Uncertainty?

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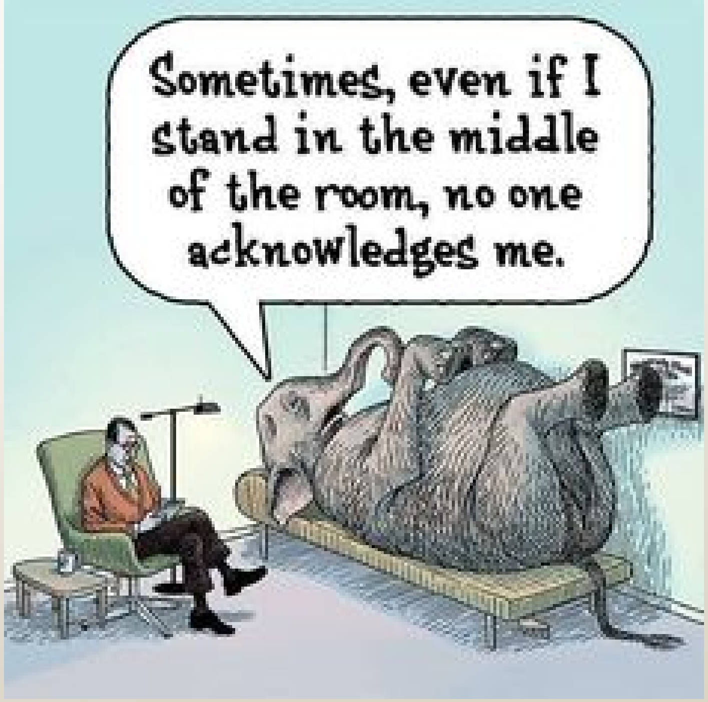
Basics

- Repeated measurement of acoustic quantities such as sound pressure level, reverberation time or vibration level will usually yield a range of results, indicating a degree of uncertainty or doubt about the measured value.
- The ISO Guide to uncertainty in measurement (G.U.M.) and the UKAS document M3003 explain in detail the statistical evaluation of measurement uncertainty leading to an expanded uncertainty, stated to certain confidence level (usually 95%).

Understanding causes of uncertainty is about understanding what factors associated with the measurement procedure might vary, and so cause the result to vary if we were to repeat the measurement.

Many acousticians regard uncertainty as the elephant in the room and ignore it.



Repeatability

This is a measure of how repeatable a measurement is. Repeatability conditions require the same tester, using the same equipment and the same test method, repeatedly measuring the sound insulation of the same partition over and over again.

The spread of the results around the mean value forms the basis of ways of quantifying the uncertainty of the measurements.

The most usual way of specifying the uncertainty of the results is to calculate and state the standard deviation of the sample of repeated results. The standard deviation is a way of showing how, on average, the measurement results differ, or deviate, from the mean value. It is the square root of the mean squared deviation of the measurements.

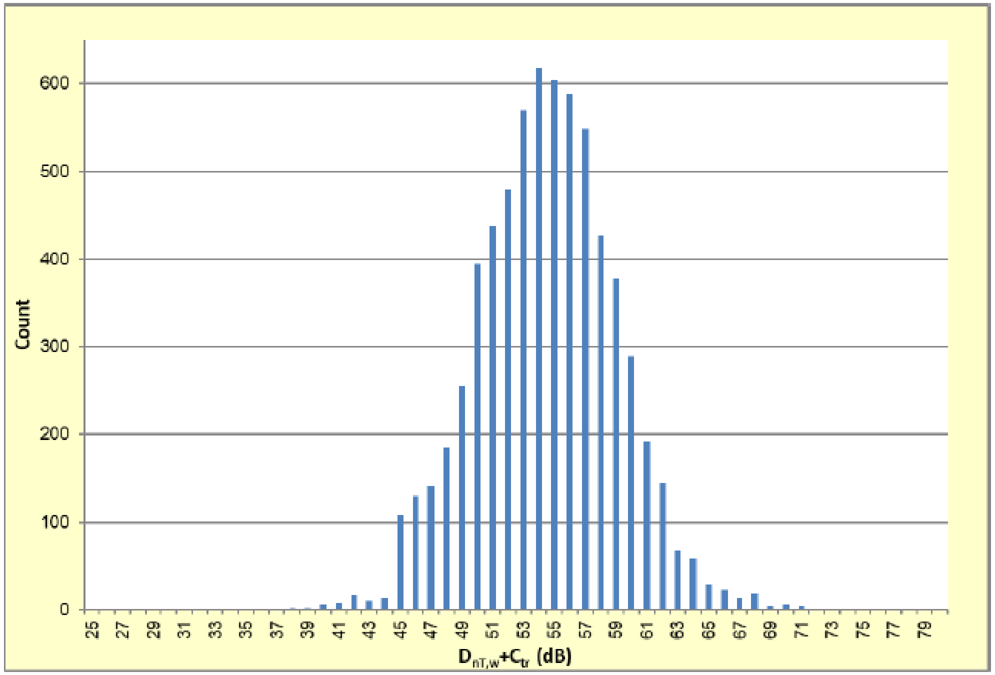
What we as testers want is to reduce the uncertainty in the repeatability and consequently reduce the uncertainty of the reproducibility.

Reproducibility

This is a measure of how reproducible a measurement is. Reproducibility conditions require different testers, using the different equipment and different test methods (within the proscription of the ISO), measuring the sound insulation of the same partition.

This is what we do as testers. It would be helpful if everyone got the same answer for the SNQ. Then there would be no doubt about any PASS/FAIL decisions.

The results of all tests in the Advance data base for purpose-built houses and flats, walls, airborne.



Category	No. Tests	No. Passes	No. Fails	Percent Pass (%)	Mean Index (DnT,w+Ctr) (dB)	Std. Dev
Type 1	359	334	25	93.0	52	5.3
Type 2	1826	1815	11	99.4	54	4.4
Type 3	379	378	1	99.7	53	5.1
Type 4	2798	2791	7	99.7	55	4.2
Other	1419	1404	15	98.9	55	4.7

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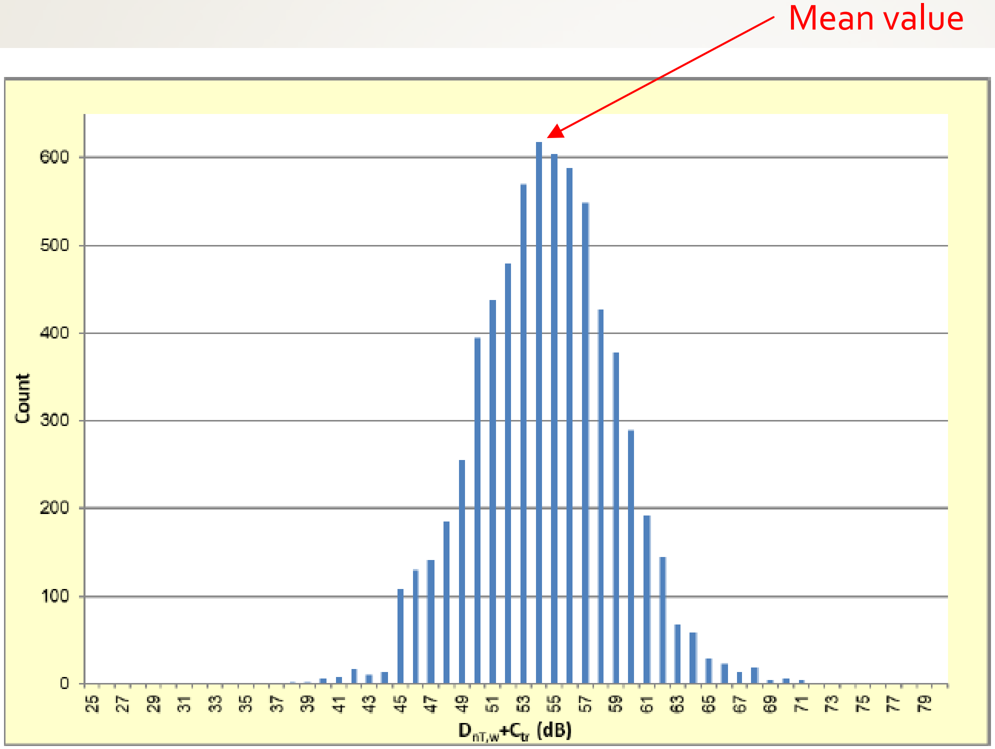

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For a Type 2 wall is the uncertainty 4.4 dB?

No!

The uncertainty is much smaller than that because what we are seeing here is the uncertainty of the measurement plus the variability introduced by workmanship.

What is the uncertainty of a sound insulation test and how do we quantify it?


BS EN ISO 12999-1:2014

BSI Standards Publication

Acoustics — Determination and application of measurement uncertainties in building acoustics

Part 1: Sound insulation (ISO 12999-1:2014)

bsi.

...making excellence a habit.™

BS EN ISO 12999-1:2014

Uncertainties should preferably be determined following the principles of ISO/IEC Guide 98-3 (G.U.M.). This Guide specifies a detailed procedure for the uncertainty evaluation that is based upon a complete mathematical model of the measurement procedure.

At the current level of knowledge, it seems to be impossible to formulate these models for the different quantities in building acoustics.

Therefore, the only way to asses the measurement uncertainty is by the use of round robin tests in a large number of laboratories.

BS EN ISO 12999-1:2014

This ISO describes several test scenarios.

Situation B has different measurement teams come to the same location to carry out measurements. The location may be a usual building or a test facility. The measurand is a property of one particular element in one particular test facility or the property of a building.

The standard uncertainty obtained for this situation is called the '*in situ*' standard deviation. This is the uncertainty value we are seeking.

BS EN ISO 12999-1:2014

Standard uncertainties for single-number values in accordance with EN IS0 12999-1 and with EN ISO 717-1

Descriptor	σ_R
R_w	1,2
$R_w + C$	1,3
$R_w + C_{tr}$	1,5
$R_w + C_{100-5000}$	1,3
$R_w + C_{50-3150}$	1,3
$R_w + C_{50-5000}$	1,3
$R_w + C_{tr,100-5000}$	1,5
$R_w + C_{tr,50-3150}$	1,5
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$R_w + C_{50-5000}$	1,3
$R_w + C_{tr,100-5000}$	1,5
$R_w + C_{tr,50-3150}$	1,5
$R_w + C_{tr,50-5000}$	1,5

The joint research project

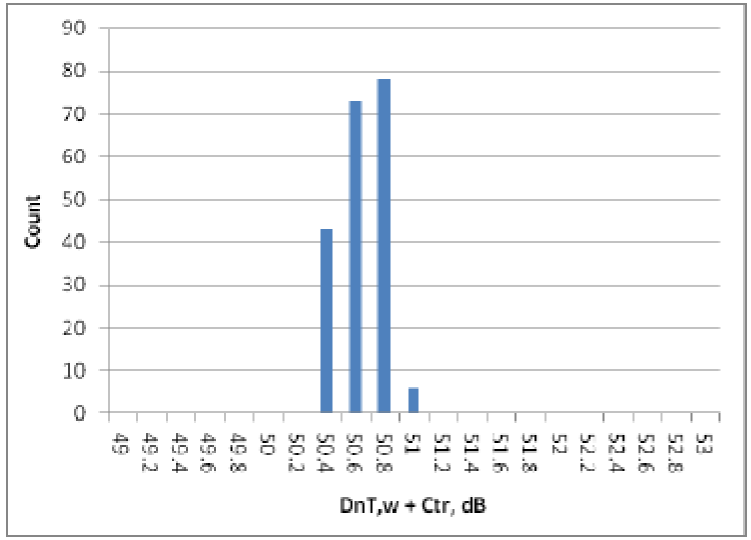
An empirical study of the effects of occupied test rooms and a moving microphone when measuring Airborne Sound Insulation.

A joint research project by the Association of Noise Consultants (ANC), Robust Details Ltd (RDL) and the Building Research Establishment (BRE).

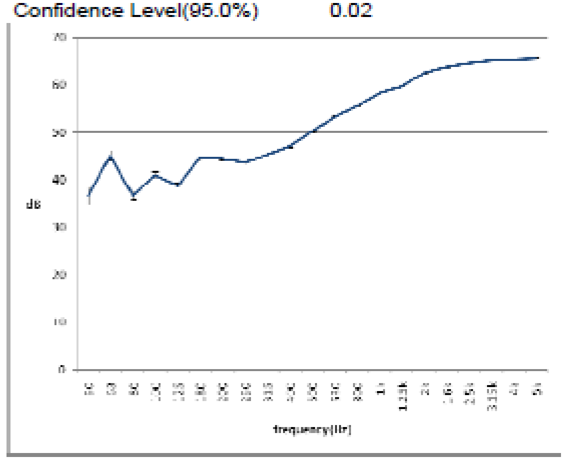
This was presented at the Spring Conference of the Institute of Acoustics 2008.

It can be downloaded from:

http://www.pdaltd.com/documentation

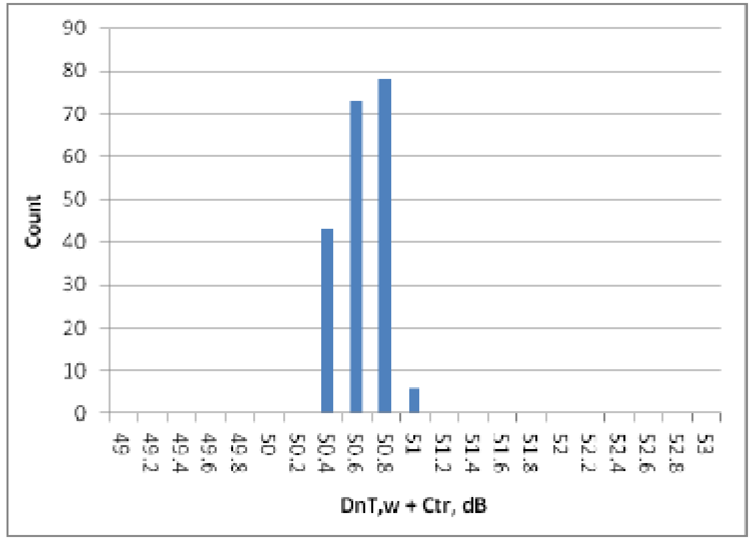


Mean	50.55
Standard Error	0.01
Median	50.57
Standard Deviation	0.16
Sample Variance	0.02
Range	0.71
Minimum	50.24
Maximum	50.94
Sum	10110.10
Count	200.00
Confidence Level(95.0%)	0.02



Dntw + Ctr = 50.57

Figure 22 Test 14 26th July Moving Microphones (Method 4)



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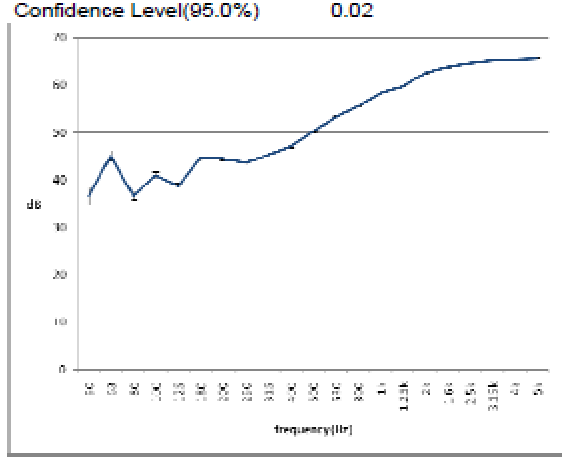

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Figure 22 Test 14 26th July Moving Microphones (Method 4)

The joint research project demonstrated that ANC testers, measuring in situ, produce results for sound insulation tests that have a much lower uncertainty value than that measured in laboratories!

So should we all now start quoting the measurement uncertainty in our PCT reports?

Absolutely NOT!

When the then ODPM set the pass fail criteria for ADE they included an uncertainty value in the PASS/FAIL levels.

This led to the statement by Les Fothergill that the first result must always stand and that testers must not repeat tests until they get a different outcome.

So what do we do about uncertainty?

We do not mention it at all in our reports but take every prudent step to reduce the level of uncertainty in our measurements.

The joint research project was the evidence that ultimately lead to the production of the 'Practice Guidance' and Iain will be discussing that as well as to how to engage your brain in the next presentation.

So what do we do about uncertainty for other types of measurements?

THANK YOU

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