amc technical brief

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Analytical and sampling strategy, fitness for purpose, and computer games

"What accuracy do you need?" This is a sensible question, which needs to be asked, yet how often do we receive a sensible answer? The naïve customer might say "the best possible accuracy", which is not very sensible because it implies an enormous cost. Some customers give a number that is plucked out the air: this at least has the advantage of providing them with a specification against which the results can be checked by quality control procedures. But is it a sensible answer? *Is* there a sensible answer?

The whole thing boils down to what the results are needed for. That is nearly always to enable the customer to make an informed decision. A

the appropriate uncertainty is therefore such as to minimise total costs on average. But in our example, we would have to consider the effect of uncertainty on *all* of the costs.

A result is fit for purpose when its uncertainty maximises its expected utility.

urement cost, if consideredin isolation, suggests that uncertainty should be as largeas the customer cantolerate. But what uncertainty can the customer tolerate?

Costs of bad decisions

To get to grips with this, we notice that decisions (*e.g.*, accept the batch of copper) in themselves involve extra costs if they turn out to be incorrect. One possibility is that a batch of copper is rejected when it should have been accepted. The manufacturer then unnecessarily has to bear the cost of reprocessing the batch to reduce the apparently excessive arsenic content. This situation is more likely to occur if the uncertainty on the measurement is greater (see Box).

A different outcome related to costs occurs if a defective batch is accept

A smaller uncertainty means that we decrease the chance of making an incorrect decision. For example, if the contractual maximum for am for l

reduce this cost.

In combination, these post-measurement misjudgements tend to give rise to expected losses that increase as a function of uncertainty, and increase somewhat more rapidly than yto expint los s proportionality. The exact calculations may be tricky, but the general effect can be seen as line B in Figure 1.

Similar considerations can be applied to most other situations involving chemical analysis. While these calculations can take some effort they can save money. Many people are spending money unnecessarily on very high accuracy. Maybe you could get more information for your money by taking more samples and using a less accurate (higher uncertainty) analytical method.

Sampling and analysis

The customer needs to know the mean composition of the target (in our example, the concentration of arsenic in the batch of copper) but actually gets, instead of the true value, a result with an uncertainty. The uncertainty springs from two stages of the chemical measurement: sampling and analysis. Virtually all chemical measurement implies prior sampling: we apply the measurement process to a sample, a small portion of the target. Targets are often large and always heterogeneous, so a sample differs in composition from the target, giving rise to uncertainty from sampling . The sample is then analysed, giving rise to the uncertainty of analysis . The important uncertainty from