Industry Metering Advisory Group
In Service Testing Report

(approved 10th January 2008)

for submission to the Industry Metering Advisory Group Executive

Summary

The Industry Metering Advisory Group (IMAG), sponsored by ELEXON and OFGEM, set up the In-Service Testing and Post-MID Expert Group (IST1), to develop proposals for the in-service accuracy monitoring of gas and electricity meters following the introduction of the MID. The proposals would be submitted to IMAG for consideration and if approved, presented to the IMAG Executive with recommendations for implementation.

Subsequently a further Expert Group (IST2) was established to develop additional proposals to ensure that the other requirements in current legislation (over and above those of accuracy) were also met. This report presents the combined proposals of both these Groups for the in-service monitoring of MID approved gas and electricity **domestic type** meters. The adoption of these proposals may assist a company to demonstrate that it has conformed to the requirements of Schedule 2B section 3(3) of the Gas Act 1986 (as amended) and Schedule 7 section 10(2) of the Electricity Act 1989 (as amended).

The report identifies how homogeneous populations of such meters may be defined. It proposes intervals for the monitoring of these populations and a sampling plan to draw samples for testing. It recommends that suitable test results can be obtained from meter samples selected from “churn” and anticipates that sufficient samples may be available from churn but, if this is not the case, then suitable samples will need to be removed from premises. It is anticipated that the opportunity to obtain meters from “churn” will reduce with the introduction of Smart Meters. The types of meters suitable for sampling are given in the report.

The report also defines the requirements for test stations which are suitable for testing the samples and sets out the method for assessment of an overall population against defined criteria.

IST1 sought to achieve a balance between the need to demonstrate that an acceptable proportion of meters are within the required limits of accuracy, and the cost and inconvenience to the consumer of both testing and meter replacement. In the absence of any formal analysis of cost benefit, IST1 relied on its expert judgement to achieve this balance.

In addition IST1 has produced an end to end process map which can be followed by anyone carrying out such monitoring. There was a view from some members of IST1 that a National Body should be set up to follow the process map and administer the testing on a national basis. IST1 was also advised that all domestic suppliers supported this view subject to clarity on process and cost. Throughout the report it has been assumed that such a National Body will exist, however, some MOPs/MAMs may decide to carry out this sampling regime independently provided that they conform in all other respects with this process. The benefits of utilising the national approach are listed in section 15.

IST1 recommends that the proposal contained in this document is governed through the inclusion of suitable clauses in the OFGEM MAMCoP and the ELEXON COP 4 as an Industry accepted method of fulfilling legal responsibilities regarding in-service performance monitoring for Gas and Electricity meters respectively.

This report only applies to domestic type meters as many problems were envisaged applying these methods to smaller populations of larger capacity meters. IST1&2 invite IMAG to consider whether to extend these arrangements to non-domestic type meters and, in addition, to domestic type meters certified or stamped prior to the introduction of MID.
The need for further work is identified in section 17.

The Membership of IST1 is given in Annex 2.

The Membership of IST2 is given in Annex 3

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1.0 Introduction

The Industry Metering Advisory Group (IMAG), sponsored by ELEXON and OFGEM, set up the In-Service Testing and Post-MID Expert Group (IST1), to develop proposals for the in-service accuracy monitoring of gas and electricity meters following the introduction of the MID. The proposals would be submitted to IMAG for consideration and, if approved, presented to the IMAG Executive with recommendations for implementation.

Subsequently a further Expert Group (IST2) was established to develop additional proposals to ensure that the other requirements in current legislation (over and above those of accuracy) were also met. This report presents the combined proposals of both these Groups for the in-service monitoring of MID approved gas and electricity domestic type meters to ensure continued compliance with current legislation.

The work was considered necessary because the concept of certification life will not apply to post MID electricity meters and as there has been no equivalent specified procedure in the gas industry for maintaining meter accuracy there is now an opportunity to align practices in both industries.

IST1 restricted its scope to that detailed in section 3 based on the recommendation from the IMAG. Subsequently IST2 considered what further monitoring was necessary to supplement this work to achieve full compliance with legislation.

This report presents the proposals of IST1 for the in-service accuracy monitoring of domestic gas and electricity meters following the introduction of the MID and the associated monitoring proposals from IST2 for other metering requirements for legislative compliance. The adoption of these proposals may assist a company to demonstrate that it has conformed to the requirements of Schedule 2B section 3(3) of the Gas Act 1986 (as amended) and Schedule 7 section 10(2) of the Electricity Act 1989 (as amended).

MID

The Measuring Instruments Directive (MID) is a European Directive (2004/22/EC), adopted in March 2004, that covers a number of different measuring instrument types including gas meters and active electrical energy meters. The aim of the MID is to create a single market in measuring instruments for the benefit of manufacturers and, ultimately, consumers across Europe.

In the UK the MID is implemented by Regulations for the different instrument types which are available to download from the OPSI website at: **http://www.opsi.gov.uk/stat.htm**. For gas and electricity meters the relevant legislation is:

- The Measuring Instruments (Gas Meters) Regulations (SI 2006/2647)
- The Measuring Instruments (Active Electrical Energy Meters) Regulations (SI 2006/1679)

These Regulations came fully into force on 30 October 2006. Since this date all new designs of gas and electricity meters, that are within the scope of the Directive, must meet the requirements of the Regulations.

There is a transition period for instruments approved under UK national legislation before 30 October 2006, along with any authorised modification to that certificate, issued at any time. For gas and electricity meters this permits these instruments to continue to be placed on the market until 30 October 2016.

Note: Any instrument already in service may continue to be used indefinitely, as long as it meets the requirements of the Regulations.

The report shows how the performance of homogeneous populations of such meters can be predicted from the results of sample tests. It proposes intervals for the monitoring of these populations and a sampling plan to draw samples for testing.

This proposal for in-service testing of gas and electricity domestic meters is considered to fulfil the minimum requirements on those responsible for ensuring compliance of meters for ascertaining or registering quantities of electricity/gas.

The proposal applies only to domestic type meters subject to legal metrology for the purpose of consumer protection.

Subject to governance arrangements, should a MOP/MAM wish to utilise an alternative method for maintaining accuracy, the onus will be on that MOP/MAM to demonstrate to the Governance Board that it is equivalent to or better than the approach described in this document.

2.0 References.

The following documents have been used in the preparation of this report:

a) Measuring Instruments (Active Electrical Energy Meters) Regulations 2006 – SI No. 1679

b) Measuring Instruments (Gas Meters) Regulations 2006 – SI No. 2647

c) BS 6002-1:1993 ISO 3951:1989 Sampling Procedures for Inspection by Variables[1]

d) BS EN 50470-3:2006 - Electricity metering equipment (a.c.) — Part 3: Particular requirements — Static meters for active energy (class indexes A, B and C)

e) WELMEC 4.2 - Issue 1, June 2006: Elements for deciding the appropriate level of confidence in regulated measurements.(Accuracy classes, MPE in-service, non-conformity, principles of uncertainty).
http://www.welmec.org/publications/4-2.pdf

f) Committee Draft (CD 2) for a Document of OIML drawn up within TC 3/SC 4 December 2005 Surveillance of utility meters in service on the basis of sampling inspections.
www.oiml.org/download/cds/tc3_sc4_2cd.pdf

3.0 Scope

As recommended by IMAG, the scope of this report is in-service monitoring of MID approved domestic gas and electricity meters. It is intended to be a minimum process for assessing legislative compliance and it is considered that those responsible will have parallel processes in place to identify and remove any meters exhibiting other faults where additional functionality is required.

The report excludes the areas detailed in Section 17 (Recommendations for further work).

4.0 Methodology Overview

The legal responsibility for ensuring in-service compliance lies with the Gas Act Owner (GAO)/Electricity Supplier.

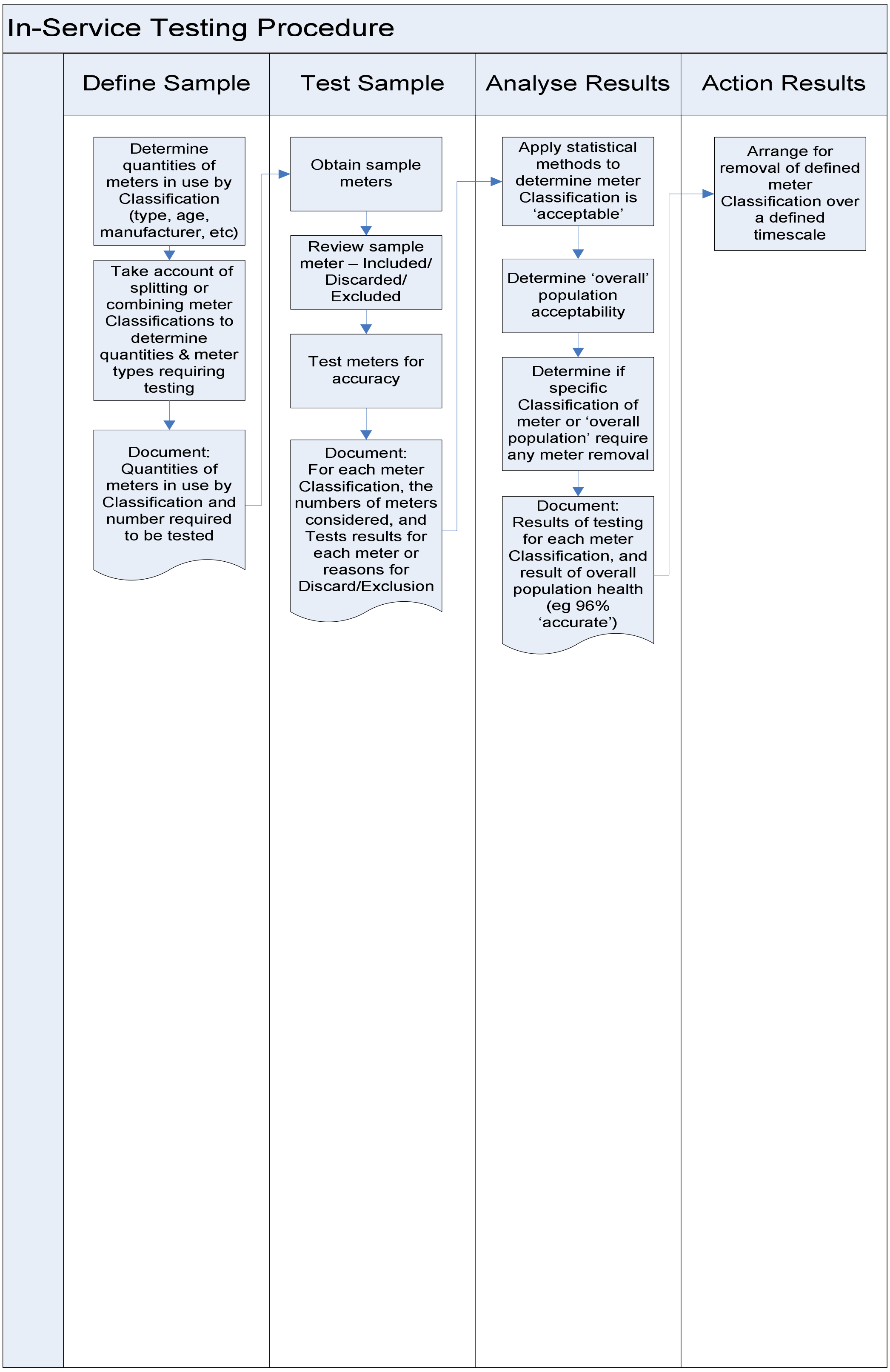
[1] This document has since been superseded by "BS6002-1:2007 Sampling procedures for inspection by variables. Guide to single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL".

To enable the person responsible to demonstrate that the meter asset currently in-service has a proper display of consumption and is measuring accurately, a sampling methodology and reporting procedure is outlined in this document. The objective is to provide an approach that can be adopted by all responsible persons, regardless of the meter population size.

This document provides the basis for responsible persons to determine the appropriate sample size required, the testing regime for the meters, and a mechanism whereby the responsible person and a National Body can ascertain the level of performance of the asset.

Taking a sample of the meter population is an acknowledged method of providing a measure of performance for the whole. However, to provide measures which are meaningful, the sampling must be undertaken in a controlled manner, and include the declaration of a lot/batch and the selection of an appropriate sample size, the methodology for testing and the interpretation of the results.

The proposed method in this report is based on the requirements of BS 6002-1 1993 ISO 3951:1989 'Sampling Procedures for Inspection by Variables' (BS 6002). The percentage of non conforming meters in the samples is used to define the quality of these samples and of the specific population under test. An overview of the proposed procedure is shown below:



The methodology ensures that the performance results for each meter are assessed consistently and is described in the main body of the document. Determination of the sample size is in accordance with BS 6002 and is based on population size.

The interpretation of the results for each population can be used by the responsible person to demonstrate a systematic approach to the maintenance of suitability and accuracy for those gas and electricity meters for which they are responsible.

Where sampling for a particular meter type has been carried out by a number of parties, the National Body will compile the resulting data from these parties and analyse results to enable a conclusion to be reached.

DEFINE SAMPLE

5.0 Definition of populations

5.1 Standard populations

In-service testing by sampling should only be carried out on homogeneous populations of meters.

For a population to be considered homogeneous all the meters in it shall consist of meters of the same characteristics, namely:

- Manufacturer
- Type or model
- Capacity/Rating
- Year of manufacture
- Number of the EC type examination certificate or the EC design examination certificate

Moreover, the following shall be identical in all meters:

(a) Electrical Energy Meters

- Number of registers (unless multi–rate version shares approval characteristics and is metrologically equivalent)

(b) Gas meters

- Diaphragm material (where applicable)
- Integral temperature conversion

5.2 Splitting of populations (sub-populations)

Meters which share the common characteristics defined above may be combined to form a single population but this does not prevent such a population being split on other bases (e.g by serial number range or by asset management company).

5.3 Combination of different populations

With the approval of the Governing Body and subject to the conditions stated below, combined lots of meters may be formed which are of different characteristics (e.g. single rate/two rate), provided that appropriate conditions for the assembly into such lots have been clearly stipulated by the body concerned, and which are owned or managed by different parties.

5.4 Combination of populations of the same type of meter (super-populations)

In the case of electricity meters of the same type (having the same approval number or conformity certificate) and subject to Quality Assurance control of manufacture, a number of years' manufacture, up to but not exceeding five years, may be combined to form a 'super population' of that type. The results obtained from tests on samples from the first year's population may be applied to subsequent years' production comprising the super-population without requiring further testing (Section 13.4.1 refers).

Note 1: Treatment of meters in this way is dependent upon the continuing consistency of metrological characteristics and, on a periodic basis, assurances should be sought from the manufacturer concerned that there have been no modifications to the pattern as submitted for EC-type verification which might affect such consistency.

Note 2: Experience of using this method, over many years, has indicated that it is satisfactory for electricity meters. A check on its continued acceptability is provided by the results of disputed meters.

Note 3: This method is not considered satisfactory for gas meters where experience has shown that populations from different years perform differently.

5.5 Repaired meters

Meters which are repaired without disturbing the metrological seal (e.g. gas meters that have had a pressure test point replaced,) are still to be considered as part of the original population to which they belonged before repair as they retain their original metrological approval.

Meters which require a new metrological seal after being repaired will have to be considered as a separate population. This is because they will have a different sealing date from similar meters manufactured at the same time. If the repair involves a change to the meter (e.g. a change of an electronic part), then this may require a new metrological approval or an extension to an existing approval.

6.0 Time intervals for in-service monitoring

This report recognises that because of their inherent design and the conditions under which they are used the accuracy of gas meters with time may be more susceptible to variation. For this reason different time intervals have been prescribed for gas and electricity meters.

Year of manufacture of meters	Y
Nominal Year of first assessment	Y+ A_1
Nominal Year of second assessment	Y+ A_2
……………	
Nominal Year of xth assessment	Y+A_x

	Years Gas Meters	Years Electricity Meters
A_1	3	8
A_2	6	13
A_3	9	18
…		
…		
A_x	3x	8+5(x-1)

Table 1

For the x[th] assessment, sampling, testing and analysis, for the purposes of this minimum process, shall not commence earlier than the start of the year Y+A_x and shall be completed (including any splitting of the population or agreed re-testing) by the end of the year Y+A_x+1.

The reference year for determining the year of manufacture shall be the two digit year following the 'M' mark on the meter.

Once a MAP starts installing a new meter type it will know well before the '8 year' requirements how many have been installed in years 1, 2, 3 etc.

7.0 Sampling plan and criteria for meter populations requiring replacement.

Sampling by variables shall be used as defined in Tables I-A and I-B of BS 6002. The number of samples required for a known population size is given in the following table.

Population by type and year	Sample Size
1,201 to 3,200	50
3,201 to 10,000	75
10,001 to 35,000	100
35,001 to 150,000	150
>150,000	200

Table 2

Note1: For Sampling by Variables, the sample size is independent of the Acceptable Quality Level (AQL) – it is the acceptance number, and hence the failure rate, that is dependent on the AQL. See section 12.3.

Note 2: Populations to be sampled may be the combined populations of a meter type within the control of a number of responsible persons. For example, should those reporting to the National Body have 140,000 meters of a population between them for a particular year, then the total sample to be obtained is 150 meters. The sample required from a particular entity shall be in proportion to the population of that meter held by the entity.

Note 3: It is not considered that populations smaller than 1201 will be economic for domestic type meters.

8.0 Drawing of samples

To minimise the disturbance to customers and to reduce costs, samples may be drawn from "churn". To ensure that there are sufficient samples suitable for testing extra samples may be drawn to allow that some samples will be unsuitable for test.

The following table should be used to determine which meters may be used for assessment:

METER CLASSIFICATION	INCLUDED (-suitable for accuracy test)	DISCARDED (-unsuitable for accuracy test)	EXCLUDED (-unsuitable for accuracy test but the reason for exclusion is to be recorded)
Normal condition	✓		
Disputed		✓	
Tampered (Physical evidence)		✓	
Missing security seals		✓	
Unsafe or broken case		✓	
Meter contaminated – (i.e. water)		✓	
Faulty display			✓
Deteriorating case			✓
PPM which cannot be enabled for test with a new key or token			✓
Advances under no load			✓
Passes un-registered gas (see note)			✓
Fails gas tightness			✓

Table 3

Note: A meter is deemed to pass un-registered gas if the test drum fails to rotate at least 3 dm^3 in less than 1 hour when air is passed through the meter at 14 dm^3/h.

The following table should be used to determine whether meters showing error indications or flag operation can be used:

Flag Operation -Ultrasonic Gas Meters to BS EN 14236:2007	INCLUDED (-suitable for accuracy test)	DISCARDED (-unsuitable for accuracy test)	EXCLUDED (-unsuitable for accuracy test but the reason for exclusion is to be recorded)
'A' - catastrophic failure			✓
'C' – operational problem	✓		
Unsatisfactory reading			✓
'b' – event – possible tamper	✓		
'r' – battery change imminent	✓[2]		
'F' - battery change overdue	✓[3]		
Flag Operation - Electricity			
EEPROM Error (may be due to meter interference)			✓
Microprocessor Failure (may be due to meter interference)			✓
Volatile Memory Failure (may be due to meter interference)			✓
Token/key communication failure		✓	
Phase Imbalance	✓		
Power Loss	✓		
Overload		✓	
Default Date and Time	✓		
Battery Low	✓		
Battery dead	✓		
Low Voltage	✓		
Signal Failure	✓		

Table 4

The additional number of samples required may be established by experience.

Even when drawn from churn, reasonable efforts shall be made to select meters as randomly as possible.

The inlet and outlet connections of gas meters should be sealed immediately after they have been removed from the supply network. Gas meters may be purged with air or inert gas for a short time.

No other processes such as repair, index exchange or flushing with liquid are permitted.

The meters shall be transported and stored carefully. Advice about this should be sought from the manufacturer when dealing with unfamiliar meter types.

The period between the removal of gas meters from the network and the assessment should be as short as possible and should not exceed one month.

9.0 Reporting of Excluded Meters

Meters which are classified as 'excluded' and deemed unsuitable for the testing process shall not have their accuracy checked but the reason for their exclusion is to be recorded by serial number and a report included with the accuracy results for the particular batch indicating the total in each category of exclusion.

[2] The battery may be changed before accuracy testing
[3] The battery may be changed before accuracy testing

Subject to governance arrangements, the National Body will monitor these results against population type. Where statutory register displays or meter construction appear to be deteriorating in an unacceptable manner they may call for additional samples to be taken or specify particular remedial action.

TEST SAMPLE

10.0 Test station requirements

An OFGEM (or its legal successor) appointed body shall authorize test stations.

The equipment used for testing shall have a total uncertainty of measurement of less than or equal to 0.5% for gas meters and less than or equal to 0.4% (at unity power factor) for electricity meters.[4]

Test measurements made by equipment satisfying the above uncertainty levels shall be deemed to be accurate (i.e. in assessing the population no allowance shall be made regarding the uncertainty of measurement).

11.0 Testing of samples

The testing of the samples shall be carried out by an authorized test station in a controlled manner, as described below.

11.1 All meters

A visual examination of samples shall be carried out before test and any that cannot be tested for accuracy as part of the sample for the reasons given in Section 8 shall be discarded or excluded.

11.2 Testing requirements for Electricity Meters

11.2.1 Visual inspection of samples accepted for test

Samples shall be inspected for fitness of purpose following energisation and classified according to the tables in Section 8. Where meters are to be 'Excluded' the reason for exclusion shall be recorded.

Meters showing indications of interference shall be discarded.

11.2.2 Testing procedure

11.2.2.1 Pre-heating

Prior to the commencement of any of the accuracy tests, the meters shall be pre-heated as specified in SI 1566:1998; Schedule 3 Para. 1.

11.2.2.2 Methods of test

Accuracy tests shall be conducted as specified in SI 1566: 1998; Schedule 3 Para. 4.

Where 'Method "B" or "C" Tests are conducted an additional 'Method "A" test shall be carried out at one of the test points.

All tests shall be of such duration to enable the meter error to be calculated within a tolerance of NOT greater than +/-0.2% .

[4] These values represent best practice rather than the normal applicable criteria for measurement accuracy.

11.2.2.3 Test loads

Meters shall be tested at unity power factor at the following load points:-

1 amp, 20 amps and I_{max}.

11.3 Testing requirements for Gas Meters

11.3.1 Initial testing of Gas Meters

Meters for testing shall be acclimatised in the test environment for a minimum of 8 hours. Prior to carrying out accuracy testing meters shall be tested for gas tightness and passing unregistered gas (PUG). Any meter which fails a gas tightness test or is found to be passing unregistered gas shall be excluded[5].

11.3.2 Test method

For diaphragm meters, before starting the tests, a volume of air equal to at least fifty times the cyclic volume of the meter shall be passed through the meter.

The accuracy of the gas meter shall be tested at the following flow rates:

0.2 Q*max* and 1.0 Q*max*

Analyse Results

12.0 Assessment of results including criteria.

12.1 Criteria

The applicable maximum permissible errors (MPE) are given in the tables below:

For gas meters, the limits of error for test purposes are:

Flow rate	MPE Class 1.5	MPE Class 1.0 (no additional in-service tolerance)
0.2 Q*max*	±3.0%	±1.0%
1.0 Q*max*	±3.0%	±1.0%

Table 5

NOTE: These values are taken from Statutory Instrument No. 2647 – The Measuring Instruments (Gas Meters) Regulations 2006.

For electricity meters, the limits of error for test purposes are:

Load point	MPE for meters of Class A	MPE for meters of Class B	MPE for meters of Class C
1 amp	+/- 2.5	+/- 1.5	+/- 1.0
20 amps	+/- 2.0	+/- 1.0	+/- 0.5
I_{max}	+/- 2.0	+/- 1.0	+/- 0.5

Table 6

[5] Meters passing unregistered gas are normally caused by dust storms in particular areas of the gas network. This is a particular UK problem due to the age of the network and the change from manufactured to natural gas.

NOTE: These values are based on the test requirements in Table 4 of EN 50470-3:200(6) for tests of accuracy at reference conditions, allowing for the additional errors due to variation of influence conditions to be taken into account.

12.2 Outliers

All the assessment methods given in 12.3 require the calculation at each test point of the sample average error (xbar) and the sample standard deviation (*s*) for each population. As part of this assessment the effect of any outliers must be evaluated. Other methods (e.g. Grubb's test,) could be used, however, for these purposes in order to simplify the process and avoid the possibility of repeated iterations being used to 'clean up' data, an outlier is defined as:

- For all the specified loads and flow rates – any result that indicates more than twice the permitted error[6].

Regardless of the number of outliers found only the numbers specified below may be removed:

Population	Minimum +Sample Size	Max No. of Outliers to be Removed
1,201 – 3,200	50	1
3,201 – 10,000	75	2
10,001 – 35,000	100	2
35,001 – 150,000	150	3
150,001 – 500,000	200	4

Table 7

12.3 Assessment methods

Populations may be assessed individually or as part of an overall population (- section 12.3.3 refers). Electricity meters may be assessed as super-populations

12.3.1 Normality

It has been assumed throughout that the results from tests will exhibit a normal distribution

12.3.3 Individual population assessment

To assess an individual population the sample average error (xbar) and the sample standard deviation (*s*) are calculated.

Determine the value of the following two expressions: USL-xbar)/*s* and (xbar-LSL)/*s*.

If for any test point:

(USL-xbar)/*s* < *k*   or   (xbar-LSL)/*s* < *k*,

then the population shall be deemed unacceptable. (However, see 12.3.3 for Overall Population Assessment.)

where:

k is the acceptability constant[7] for an AQL of 5 given in table 8

[6] Taken from Australian and New Zealand: AS/NZS 1286.13:2002 Electricity metering - In-service compliance testing.

[7] The value of *k* is dependent on the population size (and hence the sample size) and the defined acceptable quality level (AQL). Table II-A – Single sampling plans for normal inspection (master table): "s" method for ISO3951: 1989 has been utilised to derive the appropriate values of *k*.

USL (the upper specification limit) is the positive tolerance given in 12.1
LSL (the lower specification limit) is the negative tolerance given in 12.1

The values for *k*, for the relevant AQLs are shown in the following table (further information on the calculation of AQL's can be found in Annex 4:

	AQL	Sample Size 50 *k*	75 *k*	100 *k*	150 *k*	200 *k*
	1.00	1.93	1.98	2.00	2.03	2.04
	2.00	1.70	1.74	1.76	1.79	1.79
	3.00	1.54	1.58	1.59	1.62	1.63
	4.00	1.42	1.46	1.48	1.51	1.51
Target	5.00	1.32	1.35	1.37	1.40	1.40
	6.00	1.24	1.27	1.29	1.31	1.31
	7.00	1.16	1.20	1.21	1.24	1.24
	8.00	1.10	1.13	1.15	1.17	1.17
	9.00	1.04	1.07	1.09	1.11	1.11
Backstop	10.00	1.00	1.03	1.05	1.07	1.07

Table 8

The Governing Body will also monitor the reports of excluded meters against population type. Where statutory register displays or meter construction appear to be deteriorating in an unacceptable manner it may call for additional samples to be taken or specify particular remedial action.

12.3.3 Overall Population Assessment

A MOP/MAM may choose to maintain its overall portfolio to a specified level of accuracy (e.g. the MAM maintains that 95% of its total portfolio of meters is within the MPE limits). The overall portfolio of a MOP or MAM shall be assessed each year from sample results as follows:

1) For each individual population of meters tested (N_i), calculate the percentage of meters within the MPE (P_i) i.e. find the lowest AQL that satisfies the two inequalities given in Section 12.3.2.
2) Multiply the total number of meters in the individual population by the fraction that is within the MPE (N_i*P_i).
3) Calculate this figure for each individual population and sum to find the total number of meters in the overall portfolio that are predicted to be within MPE.
4) Divide the total number of meters within MPE by the total portfolio to determine the overall performance measure.

$$Overall = \frac{\sum_{i=1}^{n} N_i * P_i}{\sum_{i=1}^{n} N_i}$$

- Where there are n individual populations and for the ith population, N_i is the total number of meters of that type in the overall portfolio and P_i is the proportion of meters of that individual type that are estimated from the testing results to perform within the MPE limits.

N.B. The following rules shall apply in respect of meters for which test data is limited;

- Until a particular meter population is tested for the first time (A_1) it will be assumed that 100% are within MPE.

- For populations that have been tested once, the fraction within MPE as tested at time A_1 years shall be applied until the meters are next tested.
- For populations that have been tested twice, the fraction within MPE as tested at time A_2 will be applied until the meters are next tested
- After 3rd testing in year A_3, estimates based upon a trend line shall be used to estimate performance in intervening years, using all previous test results, eg A_1, A_2, A_3.
- If there are meter types within the portfolio that have been identified under the backstop arrangements (see 13.1) below then these shall be excluded from the calculation of the overall population assessment.

ACTION RESULTS

13.0 Interpreting results and determining actions.

13.1 Backstop Arrangements

In order to ensure that poorly performing meters are always removed from the system, any meter types where the sample shows their acceptance AQL is [10%][8] or higher shall be removed from the system within 2 years. This shall apply under both the individual population assessment and the overall population assessment methods.

13.2 Overall population assessment

Where a MAM chooses to manage the overall population, action taken as a result of the testing should ensure that the overall percentage of his portfolio estimated to be within MPE never drops below 95%. If less than 95% of the population is estimated to be within the MPE then urgent action shall be taken to restore the population to the target status within two years.

Note that the backstop arrangements shall be applied before the overall population assessment is made. If the overall population assessment, taking into account any exclusions made as a result of the backstop arrangement, is above the required level then no further meter replacements, other than those subject to the backstop arrangements shall be required.

13.3 Removal of unacceptable populations

If the assessments above call for a meter population to be replaced then the replacement shall be completed within two years from the decision being taken, subject to consumers' responses to reasonable efforts being taken to gain access. An extension to this period may be granted for large replacement volumes.

It is proposed in Section 17 that further work be carried out to develop a recommended procedure for obtaining access to customer premises for meter exchange.

N.B. Nothing in this document shall remove the legal obligation to maintain individual meters within the prescribed levels of accuracy. The Regulatory Authority may require further sampling of any meter population where there is evidence from 'disputed meter' investigations that certain types of meter are not performing to the required standard.

13.4 Treatment of electricity meter super-populations assessed individually

13.4.1 Basic Process

[8] Some members felt that this figure should be larger so that this testing regime could be more easily extended to legacy as well as MID approved meters.

Tests on meters of the first year's production Y of a super-population (as defined in 5.4) dictate what happens to all meters in that super population, subject to the safeguards below.

If the tests in year Y+A_1 are satisfactory (for explanation of A_1 etc see Section 6 and for population acceptance criteria see 12.3.2) then no further tests are carried out until year Y+A_2, when that year's population is tested again. Meters produced in years Y+1, Y+2, Y+3, etc are deemed to meet requirements until the next tests.

13.4.2 Safeguards

For assurance in this process it is important that

- the super-population comprises meters having consistent metrological properties (see 5.4), and
- the first year's production is of sufficient volume to be representative of the yearly populations to follow, and
- the sample size (as indicated in Table 2) is related to the *total superpopulation* not the population of the year(s) tested

In respect of the second point, a population below the threshold as in Table 2 (ie less than 1201) would not be considered satisfactory and testing should be deferred until year Y+A_1+1. Where the population exceeds 1201, but is less than [30%] of the next year's population, testing may be done in year Y+A_1. In both cases samples should be taken from both years Yand Y + 1 to make up the sample size as dictated by the total superpopulation. Where the first year's population is greater than [30%] of the next year's population, then samples may be drawn from year Y only.

NOTE 1: Where a National Body is arranging testing, then these decisions will be based on national populations as advised.

13.4.3 Removal of Defective Meters

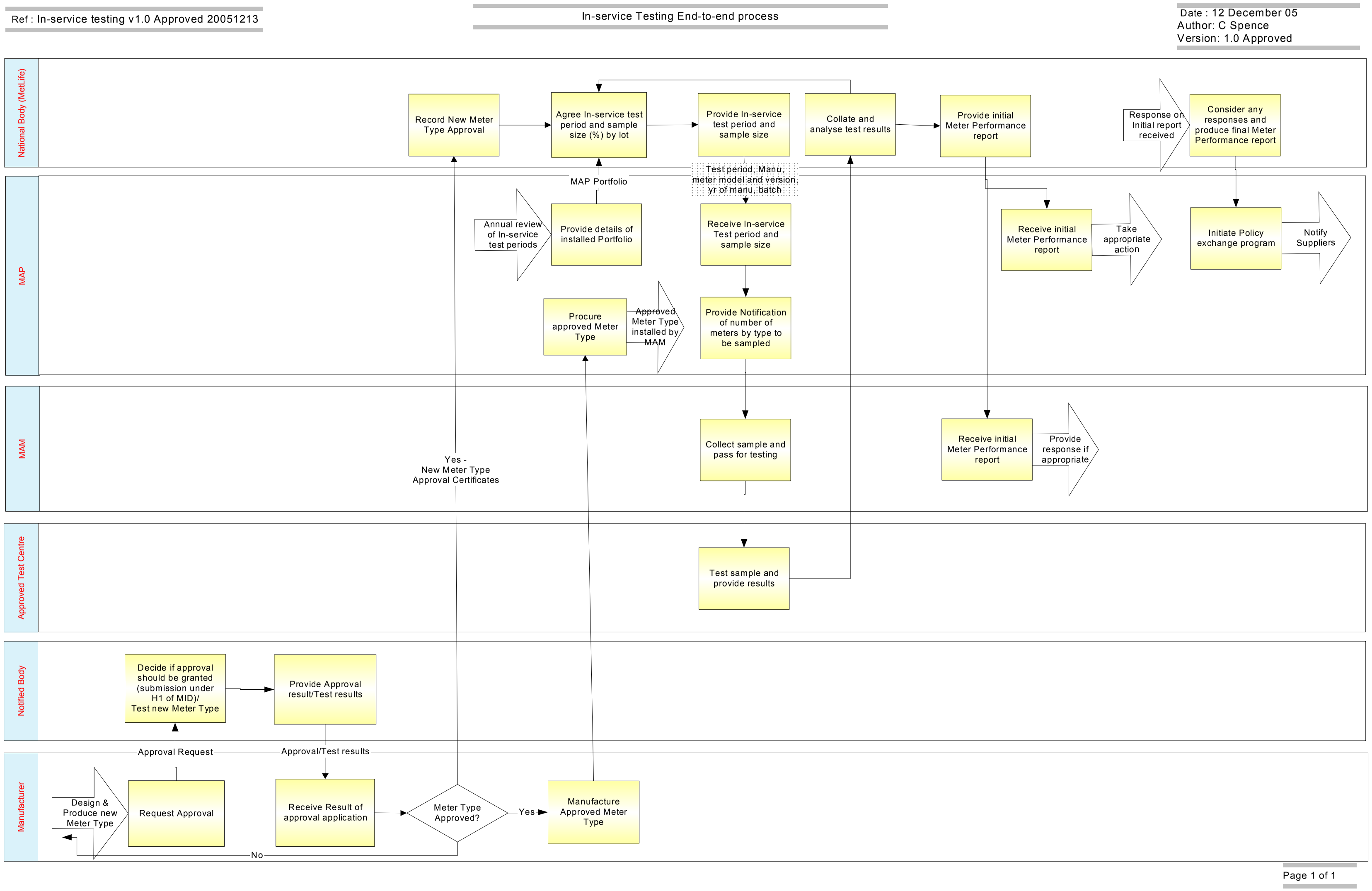
If the tests in any year Y+A_x do not meet the acceptance criteria of an AQL of [5%] but the actual AQL is less than 10%, then the meters produced in year Y shall be removed within 2 years. Meters produced in year Y+1 shall be removed within 2 years from year Y+A_x+1, meters of year Y+2 within 2 years of year Y+A_x +2, and so on.

If the results of the tests indicate an AQL of 10% or greater, then the entire super-population shall be removed within 2 years of year Y+A_x

NOTE: In the event that this causes logistical problems additional testing may be carried out on meters produced in other years which may confirm the need for such action or indicate that additional time for removal could be justified.

14.0 End to end process map

A process map is presented below which sets out how the testing process might be organized by the National Body acting regionally or nationally and supported by a number of entities responsible for the maintenance of meter accuracy.


Ref : In-service testing v1.0 Approved 20051213
In-service Testing End-to-end process
Date : 12 December 05
Author: C Spence
Version: 1.0 Approved
National Body (MetLife)
MAP
MAM
Approved Test Centre
Notified Body
Manufacturer
Record New Meter Type Approval
Agree In-service test period and sample size (%) by lot
Provide In-service test period and sample size
Collate and analyse test results
Provide initial Meter Performance report
Response on Initial report received
Consider any responses and produce final Meter Performance report
MAP Portfolio
Test period, Manu, meter model and version, yr of manu, batch
Annual review of In-service test periods
Provide details of installed Portfolio
Receive In-service Test period and sample size
Receive initial Meter Performance report
Take appropriate action
Initiate Policy exchange program
Notify Suppliers
Procure approved Meter Type
Approved Meter Type installed by MAM
Provide Notification of number of meters by type to be sampled
Yes - New Meter Type Approval Certificates
Collect sample and pass for testing
Receive initial Meter Performance report
Provide response if appropriate
Test sample and provide results
Decide if approval should be granted (submission under H1 of MID)/ Test new Meter Type
Provide Approval result/Test results
Approval Request
Approval/Test results
Design & Produce new Meter Type
Request Approval
Receive Result of approval application
Meter Type Approved?
Yes
No
Manufacture Approved Meter Type
Page 1 of 1

15.0 Benefits of a National Body

The following details the potential benefits identified to IST1 in the establishment of a National Body:-

a) A National Body would provide the opportunity to combine meter populations across Suppliers/MAP individual populations with the consequence of lower pro-rata sample sizes and lower associated costs, and less disruption to the consumer (reduces any requirement to exchange meters for sampling). This supports one of the key requirements of the IMAG IST to minimise costs across the Industry.
b) Contains costs - reduced costs of end-to-end process through centralised management of IST process (key IMAG IST requirement).
c) Ensures minimum costs to the end consumer, with the process and systems requirements being consistently managed centrally (once) through a non-profit making body (key IMAG IST requirement).
d) Provides a robust process and solution.
e) A National Body that has access to all In-Service meter data will be able to provide a means to provide cross-industry reporting on meter performance. This can be provided as a confidential service so that Suppliers do not gain knowledge of the performance of other Suppliers' meter populations.
f) Representative of the whole population of meters - ensures validity of statistical analysis by pooling meter populations to ensure consolidated view, which is likely to be more reflective of true trends and issues in metering nationally.
g) Sets common processes and ensures all parties understand their obligations.
h) Opportunity to extend scope of testing to cover meter system functionality beyond the minimum requirements of the IMAG Scheme (such as pre-payment modules and communications modules) as a separately funded service.
i) A National Body will provide for independent/impartial, third party verification of meter performance based on submitted meter performance data without any vested commercial interests influencing the assessment.
j) Could provide comprehensive fault collection and consistent results as a separate service.
k) Provides visibility of why a particular product life has been increased or terminated.
l) A National Body would reduce the number of organisations a MAP would have to deal with to report on their entire meter population.
m) Ensures consolidated history and trends of meter to be understood through central point (churn means Suppliers and MAM's/MAP's will not have complete history)
n) If the National Body is set up by the Industry, its operation can be guided by industry requirements, subject to respecting its 3rd Party independence.

16.0 Governance

It is recommended that governance be provided through MAMCoP and BSC COP 4. Appropriate governance arrangements will be necessary and these can be developed in future work.

Ongoing maintenance of this testing process should be undertaken by the Governing Body established for this purpose.

17.0 Recommendations for further work

IST1 recommends that IMAG consider whether and by whom the following further work should be carried out: -

17.1 Priority work

17.1.1 Develop governance arrangements for both gas and electricity industries to ensure that the requirements for both industries do not 'drift' apart and that any proposed modifications to the proposed system or procedures can be addressed.

17.1.2 Undertake future development work on backstop arrangements.

17.2 Long term work

17.2.1 Progression of the appointment/implementation of a National Body including the definition of suitable file formats for the interchange of information and affiliation costs for data analysis.

17.2.2 Development of a recommended procedure for arranging access to customers' premises for the purpose of changing meters in accordance with the in-service testing procedure.

17.2.3 The application of this or a similar process to legacy meters including the issues of imperial gas meters and electricity meters which could be allowed to continue to the end of their current certification lives.

17.2.4 Application of a modified form of this process or of a different process to non-domestic type meters.

Annex 1 General definitions

AQL

Acceptable quality level.

Churn

Meters which are removed from premises as part of routine operations e.g. changing the customer from credit to prepayment, removal before the demolition of a property, removal because the supply is no longer required.

Discarded meter

A meter deemed by initial inspection to be unfit for inclusion in the sampling process and may be replaced with an acceptable meter.

Defective meter

A meter which fails to comply with the pass criteria.

Domestic type electricity meter

For the purposes of this document a whole current single phase meter.

Domestic type gas meter

A meter with a Q_{max} not exceeding 6 m^3/h.

Excluded meter

A meter that is deemed to be ‘abnormally’ defective and which is excluded from any statistical data but whose reason for exclusion is recorded.

Governance Board

A group of industry representatives chaired by Ofgem and established to ensure that any changes to processes and procedures for the maintenance of in-service accuracy and suitability of electricity and gas meters are implemented.

Grubb’s test

A method for identifying data outliers

I_{max}

The maximum rated current of an electricity meter

MAP – Meter Asset Provider.

The party responsible for the ongoing provision of the meter installation at that meter point. This could be the Meter Title Owner of the Meter, or a third party with whom the MAM contracts for the provision of a meter. For Gas meters where the Title Owner is not directly involved in the Gas Act Ownership of the Meter, the Meter Asset Provider needs to be identified so that the incoming MAM can make appropriate contractual arrangements for the ongoing provision of the metering equipment in situ at the Meter Point.

MAM – Meter Asset Manager(Gas)

A party approved by OFGEM as conforming to the Meter Asset Manager’s Code of Practice (MAMCoP).

Manufacturer
A person responsible for the conformity of a relevant instrument with the essential requirements with a view to either placing it on the market under his own name or putting it into use for his own purposes, or both

Meter Worker

Actual person or organisation that will do physical work on the Assets at a Meter Point. If they are not registered as an Ofgem Approved Meter Inspector (OAMI) or Council for Registered Gas Inspector (CORGI), then the Supplier will have to arrange an inspection by an OAMI to check that the installation registers accurately.

MID

The European Measuring Instrument Directive and the accompanying legislation implementing it in the UK through SI 1679 – The Measuring Instruments (Active Electrical Energy Meters) Regulations 2006, and SI 2647 - The Measuring Instruments (Gas Meters) Regulations 2006.

MO - Meter Operator (Electricity)

A party qualified by Elexon under BSC as a Meter Operator Agent

MO - Meter Operator (Gas)

Term used to group the MAM, Meter Worker and possibly also Legal Title (Meter) Owner.

MPE
Maximum permitted error.

National Body

A body set up to manage and co-ordinate meter in-service testing on gas and electricity meters on a national basis see section 15.

Title (Meter) Owner

This is also referred to as Legal Title Owner. The person or Organisation to which the asset belongs, and who makes such assets available for the purpose of the Gas Act Owner.

Inspection lot

Quantity of items (measuring instruments, parts of measuring instruments) submitted for testing or inspection.

Inspection lot size (N)

Number of items in the inspection lot.

Q_{max}

The maximum rated flow rate of a gas meter

Sample

Number of items taken from an inspection lot for inspection.

Sample size (n)

The number of items in the sample.

Sampling inspection

Inspection based on a sampling instruction in the case of which the inspection lot is assessed in accordance with the result obtained for a single sample or, if necessary, for various samples.

Year of manufacture

The MID requires that a meter be marked with the 'CE' mark, followed by the 'M' mark, then "the last two digits of the year of its affixing surrounded by a rectangle" – equivalent to the year of manufacture for these purposes.

Annex 2 Membership of IST1

Member	Affiliations	
Heinrich Bertke Trevor Billington	SBGI	Elster Jeavons
Andy Blythe	BEAMA	Landis + Gyr
Steve Briggs Jon Russell	ERA	Centrica
Mike Buss	SBGI	Actaris
Keith Campion	ELEXON	
Barry Cook	SBGI/AMO	National Grid Metering
Alan Dick	UKMF	
Steve Gandy	SBGI	Siemens Energy Services
Bob Gibbs	UKMF	EDF Energy
Peter Hellewell Steve Mylonas	ERA	npower
Rae Jackson Phil Mark	OFGEM	SGS
Richard Jeffers	SBGI	Sensus Metering Systems
Mark Knight Martyn Edwards	ERA	Scottish & Southern Energy
Chris Lawton	AMO/ENA	UU
Finlay Macdonald Gordon Morris	ERA/Gas Forum	Scottish Power
John Parsons	BEAMA	
Mark Powell	ERA	E.ON
Adrian Rudd David Moorhouse	NWML	
John Stevens Steve Rowe	OFGEM	
Chris Spence	ERA/Gas Forum	EDF Energy
Keith Sullivan	AMO	
Vic Tuffen	SBGI	GWi
Ian Witherspoon	-	Iskraemeco
Papers only		
Ed Reed	Energywatch	

Annex 3 Membership of IST2

Member	Affiliations	
John Stevens	OFGEM	(Chairman)
Russell Hamblin-Boone	ERA	
Mike Buss	SBGI	Actaris
Barry Cook	SBGI/AMO	National Grid Metering
Alan Dick	UKMF	
Bob Gibbs	UKMF	EDF Energy
Steve Mylonas	ERA	NPower
Mark Knight	ERA	Scottish & Southern Energy
Tom Chevalier	AMO	
Paula Ollenbuttel	ERA	Centrica
Gerry Morrison	ERA	Scottish Power
David Moorhouse	NWML	

Annex 4 – Calculation of AQL Values

The tables and graph below indicate the mechanism to calculate *k* values for different AQLs and for different sample sizes.
The value of *k* is dependent on the population size (and hence the sample size) and the defined acceptable quality level (AQL). The values shown below as "Actual *k*" have been drawn from Table II-A – Single sampling plans for normal inspection (master table): "s" method for ISO3951: 1989. The values shown as "Predicted *k*" have been calculated from a curve fitting the equation that shows a good fit to the Standard values.

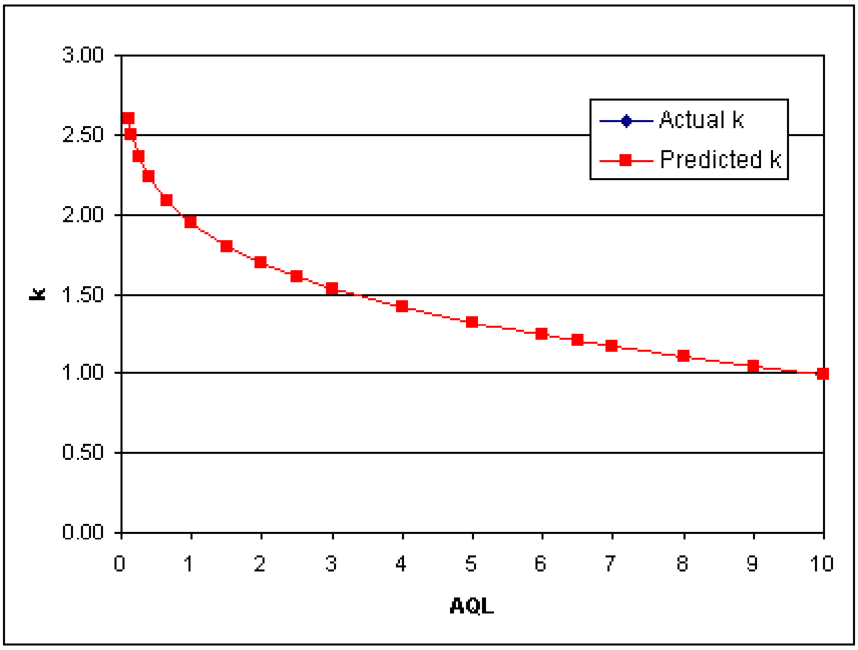
***k* can be predicted from the equation:** $y = \frac{(a + c \ln x)}{(1 + b \ln x)}$

For:

SAMPLE SIZE = 50

a = 1.942
b = -0.082
c = -0.495

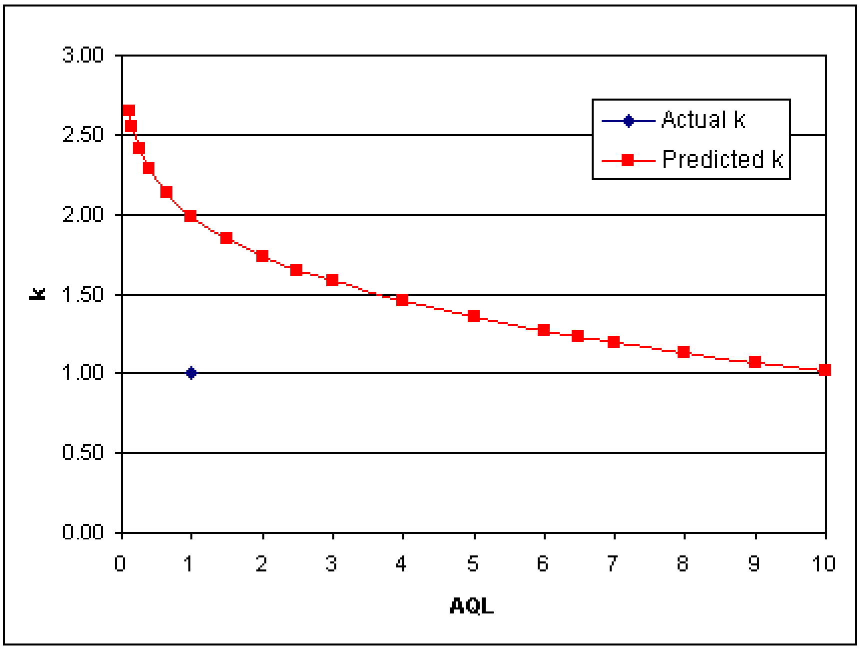
AQL	Actual k	Predicted k
0.10	2.60	2.59
0.15	2.50	2.49
0.25	2.35	2.36
0.40	2.22	2.23
0.65	2.08	2.08
1.00	1.93	1.94
1.50	1.80	1.80
2.00	N/A	1.70
2.50	1.61	1.61
3.00	N/A	1.54
4.00	1.42	1.42
5.00	N/A	1.32
6.00	N/A	1.24
6.50	1.21	1.20
7.00	N/A	1.16
8.00	N/A	1.10
9.00	N/A	1.04
10.00	1.00	0.99



SAMPLE SIZE = 75

a	=	1.988
b	=	-0.083
c	=	-0.506

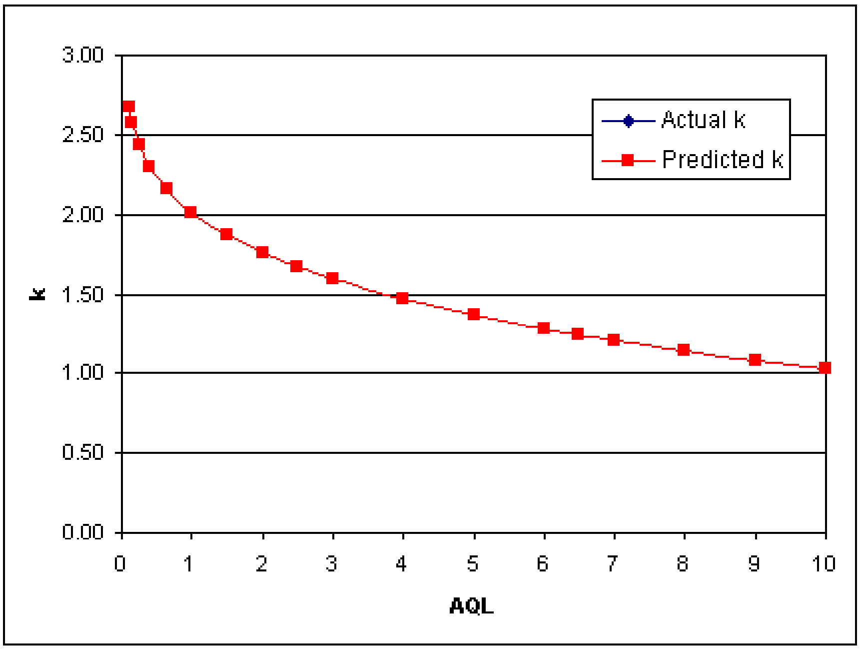
AQL	Actual k	Predicted k
0.10	2.66	2.65
0.15	2.55	2.55
0.25	2.41	2.41
0.40	2.27	2.28
0.65	2.12	2.13
1.00	1.98	1.99
1.50	1.84	1.84
2.00	N/A	1.74
2.50	1.65	1.65
3.00	N/A	1.58
4.00	1.46	1.45
5.00	N/A	1.35
6.00	N/A	1.27
6.50	1.24	1.23
7.00	N/A	1.2
8.00	N/A	1.13
9.00	N/A	1.07
10.00	1.03	1.02



SAMPLE SIZE = 100

a	=	2.010
b	=	-0.083
c	=	-0.511

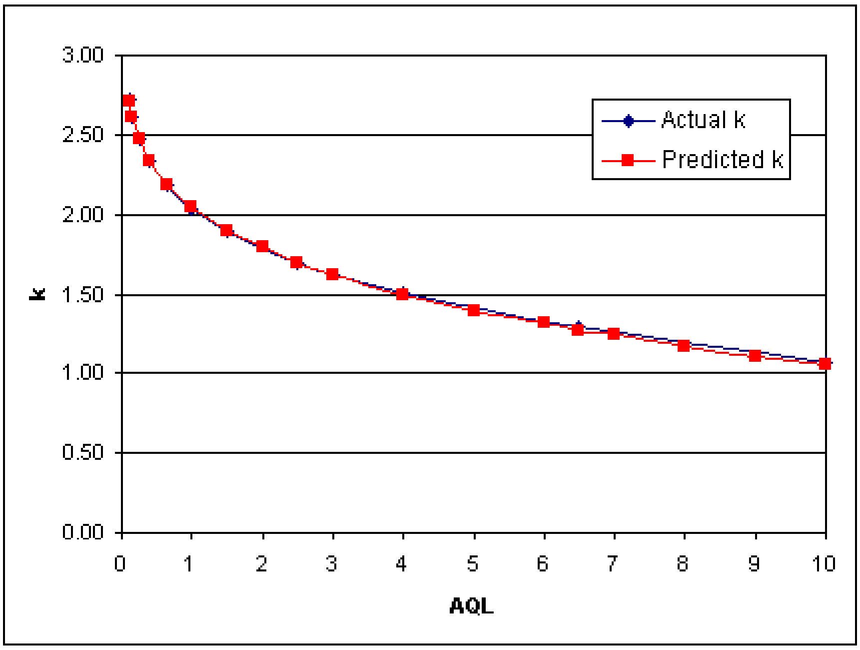
AQL	Actual k	Predicted k
0.10	2.69	2.68
0.15	2.58	2.57
0.25	2.43	2.44
0.40	2.29	2.30
0.65	2.14	2.15
1.00	2.00	2.01
1.50	1.86	1.87
2.00	N/A	1.76
2.50	1.67	1.67
3.00	N/A	1.59
4.00	1.48	1.47
5.00	N/A	1.37
6.00	N/A	1.29
6.50	1.26	1.25
7.00	N/A	1.21
8.00	N/A	1.15
9.00	N/A	1.09
10.00	1.05	1.03



SAMPLE SIZE = 150

a = 2.044
b = -0.085
c = -0.520

AQL	Actual k	Predicted k
0.10	2.73	2.71
0.15	2.61	2.61
0.25	2.47	2.47
0.40	2.33	2.34
0.65	2.18	2.19
1.00	2.03	2.04
1.50	1.89	1.90
2.00	N/A	1.79
2.50	1.70	1.70
3.00	N/A	1.62
4.00	1.51	1.50
5.00	N/A	1.40
6.00	N/A	1.31
6.50	1.29	1.27
7.00	N/A	1.24
8.00	N/A	1.17
9.00	N/A	1.11
10.00	1.07	1.05



SAMPLE SIZE = 200

a = 2.046
b = -0.085
c = -0.520

AQL	Actual k	Predicted k
0.10	2.73	2.71
0.15	2.62	2.61
0.25	2.47	2.48
0.40	2.33	2.34
0.65	2.18	2.19
1.00	2.04	2.05
1.50	1.89	1.90
2.00	N/A	1.79
2.50	1.70	1.70
3.00	N/A	1.63
4.00	1.51	1.50
5.00	N/A	1.40
6.00	N/A	1.31
6.50	1.29	1.28
7.00	N/A	1.24
8.00	N/A	1.17
9.00	N/A	1.11
10.00	1.07	1.06