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Surveillance of utility meters in service based on sampling inspections

Contents

Foreword

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Surveillance of utility meters in service based on sampling inspections

1 Introduction

Two of the key elements of metrological control for establishing and maintaining the quality and performance of meters used for billing purposes are:

- their initial verification (before use), and
- their subsequent verification at periodic intervals while in use.

Mandatory verification of electricity meters, gas meters, water meters, and heat meters - generally referred to as utility meters in this Document - and the period of validity of such verifications are governed by national regulations. When the period of validity of the meter's verification expires, it must normally be submitted for subsequent verification.

The period of the validity of the verification is normally set at a fixed number of years corresponding to the national regulatory authority's confidence with respect to the meter type's reliability (i.e. its ability to remain accurate while in use). As meter reliability is affected by numerous factors including those pertaining to design, production, usage, time, and the environment, the effects of such factors are difficult to assess, therefore the period of validity initially established for the verification of a meter may be either longer or shorter than it should be.

One generally accepted aim of legal metrology is that a high percentage of the meters installed in the energy distribution net respect the maximum permissible errors (MPE) in service during use. The national regulatory body usually defines the level of consumer protection to be applied by determining the precise percentage of meters which have to remain within the MPE.

This Document provides an objective means to address the above issue, using statistical methods to make an assessment regarding the appropriateness of initially established periods of validity with respect to specified meter performance and conformance standards. It permits lot quality at the time near the expiration of the period of validity to be re-assessed on the basis of sampling inspection.

Usually the period of validity is fixed based on a long experience and observation (statistical follow-up) of the metrological behavior of the utility meters installed in the service net. The quality of a meter type may allow the period of validity to be extended (or shortened).

Representative random samples are selected from lots formed from meters which are homogeneous with respect to the factors which affect meter reliability, the sample meters are inspected, and the results of the inspections are compared with criteria based on probability theory to determine whether or not an extension to the period of validity of the verification should be granted to the meters in the lot.

As the replacement of in-service meters when their periods of validity expire is a costly matter and the results of sampling inspection may suggest that such replacement is premature, a significant reduction in the meter owner's operating costs is possible when meter reliability is high.

National regulatory authorities will also be able to use the results of the implementation of this Document to make sound decisions regarding the increase or reduction in the initial periods of validity for the verification of various meter types as experience is gained over time.

The sampling plans as given in Annex 2 are not suitable for testing the performance of measuring instruments on a production line, because the control of a sequence of product batches requires so-called "switching rules" with repercussions on inherent changes of the production process. For the same reason the sampling plans in Annex 2 are not applicable for the purpose of initial verification[1]. The national regulatory authority or the "supervising authority" might use the outcome of the statistical results within their obligations for the metrological control within their surveillance activities of utility meters in service.

It should be clearly stated that the selection of the kind of sampling plans is a purely political decision on the level of consumer protection as defined by the limiting quality values (LQ).

Very small LQ values would increase the size of the sample to such an extent that the workload would come close to an (almost complete) re-verification procedure - thus jeopardizing the objective of this Document.

Therefore, the LQ values chosen for the sampling plans as shown in Annex 2 attempt to reflect a sound compromise between a level of consumer protection that is regarded as sufficient for legal metrology purposes, and a manageable workload (see also 2.4).

2 Scope

2.1 The present Document relates to the method and procedure according to which the period of validity of the verification of utility meters forming part of a defined lot is extended if the correctness of the meters has been proved by sampling inspections prior to the expiry of the period of validity of the verification. This is basically for meters used at private homes but with a sufficient number of instruments forming the size of a lot.

2.2 It is the responsibility of the national regulatory body to define the maximum permissible error (MPE) of a utility meter as a percentage of the MPEs in service as a criterion of acceptance as well as the validity period of verification.

2.3 Only those types of utility meters that are subject to legal metrology requirements for the purpose of consumer protection are to be taken into account. For example, in the case of

[1] The same non-applicability holds true for the procedure of "putting into use" in accordance with the EU Measuring Instruments Directive (MID).

water meters this means that only those meters of accuracy class 2 are to be taken into account, since class 1 refers to industrial application.

2.4 The sampling instructions applied have been compiled in the sampling plans (see Annex 2). They are valid for a limiting quality (LQ) of 8 % in compliance with ISO 2859-2 [2], thus corresponding to a consumer's risk of 10 %. (Sampling procedures for inspection by attributes; Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection).

3 Terminology

3.1 The terms of statistics used in this Document have been defined in International Standards ISO 3534-1 [3] and ISO 2859-1 [1].

3.2 The metrological terms used in this Document have been defined in the relevant OIML International Recommendations:

- R 46 Electricity meters – (currently under revision);
- R 137:2006 Gas meters;
- R 49:2006 Water meters intended for the metering of cold potable water and hot water;
- R 75:2002 Heat meters.

3.3 For the purpose of this Document the term "*national regulatory body*" means the official body responsible for determining legislative requirements.

3.4 For the purpose of this Document the term "*body responsible for subsequent verification"* means a body officially appointed at national or some other level of government to be responsible for ensuring that requirements for subsequent verification are adhered to. It may carry out the verification function itself or, according to legislative requirements, appoint other verification bodies to carry out the verification function on its behalf.

3.5 For the purpose of this Document the term "*legally responsible entity*" means a body/organization which is in charge of performing the reading out, collection and/or processing of the measurement data according to the national legislation.

3.6 For the purpose of this Document the term "*supervising authority*" means an agency which is in charge of safeguarding the legally prescribed performance of the "bodies responsible for subsequent verification" or "legally responsible entities", depending on the state of privatization of the legal metrology system. The supervising authorities are also often in charge of market surveillance activities.

3.7 The most important terms of statistics have been compiled in Annex 1.

4 Carrying out the sampling inspection – General

4.1 If a sampling inspection is to be carried out in order to extend the period of validity of the verification of utility meters, the legally responsible entity of the meters (usually public

utility companies) must file an application with the body responsible for subsequent verification.

4.2 The sampling inspection is to be carried out in good time before the expiry of the period of validity of verification so that in the case of non-compliance with the requirements, all utility meters forming part of the lot can be removed from the network prior to the expiry of the period of validity of verification and be replaced by verified meters.

4.3 The selection of sample meters and the inspection thereof may be carried out only by the body responsible for subsequent verification or under the direct supervision of this body.

4.4 If a check is made and if so requested by the body responsible for subsequent verification, the legally responsible entity of the utility meters must prove (by indicating the meter number, the place of installation and supplying the necessary data) for which meters and up to which date the period of validity of verification has been extended.

5 Criteria for the assembly and delimitation of a lot

5.1 Only such utility meters that fulfil the same minimum requirements may be assembled into a lot. Additional requirements may be necessary; these shall be worked out by the national regulatory body[2]:

- manufacturer (including other manufacturers that are licensed to make exactly the same meters);
- type or model of the meter;
- serial number or year of production;
- accuracy class;
- type approval number or mark;
- date of initial or subsequent verification.

The year of manufacture or the year of the last verification shall not vary by more than one year. In any case the fixed period for statistical control as defined by the national regulatory body must not be surpassed. These meters usually have an identical approval number or mark. The rated operating conditions of all meters shall be the same.

Moreover, the following characteristics must be identical in all meters:

(a) Electrical energy meters

- nominal voltage;
- transitional current;
- maximum current;
- basic current (for direct meters) up to 30 A;
- current-carrying capacity (maximum current/basic current proportion) up to 4 times or more than 4 times;

[2] e.g.:
- requirements for transportation and storage of utility meters after being dismantled from their place of utilization and before their inspection in laboratories, or
- parameters of operating and ambient conditions.

- rated current (for transformer meters) - all values mentioned in electrical energy standards;
- the same class of accuracy;
- one tariff or multi tariffs (electro-mechanical meters only).

(b) Gas meters

- maximum flow rate;
- temperature compensation (y/n);
- membrane material (if applicable);
- physical technique used (mechanically or electronically).

(c) Water meters

This Document incorporates only water meters of accuracy class 2 covering a flow rate up to $Q_3 \leq 100$ m^3/h:

- permanent flow rate (Q_3);
- ratio of the permanent flow rate to the minimum flow rate (Q_3/Q_1);
- nominal diameter.

(d) Heat meters

- nominal flow rate (of the flow sensors);
- limiting flow rate values;
- same components (subassemblies)[3].

As for water meters and flow sensors of heat meters, only those meters that were operated with water of identical or comparable quality may be assembled into a lot.

5.2 With the approval of the national regulatory body and subject to the conditions stated below, combined lots may be formed of meters:

- that are of a different type, provided that appropriate conditions for the assembly into such a lot have been clearly stipulated by the national regulatory body concerned;
- that are the property of different public utility companies, provided that responsibility for the individual undertakings has been made quite clear.

5.3 Once determined, the sample should be kept for all subsequent verifications based on sampling inspections. The same meter can be selected for one lot only.

6 Application for sampling inspection

The application for sampling inspection must provide the following information with reference to 5.1:

[3] For further reference see also EN 1434-1 Heat meters, 2007, No. 9.2.1.

(a) type, manufacturer, approval mark, date or dates of the last verification (year);

(b) **for electrical energy meters:**

- nominal voltage, transitional current, maximum current.

for gas meters:

- accuracy class, membrane material and whether temperature correctors have been provided.

for water meters:

- accuracy class;
- nominal diameter.

for heat meters:

- nominal flow rate (of the flow sensor) and limiting flow rate values.

(c) lot size;

(d) public utility entities which are the owners of the utility meters;

(e) statement by the public utility undertaking or entity as to whether the lot for which sampling inspection is applied was previously subjected to sampling inspections;

(f) date on which the meters selected for sampling inspection will presumably be removed from the network and made available for inspection;

(g) sampling instruction chosen.

7 Selection and treatment of the sample meters

Reference shall be made to the specific OIML Recommendation which might contain further updated criteria.

7.1 The following shall be agreed between the body responsible for subsequent national verification and the applicant:

(a) Procedure and characteristics for random sampling of the utility meters (for example: by manufacturer's serial number, owner's or customer's number; table of random numbers or program for the computer-aided generation of random numbers), in order to ensure that the samples are representatives of the lot.

(b) Sampling instruction to be applied (see Annex 2).

(c) Date or period of removal of sample meters from the network and date of their delivery to the inspection place or period between the two operations.

(d) Procedure reducing the possibility of inadmissible interventions in the sample meters during the period between their removal from the network and the inspection.

7.2 Depending on the lot size and the sampling instruction chosen, the sample meters and the spare meters are selected from the defined lot. The selection must be made in compliance with the rules of mathematical statistics, i.e. the probability to be selected as a sample meter or spare meter must be the same for each meter forming part of the lot. Cf. Annex 2 for sample size and number of spare meters.

7.3 The inlet and outlet sockets of gas meters, water meters and flow sensors of heat meters must be sealed immediately after the devices have been removed from the supply network.

- Gas meters may be rinsed with air or inert gas for a short time.
- Water meters and flow sensors of heat meters have to be protected against drying out. They should be removed from the network in such a way that as much water as possible remains in the meters.

7.4 The period between the removal of gas meters, water meters and heat meters (all properly sealed) from the supply network and their inspection should be as short as possible, but in any event this period should not exceed one month.

7.5 During transport, the meters may not be subject to extreme mechanical stress.

7.6 Any interventions such as repair, adjustment, exchange of the counter or the like, are inadmissible, except the purging of gas meters and the rinsing of water meters or of the flow sensors of heat meters.

8 Sampling inspection

8.1 Non-conforming meters

8.1.1 Type approval certificate

A meter forming part of the sample is considered non-conforming if it does not comply with the specifications of the type approval certificate and if it does not meet the regulations for mandatory verification.

8.1.2 Display test

The display must be tested for legibility and correct operation according to the relevant OIML Recommendation, if applicable.

8.2 Test points

The metrological characteristics of the sample meters are generally tested at the test points required by national legislation for the extension of the validity period. Annex 3 provides proposals of test points for gas meters for possible use.

8.2.1 Electrical energy meters

- Running with no load

When the voltage is applied with no current flowing through the current circuit (the current circuit shall be an open circuit), the meter shall not register energy at any voltage between 0.8 U_{nom} and 1.1 U_{nom}.
The term I_{tr} is the declared value of current at and above which the meter purports to lie within the smallest maximum permissible error corresponding to the class index of the meter.
The ratio $\frac{I_{max}}{I_{tr}}$ must be equal to or higher than 50 for direct connected meters.

- Accuracy tests 0.5 I_{tr}; 1.0 I_{tr}; 10 I_{tr} and 1.0 I_{max}.

- Starting current: An electrical energy meter is deemed to be non-conforming if it does not start to register energy at 1.5 times the starting current.

8.2.2 Gas meters

Test points for gas meters

Test points at Q_{max}, Q_t and Q_{min}.[4]
The flow rate characteristics of a gas meter shall be defined by the values of Q_{max}, Q_t and Q_{min}.

Table 1 Flow rate characteristics

Q_{max} / Q_{min}	Q_{max} / Q_t
≥ 5 and < 50	≥ 5
≥ 50	≥ 10

Q_t is the transitional flow rate that occurs between the maximum flow rate Q_{max} and the minimum flow rate Q_{min} that divides the flow rate range into two zones, the "upper zone" and the "lower zone", each characterized by its own maximum permissible error.[5]

If the examination is conducted at different flow rates, the accuracy of the results shall be at least equivalent to those obtained by the tests mentioned above.

Q_t is also required to be marked on the identification plate of the meter[6].

[4] The national regulatory body may decide whether the test point Q_{min} may be applied for sample testing.
[5] See also Annex 3
[6] See also Annex 4, 5.2, article 4.2

8.2.3 Water meters

Test points for water meters

The following scheme relates to 6.3.3 of OIML R 49-1:2006 [6], which prescribes test points for the initial verification of water meters.

The errors (of indication) of the water meters in the measurement of actual volume shall be determined for at least the following flow rates:

(a) between Q_1 and 1.1 Q_1;
(b) between Q_2 and 1.1 Q_2; and
(c) between 0.9 Q_3 and Q_3
(d) for combination meters, between 1.05 Q_{x2} and 1.15 Q_{x2}

However, depending on the shape of the error curve, additional flow rates may be specified in the type approval certificate.

8.2.4 Heat meters or sub-assemblies of heat meters

Flow sensors: 0.1 q_p, q_i, q_p (in the order stated)

Calculators: $\Delta\Theta_{min}$; $\Delta\Theta_{max}$; $\Delta\Theta$ = 10 K or $\Delta\Theta$ = 20 K

Temperature sensor pairs: $\Delta\Theta_{min}$; $\Delta\Theta_{max}$ and another value, preferably $(\Delta\Theta_{min} + \Delta\Theta_{max}) / 2$.

8.3 Spare meters

If the sample meters selected comprise meters:

(a) which are damaged at the outside;
(b) whose protective mark is damaged;
(c) which can no longer be localized or which have been incorrectly filed;
(d) which are not accessible;

replacement of such meters by spare meters is permissible before the inspection process is started.

In cases (a), (b) and (c) only 6 % (in total) of the sample selected may be replaced by spare meters. The actual number of meters to be replaced by spare meters depends on the size of the lot and is provided in Tables 1–4 in Annex 2.

- Replacement may only be done once, just after visual examination;
- Spare meters used for replacement are chosen from the spare lots at random.

If it is impossible to complete whole sample according to the rules mentioned above, the application to extend the period of validity of the verification on the basis of sampling inspection must be rejected.

Remark: Limiting of the number of spare meters used for replacing sample meters in cases (a), (b) and (c) results from the assumption that if the limit is exceeded, this means that a lot contains too many meters meeting those three criteria.

8.4 Test methods

The test methods should be the same as during initial verification. Special attention should be paid to the fact that the uncertainty requirements for the test facilities and reference conditions should be the same as those specified in the relevant OIML Recommendation.

8.4.1 Electrical energy meters

(a) The individual meters are tested at nominal voltage at unity power factor; poly-phase meters are submitted to an additional test at single-phase load but with balanced poly-phase voltages applied to the voltage circuits.

(b) The test may be carried out by a short-time test method or by a method with the meter energized continuously. The test performed with the meter energized continuously is to be carried out for a period to reach a constant 4 kWh per test cycle with a resolution of 0.1 %.

8.4.2 Gas meters

Before starting the tests, the volume passed through the meter shall be at least 50 times the cyclic volume of the meter.

8.4.3 Water meters and heat meters

Water meters and flow sensors for heat meters are to be removed from the network in such a way that as much water as possible remains in the meters.

The same conditions have to be observed for mounting the meters into the test rig.

Having inserted the meters, the meters and the complete measuring section have to be filled slowly in order to remove all air before beginning the testing.

After the test, the inlet and outlet sockets must be sealed again to keep the inside of the meters moist for possible re-testing. Stabilize the temperature at the desired test value.

8.5 Retention periods

The body responsible for subsequent verification or the supervising authority may fix a deadline up to which the sample meters are to be retained unchanged. For water meters, heat meters and flow sensors of heat meters this period should not exceed one month (water meters) or two months (gas meters) from the day of the sampling inspection up to the day of reverification in order to prevent the meters from drying out.

The supervising authority may determine the period up to which the reverified meters have to be maintained in storeage for reasons of control.

9 Sampling plans

9.1 The sampling instructions applicable to sampling inspection are given in Annex 2. From the statistics point of view, the sampling instructions in Tables 1 and 3 are equivalent and are binding for the body carrying out the inspections. They must not be deviated from without the prior approval of the body responsible for subsequent verification. For lot sizes larger than 35 000 meters, the tables in Annex 2 can be extended in compliance with ISO 2859-2 [2].

9.2 In order to achieve a higher acceptance probability for lot sizes, a sampling instruction applicable to larger lot sizes with a correspondingly larger sample size may be chosen.

9.3 It is not permitted to switch from the sampling instruction originally chosen to another one after the sampling process has been started, unless the national regulatory body has agreed otherwise.

10 Test results

10.1 All test results are to be recorded and stored in such a way that they can be re-evaluated by the national regulatory body. Re-testing of the sample by the body responsible for subsequent verification must be possible within a certain period of time.

The lot is accepted if the requirements of the sampling instruction have been met and a possible re-test by the body responsible for subsequent verification has not led to any objection.

If the lot is rejected, all units of the lot must be put out of service before the period of validity of the verification has expired.

10.2 If the lot is accepted after the inspection has been carried out according to one of the sampling instructions given in Annex 2, the period of validity of the verification of all the meters forming part of the lot is extended to 50 % of the period valid for initial verification or to a period specified by the national regulatory body. The initial verification period has to be fixed by the national regulatory body according to the level of performance (i.e. durability test) of the utility meters prevailing in the country.

10.3 The extension of the period of validity of the verification begins with the month following the month in which the sampling inspection was carried out.

10.4 The supervising authority is to be informed about the result of the sampling inspection. The individual test results are to be submitted upon request.

10.5 The disposal of the sample meters is left to the discretion of the owner of the instrument according to national legislation.

Annex 1

Terminology
Statistical terms

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

2 Inspection lot size (N)
Number of items in the inspection lot.

3 Sample
Number of items taken from an inspection lot for inspection.

3.1 Sample size (n)
Number of items in the sample.

3.2 Cumulative sample size (n_K)
Cumulative sample sizes in double sampling; for the first sample, the cumulative sample size corresponds to the sample size of the first sample; for the second sample, it corresponds to the sum of the sample sizes of the first and the second samples.

4 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.

4.1 Single sampling inspection
The decision whether or not the criteria defined in the sampling instruction are complied with is taken on the basis of a single sample.

4.2 Double sampling inspection
The decision whether or not the criteria defined in the sampling instruction are complied with is taken on the basis of the first sample or, if necessary, on the basis of the second sample, depending on the result.

4.3 Sampling instruction
Instruction for taking one or, if necessary, several samples, and for evaluating the result with regard to acceptance or rejection of an inspection lot.

4.4 Sampling plan
Compilation of sampling instructions according to general aspects in order to limit the risk of non-conforming items being tested.

5 Acceptance
Conclusion that an inspection lot satisfies the requirement criteria defined in the sampling instruction.

5.1 Acceptance number (c)
Highest number of non-conforming items specified in the sampling instructions, or the specified highest number of non-conformities in the individual samples that permits acceptance of the inspection lot.

6 Rejection
Conclusion that the inspection lot does not satisfy the requirement criteria stated in the sampling instruction.

7 Rejection number (d)
Lowest number of non-conforming items or the lowest number of non-conformities in the individual samples specified in the sampling instructions in the case of which the inspection lot is rejected.

8 Inspection by attributes
Inspection of attributes or variable characteristics classified accordingly, in which a distinction is made only between conforming and non-conforming items.

9 Non-conforming items
Item, one or more characteristics of which do not meet the requirements.

Annex 2

Sampling plans with a Limiting Quality level (LQ) of 8 % at a consumer risk of 10 % according to ISO 2859-2

Table 1 Single sampling inspection for electricity meters, gas meters and water meters

No.	Lot size	Sample size	Number of non-conforming meters		Spare meters according to 8.3
			Criterion for acceptance of lot (c)	Criterion for rejection of lot (d)	
1.1	up to 1 200	50	1	2	10
1.2	1 201 to 3 200	80	3	4	16
1.3	3 201 to 10 000	125	5	6	25
1.4	10 001 to 35 000	200	10	11	40

Table 2 Single sampling inspection for complete heat meters

No.	Lot size	Sample size	Number of non-conforming meters		Spare meters according to 8.3
			Criterion for acceptance of lot (c)	Criterion for rejection of lot (d)	
2.1	up to 90	24	0	1	5
2.2	91 to 150	26	0	1	8
2.3	151 to 280	28	0	1	10
2.4	281 to 500	32	0	1	10
2.5	501 to 1 200	50	1	2	10
2.6	1 201 to 3 200	80	3	4	16
2.7	3 201 to 10 000	125	5	6	25
2.8	10 001 to 35 000	200	10	11	40

Table 3 Single sampling inspection for components of heat meters

No.	Lot size	Sample size	Number of non-conforming meters		Spare meters according to 8.3
			Criterion for acceptance of lot (c)	Criterion for rejection of lot (d)	
3.1	up to 90	24	0	1	5
3.2	91 to 150	26	0	1	8
3.3	151 to 280	28	0	1	10
3.4	281 to 500	32	0	1	10
3.5	501 to 1 200	50	0	1	10
3.6	1 201 to 3 200	80	1	2	16
3.7	3 201 to 10 000	125	2	3	25

Table 4 Double sampling inspection for electricity meters, gas meters, water meters and complete heat meters

No.	Lot size	Sample	Sample size	Cumulative sample size	Number of non-conforming meters**)			Spare meters according to 8.3
					Criteria for acceptance of lot (c)	Criteria for rejection of lot (d)	Criteria for required 2nd sample*)	
4.1	up to 1 200	first second	32 32	32 64	0 1	2 2	1	6 6
4.2	1 201 to 3 200	first second	50 50	50 100	1 4	4 5	2 to 3	10 10
4.3	3 201 to 10 000	first second	80 80	80 160	2 6	5 7	3 to 4	16 16
4.4	10 001 to 35 000	first second	125 125	125 250	5 12	9 13	6 to 8	25 25

Explanations:

*) A second sample of the same size as the first sample is to be randomly drawn from the lot if the non-conforming meters stated in this column are part of the first sample.

**) In each of the lines headed by “second sample”, the number of non-conforming meters relates to the cumulative sample size.

Annex 3

Proposals for sampling testing of gas meters

Maximum permissible errors (MPE) of gas meters in ±.

Table 1 Criteria of acceptance for sample testing

Flow rate Q	Criteria of acceptance for Sample testing [MPE] Class			MPE In-service Class		
	0.5	1	1.5	0.5	1	1.5
$Q_{min} \leq Q < Q_t$	-	3.5 %	5.5 %	2 %	4 %	6 %
$Q_t \leq Q \leq Q_{max}$	-	1.5 %	2.75 %	1 %	2 %	3 %

Table 2 Test points for sample testing

Q_{max} / Q_{min}	Class 1	Class 1.5
≥ 50	Q_{max}, Q_t, Q_{min}	Q_{max}, Q_t, Q_{min}
≥ 5 and < 50	Q_{max}, 0.1 Q_{max}, Q_{min}	Q_{max}, 0.1 Q_{max}, Q_{min}

At the Q_{min} test point, mechanical gas meters may have negative errors outside the MPEs, which is especially due to locally different influences (dust, temperature, mechanical shocks etc.). In the upper flow rate range, however, they usually work reliably within the established MPEs because the main consumption occurs in the flow rate range between Q_{max} and Q_t.

Given this fact, and in view of the undue increase in costs that would arise if gas meters were replaced which, under normal conditions of consumption, work satisfactorily, it might - from an economic point of view - be justified to apply only the test points between Q_{max} and Q_t.

Therefore, the national regulatory body may decide not to apply the test point Q_{min}.

Annex 4

References
Further test procedures as applied
to the different kind of utility meters

1. ISO 2859-1:2001, Sampling Procedures for Inspection by Attributes, – Part 1: Sampling Schemes Indexed by Acceptance Quality Limit (AQL) for Lot-By-Lot Inspection

2. ISO 2859-2:1985, Sampling Procedures for Inspection by Attributes – Part 2: Sampling Plans Indexed by Limiting Quality (LQ) for Isolated Lot Inspection

3. ISO 3534-1:1993, Statistics – Vocabulary and Symbols – Part 1: Probability and General Statistical Terms

4. Electricity Meters
   Draft revision of OIML R 46 (TC 12/WG1 4CD - 2009)

5. Gas Meters
   5.1 OIML R 31:1995
   5.2 OIML CD 3 (TC 8/SC 8 -2005)

6. Water Meters
   OIML R 49-1:2006, R 49-2:2006, R 49-3:2006

7. Heat Meters
   OIML R 75-1:2002
   OIML R 75-2:2002
   OIML R 75-3:2006

8. Temperature Sensor Pairs
   OIML R 75-1:2002
   OIML R 75-2:2002
   OIML R 75-3:2006