SA Water

Engineering

Technical Standard

TS 0260 - Requirements for Flow Meters

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Users of this Standard accept sole responsibility for interpretation and use of the information contained in this Standard. Users should independently verify the accuracy, fitness for purpose and application of information contained in this Standard.

Only the current revision of this Standard should be used which is available for download from the SA Water website.

Significant/Major Changes Incorporated in This Edition

This document supersedes Technical Guideline TG31 – Selection of Flow Meters, which was issued 21/1/2005.

Document Controls

Revision History

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0.2	02/04/20	MST / CH	Final comments and minor changes made by Gordon Holmes
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1 Introduction

SA Water is responsible for operation and maintenance of an extensive amount of engineering infrastructure.

This standard has been developed to assist in the design, maintenance, construction, and management of this infrastructure.

1.1 Purpose

The purpose of this standard is to detail minimum requirements to ensure that assets covered by the scope of this standard are constructed and maintained to consistent standards and attain the required asset life.

This Standard adopts some of the requirements of AS 4747 – Meters for non-urban water supply – that relate to measurement of flow in closed conduits. AS 4747 was created primarily for the irrigation industry in response to the National Water Initiative. Despite this, some of the requirements of AS 4747 are applicable to water and wastewater applications within SA Water.

1.2 Glossary

The following glossary items are used in this document:

Term	Description
SA Water	South Australian Water Corporation
TG	SA Water Technical Guideline
TS	SA Water Technical Standard

1.3 Reference Documents

1.3.1 Australian

The following table identifies the standards, documents and/or articles that are referenced in this document:

Number	Title
AS 4747.2	Meters for non-urban water supply Part 2: Technical requirements for closed conduits fully charged
AS 4747.5	Meters for non-urban water supply Part 5: Installation and commissioning of closed conduit meters fully charged
AS/NZS 4020	Testing of products for use in contact with drinking water
AS/NZS 4087	Metallic flanges for waterworks purposes
NMI M 10	Meters intended for the metering of water in full flowing pipes Part 1: Metrological and technical requirements
NMI R 49-1	Water meters intended for the metering of cold potable water and hot water Part 1: Metrological and technical requirements
AWWA Manual of water supply practices	M33 Flow meters in Water Supply, 2nd Ed, AWWA, 2006.

1.3.2 SA Water

The following table identifies the standards, documents and/or articles that are referenced in this document:

Number	Title
TS15	Protection of Steelwork in Submersible Environments
TS16	Protection of Steelwork in Atmospheric Environments
TS18	Protection of Steelwork in Buried Environments
TS0109	Asset Design Life – Not Yet released
TS0133	Requirements for Asset Labelling
TS300	Supply and Installation of Low Voltage Equipment
SA Water Drawing 4004-00001-51	Sacrificial Anode Arrangement on Below Ground Flow Meter

2 Definitions

Refer to NMI M 10 for terms and definitions of metrology, water meter components and operating/test conditions. Some of the key definitions referred to in this standard are listed below:

- **Flow rate, Q** – The actual volume of water passing through the meter and the time taken for this volume to pass through the meter. Expressed as megalitres per day (ML/d), litres per second (L/s), cubic metres per hour (m3/h) or kilolitres per hour (kL/h).
- **Permanent flow rate, Q3** – The highest flow rate within the rated operating conditions at which the meter is required to operate in a satisfactory manner within the Maximum Permissible Error (MPE).
- **Minimum flow rate, Q1** – The lowest flow rate at which the meter is required to operate within the MPE.
- **Rated Operated Conditions (ROC)** – Conditions of use giving the range of values of the influence factors, for which the errors of indication of the meter are required to be within the MPE.
- **Maximum Permissible Error (MPE)** – The extreme values of the relative error of indication of a meter that is permitted.

3 Scope

This Standard covers the functional, mechanical and hydraulic requirements for the design, installation, testing and commissioning of flow meters for the following applications:

- measurement of water and wastewater flow in closed conduits (generally pipes) flowing full
- flow meters for installation in SA Water's water and wastewater networks, including bulk transfer systems, distribution networks, pump stations, tank sites and treatment plants
- the fluid being measured has typical water or wastewater properties at normal operating temperatures (5°C - 30°C).

This Standard is not intended to cover the following:

- measurement of flow in open channels or partially full pipes
- chemical dosing metering
- sludges or solids containing fluids >1% in water or wastewater treatment plants
- meters installed in customer connections intended for consumption metering and charging, (such as conventional mechanical meters or smart customer meters)

Flow meters used to measure the extraction rate of water from the environment (e.g. bores, aquifers, rivers), or to balance water extraction for reporting to authorities, or to balance water extraction that is transported through SA Water mains to a licensed third party, or to account for water allocated to specific water licenses are required to use a flowmeter that has Pattern Approval in accordance with AS4747. A list of currently approved meters can be obtained from a Murray-Darling Basin Authority document – "Pattern Approved non-urban Water Meters".

4 Selection

4.1 General

This section describes features of the different flow meters suitable for use in water and wastewater applications within SA Water.

4.2 Types

4.2.1 Electromagnetic (Full Bore) Flow Meter

Electromagnetic flow meters have no constriction or obstruction to the flow, resulting in a very low relative head loss. This feature also makes it suitable for use in wastewater applications. This type of meter also has good accuracy and rangeability. The performance of electromagnetic flow meters is less affected by changes in fluid temperature, pressure and velocity profile. An electromagnetic flow meter relies on the conveyed fluid having sufficient electrical conductivity, which is generally the case in water and wastewater applications.

4.2.2 Insertion Type Electromagnetic Flow Meter

This type of meter generally has similar performance characteristics to the full bore electromagnetic meter – low relative head loss, good accuracy and rangeability and low sensitivity to changes in pressure and temperature. However, there are two types of insertion meter which have important distinctions as follows:

- ***Averaging insertion type electromagnetic flow meter***. This type of meter has multiple sensing points along the probe that are effectively averaged to determine the overall average area velocity. As such, this type of meter is able to provide an accurate measurement of volume flow rate even if the flow does not have a fully developed flow profile. The undisturbed upstream pipe requirements are similar to that of a full-bore electromagnetic flow meter.
- ***Single sensor insertion type electromagnetic flow meter***. This type of meter has only a single sensing element at the end of the probe. This provides an accurate measurement of local velocity, but the calculation of volume flow rate is only accurate for a fully developed flow profile. As a result, a greater length of hydraulically undisturbed upstream pipe or flow straightener is required to achieve accurate results.

An insertion type electromagnetic flow meter can be installed through a small tapped connection in the pipe. If a live tapping is performed, the sensor can be installed without interrupting the service of the pipe.

Due to the probe being inserted into the bore of the pipe, this meter is not suitable for fluids containing solids (e.g. wastewater, raw water). There is an upper limit to the fluid velocity in which the probe can be installed due to the slender nature of the rod. This becomes more of a limitation in larger pipe sizes. Good accuracy relies on an accurate measurement of the pipe internal diameter, appropriate sizing of the insertion probe for the particular diameter, precise installation (e.g. installation depth of probe) and the absence of impurities within the measuring fluid which can buildup and impact response and accuracy.

4.2.3 Ultrasonic (Transit Time) Flow Meter

This type of meter is available as a pipe spool with integral sensors, or as sensors only that are mounted externally to the pipe (fitted via threaded socket fittings, strapped or clamped in place). Often pipe operation is not affected during installation or maintenance activity for this sensor type. There is no head loss associated with this type of meter. The meter does not rely on the fluid being conductive (as for electromagnetic meters).

Transit time ultrasonic flow meters function by measuring the difference in propagation of high frequency sound waves with and against the direction of fluid flow. As such, this type of flow meter is sensitive to changes in fluid composition, high solids content, entrained air or gas bubbles, noise, excessive turbulence and vibration. Single path sensor measurements are more susceptible to inaccuracy for flow profiles that are not fully developed and as such should not be used. Multiple path sensor measurements should be used. Good accuracy is also dependent on the pipe and fluid parameters which, in the case of externally mounted sensors, need to be input by the user (e.g. pipe material, diameter and wall thickness etc.). These parameters need to be known and input correctly in order to achieve an accurate measurement. Furthermore, these parameters can vary over the course of operation, for example due to lining deterioration, solids deposition, change in hydraulic conditions, biological growth, corrosion or variation in fluid composition. As such, the accuracy for a given installation can be variable.

The installation cost of ultrasonic sensors integral with a pipe spool is similar to an electromagnetic flow meter. As such and given the ultrasonic meter's sensitivity to process fluid changes and external factors, the electromagnetic flow meter is preferred over the pipe integral ultrasonic flow meter.

The use of clamp-on ultrasonic flow meters in new or permanent installations should be limited to applications where variability of the above-mentioned parameters is unlikely (e.g. potable water flow in stainless steel pipe). Given their adaptability to a variety of applications, ultrasonic flow meters are ideal for portable meters and temporary installations. However, care should be taken on reliance of the output where there is uncertainty or variability of the input parameters.

Installation of clamp-on ultrasonic flow meters shall include the requirement for acoustic coupling gel to be used.

4.2.4 Non-Preferred Flow Meter Types

Other types of flow meters include differential pressure (e.g. orifice plate, venturi), vortex, turbine/propeller and doppler ultrasonic flow meters. While these types of meters may have been used within SA Water in the past, they are not preferred for various reasons specific to each type of meter. These types of meters should not be considered unless there are exceptional circumstances that preclude the use of preferred meter types described above. In this case, consult SA Water Engineering.

4.3 Basis of Selection

Flow meters shall be selected based on the liquid being conveyed. Insertion type meters, or any meters that have parts protruding into the bore of the pipe or meter primary, or meters that have reduced internal bore size shall not be installed in wastewater applications.

Flow meters shall be selected based on the required accuracy for the application. As a minimum, the accuracy of flow meters shall comply with NMI M 10 (accuracy class 2.5, which implies accuracy to +/- 2.5%). This is suitable for most water and wastewater applications. Where a higher level of accuracy is required the accuracy shall be specified in accordance with NMI R 49-1 class 1 (which implies accuracy to +/- 1%). While NMI R 49-1 does not allow specification of accuracy class 1 for meters with Q3 (permanent flow) < 100m3/hr (28L/s), class 1 accuracy may still be specified for high accuracy meters for these design flow rates.

Flow meters shall be selected such that the range of design flow rates (including reverse flow if applicable) over which the Maximum Permissible Error (MPE) must be met falls between Q1 and Q3 (as defined in NMI M 10). In addition, the maximum instantaneous fluid velocity through the flow meter (or pipe containing the flow meter) shall not exceed 4.5m/s.

The type of flow meter to be used may be influenced by the nature of the installation, operational constraints and cost of installation. For permanent installations in new pipework, full bore electromagnetic flow meters are generally preferred. Insertion type electromagnetic flow meters and externally mounted ultrasonic flow meters are more economical to install into existing pipelines and can be installed without interruption to fluid flow. The use of externally mounted ultrasonic flow meters should be limited to applications where the process and pipe conditions are known and are unlikely to change.

Table 1 - Flowmeter selection guide

Flow meter type	Water	Wastewater	Accuracy	Rangeability	Undisturbed upstream pipe requirements	Undisturbed downstream pipe requirements	Installation cost in existing pipework (>DN375)	Permanent installation
Electro-magnetic (full bore)	Y	Y	Good	Good	5 – 10 x DN[5]	≥2 x DN[5]	High	Y
Insertion type electro-magnetic	Y	N	Good[1]	Good for small & intermediate sizes, limited in large sizes[2]	5 – 10 x DN[4]	>5 x DN	Low-medium	Y
Ultrasonic (transit time) – externally mounted sensors	Y	Y	Variable[3]	Good	10 - 20 x DN	>10 x DN	Low	Limited[3]

[1] Applicable for averaging insertion probes only. For single sensor probes, accuracy is only good for a fully developed flow profile.
[2] Limitation is due to structural properties of the probe as opposed to the sensor properties.
[3] Refer to Section 5.3
[4] Applicable for averaging insertion probes only. For single sensor probes, the requirement is much greater
[5] Where manufacturer's requirements can achieve less than indicated, the Designer and/or Contractor shall still include sufficient uninterrupted pipe lengths for future flowmeter installations to comply with the requirements in the above table

4.4 Design Life

Flow meters must be able to operate continuously in the rated operating conditions and maintain the specified accuracy over the life of the meter.

The designer and/or contractor must seek clarification from the proposed flowmeter vendor of the minimum design life of all components which are expected to require periodic maintenance and/or replacement. This detail shall be provided by the designer, contractor and/or vendor of the flowmeter.

SA Water will release the new Technical Standard TS0109 – Asset Design Life. In the absence of this standard, the following design life requirements shall be adopted in the interim, however, these will be superceded upon release of TS 0109.

The minimum design life of a flowmeter tube shall be 25 years. All electrical components shall have a minimum design life of 15 years. If components are identified to depart from the design life required, the specific components identified shall be provided by the proposed flow meter vendor to the designer and/or contractor for assessment. This information shall be reported to SA Water Engineering for endorsement before any flowmeter is procured. SA Water may require the designer and/or contractor to provide a maintenance schedule with estimated present-day costs before any flowmeter is procured.

5 Specification

5.1 Mechanical and Hydraulic

The size of the flow meter shall be specified such that the range of design flow rates over which the MPE must be met falls between Q1 and Q3. The MPE shall comply with NMI M 10 for accuracy class 2.5 or NMI R 49 for accuracy class 1.

The flow meter's maximum admissible pressure rating shall take account of all operating and testing scenarios, including static conditions, dynamic conditions (including surge, maximum and minimum pressures) and hydrostatic test conditions.

The flow meter shall provide an easily read display, either integral to the sensor or remotely. As a minimum, the display shall show instantaneous flow and totalised volume (not necessarily simultaneously) along with the units of each measure. Depending on the application, the display for instantaneous flow may be in either litres per minute (LPM), litres per second (L/s), metres cubed per hour (m3/h) or megalitres per day (ML/d). The display for totalised volume may be in either litres (L), kilolitres (kL) or megalitres (ML).

The designer and/or contractor shall identify all parameters associated with the installed environment and fluid chemical characteristics passing through the flowmeter. These parameters shall be provided and written on a technical datasheet. The technical datasheet shall be issued to flowmeter vendors.

Materials and IP ratings for electronic components shall be appropriate for the environment in which they are installed. At a minimum, materials shall be in accordance with AS 4747.2 Section 2. Material coatings shall be in accordance with SA Water's Material Science Technical Standards. For direct buried flowmeters, the entire installation shall be wrapped in accordance with the manufacturers requirements or in the absence of these, in accordance with TS18. Materials and coatings detail shall be written and provided on a technical datasheet by the flowmeter vendor.

End connections shall be flanged in accordance with AS/NZS 4087. The designer and/or contractor shall install a flanged flow meter such that there are no sudden change and/or steps across the upstream and downstream flanges (this applies to all water and wastewater applications). This is particularly important for wastewater applications to avoid problematic rag-ball formations and hydraulic chokes within pipelines. Additionally, this is important in water applications to achieve measured accuracy.

A name plate shall be fixed to the meter with the following information about the meter:

- manufacturer
- serial number
- pattern approval mark or manufacturing standard
- numerical value of Q3 (including units) and the ratio Q3/Q1
- size (DN, mm)
- direction of flow arrow
- Maximum admissible pressure.

5.2 Electrical

The flow meter shall comply with TS300 in regard to instrumentation equipment and the following:

Operational voltage: 24V DC (preferred); or 12VDC or 230V AC (where necessary).

Flow integrators shall be in accordance with clause 4.23.5 Integrators of TS0300 and the following:

- Direct reading digital total flow in the specified units;
- Reading shall be retained during a power failure;
- Shall not earth the instrument loop at either input; and
- Provide digital signal from flow transmitter integrator over Modbus/HART connection for totaliser flows through to SCADA.

5.2.1 Sensor

The flow meter sensor should comply with the following:

- Accuracy: shall comply with Clause 5.3 of this standard.
- Terminal housing: IP68

5.2.2 Transmitter

The operating temperature for the transmitter shall comply with the requirements of TS 0300 for integral and remote mounted transmitters.

The following output signals are required:

- 4 – 20mA (Instantaneous flow); and
- Totalised flow.

The transmitter shall make use of any of the following communication methods for connection to a PLC or RTU:

- Modbus via RS232 or RS485 (preferred);
- Analogue 4 – 20mA / HART (preferred); or
- Digital pulse signal (least preferred).

The transmitter shall also have local indication via LCD/LED display.

Serial communications will also provide additional information regarding the health of the transmitter that may be utilised for special applications.

5.2.3 Earthing rings

The earthing configuration at the site of installation needs to be accessed for the requirement of the earthing system. Earthing rings shall be installed if required and the earthing installation shall comply with the manufacturer's recommendations.

The earthing rings material shall be 316L stainless steel unless otherwise advised by the manufacturer.

6 Installation

Flow meters shall be installed in such a way that minimises hydraulic disturbances that affect the accuracy of the flow measurement. Hydraulic disturbances upstream of the flow meter typically have a greater impact on accuracy than flow disturbances downstream of the flow meter.

Electromagnetic flowmeters, whether bore or probe types, should not be installed in the vicinity of each other, as the electromagnetic fields of one may affect the operation and accuracy of the other. Suggested minimum separation is 1m.

The design of a flow meter installation shall be in accordance with the following, in order of precedence:

- the minimum requirements of this Standard, set out below
- the requirements of the flow meter manufacturer
- the requirements of AS 4747.5 Section 2.3.

The following are minimum requirements and shall take precedence where the requirements of the flow meter manufacturer or AS 4747.5 are less stringent. Where the requirements of the flow meter manufacturer are more stringent than the minimum requirements stated below, the requirements of the flow meter manufacturer shall be adhered to.

The minimum straight length of pipe immediately upstream of the flow meter without sources of hydraulic disturbance (e.g. tee junctions, elbows, non-full bore valves) shall be 5 times the nominal diameter of the flow meter. Where possible, it is preferred that this be increased to 10 times the nominal diameter, particularly after pumps. Upstream hydraulic disturbances that cause swirl (e.g. bends that are out of plane to each other) should be avoided. If this cannot be avoided, a longer upstream section of hydraulically undisturbed pipe or a flow straightener is required.

The minimum straight length of pipe immediately downstream of the flow meter without sources of hydraulic disturbance shall be 2 times the nominal diameter of the flow meter.

Flow meters shall not be installed in vertical pipe where the flow is downward.

Where a flow meter is smaller in diameter than the pipe in which it is installed (e.g. to achieve satisfactory accuracy for the design flow rate), tapers shall be used to make the transition in pipe size. The tapers shall be considered a source of hydraulic disturbance. Use of tapers shall consider the likelihood of air pocket formation on concentric tapers. Eccentric or flat top reducers (tapers) should be considered to avoid the likelihood of air/gas pocket formation. Tapers shall conform to flowmeter manufacturers requirements in terms of maximum change of angle allowed.

The installation shall be designed to avoid the possibility of air or other gases accumulating at or near the flow meter and for the flow meter to flow full under all normal operating conditions. Where the installation has the possibility of accumulating air at or around the flowmeter, a manual air release valve should be considered.

The installation shall be designed to avoid the possibility of solids collection at or near the flow meter.

For below ground pipes, chambers or direct buried applications, Figure 1 provides designers, contractors and others with indication of installation preferences.

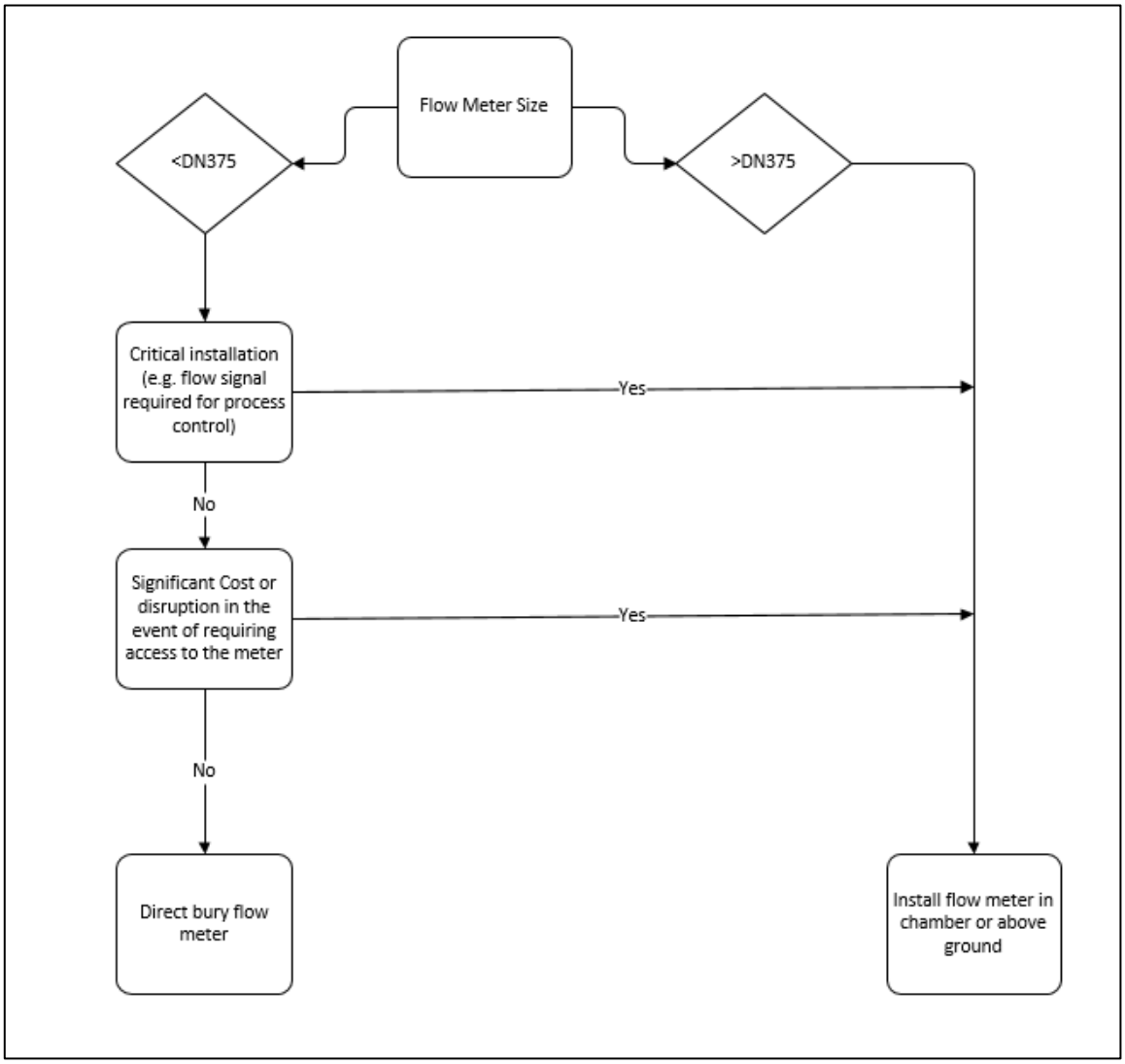

Figure 1 - Installation preferences

Where flow meters are to be installed above ground or in chambers, suitable means of removing the flow meter for inspection or maintenance shall be provided. This may be through the provision of a dismantling joint, or by arrangement of the pipework such that removal of other components (e.g. elbows) facilitates the removal of the flow meter.

Flowmeters shall have provision for safe lifting and handling during transport, installation and maintenance, where applicable.

Designers and contractor shall consideration the need for a bypass pipe arrangement around the installed flow meter. This may be required for critical and/or difficult locations where demand or supply conditions cannot afford any water supply outage.

Flowmeter electronic components shall be installed such that they are shielded from direct exposure to sunlight. The installation shall allow the nameplate details of the equipment to still be easily accessible and visible.

Sensor installation shall comply with the manufacturer's recommendations for potting of the terminal housing (below / above ground).

Stresses in the pipework (e.g. due to thermal expansion/contraction, hoop stress, thrust forces, vertical loading, external loading etc.) must be considered when designing the pipework. Flow meter bodies must not be subjected to large stresses. The flow meter manufacturer should be consulted to determine the allowable stresses on the body or flanges of the flow meter. Flow meters installed in welded steel pipelines, or any other installation where large stresses would otherwise be transferred through the flow meter, shall be installed with an unrestrained dismantling or expansion joint so that pipe stresses are not transferred through the flow meter. Pipe anchorage to facilitate this installation arrangement must also be considered along with any support required for the flowmeter body. Dismantling or expansion joints should not be direct buried.

In situations where cathodic protection systems are installed on pipes, special attention needs to be given to the isolation of the pipe from the flowmeter. SA Water drawing 4004-00001-51 provides guidance on the use of insulating joints.

Labelling of flowmeters shall follow the requirements in SA Water Technical Standard TS0133 – Requirements for Asset Labelling.

6.1 Wastewater Flow Meter Installations

Flow meters installed within wastewater applications (i.e. pumped rising mains, full pipe gravity mains, and other wastewater applications typical of wastewater treatment operations) shall adopt a flow meter with a full internal bore and nominal size (i.e. DN) that matches upstream and downstream pipe sizes.

7 Testing and Commissioning

Prior to bringing a flow meter into service, the flow meter installation shall be verified, including the following:

- verifying that the flow meter is installed in accordance with this standard and the manufacturer's requirements
- verifying there are no leaks during the hydrostatic pressure test
- verifying that all configurable parameters are consistent with the meter's factory calibration
- where the flow meter provides notification of errors, verifying that no such condition exists.

Requirements to be achieved as a minimum for factory inspection and testing of each flowmeter and documentation requirements shall be as listed in the flowmeter technical datasheet under the "Testing, Certification & Documentation" section. Coating certification for internal coatings or linings requiring compliance with AS4020 - Testing of Products for Use in Contact with Drinking Water shall also be included.

Where the flow meter provides system diagnostics, carrying out these functions and recording parameters as a baseline for future comparison. Where possible, flow sensor information shall be input into the transmitter for traceability.

For each installation, verification of the accuracy of the flow meter shall be undertaken by comparison with another form of measurement of the same volume flow rate. This may be achieved by either using another flow meter or a volumetric calculation. The measurement errors associated with either option shall be taken into consideration when comparing results.

On completion of commissioning, the 'zero flow' value must be set and the flow range between the transmitter and the PLC/SCADA must be verified as being the same.

8 Maintenance

SA Water periodically conducts tests to verify flowmeter accuracy. Consideration for flowmeter maintenance and future verification is to be made by the Designer and/or Contractor in the installation arrangement for any new flowmeter.

Whilst some of the newer flowmeter models can be verified through an Original Equipment Manufacturer, a volumetric drop test from an immediately upstream or downstream tank will also serve to verify the accuracy. Location of flow meters should be selected to facilitate the ongoing maintenance aspect such that the volumetric drop test can be conducted in service (e.g. provision of valving arrangements).