# Instrumentation corner

## Richard Tyler. Coupling an acoustic calibrator to a sound level meter

An acoustic calibrator is usually employed to establish the 'correct' calibration setting of sound level meters. The act of adjustment is usually simple: knowing the level to adjust it to is not always so simple, and this article is a reminder of the factors that need to be considered.

International Standard IEC 60942:2003 defines the requirements for an acoustic calibrator. In this Standard there are three classes – LS, Class 1 and Class 2. The most significant difference between the classes is the accuracy of the sound pressure level produced - ±0.2dB for Class LS (laboratory standard), ±0.4dB for Class 1, and ±0.75dB for Class 2 at 1kHz (including measurement uncertainty.) Influencing factors such as temperature, atmospheric pressure and electromagnetic fields must not alter the level so that these tolerances are no longer met.

### Output level of the calibrator

This is a number that is frequently misunderstood. The level may be reported on calibration certificates as a sound **pressure** level, or it may be quoted as an **equivalent free field** level. It is important to know which it is, as this will influence the level expected on the sound level meter. Calibrators are close-coupled devices, and so their actual output is usually a sound pressure level. The way this interacts with the microphone inserted into the calibrator determines whether there are alterations to the pressure level to arrive at the free-field level usually required in the UK for setting up sound level meters for measurement in open space. The most reliable value to obtain for a given calibrator is its **actual sound pressure** level, as any microphone effects can always be defined and added to or subtracted from the sound pressure level to arrive at the setting level for the sound level meter. In order to comply with the Standard, a calibration laboratory verifying the calibrator should have an expanded uncertainty of calibration of less than 0.1dB, 0.15dB or 0.35dB for Class LS, Class 1 and Class 2 respectively. It would be usual to identify the type of microphone used to calibrate the calibrator if appropriate.

Besides the level, calibration laboratories should report the exact frequency of the calibrator, and this must be within 1% of its stated value for Class LS and Class 1, and 2% for Class 2. Also the total distortion produced by the calibrator is required to be less than 2.5% for Class LS, less than 3% for Class 1 and less than 4% for Class 2 at 1kHz. All spurious components should be measured, and this requirement is not usually a problem for electronic calibrators today, but pistonphones need to be in good condition to meet this requirement.

### Environmental effects

Temperature, humidity and atmospheric pressure can all influence the accuracy of a calibrator. Modern calibrators are mostly now not affected by temperature provided they are used within their correct operating range, which is 16 to 30°C for Class LS, -10 to 50°C for Class 1 and 0 to 40°C for Class 2. Similarly, relative humidity usually has little effect over the range 25% to 90% for all classes. Atmospheric pressure, however, may require some compensation, depending on the type of calibrator being used. Calibrators are allowed to change by a small amount over the range 65 - 108 kPa, but if the change is greater than the allowance, then the calibrator should be marked with /C to show

*continued on page 22*

**Instrumentation corner** - *continued from page 20*

corrections are required. Class 1/C and Class 2/C calibrators must be supplied with an appropriate barometer to enable these corrections to be readily made.

In general, all types of pistonphone will require corrections for the prevailing atmospheric pressure. Some older electronic calibrators also have pressure effects similar in magnitude to pistonphones, and must be suitably compensated, but many modern electronic calibrators operate on a principle that reduces the effects of changes in atmospheric pressure to within the limits allowed in the Standard.

## Adaptors

Although by far the most popular size for a microphone is a nominal diameter of ½" (actually 13.2 mm), many calibrators have opening cavities for nominal 1" diameter microphones and require an adaptor to be fitted for the ½" size, and for ¼" microphones an adaptor is universally required. These small items, usually plastic, are often a key element in the level produced by the calibrator, and **it is vital that the correct part is used to marry calibrator and microphone together**. The mix-and-match of manufacturer A's calibrator with manufacturer B's adaptor for calibrating manufacturer C's microphone/sound level meter is a recipe for error on a grand scale and should **never** be employed! In most cases, there is an O-ring rubber seal at the microphone/adaptor joint, (as there usually is in the main cavity of the calibrator as well), and this should be maintained carefully to ensure an airtight seal exists between them. An occasional very light smear of silicone grease on the O-ring prolongs its life and usually improves its fit as well.

## Pressure to equivalent free-field corrections

This is a number that is fixed for a given calibrator (plus adaptor) and microphone model. It is not necessarily the same for any two makes or models of microphone and must be added to the calibrator's pressure level if the sound level meter is to be used as a free-field measuring device.

If the microphone is not a free-field type, or the meter has been set to a random incidence or diffuse field correction, there will normally be no microphone correction factor required if the microphone is on an extension cable. There **may** be a correction factor for the shape of the case of the meter if the microphone is mounted on a preamplifier that is part of the main instrument. The pressure to free-field correction may also include this effect, in which case it is possible that a different correction factor will apply if the microphone is on an extension cable. This may also be true when an accessory such as a windshield is used. The correction data supplied needs to be clear about the conditions to which it applies.

## Settling time

As most calibrators form a fairly airtight seal around the microphone when correctly positioned, the insertion of the microphone acts a little like a pump on the air inside the calibrator. This effect is usually dissipated via small air passages in both the microphone and the calibrator, but these do take time to return the air inside the calibrator to atmospheric pressure. The time taken can in part be offset by inserting the microphone (and removing it) only slowly.

## Applying the calibrator to instrumentation

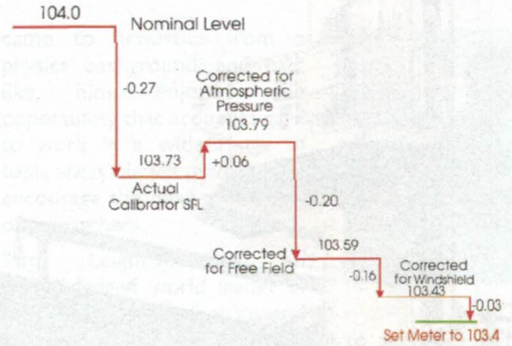
With a knowledge of the 'true' level of your calibrator, you are in a position to work out the correct level to which your sound level meter should be set. For a typical calibration using a calibrator with a known pressure level and a free field microphone, this can be mostly summarised as follows.

- Take the certified pressure level of the calibrator
- Add or subtract any relevant correction factors for adaptors in use (if not included in the level stated above)
- If the calibrator is sensitive to temperature, humidity or atmospheric pressure, measure the parameter(s) of influence and add or subtract their effects using data provided by the manufacture of the calibrator
- Add or subtract the pressure to free-field correction for the microphone/calibrator combination (if applicable)
- If a windshield or other accessory is to be used, add or subtract its effect at the calibration frequency
- Round the answer to the nearest level displayed by the meter and adjust accordingly.

**The result will be the correct and most accurate setting for your sound level meter.**

## Correct For :-

Environmental Conditions
Free-Field Use
Windshield




**Richard Tyler** FIOA is with AV Calibration Ltd, Shefford, Bedfordshire SG17 5HQ and is chairman of the Measurement and Instrumentation group of the IOA.