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TECHNICAL REPORT

Home laundry appliances – Uncertainty reporting of measurements

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HOME LAUNDRY APPLIANCES – UNCERTAINTY REPORTING OF MEASUREMENTS

FOREWORD

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IEC 62617, which is a technical report, has been prepared by subcommittee 59D: Home laundry appliances, of IEC technical committee 59: Performance of household and similar electrical appliances.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
59D/355/DTR	59D/356/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

To encourage the efficient use of energy and other resources, National governments and regional authorities have issued regulations, which mandate the provision of information to consumers regarding the energy and water consumption of household appliances and associated performance characteristics. This information is usually conveyed by labels attached to appliances at the point of sale and also by brochures provided by manufacturers.

Methods for measuring declared values for energy and water consumption and performance characteristics must be of sufficient accuracy to provide confidence to governments, consumers and manufacturers. The accuracy of a test method is expressed in terms of bias and precision. Precision, when evaluating test methods, is expressed in terms of two measurement concepts: repeatability and reproducibility. Therefore, standard procedures are required for determining the repeatability and the reproducibility of test methods developed by technical committee 59 and its subcommittees. The repeatability of a test method must be sufficiently accurate for comparative testing. The reproducibility of a test method must be sufficiently accurate for the determination of values which are declared and for checking these declared values.

Uncertainty reporting is essential to ensure measured data are interpreted in a correct way. Especially when data of measurements are to be compared between laboratories or when normative requirements are set up, it is necessary to know the uncertainty with which data can be measured.

HOME LAUNDRY APPLIANCES – UNCERTAINTY REPORTING OF MEASUREMENTS

1 Scope

This Technical Report (TR) applies to uncertainty reporting of home laundry electrical appliances.

It allows to estimate the uncertainty of a measured result and to predict the range of values that may be measured when the same appliance is measured in another laboratory following the same measurement method.

NOTE The provisions in this TR can also be used to evaluate other kinds of products.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

IEC 61923:1997, *Household electrical appliances – Method of measuring performance – Assessment of repeatability and reproducibility*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
repeatability conditions
conditions where independent test results are obtained with the same method on identical test items in the same laboratory by the same operator using the same equipment within short intervals of time

[IEC 61923:1997, 3.6]

3.2
repeatability standard deviation
standard deviation of test results obtained under **repeatability conditions**

[IEC 61923:1997, 3.7]

3.3
reproducibility conditions
conditions were test results are obtained with the same method on identical test items in different laboratories with different operators using different equipment

[IEC 61923:1997, 3.9]

3.4
reproducibility standard deviation
standard deviation of test results obtained under **reproducibility conditions**

[IEC 61923:1997, 3.10]

3.5
statistical uncertainty
repeatability standard deviation obtained in one laboratory under **repeatability conditions**

3.6
expanded uncertainty
confidence interval, which allows to calculate the minimum and maximum value where the average measured result may be found when the measurement is re-done at any other laboratory following **reproducibility conditions**

4 The approach to uncertainty measurement

4.1 The importance of the uncertainty

When a measurement has been performed giving a figure as a result for some quantity (i.e. the measurand), how sure is this figure? In other words:

– if the measurement is repeated, will the same figure be achieved as the result?

– if another group or another laboratory performs the measurement, how close will the results expected to be?

By means of an uncertainty amount an uncertainty interval $y \pm U$ may be calculated, where y is the measurement result and U the **expanded uncertainty** that is determined to give the interval a high probability (often 95 %) to cover the true value, Y, of the measurand. U is said to be the uncertainty associated with the result y.

The uncertainty interval of a measurement is therefore a basis for qualifying the measurement. The more narrow the confidence interval is desired, i.e. the smaller the value of the uncertainty U is pursued, the more careful the measurement method, the measuring equipment, the training of the operators and the number of repetitions of the same experiment have to be.

4.2 Ways to access uncertainty

There are in principle two ways to estimate uncertainty: a bottom up method and a top down method. The two methods should often be used in parallel to achieve a reliable uncertainty amount.

a) The bottom up method (Refer to Clause 2, *Guide to the Expression of Uncertainty in Measurement*)

In this method the test result y is expressed as a function of input quantities. This function is often the formula used for the calculation of the result.

In the case of home laundry appliances, the y may be one of the final test results like water consumption, energy consumption, washing performance, spin speed, spin drying performance, program duration or rinsing efficiency. The input quantities may be temperature, masses, times, power etc.

The magnitude of all the uncertainty contributions of each input quantity is estimated.

By combining the uncertainties of the input quantities according to the law of propagation of uncertainty (see Clause 2, *Guide to the Expression of Uncertainty in Measurement*) the uncertainty of the result y can be calculated.

With this calculation it can be seen how a specific uncertainty contribution from an input quantity does influence the combined uncertainty of the final result and therefore how a reduction in an uncertainty contribution from an input quantity will influence the combined uncertainty of the final result.

Uncertainties may usually be reduced at some cost by making more measurements, using other methods or other equipment. This means that different approaches can be followed to reduce the uncertainty of the final result in the most cost effective way.

b) The top down method (see IEC 61923)

In this method the **reproducibility standard deviation** is estimated from testing of the same machine (or the same model) in different laboratories using the same measurement method. This testing is in general named ‘ring test’ or ‘round robin test’. The **reproducibility standard deviation** of the test results can then be seen as the inherent uncertainty of the measuring method as it may be influenced by remaining differences in the ambient, the people and whatever else may be different between different measurements in different laboratories. In principle it is only valid for the machine investigated in each ring test, but results may be also true for similar types of machines.

Therefore the two methods ‘bottom up’ and ‘top down’ may be used in parallel to achieve a reliable uncertainty quantification. But both methods depend on the validity of the model (for the bottom up method) or the data (for the top down method) used.

5 Expanded uncertainty calculation

The uncertainty of a measured result has two sources:

– the **statistical uncertainty** of what is measured, as expressed in the **repeatability standard deviation**, showing the accuracy of the measurement in the laboratory having done the measurement;

– the uncertainty of the measuring method itself. This is expressed as **expanded uncertainty** where it is common to set the borders at a 95 % confidence interval, which give the minimum and maximum value where the average measured result may be found when the measurement is re-done at any other laboratory.

To be meaningful, the uncertainty statement must have an associated confidence level: i.e. it is necessary to state the probability that the true value lies within the range given. The reasons for choosing a 95 % confidence level in this standard are as follows:

– it is established practice throughout much of Europe, North America and Asia;

– the GUM assumes that the combined uncertainty has a distribution that is a close approximation to a normal distribution. A 95 % confidence level approximates to a range of 2 standard deviations. It is a widely held view that, for most measurement systems, the approximation to a normal distribution for the distribution of the combined uncertainty is reliable out to 2 standard deviations, but beyond that the approximation is less reliable.

If a normal distribution may be assumed the 95 % confidence interval is given by multiplying the reproducibility standard deviation by a factor of 2.