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Amendments

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-	-	-	-	-

Preface

The Chief Metrologist has determined that NITP 14.0 together with NITP 14.1 are the national instrument test procedures for gas meters.

This document specifies:

- the test procedures for the verification of gas meters including individual verification for individual gas meters and individual verification using batch/lot sampling regimes to allow for a reduction in the number of test points
- the related requirements for utility meter verifiers.

This document does not mandate the pattern approval or verification of utility meters that are of a type and class exempt from the operation of the *National Measurement Act 1960* (Cth) (the Act) under regulation 5.6 of the *National Trade Measurement Regulations 2009* (Cth) (the Regulations).

Contents

Abbreviations

Refer to NITP 14.0 for all terms and abbreviations.

1. Scope

NITP 14.1 describes the specific test procedures for the verification of gas meters. Together with NITP 14.0 these are the test procedures to assess whether gas meters operate within the maximum permissible errors (MPEs) and of an approved pattern.

Certificates of approval for gas meters are based on NMI R 137 *Gas Meters* (NMI R 137).

All gas meters must also comply with the Act and the Regulations.

2. Standard procedures

2.1 Accuracy

2.1.1 General

An accuracy test determines whether a gas meter complies with the MPEs for specified test points and the maximum permissible weighted mean error (WME) over its flowrate range. Guidance on accuracy testing can be found in NMI R 137.

1. Perform a test at each specified flow rate (clause 3.2 or clause 3.3) by passing the reference quantity of gas through the gas meter and record the quantity indicated by the gas meter.
2. Calculate the error (of indication) for each flow rate and compare with the applicable MPE, using the formula:

$$\mathrm{E_m} = \frac{(\mathrm{V_i} - \mathrm{V_a})}{\mathrm{V_a}} \times 100\ \%$$

where: E_m is the error of indication of the gas meter under test, expressed as a percentage

V_a is the reference quantity measured by the reference device

V_i is the quantity indicated by the gas meter under test.

3. Calculate the WME of the gas meter over its flowrate range using the formula:

$$WME = \frac{\sum_{i=1}^{n} k_i E_i}{\sum_{i=1}^{n} k_i} \quad \text{with} \quad k_i = \frac{Q_i}{Q_{max}} \quad \text{for } Q_i \le 0.7\, Q_{max}$$

$$k_i = 1.4 - \frac{Q_i}{Q_{max}} \quad \text{for } 0.7\, Q_{max} < Q_i \le Q_{max}$$

where:

k_i = weighting factor at the flow rate Q_i;

E_i = the error at the flow rate Q_i.

2.1.2 Acceptance criteria

1. The gas meter passes the test if:
   a) the error (of indication) at each test point does not exceed the applicable MPE
   b) the WME of the gas meter does not exceed the maximum permissible WME.
2. Otherwise, the gas meter fails the test.

2.1.3 Maximum permissible errors

MPEs are stated in the relevant certificates of approval.

For reference, the usual MPEs are provided in Table 1.

The maximum permissible WMEs are provided in Table 2.

Table 1. MPEs for gas meters

Flow rate *Q*	Initial Verification			Subsequent Verification		
Accuracy class	0.5	1	1.5	0.5	1	1.5
$Q_{min} \leq Q < Q_t$	± 1 %	± 2 %	± 3 %	± 2 %	± 4 %	± 6 %
$Q_t \leq Q \leq Q_{max}$	± 0.5 %	± 1 %	± 1.5 %	± 1 %	± 2 %	± 3 %

Table 2. Maximum permissible WMEs for gas meters

	Initial Verification		
Accuracy class	0.5	1	1.5
WME	± 0.2 %	± 0.4 %	± 0.6 %

3. Test procedures

3.1 General requirements

The following test procedures determine if a gas meter meets the requirements for verification.

All tests must be performed while the gas conditions are kept as close as possible to the intended in-service operating conditions (pressure, temperature, gas type) of the gas meter.

Where the in-service conditions are unknown or unquantified, all tests must be performed at the reference conditions specified in NMI R 137 (2013).

Where the capability to test at in-service operating conditions is not available within Australia (e.g. high working pressure), the utility meter verifier must test the gas meter using the available testing capability, however they may consider the results of testing performed in overseas facilities to inform their decision to verify the gas meter.

Check the certificate of approval for any additional tests that may be required.

Consider and comply with any relevant safety requirements.

3.1.1 Gas type

Verification may only be performed with a type of gas (e.g. air) other than the type for which the gas meter is intended to be used, provided that the gas meter is approved for use with both gas types. Approved gas types are specified in the certificate of approval.

In this case the maximum difference between the error curves of the test gas and the in-use gas must be determined, and the need to use correction factors during verification testing is established as follows:

1. If the difference is within one-third of the MPE, verification may be performed with the alternative test gas.
2. If the difference exceeds one-third of the MPE, verification may only be performed with the alternative test gas if correction factors are applied.

3.1.2 Orientation

If the gas meter can be used in more than one meter orientation, verification must be performed in each of the orientations specified by the manufacturer, unless the certificate of approval indicates that the gas meter performance is independent of meter orientation.

3.1.3 Flow direction

If the gas meter can be used in forward and reverse flow applications, verification must be performed in both flow directions.

3.1.4 Ancillary devices

If the gas meter is intended to incorporate ancillary devices operated by the output shafts, these devices must be attached during the verification, unless attachment after verification is explicitly authorised in the certificate of approval.

3.2 Individual verification – individual gas meters

3.2.1 Gas meters (other than diaphragm gas meters)

Complete an accuracy test (clause 2.1) at flow rates distributed over the measuring range of the gas meter at regular intervals, including at Q_{min} and Q_{max} and preferably Q_t (included in the test points calculated below).

Based on three test points per decade the minimum number (N) of test points, ranking from i = 1 to i = N can be calculated according to:

$$N = 1 + 3 \cdot \log\left(\frac{Q_{max}}{Q_{min}}\right)$$

Where $N \geq 6$, and rounded to the nearest integer.

For flow rates covering two decades or more the following formula presents an adequate regular distribution of flow rates for i = 1 to i = N–1 and $Q_N = Q_{min}$.

$$Q_i = \left(\sqrt[3]{10}\right)^{1-i} \cdot Q_{max}$$

3.2.2 Diaphragm gas meters

Complete an accuracy test (clause 2.1) at the following flow rates:

1. Q_{min}
2. $0.2 \cdot Q_{max}$
3. Q_{max}.

3.2.3 Adjustments

If the errors of indication or the WME do not comply with the limits specified in Tables 1 and 2 respectively, the gas meter must be adjusted such that the WME is as close to zero as the adjustment and the MPE allow. Any adjustments are to be performed by the utility meter verifier.

Note 1: After making a linear adjustment it is not necessary to repeat all the tests. It is sufficient to repeat a test at one flow rate and calculate the other error values from the previous ones. However if the adjustment is polynomial, retesting is required at all flow rates.

Note 2: For high pressure applications, adjustment is performed while taking into account the operating conditions.

3.3 Individual verification – batch of diaphragm gas meters

3.3.1 General

Use this procedure to verify a batch of gas meters that comply with the requirements in clause 3.3.2. This procedure permits the utility meter verifier to undertake batch testing to allow for a reduction in the number of test points required to be tested. Examples are provided in Appendix A.

3.3.2 Requirements for determining a batch

A batch must only comprise gas meters that meet all of the following conditions:

1. of the same pattern
2. of the same accuracy class
3. manufactured in the same location
4. manufactured within the same 12-month period
5. produced in a unform and continuously operating process resulting in a large number of identical units
6. compliant with any additional criteria for a batch that is specified in the certificate of approval.

3.3.3 Test procedure

1. Complete an accuracy test (clause 2.1). All gas meters in a batch must be tested at Q_{max} and $0.2 \cdot Q_{max}$.
2. Draw a sample of gas meters at random from a batch in accordance with Table 3. Batch sizes and sample sizes must be determined and documented by the utility meter verifier.

   Note 1: The sampling plans specified below are based upon single sampling plans from *AS 1199.1 Sampling procedures for inspection by attributes*. Utility meter verifiers may develop and implement alternative sampling plans, such as those described in *AS 2490 Sampling procedures and charts for inspection by variables for percent nonconforming*. All sampling plans must be of reasonable and appropriate design, providing confidence equal to or better than the examples provided and therefore a sound statistical basis for decision making concerning the verification of a batch of utility meters.

   Note 2: The sampling plans do not allow the use of switching rules or skip-lot sampling (as described in AS 1199.1). Each batch must be considered in isolation without reference to the performance of previously tested batches. The sample size must be determined and implemented consistently, without adjustment.

3. For all gas meters in the sample complete an accuracy test (clause 2.1) at Q_{min}.

4. Determine if the batch passes or fails. The batch passes if:

   a) every gas meter in the batch passes the testing in step 1, and

   b) the sample of gas meters passes the testing in step 3. The sample passes if the number of gas meter failures is equal to or less than the acceptance number (see Table 3). The sample of gas meters fails if the number of gas meter failures is equal to or higher than the rejection number (see Table 3).

   Note: An individual gas meter in the sample fails if it fails the test in step 3.

   If a batch of gas meters fails, the batch must be rejected and cannot be verified.

   If the batch of gas meters passes, all gas meters in the batch, except for any individual gas meters that failed, can be verified. Any individual gas meters in the sample that fail must not be verified.

   In this procedure (clause 3.3) verified gas meters must be marked with a verification mark.

   Note: Gas meters from a failed batch may be individually reconsidered for verification in accordance with clause 3.2.

Table 3. Sampling plans – sample sizes and acceptance levels (inspection level II)

Size of batch	Sample size	Acceptance level 0.1%	
		Accept	Reject
2 to 8	2	0	1
9 to 15	3	0	1
16 to 25	5	0	1
26 to 50	8	0	1
51 to 90	13	0	1
91 to 150	20	0	1
151 to 280	32	0	1
281 to 500	50	0	1
501 to 1200	80	0	1
1201 to 3200	125	0	1
3201 to 10 000	200	0	1
10 001 to 35 000	315	1	2
35 001 to 150 000	500	1	2
150 001 to 500 000	800	2	3
500 001 and over	1250	3	4

Appendix A. Examples

A.1 Example 1

This example shows a batch of class 1 gas meters that have been batch tested to allow for a reduction in the number of gas meters required to be tested at Q_{min} in accordance with the provisions for batch testing detailed in clause 3.3. It is assumed the gas meters comply in all other respects not detailed. This example meets the requirements for batch verification.

The number of gas meters forming the batch is 4000.

The utility meter verifier tests all 4000 gas meters in the batch at Q_{max} and $0.2 \cdot Q_{max}$.

- Test results indicate that all 4000 gas meters are within MPE at Q_{max} and $0.2 \cdot Q_{max}$.

The utility meter verifier randomly selects a sample of 200 gas meters from the batch in accordance with Table 3. All 200 sample gas meters are tested at Q_{min}.

- Test results indicate all 200 sample gas meters meet the acceptance criteria.

Based on the results of testing, the utility meter verifier determines that the batch of 4000 gas meters meets the acceptance criteria and marks each gas meter with a verification mark.

A.2 Example 2

This example shows a batch of class 1 gas meters that have been batch tested to allow for a reduction in the number of gas meters required to be tested at Q_{min} in accordance with the provisions for batch testing detailed in clause 3.3. It is assumed the gas meters comply in all other respects not detailed. This example does not meet the requirements for batch verification.

The number of gas meters forming the batch is 4000.

The utility meter verifier tests all 4000 gas meters in the batch at Q_{max} and $0.2 \cdot Q_{max}$.

- Test results indicate that all 4000 gas meters are within MPE at Q_{max} and $0.2 \cdot Q_{max}$.

The utility meter verifier randomly selects a sample of 200 gas meters from the batch in accordance with Table 3. All 200 sample gas meters are tested at Q_{min}.

- Test results indicate the following:
  - 199 sample gas meters meet the acceptance criteria
  - 1 sample gas meter failed to meet the acceptance criteria.

Based on the results of testing, the utility meter verifier determines that the batch of 4000 gas meters does not meet the acceptance criteria and therefore none of the 4000 gas meters can be verified.

The utility meter verifier tests the remaining 3999 gas meters individually in accordance with clause 3.2.

- Test results indicate the following:
  - 3987 gas meters individually tested meet the acceptance criteria
  - 12 gas meters individually tested failed to meet the acceptance criteria.

The utility meter verifier marks each of the 3987 gas meters that met the acceptance criteria with a verification mark.

The 13 gas meters that failed are repaired several days later and then individually tested in accordance with clause 3.2. All 13 gas meters meet the acceptance criteria.

The utility meter verifier marks each of the 13 gas meters with a verification mark.