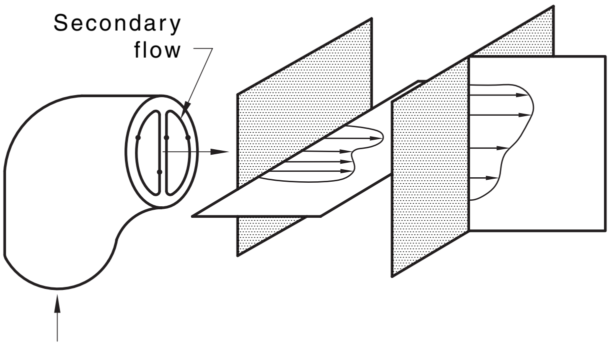
**Figure B.2 — Examples of best practice meter installations**


**Key**

1 Feed line

2 Main line

**Figure B.3 — — Example of water feed line connection to main line**



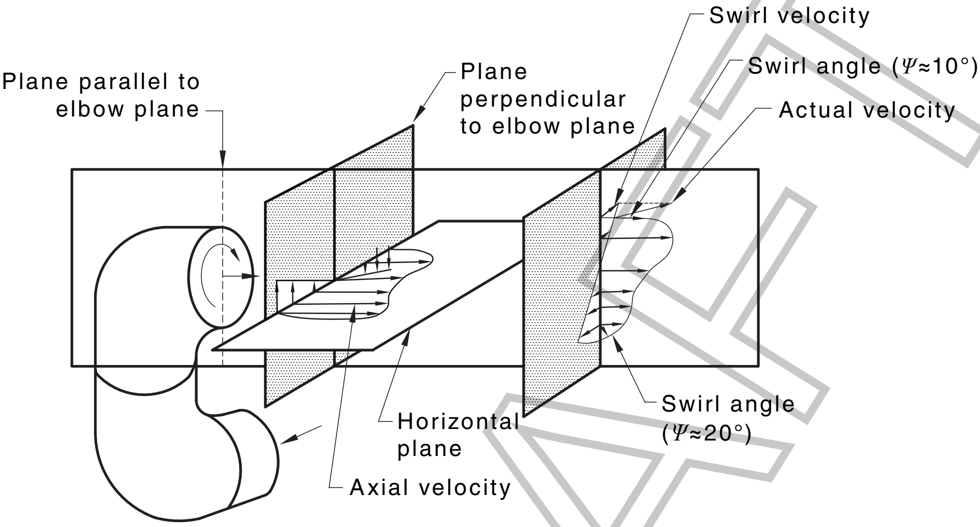




**Figure B.4 — Example of the effect on the flow profile caused by bend(s)**

# Appendix C
(informative)

## Flow disturbances that adversely affect metering system performance (closed conduit installations)

This appendix provides examples of the potentially significant effect of flow disturbances on metering system accuracy. The data are based on testing performed using only one meter type and model. It should be considered indicative for flow meters in general.

Figure C.1 shows a flow meter installed without the presence of flow disturbances. In this installation it is expected that the meter will operate within MPE and minimal error.

Figures C.2 to C.11 show non-optimal installations that result in meter errors. The errors are shown as multipliers rather than actual measurement errors.

The graphs show indicative error multipliers only and should not be used to calculate errors for the design or installation of metering systems.

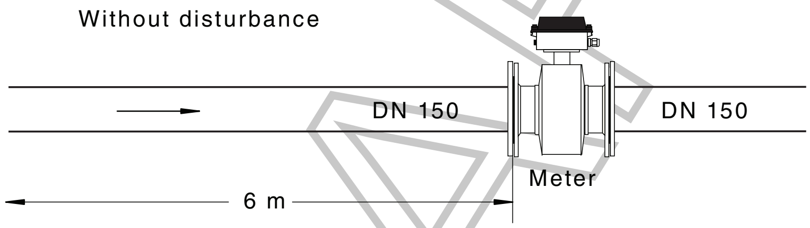
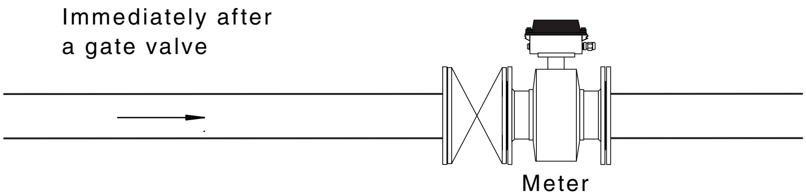
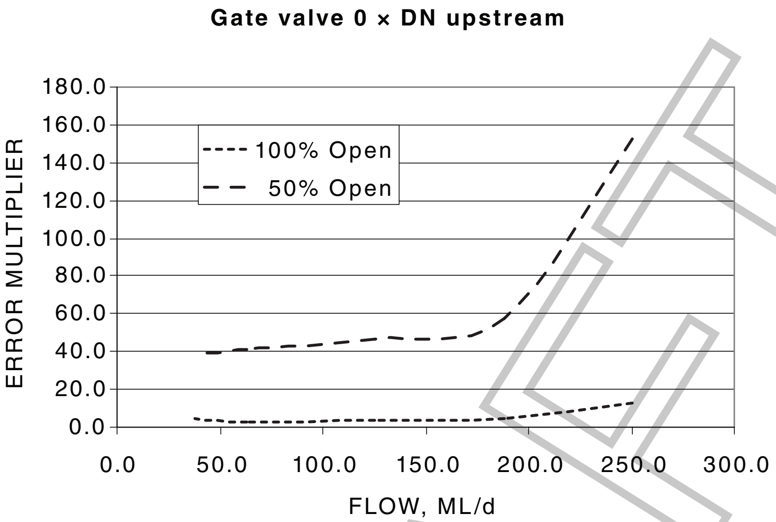


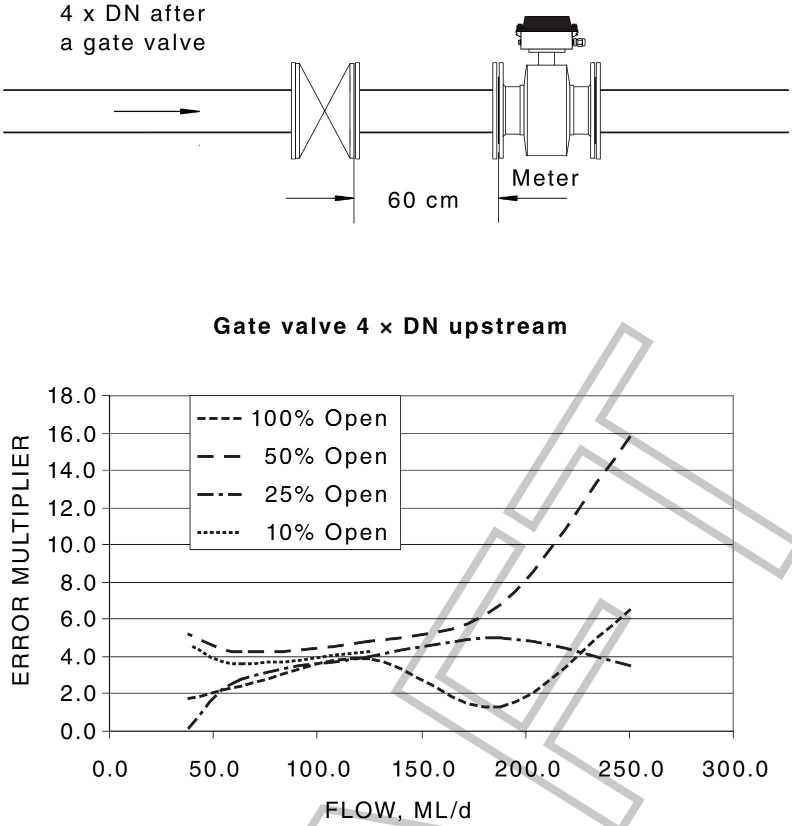

**Figure C.1 — Typical flow meter (no disturbance)**




NOTE The installation of valves upstream of the meter is not recommended.

**Figure C.2 — Gate valves upstream of the meter**




NOTE Off-centre disturbances should be avoided. Gate valves for isolation should be operated at 0 % or 100 % open.

**Figure C.3 — Gate valves for isolation upstream**

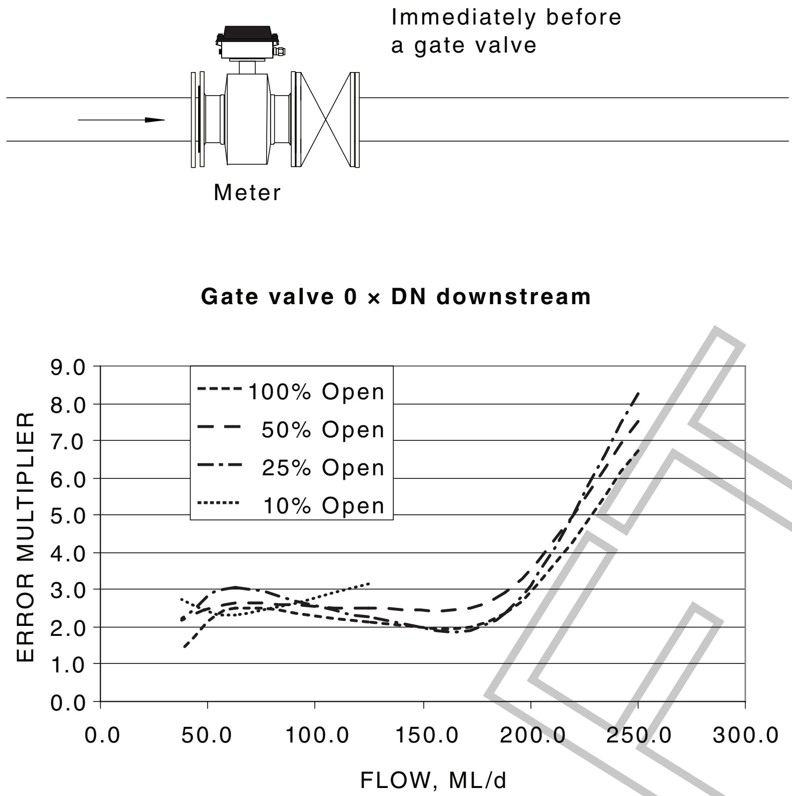
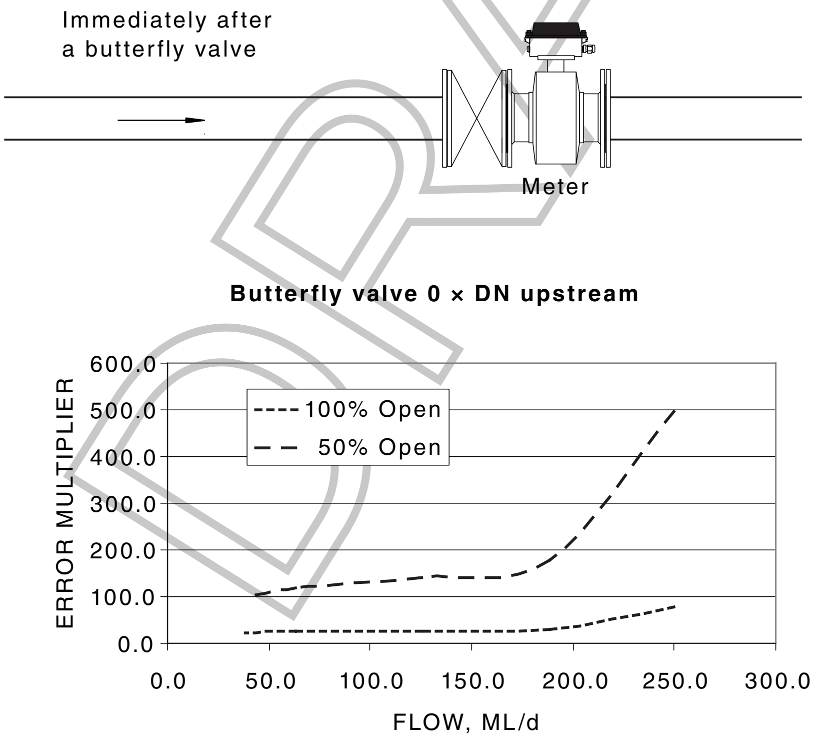
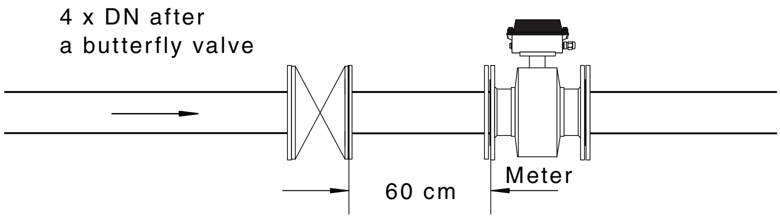


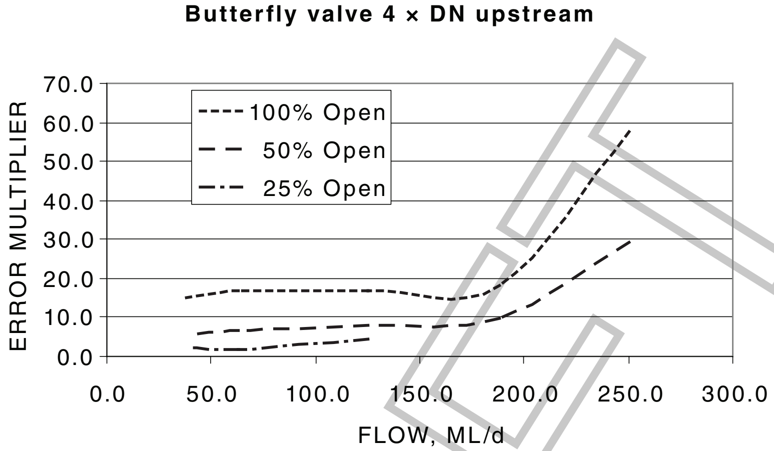

**Figure C.4 — Gate valves for isolation downstream**




NOTE Butterfly valves should not be used for isolation upstream.

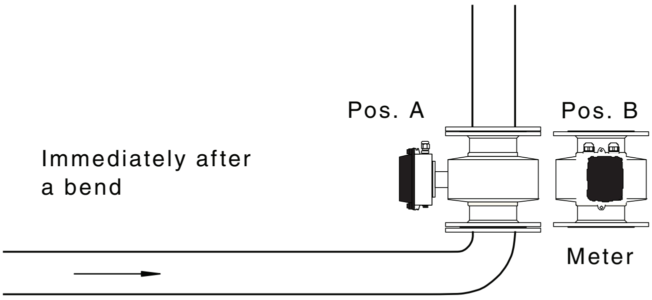
**Figure C.5 — Butterfly valves for isolation upstream immediately before the meter**

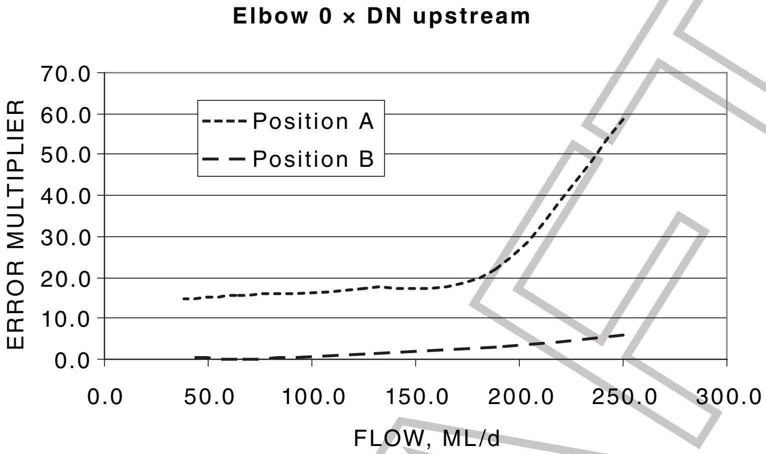



NOTE Even with some distance between the valve and the meter, butterfly valves are not recommended for isolation.

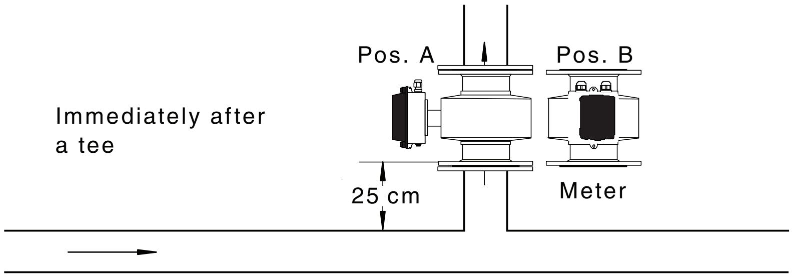
**Figure C.6 — Butterfly valves for isolation upstream**

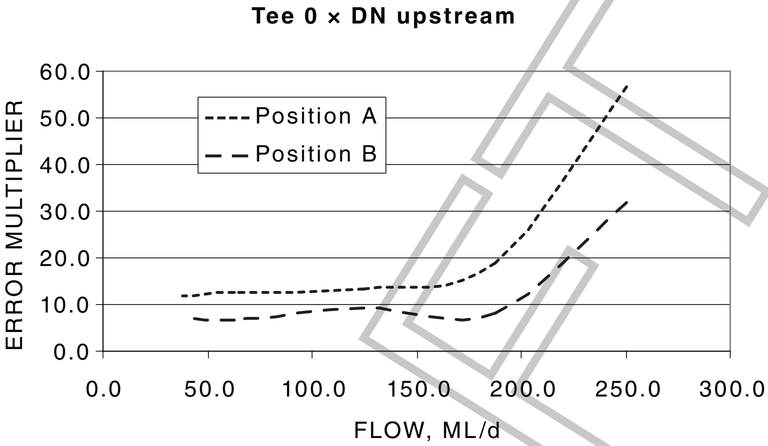



NOTE The orientation of the meter can affect measurement performance. The product specifications should be consulted before installation.

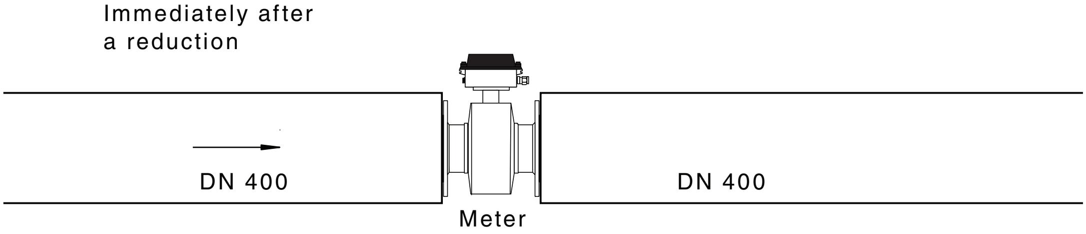
**Figure C.7 — Sensing axis of the meter**

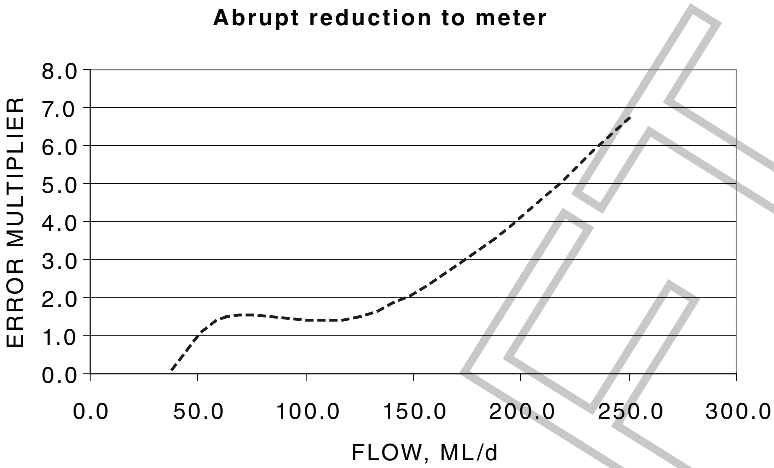



NOTE The sensing axis should be in the same plane as the tee.

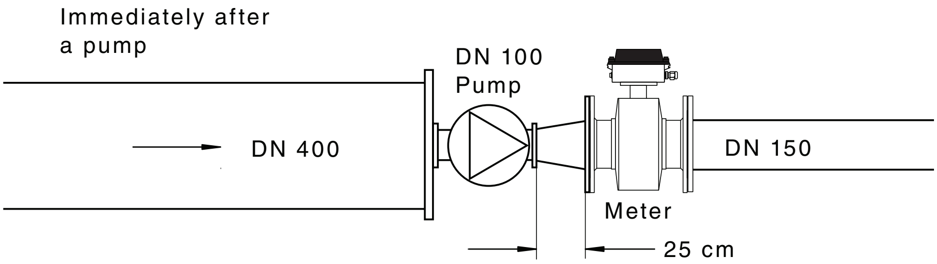
**Figure C.8 — Sensing axis at a tee**

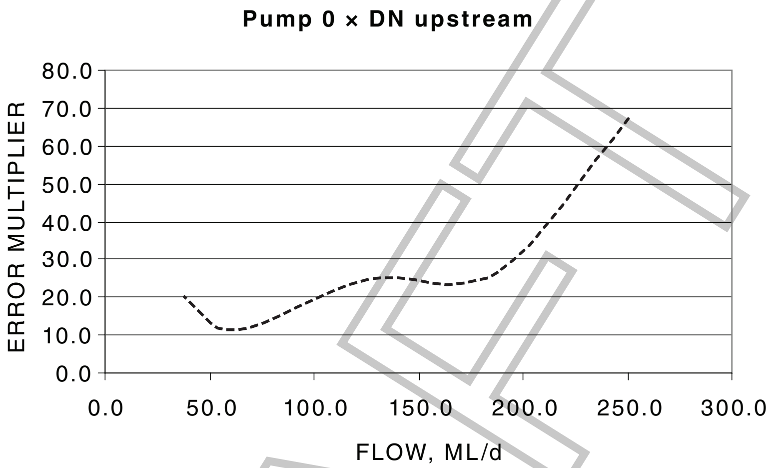



NOTE If the reduction is unavoidable, then it should be concentric, i.e. the centre lines of both the pipe and the meter should be in a straight line.

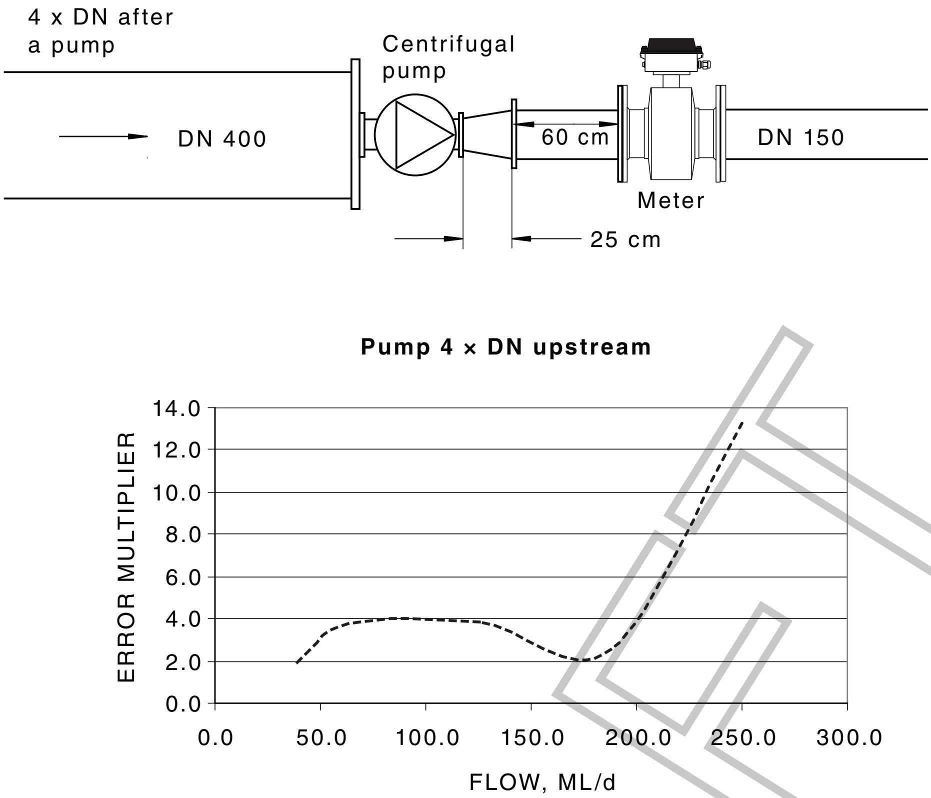
**Figure C.9 — Pipe reduction**




NOTE Different pump styles have varying effects on the flow profile.

**Figure C.10 — Pump configuration with pump immediately before the meter**




NOTE Different pump styles have varying effects on the flow profile.

**Figure C.11 — Pump configuration with distance between pump and meter**

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