GENERAL INFORMATION ON UNCERTAINTY OF MEASUREMENT

For those relying on test results to make informed decisions and judgements.

UNCERTAINTY OF MEASUREMENT

Many important business decisions are based on the results obtained from quantitative testing. It is important that an indication of the quality of reported numerical test results is available to you.

The result of tests is not perfect. It is only an estimate of the value of the test item's characteristic being measured. The result is complete only when it is accompanied by a statement of the uncertainty of that estimate. Accredited laboratories are required to have estimated the uncertainty of measurement of each result. This information is considered in evaluating whether test results are fit for your purpose.

Some measurements, such as trace measurements in complex mixtures of materials, have an inherently large measurement uncertainty, which may mean that results are close to limits of detection. Such limitations may reflect the constraints of available technology.

Measurement uncertainty is a vital part of the test result that gives this information, and one that is used internationally.

THE TESTING PROCESS

Each step of the testing process, from sampling to the final measurement, involves variables that affect the results of the tests.

Accredited laboratories select and control the test methods to ensure that the overall variability is small enough for the end result to be appropriate for your requirements.

RESULTS SHOULD BE FIT FOR THE INTENDED PURPOSE

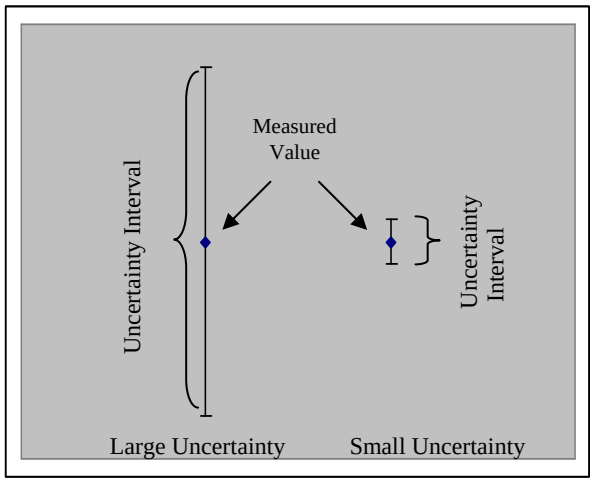
If the uncertainty of a test result is too large, you will not be able to make a reliable decision. If it is smaller than you require, the test may be unnecessarily complex and costly. Test result uncertainties should be fit for the intended purpose. If you make clear to the laboratory, what the results are going to be used for, then the laboratory will select test methods that ensure that the level of uncertainty is suitable for your requirements.

WHAT IT COULD LOOK LIKE

In the test result you receive, you will be given the normal information about what has been measured and the units of measurement.

When a test result is presented as a measured value and a measurement uncertainty, it prescribes an interval within which the true value of the quantity being measured is expected to lie with a stated level (usually 95%) of confidence. This uncertainty interval varies in size, depending on the test.

Uncertainty Interval



Example

The laboratory has found the lead content of a sample is 1.65 mg kg^{-1} ± 0.15 mg kg^{-1}. This means that the true value of the quantity being measured is expected to be between 1.50 and 1.80 with (usually) 95% confidence.

Example Report

Total lead content (Pb): 1.65 mg kg^{-1}
Measurement Uncertainty: 0.15 mg kg^{-1}
The stated uncertainty is an expanded measurement uncertainty for a 95% level of confidence.

LABORATORIES TO REPORT UNCERTAINTIES OF MEASUREMENTS

Most laboratories have until now chosen not to state measurement uncertainty in their test reports. Instead, such information has been given only when the customer has asked for it.

In the future, information about the measurement uncertainty may appear more frequently in test reports endorsed with the accreditation symbol. It is also possible that you will come across new and unfamiliar quality terms. This is because there are new international guides and standards describing requirements for uncertainty of measurement.

SAMPLING

You may wish to have information on specific characteristics of a larger bulk of material from

which a test sample was taken. You will be aware the material may not be homogeneous.

The uncertainty of the reported test result will usually not include variations associated with lack of homogeneity of the bulk material. Often variations across the bulk of material will be very much greater than the test result uncertainty.

If you require information about bulk material variations, the laboratory will need to design the sampling plan to make the necessary estimates.

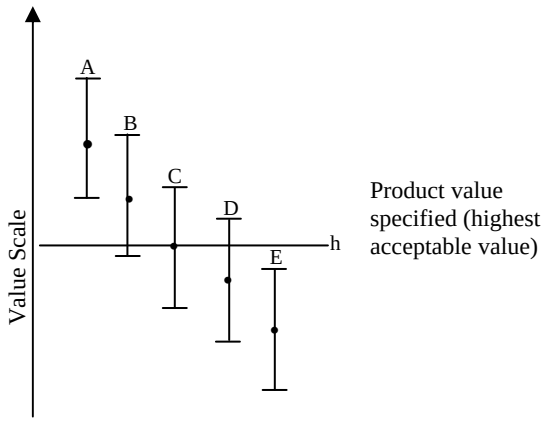
UNCERTAINTY AND PRODUCT SPECIFICATION VALUES

Many tests are done to assure you that a characteristic of a product does not exceed a regulatory or customer specification value. Without information about the measurement uncertainty, it may appear to be easy to make compliance decisions but these decisions may be unreliable.

There will be negative economic consequences when rejecting product that should have been accepted. There may be judicial, medical, safety or trade consequences of accepting product or results that should have been rejected.

Ask the laboratory how confident they are that the test item passed or failed the product specification.

Example of applying the confidence interval to test results



Test result A indicates there is more than 95% confidence that the product failed the specification.

Test result E at 95% confidence indicates an acceptable product.

For test results B, C and D, one cannot say with 95% confidence whether the product passed or failed.

For test result C, one is 50% confident that the product passed and 50% confident that it failed.

For result B, one is somewhere between 50% and 95% confident that the product failed. For result D, one is somewhere between 50 and 95% confident that the product passed. The laboratory can calculate the percentage of confidence that result B is a fail and result D is a pass.

MORE INFORMATION ABOUT TEST

Accredited laboratories have experts ready to advise on all matters regarding sampling, test methods and uncertainty. Please talk with them about your particular tests and how to correctly interpret the results. The documents in the References below give more detailed information on uncertainty and its application.

REFERENCES

ISO/IEC Guide 98-1:1995 – Guide for the expression of uncertainty in measurement (GUM);

ILAC G8: 1996 – Guidelines on assessment and reporting of compliance with specification

ILAC G17: 2002 – Introducing the concept of uncertainty of measurement in testing in association with the application of the standard ISO/IEC 17025;

APLAC TC004: 2006 (Issue 3) – Interpretation and guidance on the estimation on uncertainty of measurement in testing;

EURACHEM/CITAC Guide CG4: 2000 (2nd edition) – Quantifying uncertainty in analytical measurement;

EURACHEM/CITAC Guide: 2007 – Measurement uncertainty arising from sampling

AUTHORSHIP

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FURTHER INFORMATION

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