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Pre-Completion Testing: The ANC Good Practice Guide

A James BSc MIOA
Adrian James Acoustics

Email adrian@adrianjamesacoustics.co.uk

SUMMARY

The Association of Noise Consultants' Good Practice Guide documents the technical requirements and procedures for Pre-completion tests carried out under its Registration Scheme. This paper describes some of the technical issues addressed in the Guide. Particular emphasis is given to areas where the relevant national and International Standards are open to different interpretations or misinterpretations.   These include loudspeaker types, source noise spectra, the use of moving microphones, the effect of a tester in the source room, the use of diffusers to reduce room mode effects, the averaging of results, and the measurement of reverberation times.

This paper does not attempt to cover all aspects of the Guide, but concentrates on the principles and on some of the technical aspects that have caused most debate within the ANC. This paper includes changes to the draft Guide since March 2007, and so supersedes some aspects of a previous paper on this subject [1].

Reference is made both in the guide and in this paper to the joint ANC / RDL round robin exercise [2] and to the joint ANC / BRE research project which investigates some of the variables addressed in the Guide.   This research and the latest results are discussed in separate papers at this conference [3, 4].

NOMENCLATURE

A number of abbreviations and acronyms are used in this paper and for ease of reference these are explained below.

ANC	Association of Noise Consultants, the UK's professional body for acoustic consultants (the Institute of Acoustics represents all acousticians whether consultants or not).
DCLG	Department of Communities and Local Government, which administers building regulations in England and Wales. Previously called ODPM.
ADE	Approved Document E of the Building Regulations "Resistance to the passage of sound" [5]
UKAS	United Kingdom Accreditation Service.
PCT	Pre-completion testing – i.e. airborne and impact sound insulation tests required on new and converted dwellings
RDL	Robust Details Ltd, an organization which administers a scheme of Robust Details for new dwellings as an alternative to PCTs. The RDL Inspectorate carries out a stringent regime of inspections and sample tests on Robust Details.
"The Standards"	In this paper we use this term to the relevant parts of BS EN ISO 140 [6, 7] and BS EN ISO 717 [8, 9], and to the additional requirements and clarifications to these standards as identified in ADE.

The Good Practice Guide and the Scheme on which it is based are the result of work by the Board, Examiners and Members of the Association of Noise Consultants' Registration Committee. In this paper the terms "we" and "us" are used informally to refer to these bodies, of which the author is a member. Any opinions expressed in this paper it are the responsibility of the author alone and do not necessarily represent the corporate view of the ANC.

INTRODUCTION

In 2002 the ODPM (now DCLG) proposed changes to Part E of the Building Regulations on sound insulation in dwellings. One of these changes was to make pre-completion testing mandatory, and the consultation document stated that testers would be required to have UKAS accreditation or an equivalent alternative. At the time, however, only three consultancies in the UK were accredited for such tests. Clearly a very large increase in the number of accredited testers would be required, and as the professional body for acoustic consultants in the UK it fell to the ANC to determine how this could best be achieved.

At a presentation by UKAS to the ANC, it became clear that the cost and administrative burden of obtaining accreditation would make this impracticable for many of our members. Furthermore the duration of the accreditation process, even without additional delays caused by a sudden large influx of new applicants, made it unlikely that sufficient testers could be accredited to meet the demand by the time the new regulations came into force. The UKAS representatives also pointed out that that UKAS did not have in-house capability for technical acoustic assessment, which would therefore be sub-contracted by UKAS to acoustics consultancies, who by definition would probably be ANC members.

The purpose of accreditation was to give the ODPM confidence that tests would be carried out in accordance with the standards and that, within the limitations of acoustic measurement, test results would be independent of the test organization carrying out the tests. Many of our members felt that under the circumstances, the ANC was better able than UKAS to achieve this, at considerably less cost and with less delay to its members. We therefore proposed an alternative to UKAS accreditation, created and administered by the ANC for its members. ODPM supported this proposal and after a great deal of work in a very short time, the "ANC Registration Scheme" received government approval in 2003. It is an illustration of the success of the Scheme that, at the time of writing of this paper, the Scheme has processed some 90,000 PCTs without, to the author's knowledge, any test result being successfully challenged from outside the ANC.

The process might be thought to have turned full circle with the ANC itself applying for UKAS Accreditation under ISO 17024 [10]. It should be made clear, however, that this is accreditation for the management of the registration process and not for any technical aspect of the scheme. This process is not expected to have any effect on the technical content of the Guide.

The process of setting up, administering and monitoring the Scheme has raised a number of technical questions over interpreting the Standards. In particular, we have found a number of apparent anomalies, omissions and contradictions in EN ISO 140 Parts 4 and 7. A few of these are addressed in Annex B of ADE, but others are not. As ADE requires all tests to be in accordance with these standards, the Registration Committee has had to resolve these issues and issue guidance on interpretation of these standards. This guidance is documented in the Good Practice Guide.

Given the commercial significance of standardisation in field measurements of sound insulation, there is remarkably little published research to support the standards. During development of the Guide we have therefore undertaken two collaborative research projects, one with RDL [2, 3] and a second, still in progress, with BRE. The latter work, described in a separate paper at this conference [4], will influence protocols for measurement of sound insulation for the Code for Sustainable Homes and other aspects of sound insulation measurement for BREEAM.

Our research quantifies the reproducibility and repeatability of field tests and investigates which aspects of standardisation affect these figures. It is hoped that it will influence future revisions to the Standards, and indeed that future standards will be based on a research-based procedures similar to those that we have adopted in developing the Good Practice Guide.

Note on unauthorised use of the Guide

There have been cases of non-accredited and non-registered organisations claiming to carry out tests "in accordance with the ANC Scheme", in some cases going to the trouble of issuing certificates with a remarkable and somewhat flattering similarity to those issued by the ANC. There is a risk that publication of the guide will lead to non-registered testers claiming that they are carrying out tests "In accordance with the Good Practice Guide".

The Guide is specifically written solely for the use of individuals who are registered under the ANC Registration Scheme, working for member companies which must also be registered under the Scheme. This membership and registration will remain fundamental requirements for testing in accordance with the Scheme. It is therefore not possible for non-registered testers or organisations to test in accordance with the Guide or the Scheme. Any claims from non-registered testers or organisations that they are testing in accordance with this Good Practice Guide or Scheme are, therefore, self-evidently untrue.

PRINCIPLES OF THE GOOD PRACTICE GUIDE

In drawing up the ANC Registration Scheme, a few underlying principles were agreed. It follows that the same principles apply to the Good Practice Guide.

Compliance with the standards

For PCTs to be meaningful the results have to be, as far as possible, independent of who measures the sound insulation. Hence all testers must use the same standards, even if these are flawed. In addition, as the scheme was drawn up specifically to comply with the requirements of Approved Document E, it follows that the Scheme must comply with the standards set out in ADE. ADE requires compliance with BS EN ISO 140 Parts 4 and 7, and BS EN ISO 717 Parts 1 and 2, and it follows that the Scheme must comply with these standards. This applies even where aspects of the standards have been shown to be flawed. The ANC is working to influence the revision of these standards, but this is a separate (and rather slow) process and meanwhile we have to work within the existing imperfect standards.

In some respects research has shown the standards to be unnecessarily proscriptive – for example, in the requirement for no more than 6 dB between adjacent third-octave bands in the source room spectrum. This requirement dates back to the use of meters with analogue filters. None the less, this remains a requirement in the Standard and so is a requirement in the Guide.

In some cases where the ISOs are particularly unclear, Annex B of ADE imposes a specific interpretation. For example, ISO 140 does not specify whether the sound level differences between source and receiver room should be averaged arithmetically or logarithmically. ADE specifies arithmetic averaging of level differences, and this is therefore a requirement in the Guide. This raises an interesting question for UKAS accreditation; a company can have UKAS accreditation to test in accordance with BS EN ISO 140 Parts 4 and 7 while using energy averaging of level differences, which would not comply with ADE.

In places where the standards are incomplete or ambiguous and are not clarified in ADE, we have interpreted as far as possible in terms of what the standard actually states. In the context of a national or international standard it should not be necessary to guess at the intentions of the authors.

Where the Standards offers a recommendation rather than a firm requirement, this is reflected as a recommendation in the Guide. For example, ISO 140:4 states that in tests between identical empty rooms measurements diffusers should “preferably” be used. The Guide therefore recommends the use of such diffusers but can not make them a requirement. On occasion, the standards are vague as to on what is a requirement and what is guidance. For example, Section A.2 of ISO 140-4 is titled “Guidance on selection of optimum source positions” but is in a normative annex to the standard. In this case the Guide provides both minimum requirements and additional recommendations.

A fundamental precept of the Scheme is that the measurement requirements should be no more restrictive than the standards. Where the standards allow several methodologies, the Scheme does not impose one of these methodologies at the expense of others. Neither does the scheme try to impose a “Gold standard” in excess of the requirements of the ISO. This may seem self-evident, but it contrasts with the traditional approach to accreditation which in some cases requires, for example, 12 or 18 reverberation time measurements in normal rooms as opposed to the 6 required in ISO 140 Part 4. The stated justification for this “Gold standard” approach is that each company applying for accreditation is permitted to set out a technical case justifying a reduction in the number of measurements, and that a reduction will be permitted if the accreditation body considers the case to be justified. We consider this to be a waste of time as well as contrary to the purpose of standardisation. We have assumed that if the ISO standard considers 6 measurements to be adequate for a site measurement in a normal room, no further justification is needed for a tester to use that number of measurements.

Practicalities of field measurements

One likely cause of the problems that we have had with the standards is that many members of the committees drafting them were more familiar with laboratory measurements than with field measurements. In most cases pre-completion testing takes place on working building sites, where the greatest threat to accuracy comes from varying and intrusive ambient noise levels. These noises are not random in nature – for example, there may be only a short time period when a noisy item of plant is not operating. In such cases, it may be more accurate to measure over the shortest period permitted by the standards during a period of low ambient noise, than to extend the measurement period and to have measurements affected by extraneous noise.

There are also commercial pressures, both on the client and the consultant. Down-time on building sites is expensive, and a contractor will not wish to close down his site for any longer than is necessary. A methodology that takes four hours per set of tests as opposed to two must be justified by a significant and necessary increase in reproducibility. This is a marked contrast to the more accommodating environment of the acoustic laboratory.

There are also health and safety issues to consider. On a noisy site, achieving a signal-to-noise ratio of 15 dB rather than 10 dB may require the use of large and heavy sound sources, which may have to be manhandled across uneven ground or up stairs. Smaller sources may be perfectly adequate and are much safer to handle. The Guidance has to take account of such issues, which are outside the scope of a purely technical standard..

TECHNICAL ISSUES – AIRBORNE SOUND INSULATION

Options

There are a number of options for the airborne measurement procedure, including:

1. Using one or two source loudspeakers
2. Using static or moving microphones
3. Measuring sequentially or simultaneously in source and receiver rooms
4. Simultaneous broadband or sequential band-limited measurements
5. Reverberation times – using continuous or impulsive sources

These are all independent variables and any combination of these can be used.

Room types, conditions and volumes

Rooms to be tested will normally be bedrooms and / or living rooms. Where necessary, however, tests may be carried out in other rooms including kitchens and bathrooms but not corridors, stairwells or hallways. This is clearly stated in ADE, which also states that tests should be conducted between completed but unfurnished rooms. It is inevitable that on occasion tests have to be carried out in furnished rooms and in that case the fact that the room was furnished must be stated in the report. There is no evidence that the presence of furniture in the room affects the test result.

Section B2.15 of ADE states that when measuring airborne sound insulation between a pair of rooms of unequal volume, the sound source should be in the larger room. This is more definitive than the statement in Section 6.2 of ISO 140-4 that "*If the rooms are of different volumes, the larger one should be chosen as the source room when the standardised level difference is to be evaluated and no contradictory procedure is agreed upon*".

It has been common practice when measuring airborne sound insulation across a floor to locate the source room downstairs so as to eliminate the possible effect of floor vibrations directly induced by a loudspeaker mounted on the floor. This is a not a requirement of the Standards (except arguably when a hemisphere polyhedron loudspeaker is mounted directly on the floor, as discussed later). The requirement for measuring from the larger to the smaller room therefore takes precedence. As the loudspeaker is generally mounted at least 0.5 m from the floor, directly-induced floor vibration is generally not a problem.

The Guide therefore confirms that in all cases the sound source should be in the larger room.

Loudspeaker types

Section 6.2 of EN ISO 140-4 states "*"If the sound source enclosure contains more than one loudspeaker operating simultaneously…it shall be assured…. that the radiation is uniform and omnidirectional, as specified in A.1.3."* Section A1.1 of ISO 140-4 requires the source room sound field to be as diffuse as possible, with microphone positions outside the direct field of the source. Section A.1.3 discusses polyhedral loudspeakers and sets out a procedure for assessing their directivity. The standard does not, however, specifically require polyhedral loudspeakers or preclude the use of other types of loudspeakers. In fact it acknowledges that other loudspeaker types may be used, e.g. ISO 140:4 Section A1.2 states "*When using a source with omnidirectional radiation, the distance to the microphone shall be not less than 1 m"*

Many ANC and UKAS accredited testers therefore use cabinet loudspeakers, which are in many cases more robust, capable of higher sound power levels at low frequencies, and provide a larger volume of the room out of the direct field. Our research [2, 3, 4] has shown no significant difference in results between the two methods. The Guide therefore allows both polyhedral and cabinet loudspeakers.

Loudspeaker locations for tests across walls

Section A.2 of EN ISO 140-4 states "*The distance between room boundaries and the source centre shall be not less than 0.5 m*" and "D*ifferent loudspeaker positions shall not be located within same planes parallel to room boundaries*" but does not say by how much the planes must be different. The Guide recommends a height difference of at least 100 mm and in practice, using loudspeaker stands, a height difference of more than 300 mm should be easily achieved.

Loudspeaker locations for tests across floors

The same requirements apply as for tests across walls. In particular, as discussed above, the requirement for testing from the larger to the smaller room applies even when the larger room is upstairs.

A complication is the use of hemispherical polyhedron loudspeakers. Section A.1.3 of ISO 140-4 states that "*Omnidirectional radiation into the room is also achievable with a hemisphere polyhedron loudspeaker (mounted directly on the floor). Carry out vertical measurements in this case in the direction from the lower room to the upper room*"

Allowing any type of loudspeaker to be mounted directly onto the floor contravenes Section A2 of the same standard, and is likely to excite vertical room modes. However, A1.3 does not actually instruct that this type of loudspeaker must be mounted directly on the floor – it merely points out that doing so can achieve omnidirectional radiation, which is not a stated requirement. The Guide deals with this apparent inconsistency by allowing the use of hemispherical dodecahedral loudspeakers provided that they are located in the same way as other loudspeaker types. They can be raised off the floor by 0.5 m or more using a purpose-made stand or a simple folding table.

Diffusers and room modes

ANC and RDL testers have found that room modes can have significant effects even in rooms of different shapes and volumes, particularly when these are empty and unfurnished. For rooms of typical dimensions, the effect of modes tends to be greatest in the 100 Hz and 125 Hz third-octave bands, and so of course has a disproportionate effect on $D_{nT,w}+C_{Tr}$. We have found that in rooms with strong modal response at frequencies which coincide with resonances in the separating wall, diffusers can result in an increase of as much as 7 dB $D_{nT,w}+C_{Tr}$.

ISO 140-4 states that measurements between empty rooms with identical shape and equal dimensions should preferably be made with diffusers (e.g. furniture or building boards) in each room, and that three or four objects of 1.0 m^2 should be sufficient. Use of the word "preferably" in the standard makes this a recommendation rather than an absolute requirement. The Guide therefore recommends the use of diffusers in all cases where the tester considers that room modes may be significant. This is often indicated by unusually large values of Ctr and by large variations in source and / or receiver room levels at different locations in the room, particularly at 100 and 125 Hz.

Fixed microphone locations

If using fixed microphone positions, ISO 140:4 requires a minimum of five positions equally distributed within the space permitted for measurement in the room. They should be at least 0.7 m apart, at least 0.5 m from any room surface, at least 1 m from loudspeakers and should be at different heights. Where possible these distances should be increased to sample the permitted area of the room equally.

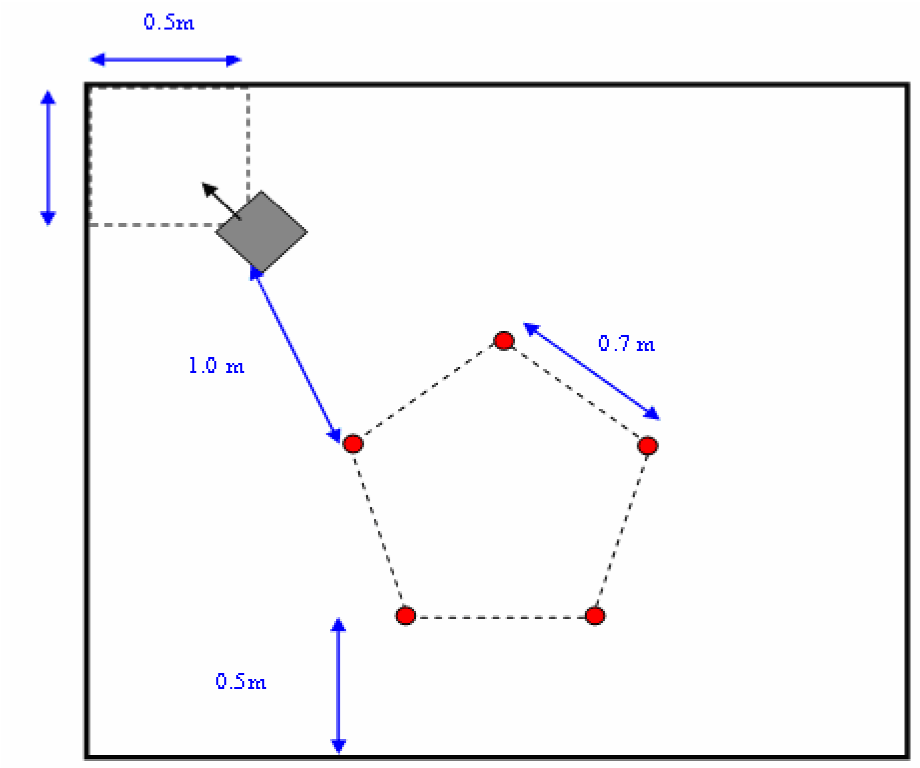

Figure 1 – Minimum speaker and fixed microphone separations (plan)

Figure 1 shows the minimum spacing locations allowed in a small room and many testers have worked precisely to these spacings, ignoring the statements in ISO 140-4 that "*Greater separating distances should be used whenever possible*" and that "*Microphone positions…shall be evenly distributed within the space permitted for measurement in the room*". The Guide emphasises these requirements.

Averaging using fixed microphones

If using fixed microphone positions, the Leq in each room must be measured using at least 5 microphone positions, with each measurement lasting at least 6 seconds. These measurements must be averaged logarithmically, i.e. on an energy basis, as specified in both ISO 140:4 and ADE. This averaging can be done within the instrument, using the "pause" function on the meter to measure, effectively, a single Leq of 30 seconds or more. Alternatively 5 separate measurements can be stored for subsequent processing in software. This allows later analysis of the individual measurements, which can be useful in post-measurement analysis, particularly to determine whether a failure might be due to strong room modes, which can cause large differences between measurement locations.

Measurements using moving microphones

Both ISO 140:4 and ADE allow use of a moving microphone instead of fixed microphone positions. The traverse of a moving microphone is defined as having… *" a sweep radius of at least 0.7 m, with a traverse period of at least 15 s and a traverse plane inclined at more than 10 degrees from any plane of the room".* A typical example in a small room is shown in Figure 2.

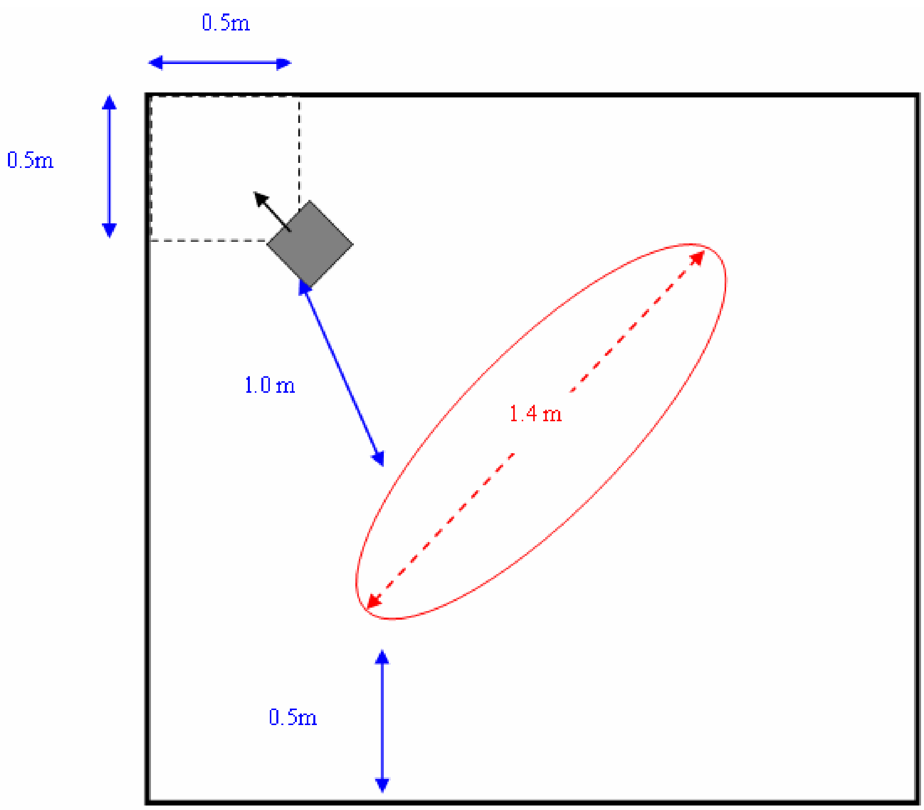

Figure 2 – Typical inclined sweep in a small room (plan)

As with fixed microphone locations, these are minimum dimensions and the traverse “shall be inclined in order to cover a large proportion of the space intended for measurement”. ISO 140:4 does not, however, state that this traverse must be achieved by a mechanical rotating boom, and the majority of testers do this manually. This is permissible under the standards and there is no obvious reason why a manually moving microphone following the correct traverse should give different results from a mechanically traversed microphone.

Fixed and moving microphone techniques have been compared in the joint IoA / RDL Round Robin test [2,3] and in the current ANC / BRE research project [4] and no significant difference has been found, even where the moving microphone does not follow a single inclined plane but is swept in geometrically indescribable shapes to sample more of the available space. The results also show that fixed microphone locations, unsurprisingly, give slightly worse repeatability.

Effect of the tester in the source room

With either fixed or moving microphones, if the tester moves from the source to the receiver room to take measurements, there will be a small reduction in the average sound pressure level in the source room. This reduction will depend on the volume and reverberation time of the source room, and a simple Sabine calculation shows this to be typically 0.5 – 1.0 dB at most frequencies. This is small compared with the reproducibility values for field tests published in Table A.3 of BS EN ISO 20140:1993 [11] which range from 3.5 dB at 3150 Hz to 9 dB at 100 Hz. This has been confirmed by the results to date of the joint research project, which conclude that the measured $D_{nT,w}+C_{Tr}$ using this method is approximately 0.5 dB lower than if all measurements are taken in unoccupied rooms.

To date, therefore, this effect has not been considered to be statistically significant and so it has not been addressed in the Guide. If this is changed as a result of our current research, the Guide may introduce a procedural change, such as substitution of the tester with an equivalent area of acoustic absorption when he or she leaves the source room, as we understand is part of some UKAS-accredited testers’ procedures. Alternatively, it may be possible to address the effect by correction factor in the calculation procedure.

Averaging

There has been considerable confusion over the averaging of sound pressure levels and level differences, and ISO 140 is not very clear on the latter point. The requirements and procedures are, however, described very clearly in Annex B of Approved Document E. There are two separate averaging processes :

i) averaging measured levels at different microphone positions in a room, which is done on an energy basis, and
ii) averaging the level differences between rooms, which is done arithmetically.

As an additional source of confusion, some sound level meter manufacturers supplied (and in some cases some still supply) software that averages the sound level differences on an energy basis. Many testers have therefore written their own spreadsheets for processing the results. This encourages familiarity with the standards as well assisting in more detailed analysis. We find that “black box” calculation modules built into sound level meters are not always conducive to a good understanding of the standards.

Using a moving microphone simplifies matters because there is no need for energy-averaging between microphone positions. A 30-second microphone “sweep” has the effect of both space-averaging and time-averaging, and is equivalent to five 6-second measurements at fixed microphone positions. Because all measurements are in terms of Leq the time-averaging is automatically on an energy basis.

Using two sound sources simultaneously further simplifies the procedure because only one measurement in the source and receiver room is required. Hence no averaging of sound level differences is necessary.

Background noise corrections

Both parts 4 and 7 of ISO 140 set out procedures for correcting the receiver room levels for background noise. Where the background noise (measured as L_{eq}) is between 6 and 10 dB below the receiver room level the correction is, as one would expect, based on a logarithmic subtraction of the two. Where the difference is 6 dB or less, however, a correction of 1.3 dB (corresponding to a difference of 6 dB) must be used. This is of course technically incorrect but is necessary to avoid nonsensical results where the background noise is very close to (or even higher than) the receiver room noise. This is possible on site because of course the background noise is measured either before or after the receiver room noise, and will vary with time.

Some testers have assumed that every effort should be made to measure the lowest possible background noise level, whereas of course the purpose is to assess the effect that the background noise had on the receiver room measurement. The measurement technique for background noise should reflect this by being identical to the technique used for the receiver room measurement. This is not made clear in the standard.

Reverberation time measurement

There have been long and heated discussions about the use of impulsive noise sources to measure RTs. Some testers use starter pistols or balloons in preference to the interrupted noise method, as this eliminates the need for a loudspeaker and power source in the receiver room. Studies have shown that if anything, impulsive noise sources measured correctly give better reproducibility on RT results than interrupted noise [12]. However, impulsive sources have sometimes been rejected because ISO 140:4 implies – but does not specifically require – use of a loudspeaker as the source for the RT measurements.

Confusingly, ADE and ISO 140:4 both refer to BSEN ISO 354 “Measurement of sound absorption in a reverberation room” which is a standard for the assessment of absorption coefficients in laboratories. They do not refer to ISO 3382 [13] which is the widely-used standard describing methods of reverberation time measurement on site. This anomaly may reflect the composition of the committee which created standards. In any case, both ISO 354 and 3382 allow the use of impulsive sources provided that the measurement system uses the Schroeder reverse-integration method (as nearly all modern measurement systems do).

The informative Annex A of BS EN ISO:140 Part 14:2004 “Guidelines for special situations in the field” [14] further confuses the issue by stating that RT measurements should be carried out “as described in ISO 140-4 or ISO 3382-2.” This reference is not helpful in that ISO 3382-2 “Acoustics – measurement of reverberation time - Part 2 Ordinary rooms" has not been published, although a draft was apparently issued for consultation in 2004.

The ANC has now obtained representation in its own right on the BSI and ISO technical committees dealing with these standards.

TECHNICAL ISSUES – IMPACT SOUND INSULATION

Compared with its airborne counterpart, impact sound insulation has raised relatively few problems in the Guide. This is largely because the measurement process is much simpler, with only one permitted type of noise source whose location in the vertical plane is substantially more constrained than that of an airborne source.

Of course some of the technical issues relating to airborne sound insulation measurement also apply to impact sound insulation. This includes reverberation time measurement, background noise correction and the locations of microphones in the receiver room (although there are differences in the number of measurements and fixed microphone positions, and the microphone must not be within 1 metre of the ceiling). Research on reproducibility and repeatability of impact tests may be undertaken at a future date. Meanwhile, technical issues relating solely to impact tests are as follows.

Tapping machine conformance checks

Some aspects of a tapping machine are considered vulnerable to change during the life of the machine and ISO 140-7:1998 states that the following parameters must be verified regularly:

- velocity of hammers
- diameter and curvature of hammer heads
- falling direction of hammers
- time between hammer impacts.

In the absence of a national standard for calibration of tapping machines, the Guide includes detailed recommendations for conformance checks by the owner. It also requires a conformance check by a third party (normally a laboratory or the tapping machine manufacturer) at least every two years, to confirm that the tapping machine is within the tolerances set out in Annex A of ISO 140-7.

Soft floor coverings

ADE states that impact sound insulation tests should be conducted on a floor without a soft covering (e.g. carpet, underlay or foam backed vinyl) except in the case of a separating floor type 1 as described in Approved Document E, or a concrete structural floor base which has a soft covering as an integral part of the floor. If a soft covering has been installed on any other type of floor, it should normally be taken up or, if that is not possible, at least half of the floor should be exposed and the tapping machine should be placed only on the exposed part.

Building Control Officers do, however, have the discretion to allow a proprietary soft floor covering to be used as part of a floor treatment. This quite frequently arises in flat conversions in buildings with timber floors. The flats are often sold or let with this material installed, the final choice of floor finish (e.g. carpet or laminate) being left up to the occupier. Building Control Officers will often insist on the material being glued to the base floor to prevent it from being taken up by subsequent residents.

If the tester performs an impact test on the underlay material, the resulting $L_{nT,w}$ value will be typically in the range of 35 dB to 45 dB $L_{nT,w}$ and as such is probably not worth testing. If the flat is eventually carpeted, there is usually little significant change in the $L_{nT,w}$ value. If, however, the flat is fitted out with a laminate floor on top of the underlay material, the impact performance will worsen considerably, typically in the range of about 50 dB to more than 60 dB $L_{nT,w}$, depending on the overall floor and ceiling construction.

The Guide therefore recommends that when a test is required on a resilient acoustic underlay material, a rigid board material should be placed beneath the tapping machine. This may be an 8 mm MDF or plywood panel as this has a similar thickness, density and hardness to most of the laminate floors commercially available. The area of the board need be no more than 50% larger than the base of the tapping machine. The report must draw attention to the presence of the resilient underlay and the use of the board for testing.

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About the Author: Adrian James BSc(Hons) ARCS MIOA is Principal Consultant at Adrian James Acoustics Ltd, and a specialist in building acoustics. He is Vice-Chairman of the Association of Noise Consultants and co-Chairman of the ANC’s Registration Scheme Committee. He is also an examiner for the ANC Registration Scheme and a Robust Detail Inspector. He normally writes much more interesting papers than this.