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# NAMAS ACOUSTICAL CALIBRATION: THE HUMAN FACTOR

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## 1. INTRODUCTION

At first glance, the title of this paper may seem a nonsense. After all, the whole purpose of NAMAS accreditation is to ensure accurate objective measurements. Rigorous procedures are designed to ensure that measurements are always carried out in a controlled and repeatable manner. Where, then, is the human factor?

The answer lies in the fact that measurements themselves form only a small part of the activities in a NAMAS accredited laboratory.

This paper sets out to illustrate some of the problems associated with the human side of NAMAS calibration work. I do not pretend to have all the answers and, despite some of the examples, I do not intend to poke fun at those who have fallen into some of the more obvious traps of acoustic life. It happens to us all.

## 2. ACCREDITATION

The first step in the trail is obviously the process of accreditation itself; however, its initialisation depends on human factors. Recently customer demand for NAMAS accredited calibration has increased due to the publication of new measurement standards which call for it, but previously - when we started working towards accreditation, for example - it was almost non-existent. It therefore required someone to recognise the potential in gaining accreditation and spend the considerable sum of money required.

Having completed this stage, the next was to decide for which measurements we should seek accreditation, and the methods which we should use. What would these hypothetical customers want? How much should it cost? What accuracy would be required? We decided that the two most commonly required calibrations would be of sound level calibrators and sound level meters. As regards accuracy, we felt that a level appropriate to the measurements which customers made would be more desirable than going for the best possible accuracy by using laboratory grade microphones. On the whole, this policy seems to have paid off.

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Accreditation is not a speedy process, even if the applicant laboratory is fully cooperative. Quality manuals need to be written, and even if the laboratory is already participating in another quality scheme it is unlikely that the manuals can be used without alteration. Procedures may need to be written or changed to meet NAMAS requirements, and uncertainty budgets will need to be prepared. All this takes time both on the laboratory's part and on that of the NAMAS Executive. It must also be said that although we have for the most part found the staff at NAMAS to be very helpful, the system under which they must work leaves much to be desired. The DTI gives the impression of having a totally different concept of time; if we, as a manufacturer and commercial calibration laboratory, moved at the same speed we would have gone out of business long ago. Response times measured in months are quite common due to lack of resources, manpower and, in some cases, planning. We have, for example, just received a new issue of our Schedule of Accreditation four days short of seven months after we were accredited for the work in question. Until this point we had no written proof that we were allowed to perform these calibrations.

## 3. CUSTOMERS

Perhaps the largest human factor of all occurs at the interface between an accredited laboratory and its customers. Why do users of acoustic instrumentation require NAMAS accredited calibration? Acoustic calibration is not the most straightforward process to perform with a sensible degree of accuracy, partly due to the nature of the beast and partly to the lack of a physical reference such as the standard kilogram. It is therefore particularly important, in my opinion, that calibrations in acoustics and similarly awkward fields such as humidity - there is no standard "hurr" either - should be independently and professionally assessed.

International standards, in particular, frequently have passages which are so badly written that they are open to various interpretations. Should any such points arise in connection with calibrations accredited by NAMAS, we must come to an agreement with the National Physical Laboratory on which interpretation to use. However, this may not agree with the customer's interpretation or that of other metrology organisations. Moreover, who is to say which interpretation is correct?

Having said all this, we find that the majority ask for NAMAS calibration for one reason only; " We don't really need it, but the new standard says we've got to".

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## 4. INTERNAL CONFLICTS

The NAMAS system is very much written around companies which are purely calibration houses. Since this is probably the case in the majority of instances, this is perhaps not surprising; but it does cause additional difficulties for organisations which do not fit this stereotype. We are such a company; our main business is the design and manufacture of acoustic instrumentation, but we offer calibration as an additional service. We have therefore to operate extra procedures to ensure that publicity material, for example, does not contain statements which could be misinterpreted as implying that products are in any way approved by NAMAS. This is fair enough, but amongst other things it also means that whilst our ISO 9002 registration logo appears on the company letterhead, we are not allowed to place the NAMAS logo there in case the following letter should refer to something which is not NAMAS accredited.

## 5. THE NAMAS MESSAGE

### 5.1 Information.

NAMAS calibration laboratories face numerous problems when dealing with customers, many stemming from the fact that the NAMAS message has not reached the majority of users. A good deal of time is spent in explaining the advantages of NAMAS accredited calibration, why this isn't the same as BS5750, and what are the drawbacks of "manufacturers' standard" calibration.

NAMAS leaflet P3 "What's so special about a NAMAS laboratory report or certificate?" helps to explain the system but, being a general leaflet, naturally makes no mention of the limitations and difficulties specific to the field of acoustics. Its greatest drawback, however, is that so few of the people who actually need the information which it contains appear to have seen it, or even heard of NAMAS.

### 5.2 Traceability.

The first problem which we often encounter is the attachment of too much importance to "traceability". No, I do not mean that traceability is unimportant, it is essential; but without proven technical ability it is useless. Unfortunately during the last few years "traceability" has effectively become a buzz-word and, encouraged by some organisations, many equipment users are now under the impression that a traceable calibration must be correct. To claim traceability, the only requirement is that there is a discernable chain of calibrations back to an appropriate measurement standard, usually the National

Standards. No restrictions on the measurements methods, accuracy or confidence level are specified, and the more links there are in the traceability chain the greater the inaccuracy will be. As a rather facetious example, in theory it would be possible for a laboratory to claim traceability on a voltmeter which had been "calibrated", say by direct comparison with a reference instrument, by a ten-year-old who had connected it up with two pieces of damp string - provided the calibration of the reference instrument was "traceable"! NAMAS accreditation covers all aspects of a laboratory's capability, and therefore gives the assurance necessary for known accuracy with known confidence levels.

5.3 The Nature of calibration.
Secondly, there is a poor understanding of calibration itself. The most common misconception is that calibration can be guaranteed for a finite period of time, say twelve months, rather like an instrument warranty. If only life were that simple! A calibration of any instrument, whether acoustic or not, can only apply at the instant at which calibration takes place. An extreme example of this way of thinking was provided by an acoustic consultant who decided not to buy a calibrator with his Type 2 sound level meter, in the belief that it would be more accurate to send the meter back to the manufacturer for recalibration once a year. Even if the instrument itself were perfect - and there is no such thing as a perfect instrument - we cannot know what the customer is going to do with it - or to it.

## 6. EQUIPMENT

6.1 Categories.
This brings me to another of the major pitfalls; the equipment itself. It is here, perhaps most of all, that the subjective side of the work comes to the fore. There are three common problems:

Instruments which were not designed to an appropriate standard

Instruments for which we are not accredited

Instruments which are damaged or otherwise faulty

6.1.1 A large number of instruments which were designed to meet standards long since obsolete, such as IEC 123 or IEC 175, or indeed were not designed to any standard at all, are still in use today. We are regularly asked to perform NAMAS accredited calibrations to BS3539 on these, and often have great

difficulty in convincing the user that, for example, a twenty-five-year-old sound level meter is not really suitable for making accurate measurements which may even result in a court case. Another more recent problem has arisen with the advent of far-eastern look-alike copies of some reputable sound level meters. These are claimed by the manufacturers to meet, for example, IEC 651 Type 2; two samples which we tested, however, met this standard on only one relatively minor parameter, the remainder mostly falling outside the Type 3 specification. Since there is no legal requirement in the UK to have meters officially approved, the only recourse is through trading standards law.

6.1.2 As regards instruments for which we are not accredited, this is largely a function of the traceability route and calibration procedures which we have chosen to follow. It is often quite tricky explaining why we cannot calibrate a perfectly good meter, but unless the complete system is changed this will always be a problem.

6.1.3 Damage. Microphones are, by their very nature, the part of the system most susceptible to damage. Many man-years of work has gone into designing just the right shape and size to allow them to slip out of the hand at the slightest provocation, and ensure that they rarely win an argument with an uncarpeted floor. This apart, we have seen some interesting examples of creative microphone destruction. There was the Environmental Health Officer who decided to unscrew the protective grid from the front of a microphone for inspection purposes by pushing a pair of needle-nosed pliers through the slots and turning it. A surgeon would have been proud to make as neat a job of cutting out the diaphragm. There was also the company which used its sound level meter over a prolonged period in a very dusty atmosphere without protecting the microphone. Since they had never previously had the instrument calibrated, they did not notice the gradually diminishing high-frequency response until one day, after using it in damp conditions, it virtually stopped responding to the sound calibrator. It was sent to us for repair followed by NAMAS calibration, and investigation revealed that the dust was in fact mostly cement powder; concrete is not a recommended diaphragm material.

6.1.4 Plumbing. Another source of problems is plumbing; not of the domestic variety, but acoustic "plumbing". There is, unfortunately, a great temptation to assume that acoustic systems are analogous to water pipes in that if one has two

parts of dissimilar diameter to connect together, any coupler with appropriate sized holes "will do". A good example of this was a pistonphone which was received from a major public sector organisation, and had a home-made ½" coupler with it. This was of an entirely different design from the correct one, and allowed the microphone to sit inside the acoustic cavity of the pistonphone with its front grid almost obscured by the piston housing. It also leaked like a sieve. A rough check for curiosity's sake showed that the level produced was several decibels adrift, and varied quite alarmingly when the "coupler" was removed and replaced. This was apparently what the customer had been using for several years since the original coupler was lost. We naturally refused to calibrate the instrument. It was later discovered that this same instrument had previously been submitted to the National Physical Laboratory, and had met with the same refusal.

6.2 Failures.
Further complications arise if we state that an instrument fails BS3539, for example. These lie in the definition of "calibration" which, in fact, does not necessarily include "adjustment" or "repair". This can lead to the question " But how can you say it fails, when we've paid you to calibrate it?" We have to point out that in order to find out that the instrument fails we have to go through the calibration procedure, and in order to have a valid calibration after any adjustments we have to do the same again.

## 7. METEOROLOGY AND MURPHOLOGY

7.1 The Weather.
Another problem which often takes some explaining - I'm sure some people are convinced that it's just an excuse - is the weather. Whilst we can usually do something about the temperature, air pressure is a little more difficult to control, and the cost of doing so would be prohibitive. All acoustic calibrators vary in level to some extent with ambient pressure, and if the conditions are too far from nominal the uncertainties associated with calibration become too great. There is a well-known law which states that a deep depression is most likely to occur during a working day, and preferably when there is a large quantity of urgent work to be done. This can result in even deeper depression.

7.2 Instruments under test.
If a customer's instrument fails on any parameter, it is almost guaranteed to do so only after most of the other tests have been completed. Repairs will affect all other parameters, so that a complete retest is necessary. The less able or willing a

customer is to pay for the work done, the more work will be required. If the user is then going to damage the instrument, he is far more likely so to do just after it has been calibrated than just before it is due for recalibration; see the previous statement.

7.3 Reference Standards.
There is a similar law governing the calibration of reference standards at the National Physical Laboratory, which has to be performed annually for each type of instrument. In addition to air pressure we have here other problems, all of which contrive to happen at the least convenient time. Microphone calibrations were delayed by six months due to refitting of the anechoic chamber, several weeks by lack of air conditioning immediately followed by instrumentation problems, and are now running at least three months late due to rewiring. Accreditation for a whole series of calibrations was delayed by some months because a vital coupler disintegrated at exactly the wrong time. In all cases I am sure that the staff of the Acoustics Branch have done their best, but the system does not allow them to provide the service which is required and which they advertise. Although in some respects things have improved, delays of three to six months are still not unlikely, and this is not acceptable when calibration is scheduled to take place annually.

## 8. THE FUTURE

Our aim is to provide a reliable, speedy and suitably accurate calibration service at a sensible price. We have learned a lot since we were accredited, and there are still improvements to be made. But how can a NAMAS accredited laboratory successfully plan its future until the DTI successfully plans its present?

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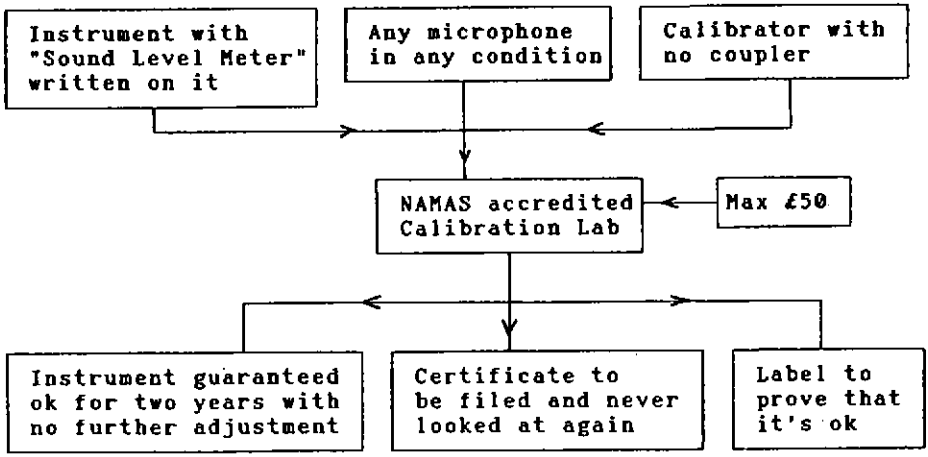


IDEALISM AND REALITY
Which is which depends upon your viewpoint