CONTROLLING EXTERNAL NOISE INTRUSION EXPECTATIONS AND REALITY

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1 INTRODUCTION

PPG24 provides extensive guidance on the measurement of the external noise levels around a potential residential site and the assessment of the suitability of the site for residential development according to those measured noise levels.

Of course, that is only half the story, and the second stage of the assessment is to determine the level of external noise intrusion into the new dwellings. This is briefly described in Annex 6 of PPG24, although most local authorities develop their own policies, which vary considerably around the country.

This paper outlines some of the practicalities of protecting residential buildings against external noise intrusion, from a consultant's perspective. We will describe some of our experiences of the clash between what local authorities want to see achieved, and what can actually be achieved in practice, and hopefully contribute towards a more coherent and pragmatic set of internal noise criteria to form part of the new PPS24.

Three aspects of the assessment process are discussed:

1) The suitability of the various internal noise design criteria used by local authorities

2) The acoustic performance of glazing systems, looking for something more than the guidance in Annex 6 of PPG24.

3) A brief discussion of whole house ventilation systems, and the new challenges they present for the acoustic consultant.

2 NOISE DESIGN CRITERIA FOR DWELLINGS

2.1 The range of noise design criteria

Under the current PPG24, the guidance for any site which falls into NEC 'B' or worse is that planning conditions should be imposed *'to ensure an adequate level of protection against noise'*. How that works out in terms of the wording of planning conditions varies considerably – in some cases we find specific internal noise design criteria within the wording of the conditions, while more often there is a generic condition requiring 'a scheme of sound insulation measures', and we try to find out what criteria the local authority are expecting to see achieved.

Planning are obviously advised by Environmental Health in this area, and we have found that the response varies widely, falling into perhaps three categories:

i) Criteria from external standards such as the WHO *Community Noise*[1] guidance or BS 8233
ii) criteria defined by the local authority themselves and perhaps formulated into a published document, for example the Birmingham City Council Planning Guidance Note 1[2].
iii) No defined set of criteria, where we are invited to select criteria that we would consider appropriate – clearly the ideal scenario from a developer's perspective!

While this variation of criteria certainly adds interest to our work, it does seem odd that the acceptable standard of external noise intrusion varies from place from place, with the public at large either blissfully unaware of the hard work undertaken to achieve L_{Aeq} 30 dB(A) in their living room during the rush hour, or wondering why they have bought a new home with double glazing and yet they can still hear the traffic.

One irony of the current system is that the urban authorities, where ambient noise levels are higher than in rural areas, tend to apply more stringent criteria than what we might call the more 'backwoods' districts, whereas the homebuyer or tenant would probably expect higher levels of noise intrusion in the city.

It could be argued that the levels outlined in the WHO *Community Noise* document should be adopted as a nationwide standard by all local authorities, with the new PPS24 requiring every residential scheme to achieve those criteria. Given the trend towards more stringent criteria in all aspects of building acoustics, we would not be at all surprised if that is exactly what happens, although there are several reasons why we believe that would be a mistake, and that a more flexible approach is required.

2.2 Internal L_{Aeq} Criteria

It seems sensible that the L_{Aeq} or some derivative of that parameter should remain the key parameter in PPS24, broken down into the day-time and night-time periods.

Having said that, the current document makes reference to the "arithmetic average" in Annex 1, Paragraph 8, and this appears to have caused some confusion. It is clearly technically incorrect to calculate an 8 or 16 hour L_{Aeq} by arithmetically averaging the hourly levels, but we reviewed numerous reports where this is precisely what has been done.

If the noise levels are relatively constant, it doesn't make much difference in practice. But we have encountered sites where the hourly L_{Aeq} levels vary by 15 dB(A) or more between 23:00 and 07:00 hours. In such cases, the arithmetic average can be 3 dB(A) less than the logarithmic average, so if the site is close to the border of two NEC categories, the use of the arithmetic average can lead to the site being categorised incorrectly. We therefore suggest that this point should be clarified in the new document.

But in terms the internal criteria themselves it seems that there is an inexorable reduction in what are considered acceptable noise levels in dwellings. Take Sheffield for example: the change in the recommended maximum levels of steady intrusive noise into bedrooms, over the last 6 years[3]:

	Bedrooms $L_{Aeq,\ 1\ 5min}$ 23:00 – 07:00	
	Steady intrusive noise	Amplified music
1999	30 – 40 dB	-
2003	35 dB	NR25 – NR30
2005 (spring)	30 dB	NR25

Community Noise recommends a criterion of L_{eq} 30 dB(A) in bedrooms overnight, and 35 dB(A) in living rooms during the day, and most urban authorities we deal with seem to be heading towards those standards, if they do not already use them. Now while we would not seek to challenge the research which has led to the publication of *Community Noise*, we would query whether it is realistic to apply those criteria to every dwelling in a crowded nation such as the UK, in the midst of a significant programme of urban renewal where many residential sites fall at least partially into NEC 'C' or worse.

A case in point for us was a large scale residential development in Sheffield. Day-time L_{eq} averaged in excess of 72 dB(A) on the worst affected elevations, and 68 dB(A) during the night. The internal criteria from the planning conditions were NR35 during the day and NR25 overnight – with the NR criteria applied on the basis that there was a small pub across the road, even though the noise emissions from that pub were insignificant compared to the road traffic noise. The combination of the high incident noise levels and stringent criteria warranted massive glass units – 10/12/16.8 – and acoustically treated trickle ventilators. During commissioning tests the visiting Environmental Health Officer remarked at how quiet the bedrooms were!

The point is that if you must achieve L_{eq} 30 dB(A) in a bedroom, then realistically the external noise levels must be less than L_{eq} 65 dB(A), and really more like 60 dB(A) to have any factor of safety. If your dwellings front onto a main road, then it doesn't take much traffic to generate an incident L_{eq} of 60 dB(A), and as a result many residential sites we work on are at the fringe of what is practically achievable in terms of controlling external noise.

Validation tests are an increasing requirement in planning conditions for dwellings. As we understand it Sheffield now apply a condition to every planning consent for residential accommodation in the city where noise is considered an issue, requiring validation tests in respect of external noise intrusion. No bad thing, one might say, although this sort of approach understandably makes developers rather nervous (not to mention the Acoustic Consultant!), in the same way that Pre-Completion Testing has done with regard to sound insulation within dwellings. And there are no robust detailed acoustic glazing systems at present.

Moving away from whether the levels themselves are appropriate, there is the question of the period over which they apply. *Community Noise* seems pretty clear that the L_{eq} criteria are for the whole day-time or night-time period, although we often find that local authorities require the criteria to be achieved during every hour, or even every 15 minute period. This creates significant problems – a single extraordinary acoustic event (for example, a once weekly street cleaner driving past) could determine whether or not a planning condition is discharged.

2.3 External L_{Aeq} Criteria

There is also a growing trend for criteria to be imposed governing noise levels in outdoor amenity areas for new residential developments. Again, *Community Noise* is taken as the Bible that most authorities refer to, with the threshold of 'serious annoyance' defined as $L_{Aeq,\ 16\ hour}$ 55 dB(A), and the onset of 'moderate annoyance at 50 dB(A). Checking those figures against the PPG24 zone boundaries reveals that even an NEC 'A' environment, perhaps once considered to be more or less ideal, could now be classified as 'moderately annoying' for the man sitting outdoors in his deck chair.

A very recent case study for us was the conversion of a 1960s office building in, let us say, a city in the north-west of England. Like many buildings of that era it features a 4 storey broad podium, with an additional seven storeys in a more slender tower. Naturally, the developer wished to utilise the 3rd floor roof area as gardens for the flats, with outstanding views of the city and the nearby Pennines.

But of course, the external day-time noise levels were close to 60 dB(A), easily controllable to suitable internal noise levels, but with a noise limit of 55 dB(A) for outdoor amenity areas imposed on us, the roof terraces would technically have required solid acoustic screening around their entire perimeter.

That could bring the noise levels to the universal WHO standard, although the obvious consequence would have been that the roof gardens would have no view whatsoever.

Other examples are balconies, which are sometimes considered as outdoor amenity areas for the purposes of complying with acoustic planning conditions, and houses with front and rear gardens – with the front garden on the road side the W.H.O. levels are often impossible to achieve, even on a relatively quiet estate.

Common sense would dictate that someone buying a city centre flat with a roof garden would not expect perfect tranquillity, and there is perhaps an argument for more flexibility in the application of the criteria for outdoor living spaces than the internal criteria.

2.4 Maximum Noise Levels

BS 8233 states that

> *'for a reasonable standard in bedrooms at night, individual noise events…should normally exceed 45 dB L_{Amax}'*

There is similar wording in the WHO guidelines.

That sounds fine in principle, although when it comes to actually applying the criteria to a real residential scheme, the definition of *normally* becomes critical. Steady traffic is obviously 'normal', and regular trains, although what about that street cleaner again, passing a block of flats at 06:00 hours just once a week? A pub that has a once weekly disco, extending one or two hours into the night-time period? The flow of inebriated pedestrian traffic from that disco when it closes? Section 4.2.3 of *Community Noise* suggests that L_{max} criteria should be accompanied by the number of noise events, but does not suggest a number.

It can also be difficult to link L_{max} to specific noise events without fully manned night-time surveys (becoming less and less popular with consultants, for obvious reasons, and with developers, for cost reasons), or continuous audio recording. We ask ourselves the question – was that L_{max} of 82 dB(A) a train, a firework, a dog barking?

I think that one solution to this problem is to steer away from the L_{max} and towards a statistical parameter which better encapsulates how common the maximum levels are, whilst excluding high extraneous events. Kirklees Borough Council in Yorkshire have adopted this approach in their standard noise design advice publication – with an $L_{A1,\ 15mins}$ of 45 dB, rather than an L_{Amax}.[4]

A more radical option would be to dispense with the maximum criteria altogether, given that the L_{eq} recorded over relatively short periods (say 10 or 15 minutes) are often controlled by any significant regular 'loud' events.

2.5 Summary – Internal Noise Design Criteria

In our view the current system of internal and external noise design criteria for dwellings needs to be revised and standardised, and this could form part of PPS24. What we would suggest is that the criteria in *Community Noise* are too low to be achieved universally.

A possible way forward would be to set 'reasonable' basic noise criteria that should be readily achievable in most dwellings, for example a day-time limit of $L_{eq,\ 1\ 6hours}$ 45 dB(A) and a night-time $L_{eq,\ 8\ hour}$ of 35 dB(A), and enforce them nationwide. A more stringent set of criteria could then be defined, say 5 dB(A) lower, with an additional L_{max} or L_{A1} criterion, which could merit some kind of 'star' rating to add value to the dwellings. That could perhaps come under the umbrella of a BREAAM assessment, which does not currently deal with external noise intrusion into dwellings.

3 ACOUSTIC GLAZING SYSTEMS

3.1 Definitions of Acoustic Glazing

The definition of what is 'acoustic glazing', and the rating of its performance, has perhaps become something of a minefield for developers, local authorities, and the general public. It is a classic example of the theory that a little knowledge can be a bad thing.

For example, a majority of the public probably believe that any UPVC double glazing system will 'stop the noise coming in' or something to that effect, when what they actually end up with is a cheap plastic frame with 4/12/4 glass units and seals that might just about stop the rain coming in, at least until the 5 year guarantee period expires.

One problem with the specification of acoustic performance of glazing systems is that there are a range of parameters in common use, including single figures such as the R_w, octave band SRI figures, and single figures linked to a specific spectrum – thinking of the R_{TRA}. Other consultants may share our fond memories of trying to help *Joe* Bloggs' Glass Solutions interpret a glazing specification set in terms of octave band SRI, with responses ranging from honesty (we have no idea what it means) to argument (ah, but it achieves R_w 35…)

The current version of PPG24 seems to promote analysis of external noise intrusion into residential buildings on a single figure basis – as can be seen from the oft-used table of noise reductions in Annex 6. That is an inherently inaccurate approach, as Annex 6 does not even provide the spectrums it has used in determining the noise reductions from the different sources. This approach is also incompatible with City Councils like Sheffield who stipulate internal noise levels in terms of NR levels and require validation testing to prove that they have been achieved!

We would like to suggest that in these days of readily available real time analysers it is not unreasonable to expect the analysis of external noise intrusion into dwellings to be conducted using measured octave band incident noise levels, octave band SRI for building elements and octave band corrections for room characteristics. Could this form the basis of a revised Annex 6 in the new PPS24?

It is worth mentioning, however, that this raises another question, namely when the octave band noise levels should be measured. For example, the frequency distribution of the L_{Aeq} level at the same measurement position may be completely different at, say 03:00 and 08:00 hours. It is therefore not valid to simply measure an octave band spectrum sometime during the survey period and then to shift the octave band levels to suit the average daytime or night-time dB(A) level. Ideally, the octave band levels would be measured continuously, and

then averaged appropriately, but is there any real necessity for the assessment to be as detailed as this?

3.2 Proposal

We would like to suggest two alternative approaches to revising Annex 6 of PPG24.

The, radical, simplest (and safest?) approach might be just to state the internal noise design criteria that must be achieved (see Section 2.5 above) and recommend that advice from a competent acoustic specialist should be sought – naturally, a member of the Institute of Acoustics. That could avoid the following kind of scenario:

i) Bloggs and Bodge Acoustics visit site for an hour or so, and manage to record some A-weighted L_{eq}.
ii) A PPG24 assessment report is prepared, with an educated (uneducated?) guess about the night-time noise levels.
iii) The controlling noise source is road traffic. B&B Acoustics deduct the figures in table 1 of Annex 6 and in less than 5 minutes they have predicted internal noise levels. The report is passed by local authority, and 'job's a good 'un'. (We have seen such an assessment based on a single hours' worth of measurements!)
iv) The buyer moves in and wonders why the traffic noise is so loud in their flat.

But if Approved Document E and the Building Bulletins for schools are anything to go by, we would assume that the authors of PPS24 are going to aim for a document that has at least twice as many pages as the current PPG24. So there might be space for some instructions on how to insulate your residential building against external noise. If it does go that way, then we would suggest that the following points are incorporated:

- Analysis should be undertaken in octave bands – octave band noise levels must be measured.
- Sound insulation of glass units and frames should be considered.
- An explanation of R_{TRA}, R_w etc. and caution regarding their use (useful only for comparing systems?)
- Guidance on making secondary glazing work well – typical details

4 WHOLE HOUSE VENTILATION SYSTEMS

4.1 Issues

Although our experience of whole house ventilation systems is rather limited, in that none of our past projects have had one, we do have several current schemes where whole house ventilation units are specified, and several issues have come to the fore.

Some may remember those halcyon days when it was possible to satisfy the requirements of environmental health departments with a scheme of sound insulation measures that worked with windows closed, and to simultaneously satisfy Building Control with windows that could be opened for rapid ventilation. That was always a sort of loophole, and environmental health departments are now increasingly insisting that the required noise criteria are achieved with simultaneous rapid ventilation.

This is where the whole house ventilation system comes into its own. The first major benefit is that trickle ventilators can be replaced with a full supply and extract system, eliminating what is often the most significant acoustic weakness in a façade.

Of course, our first question is how much external noise will come through the ducts and into the room – as consultants we can work that out, although it is rarely, if ever, mentioned in the manufacturer's datasheets for the less qualified to understand. On asking the question of whole house ventilation unit suppliers, the answer is usually 'negligible' or 'none', although we would suggest that more research / testing is warranted as this type of system becomes more widely used

Question two is of course how much noise the fans generate. This seems to vary considerably, with noise emissions often quoted just as a 'sound pressure level at 3m' or something like that. Take the largest Greenwood unit for example, the CMEV5MF, quoted as 58 dB(A) at 3m in rapid ventilation mode[5]. The smallest achieves 40 dB(A) under the same conditions. Now we have heard anecdotal evidence that in practice the fan units are hardly noticeable, although there is perhaps a case for better quality noise data – perhaps even octave band sound power levels.

Off on a slight tangent, the third issue with whole house ventilation systems that we grapple with is that the ductwork obviously has to run through the ceiling void in a block of flats – and that is probably an acoustic ceiling as well. Thus, there are even more services penetrations to reduce the performance of the acoustic ceiling – perhaps not a major issue where the separating floor is a substantial concrete slab, but critical in an improved timber joist floor.

We would therefore suggest that any reference to whole house ventilation units in the new PPS24 should raise these three points, particularly that of noise generated by the fan units, which might conceivably be higher than the internal noise design criteria that are supposed to be achieved.

5 CONCLUSIONS

1) We would suggest that there is a case for including a standardised set of noise design criteria for dwellings in the revised PPS24.

2) *Whilst it seems appropriate to retain the L_{Aeq} as the primary unit of assessment, clarification is required to about how daytime and night-time L_{Aeq} levels are derived*

3) L_{max} criteria should be disregarded in favour of a statistical parameter

4) A reasonable set of criteria should be applied to all dwellings, with a system of star ratings or similar for dwellings achieving lower noise levels in dwellings.

5) Noise design criteria for outdoor amenity should be applied more flexibly than internal noise criteria

6) PPS24 should revise Annex 6 of PPG24. If guidance on controlling noise intrusion is provided, it should be comprehensive and based on octave band measurements and analysis.

7) PPS24 should also provide caution regarding the installation of Whole House Ventilation systems, particularly in respect of fan noise.

6 REFERENCES

1. Berglund, Lindvall and Schwela, Guidelines for Community Noise, April 1999.

2. Birmingham City Council Environmental Protection Unit, Planning Guidance Note 1, Noise and Vibration(2002).

3. Sheffield Environment and Regulatory Services, Noise and Residential Development in the City Centre, first published 1999

4. Kirklees Borough Council, Noise Design Advice, November 2004

5. Greenwood Airvac, Environmental integrated ventilation systems ENV1, April 2002