Procedure

M-PRO-STD-001 Commissioning of Electromagnetic Flow Meters for Potable Water Supply

Document number: PRO-01845

Ver No.	Description	Document Owner		Document Approver		
		Position	Approval	Position	Approval	Approval Date
4	Amended	Principal Engineering Standards and Assurance	Refer to supporting Info in Rex	Manager Technical Support & Improvement	Refer to supporting Info in Rex	14/07/2023
This Engineering Procedure was endorsed by an RPEQ on behalf of Seqwater.						

Contents

Version History

Ver	Date	Description	Author	SME	Owner	Approver
4	14/07/2023	Amended Version				
3	12/05/2022	Amended Version				
2	9/07/2018	Amended Version				
1	27/04/2015	Original Version				

(Refer Controlled Document in REX for Author, SME, Owner and Approver details)

1. Purpose

The Purpose of this Procedure is to describe the Procedure for the commissioning of flow meters covered by Engineering Standard M-SPE-STD-006, Bulk Supply Meters for Potable Water except for meters with a nominal diameter of ≤DN300 provided the installation conforms to the requirements of M-SPE-STD-006. This includes bulk supply flow meters for purified recycled water and potable water. 'Bulk supply" meters are those used for revenue/billing purposes.

This procedure should also be used for the commissioning of irrigation meters, non-urban customer billing meters and raw water offtake meters covered by Engineering Standard M-SPE-STD-007, Meters for Non-Urban Water Supply and may be used as a guide for the commissioning of process meters covered by Engineering Standard M-SPE-STD-009, Flow Meters.

2. Scope

This Procedure applies to all Seqwater employees, suppliers, contractors, and consultants working for, or on behalf of, Seqwater unless otherwise stated. Deviation from the requirements in this Procedure requires written agreement from Seqwater as per the deviation process noted in Procedure *X-PRO-STD-008 Asset Standards Management and Application*.

Seqwater undertakes regular updates of its Engineering Standards. Before utilising this Procedure, the complete list of Seqwater Asset Standards should be reviewed to ensure currency and applicability of standards to be applied to the works.

Advice must be sought from Seqwater to clarify any ambiguities regarding this Procedure.

3. Procedure

3.1. General

Refer to the nominated Standard Specifications referenced in Section 0 for the minimum requirements for Seqwater works relating to the design, supply, and installation of flow meters.

Flow meters for revenue applications are factory calibrated to a high level of accuracy. To maintain this level of accuracy, it is essential that the commissioning of a flow meter is carried out in a manner that demonstrates compliance; with the design, the manufacturer's installation guidelines, and provides confidence that the installed meter is measuring accurately in the context of the hydraulic network and conforms to the QLD Bulk Water Supply Code and the QLD Water regulations, Maximum Permissible Error of +/- 5%.

An Authorised Meter Validator is required to check that all non-Urban flow meters are calibrated, installed, and operating in compliance with the applicable codes, standards and Engineering Standards and issue a validation certificate for the flow meter installation.

Once a flow meter is installed, there are limited on-site options for testing to validate its accuracy. In some cases, it will be practical to compare the meter reading to a known volume from a reservoir or to compare the reading to

another network flow meter (or multiple meters). In doing so however, it is important to note that the value to which the flow meter is being compared to will have its own level of uncertainty.

It is important to note that a failed test result does not imply that the actual flow meter is the cause of the test failure, as the meter has traceable calibration records and therefore its accuracy was validated at the time of factory calibration. The failure may be caused by the design and construction of the system installation failing to provide the necessary undisturbed, symmetrical flow for the meter to read accurately, and thus the system installation design would need to be revisited to ensure the fluid flow meets the flow meter manufacturers specification. Additional factors, such as test method uncertainty too high or external influence (such as physical damage and electrical interference) can also lead to meter error.

3.2. Commissioning Requirements

A documented commissioning process for flow meters is required under the following scenarios:

a. Installation of a new flow meter

b. Replacement of an existing flow meter

c. After major repair of an existing flow meter

d. After transmitter replacement of an existing flow meter

The meter commissioning shall be documented in accordance with M-TMP-STD-003 Electromagnetic Flow Meter Commissioning ITP Template.

In cases where repair work has been performed on an existing flow meter, the extent of re-commissioning will depend on the potential impacts from the repair work. In such cases, comments will be provided in the ITP to justify any aspects of the commissioning process which were deemed not to be applicable.

In cases where a transmitter is repaired or replaced, the following items within ITP M-TMP-STD-003 shall be completed as a minimum:

- Item 19 - Flow meter verification
- Item 20 – Instantaneous flow rate verified on SCADA
- Item 21 – Totalised volume verified on SCADA

3.3. Flow and Volume Comparison Tests

A flow or volume comparison test shall be performed on commissioning or re-commissioning of a bulk water supply billing meter to confirm the accuracy of the meter installation. The nature of the comparison test will depend on the physical location of the flow meter within the bulk water network.

A comparison test may be carried out using one of the following methods:

- Volumetric drop test
- In-series flow comparison

A volumetric drop test is the preferred method of testing as it allows comparison between an indicated volume (volume indicated by the flow meter) and an actual volume (volume calculated by a change in reservoir level) to determine a Relative Error.

Further details on these test methods are provided in the following sections.

The volume drop test or in-series flow comparison test shall be conducted by a suitably qualified metering specialist familiar with statistical techniques relevant to measurement of Relative Error and determination of uncertainty budgets in accordance with ISO 5168 - Measurement of Fluid Flow – Procedures for the evaluation of uncertainties.

The proposed comparison test method and the reasoning behind this decision shall be documented in the business case associated with the project and subsequently within the project delivery scope of work. The test method shall be agreed by the relevant region's Coordinator Supply (Regional Operations), the Senior Engineer - Asset Strategy – P5269 (Retailer Customer Experience) and the Lead Mechanical Engineer – P6252 (Engineering Standards and Assurance) considering the following:

a. The location of the meter with respect to network reservoirs and other network meters

b. The extent of network configurations, isolations, and potential interruptions to supply to facilitate the test

c. The significance of the meter from a billing perspective

d. The cost and resources required to carry-out the test

3.4. Volumetric Drop Test

3.4.1. General

A volumetric drop test compares an indicated volume against an actual volume to determine a Relative Error. This is the preferred method of comparison testing.

The Relative Error is determined from the results of the volumetric drop test by the following calculation:

$$\mathbf{E} = \frac{\mathbf{V_i} - \mathbf{V_a}}{\mathbf{V_a}} \times \mathbf{100}\ (\%) \qquad \textbf{(Equation 1)}$$

Where:

E = Relative Error of the meter (%)

Vi = Indicated volume as measured by the indicating device, i.e., commissioning meter (m^3 or kl)

Va = Actual volume passed during the test, i.e., reservoir volume (m^3 or kl)

'Equation 1' is adopted from NMI R 49-1 "Water meters intended for the metering of cold potable water and hot water - Part 1: Metrological and technical requirements". NMI R 49-1 is the Australian metering standard adopted from OIML R 49-1 published by the International Organisation of Legal Metrology.

It is important to note that the term 'error' is different to the term 'uncertainty'. Error relates to the difference between an indicated value and an actual value, while uncertainty relates to the dispersion of values that could reasonably be attributed to the measured value.

A volumetric drop test should be performed at both a low and a high flow scenario, consistent with the rated flow range of the meter and the expected low and high operating flows.

The duration of the drop test shall be planned to meet the required drop in reservoir level for both the low and high flow scenarios.

To improve the accuracy of volumetric drop test calculations, internal surveys have been performed, and are available for the network reservoirs outlined in Table 1 below.

Table 1 Surveyed Reservoirs

Reservoir	REX Reference
Aspley Reservoir	INO/MAN/607
Camerons Hill Reservoir 1	INO/MAN/612
Camerons Hill Reservoir 2	INO/MAN/613
Green Hill Reservoir 1	INO/MAN/610
Green Hill Reservoir 2	INO/MAN/609
Kuraby Reservoir	INO/MAN/611
Molendinar Reservoir	INO/DRA/779/002
North Beaudesert Balance Tank 2	INO/DRA/418
North Pine Reservoir 1	INO/MAN/615
North Pine Reservoir 2	INO/MAN/614
North Stradbroke Island CWR #2	D23/61461

Volume calculations for other network reservoirs will need to be derived from an internal reservoir dimensional survey with a volume measurement uncertainty of less than 1 % with internal survey reservoir slices taken every 10mm of reservoir depth maximum.

As-constructed drawings may be used to determine the volume of a reservoir, however due to construction tolerances the variation between the actual as-constructed reservoir dimensions compared to the drawings needs to be confirmed to ensure the test uncertainty will be within the limits stipulated in section 3.6. Due to the likely high degree of uncertainty, this method is not recommended.

3.4.2. Relative Error and Uncertainty

There are many factors which may contribute to the overall Relative Error and uncertainty of this test method.

For this procedure, the following factors will be considered:

a. The uncertainty in the reservoir level measurement

b. The uncertainty in the reservoir slice area measurement or build tolerance

c. The uncertainty in the meter reading (meter error stated by the manufacturer in the calibration certificate).

The uncertainty in the volume calculation can be minimised by:

a. Obtaining accurate measurements of the reservoir internal dimensions

b. Obtaining accurate reservoir level measurements during the test

c. Maximising the drop in the reservoir level during the test

Provided a sufficient drop in reservoir level can be achieved, and the shape of the reservoir is well understood, the change in reservoir volume over time can be calculated with a relatively high accuracy and a low level of uncertainty. The acceptable Relative Error as per Section 3.6 is applicable.

3.5. In-Series Flow Comparison

3.5.1. General

An in-series flow comparison is a flow comparison between the flow meter being commissioned and a 'check' meter. The 'check' meter may be an existing billing or process flow meter with certified calibration and current verification. The appropriate network configurations or isolations shall be applied so that both flow meters experience the same flowrate.

For some meters it may be viable to use multiple in-series 'check' meters. This can allow for reduced measurement uncertainty. In this case, calculating Relative Error and uncertainty should be performed by a metering specialist familiar with statistical techniques relevant to measurement uncertainties.

3.5.2. Relative Error and Uncertainty

The Relative Error can be calculated in accordance with "(Equation 1" by assigning the volume measured by the 'check' meter as the actual volume, Va. However, a Relative Error should only be determined when the 'check' meter has a traceable accuracy and a low level of uncertainty.

In cases where the 'check' meter/s have traceable accuracy, and a low level of uncertainty, the acceptable Relative Error as per Section 3.6 is applicable.

In cases where it is not reasonable to calculate a Relative Error (i.e., there is no traceability to the accuracy of the 'check' meter), an alternate approach is to evaluate the consistency between the 'check' meter and the meter being commissioned by applying the student's t-test. The student's t-test determines if the two sets of measurement data significantly differ from each other based on industry established uncertainty factors to a nominated level of confidence. Such work however should be performed by a metering specialist familiar with statistical techniques relevant to measurement uncertainties.

3.6. Acceptance Criteria

For new, repaired or replacement flow meters, the acceptable Relative Error based on a volumetric drop test, or an in-service flow comparison test shall be the Bulk Water Supply Code MPE, (±5%) minus the 95% confidence level uncertainty budget associated with the test as determined in accordance with ISO 5168.

For this commissioning procedure, the limit for the test uncertainty is +/-2%. If the test uncertainty is greater than +/- 2% then the result cannot be considered as a validation of the meter installation accuracy but will only provide general confidence in the operation of the meter.

For example:

1. A volumetric drop test has a 95% confidence uncertainty budget of +/-1.2% therefore the acceptable Relative Error will be +/-5% minus +/-1.2% giving an acceptance value of +/- 3.8% maximum.

   Thus, a Relative Error test result of 3.6% is a pass and a Relative Error test result of 3.82% is a failure.

2. An in-series flow comparison test has a 95% confidence uncertainty budget of 2.1%. In this case the uncertainty budget is greater than the acceptable limit of <+/- 2% and the Relative Error result cannot be considered as a validation of the meter installation accuracy but only provide general confidence in the operation of the meter. For meter installation validation, the test uncertainty must be reduced, or an alternate test method employed.

For further explanation and examples, see AS 4747 Part 8: In-service compliance for non-urban water meters, section E7, interpretation of results. This further explanation and examples are relevant for all meter types.

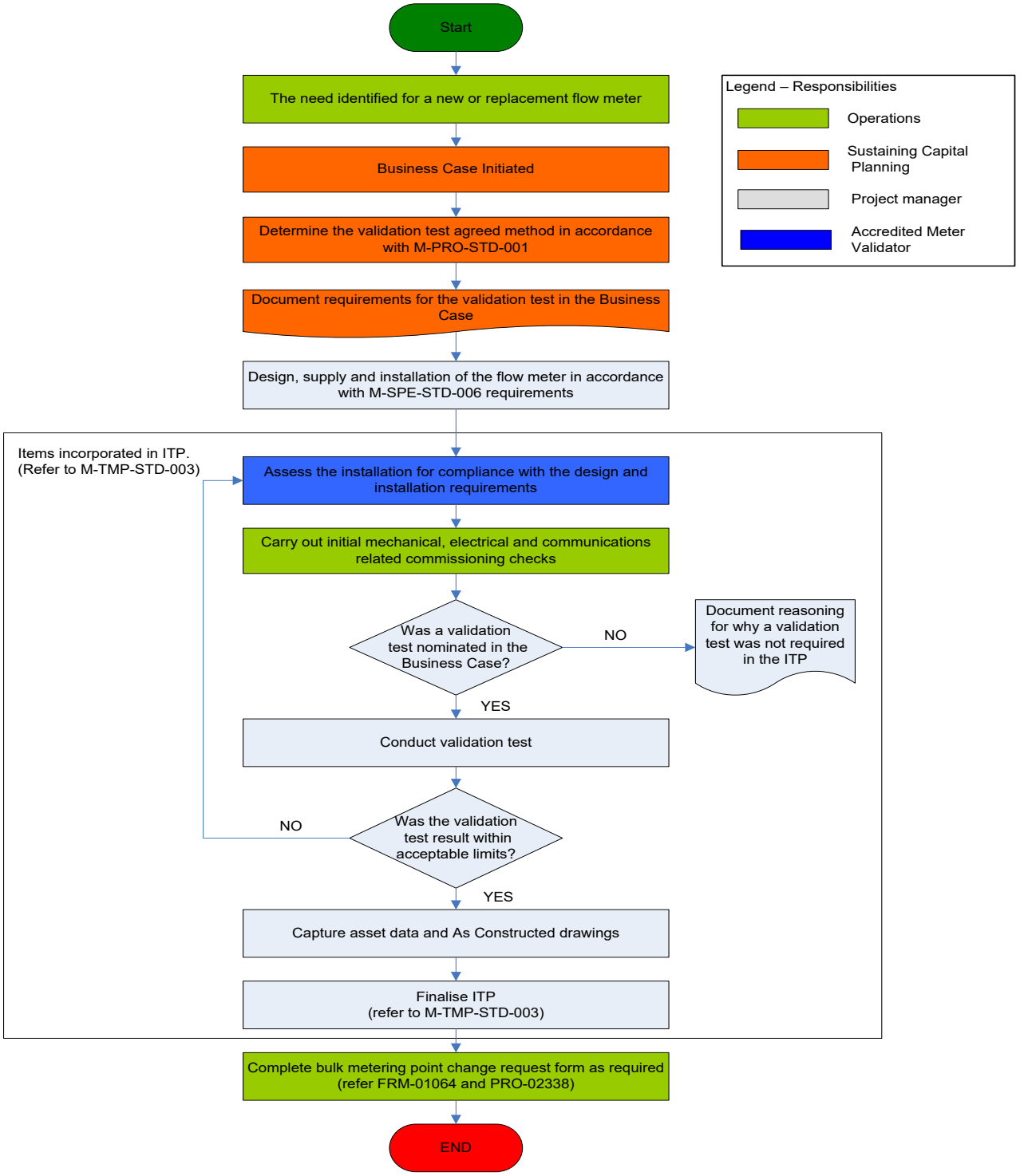
3.7. Asset Handover and Documentation Requirements

The following asset handover and documentation requirements apply to new and replacement flow meters:

- RPEQ signed Issued for Construction drawings and ES1 – Design Engineering Statement shall be submitted to engineering@seqwater.com.au on completion of the detailed design and prior to installation of the meter in accordance with Procedure X-PRO-STD-007 – Drawing and Spatial Data Standards and Procedure X-PRO-STD-009 - Engineering Design, Construction, Operation and Maintenance (PRO-01617).
- RPEQ signed As Constructed drawings and ES2 – Construction Engineering Statement shall be submitted to engineering@seqwater.com.au within 20 days of practical completion in accordance with Procedure X-PRO-STD-007 – Drawing and Spatial Data Standards and Procedure X-PRO-STD-009 - Engineering Design, Construction, Operation and Maintenance.
- Asset details shall be submitted to asset.information@seqwater.com.au in accordance with Procedure X-PRO-STD-010– Asset Information Collection Procedure.
- GPS co-ordinates of the meter location and asset details shall be submitted to gis.support@seqwater.com.au in accordance with Procedure X-PRO-STD-007– Drawing and Spatial Data Standards.
- A completed Electromagnetic Flow Meter Commissioning ITP (M-TMP-STD-003) shall be saved in the project REX folder. In addition, the completed form shall be submitted to asset.information@seqwater.com.au, engineering@seqwater.com.au and the Senior Engineer - Asset Strategy (P5269) for billing meter registration.
- A completed Bulk Metering Point Change Request form (FRM-01064) shall be submitted to Team Lead – Retailer Customer Service (P7637) in accordance with the Metering and Billing Management – Process Maps Procedures (PRO-02338).

3.8. Process Flow Chart – New or Replacement Flow Meter

The below flow chart summaries the process described within this document. It is important that this document is fully understood prior to undertaking the process. Refer to Section 3.2 for guidance in relation to flow meters undergoing major repairs.



4. Definitions and Abbrevations

Table 2 Definitions and Abbreviations

Term	Definitions
Authorised Meter Validator	A person who is accredited by Irrigation Australia Limited as a certified meter validator. (Catchment and Dams Operations Supervisors in irrigation scheme areas are accredited)
Contractor	An entity engaged by Seqwater to undertake work in accordance with an agreed contract and defined scope of work.
Employees	Means persons employed directly by Seqwater in a permanent, temporary or casual capacity.
Engineering Standard	Includes Seqwater Engineering Standard Procedures and Standard Specifications and associated supporting documents such as Standard Drawings, Guidelines, Lists, Manuals, Registers, and Templates.
Error of indication	Indicated volume minus the actual volume.
ITP	Inspection and Test Plan
Leader	Means any Level 1, 2, 3 and 4 Leader with responsibility for managing a functional area of the business, including people management responsibilities within their functional area.
Manufacturer / Supplier / Vendor / Original Equipment Manufacturer (OEM)	The entity that manufacturers or supplies equipment to meet the specifications of the Contractor.
MPE	Maximum Permissible Error
Owner / Principal / Seqwater	The entity that engages the Contractor to undertake the work and takes custody of the outcome. The Owner may delegate responsibilities to other entities to act on its behalf (e.g., a consultant).
Relative Error	Error of indication divided by the actual volume.
REX	Seqwater Electronic Document and Records Management System.
SCADA	Supervisory Control and Data Acquisition
Seqwater Approval / Acceptance	Written sign-off gained via the deviation process, as detailed in X-PRO-STD-008 Asset Standards Management and Application.
Shall / must	Indicates a mandatory requirement
Should	Indicates a recommendation
Student's t-test	A statistical hypothesis test used to determine if two sets of data are significantly different from each other.
This Procedure	TSI Procedure M-PRO-STD-001
TSI	Technical Support and Improvement

Term	Definitions
Uncertainty	A parameter associated with the result of a measurement that characterises the dispersion of the values that could reasonably be attributed to the measured value.
Worker(s)	Includes all permanent, temporary, and casual employees of Seqwater, and: • vocational and work experience placements • volunteers • contractors and consultants employed by another entity but temporarily assigned to do work for or on behalf of Seqwater.

5. Roles and Responsibilities

Table 3 Roles and Responsibilities

Role	Responsibility
Authorised Meter Validator	Responsible to validate Non-Urban Flow meters and provide an installation Validation Certificate.
Business Case Author	Assess viability of volume or flow comparison test method. Gain acceptance of volume or flow comparison test method from those nominated within this procedure.
Leaders	In addition to the responsibilities of a worker, ensure compliance with this Procedure by those they lead.
Manager Commercial and Customer Direction – P7636	Registration of meter per Metering and Billing Management Process Maps Procedure (PRO-02338)
Manager Technical Support and Improvement – P7630	Accountable for implementation and management of this procedure.
Principal Engineering Standards and Assurance – P6255	Responsible for implementation and management of this Procedure. Accountable and responsible for receipt and management of drawings.
Principal, Asset Information and Strategy – P6238	Accountable and responsible for receipt and management of asset information.
Seqwater Project Manager	Accountable and responsible for implementation of this Procedure as a whole. Some works may be delegated as appropriate.
Workers / Employees	Be aware of and comply with this Procedure

6. References and Related Materials

The documents listed in Table 4**Error! Reference source not found.** below, and the requirements therein, are relevant to this Procedure. In their latest editions, these documents form a part of this document. Note that this is not an exhaustive list of documents relevant to the works.

Seqwater undertakes regular updates of its Engineering Standards. Before utilising this document, the complete list of Seqwater Engineering Standards should be reviewed to ensure currency and applicability for the proposed works.

Table 4 Reference and Related Material

Description	Location
PRO-01617 X-PRO-STD-009 Engineering Design, Construction, Operation and Maintenance	REX & Waternet
PRO-01872 X-PRO-STD-002 Engineering Drawing Number Procedure	REX & Waternet
PRO-01873 X-PRO-STD-001 Asset Standards Documentation Classification and Naming Structure	REX & Waternet
PRO-01874 X-PRO-STD-004 Development and Review of Asset Standards	REX & Waternet
PRO-02140 X-PRO-STD-013 Engineering Technical Hazard Study	REX & Waternet
PRO-02187 X-PRO-STD-007 Drawing and Spatial Data Standards	REX & Waternet
PRO-02190 X-PRO-STD-006 Equipment Numbering and Naming Convention	REX & Waternet
PRO-02205 X-PRO-STD-008 Asset Standards Management and Application	REX & Waternet
PRO-02234 X-PRO-STD-015 Management of Change – Technical	REX & Waternet
PRO-02253 X-PRO-STD-014 Drawings Management Procedure	REX & Waternet
TEM-00224 X-TMP-STD-022 Asset Standards Deviation Request	REX & Waternet
SPE-00322 M-SPE-STD-006 Bulk Supply Meters for Potable Water	REX & Waternet
SPE-00347 M-SPE-STD-007 Meters for Non-Urban Water Supply	REX & Waternet
SPE-00434 M-SPE-STD-009 Flow Meters	REX & Waternet
TEM-00153 M-TMP-STD-003 Electromagnetic Flow Meter Commissioning ITP Template	REX & Waternet
PRO-02338 Metering and Billing Management – Process Maps Procedures	REX & Waternet
D14/146014 Attachment A - Guideline - Designation of a new, or change to a Bulk Water Customer Supply Point	REX & Waternet
FRM-01064 Bulk Metering Point Change Request Form	REX & Waternet
AS 4747 Meters for non-urban water supply Australian and International Standards Web Service	SAI Global
ISO 5168 Measurement of Fluid Flow – Procedures for the evaluation of uncertainties Australian and International Standards Web Service	SAI Global

Description	Location
NMI R 49-1 Water meters for cold potable water and hot water – Part 1: Metrological and technical requirements	National Measurement Institute (Australia)
OIML R 49-1 Water meters for cold potable water and hot water – Part 1: Metrological and technical requirements	International Organisation of Legal Metrology
Queensland Bulk Water Supply Code	Department of Regional Development, Manufacturing and Water
Queensland Water Regulations	Queensland Legislation

7. Changes from previous version

This Procedure will be regularly reviewed in accordance with the requirements of the Seqwater Controlled Document Management Procedure. Reviews will include consideration of suggestions for alteration or improvement made in accordance with Seqwater Procedure X-PRO-STD-004 Development and Review of Asset Standards. Changes made from the previous version are summarised in Table 5 below.

Table 5 Changes from previous versions

Section Number	Change
All	Reformatted to meet new Seqwater Style Guide requirements. Minor updates to wording to clarify requirements.
1	"with the exception of meters with a nominal diameters ≤DN300, provided the installation conforms to the requirements of M-SPE-STD-006." added
Table 1 (previously Table 7.1)	"North Stradbroke Island CWR #2 added"
3.5.1 (previously 7.5.1)	"Clamp on meter reference removed"
N/A (previously 7.6)	Network Flow Balance removed as an acceptable certification test method