A CONSISTENT APPROACH TO ENVIRONMENTAL NOISE ASSESSMENT. IS IT REALISTIC?

Richard A. Collman Acoustical Control Engineers Limited and Belair Research Limited

1. INTRODUCTION

One of the attractions of acoustics is the breadth of the subject. This includes both the range of fields such as ultrasonics, underwater acoustics and environmental acoustics, and also the diversity within such fields. However, most silver linings have an associated cloud and the diversity within environmental acoustics does present some challenges.

Although there is a plethora of legislation, standards, codes of practice and guidance covering many different environmental noise issues, there remains a lack of appropriate information for many situations. In other cases, such information is often mis-applied either because 'there is nothing better' or even through ignorance. The current debate about BS4142 provides a good illustration of this. The potential for confusion is often exacerbated because, in many instances, the available information is contradictory.

2. GUIDANCE, NOISE SOURCES & NOISE RECEIVERS

One limitation of most guidance is that, in order to be useable, consideration is restricted to a specific type of noise source or noise receiver. Appendix 1 provides a brief list of some of this information, summarising the areas considered. This shows that the overall result is the coverage of a broad range of specific issues, addressing many frequently encountered problems. But, by it's very nature, this highly specific approach omits many other problems that do not comply with the criteria of existing guidance.

Starting with the noise source, Appendix 2 also provides a list of some types of noise source. This covers many of the more frequently encountered sources that need to be considered in environmental noise assessments. This appendix also identifies a much smaller list of acoustic characteristics that are common to various different noise sources. If a noise source is considered as producing noise that has one or more of these characteristics, the number of variations is significantly reduced, whilst providing a way of differentiating between different source types. Aside from the characteristics, the actual source type also provides some implicit information that is useful for an environmental noise assessment.

Although an analysis of sound propagation is an essential part of any environmental noise assessment, it can be omitted from this discussion, as the emphasis is on the comparison of source noise with receiver sensitivity. Appendix 3 provides yet another brief list of some types of noise sensitive locations. Considering the characteristics, in this case typical usage of the spaces, provides some scope for reducing the size of the list.

3. ENVIRONMENTAL NOISE ASSESSMENT, BASED ON ACOUSTIC CHARACTERISTICS

Comparing the characteristics of different noise source types, against the usage of different noise sensitive locations, provides a more manageable way of assessing the suitability or otherwise of many different noise sources, affecting potential noise receivers. This approach can be used both for planning and nuisance assessment purposes.

When making this comparison, several factors should be considered.

A noise source may have several different characteristics, each of which should be considered as part of the assessment. Although this sounds complicated, it is fairly straightforward provided, that care is taken to gather suitable data, in an appropriate manner. For example, a gas powered forklift truck has characteristics similar to road traffic noise, but may also produce impulsive type sounds from a reversing alarm, tines clattering, or impact with pallets. These can be analysed with the use of appropriate measurement techniques, for example statistical data such as L_{Eq} or L_{Max} may be suitable, although there are better methods, such as graphical analysis of consecutive, short duration L_{Eq} values.

Where the noise source has similar characteristics to the ambient noise, the relative effect of the noise source should be considered. For example delivery vehicle noise for a new building beside a road should be compared with other road traffic noise, not assessed as 'industrial noise', as happens on many occasions.

Where the noise source has different characteristics to the ambient noise, the source noise level should be compared either against absolute criteria, or relative to the existing ambient noise level. Whether absolute or relative criteria are more appropriate will depend upon factors such as the ambient noise level, and noise receptor usage. For example when considering sleep disturbance an appropriate criterion may be an L_{AMax} not exceeding 45dB(A) inside a bedroom, whereas a suitable 'steady' plant noise limit may be between NR20 and NR30 in the same bedroom, depending upon the ambient noise level in the absence of plant noise.

If a criterion is related to the existing ambient noise level, the analysis should also consider the effect of possible changes to the ambient noise level in the future.

Some types of noise are more 'acceptable' (or less unacceptable) than others. For example a specific level of road traffic noise is likely to be more acceptable to the public than the same level of aircraft noise. The acceptability of railway noise will typically fall somewhere between these other two types of transportation noise. The bedrooms of most dwellings in the UK are subjected to some perceptible road traffic noise and this is generally accepted without complaint. However, relatively few bedrooms are exposed to perceptible levels of amplified music and even a relatively low level of such noise is generally regarded as unacceptable.

Similarly, the perceived necessity or otherwise of a noise source affects the acceptability of the noise. For example, a specific noise level that is judged to be 'an unavoidable part of modern life' such as from road traffic, may produce a similar level of dissatisfaction to a noise level 10dB(A) lower, but produced by a source that is felt to be unnecessary, or easy to overcome, such as a compressor outside a nearby factory.

The acceptability or otherwise of a noise source may be more appropriate for the assessment of a noise nuisance than for planning purposes, however an assessment methodology based on noise characteristics could take account of this using similar, but different criteria, for the two purposes.

Whilst it is important to develop consistent criteria for environmental noise assessment, it is more important to ensure that appropriate parameters are used for any assessment and that any measurements provide reliable data about the sound being measured. For example, ambient noise will generally contaminate source noise measurements and this contamination must be minimised and quantified as part of the source noise assessment. Parameters for the assessment may include L_{Eq} values (in which case the averaging period is significant), L_{Max}, other statistical parameters and also frequency analyses of a suitable bandwidth, where appropriate. Rather than using single figure 'averages', a better way of providing useful data for the assessment is to log consecutive short duration L_{Eq} values. For most situations, consecutive 1 second L_{Eq} values provide a wealth of information enabling reliable data to be obtained in a relatively short time. This technique has formed the basis of previous papers by this author.

4. A FRAMEWORK FOR CONSISTENT ENVIRONMENTAL NOISE ASSESSMENT

The matrix and accompanying notes in Appendix 4, show an example of how a framework could be developed to provide guidance for the assessment of most types of environmental noise source, affecting most types of noise sensitive location, in a relatively simple and therefore more generally useable way.

The key principle is a change of emphasis from assessing the effect of a specific type of noise source in a specific acoustic environment, to a much more general approach, considering the acoustic characteristics of the noise source and noise sensitive location. By doing so, the currently complicated situation involving potentially thousands of different combinations of noise sources and noise receivers can be simplified to a manageable number of alternatives.

In this example, the five previously identified noise source characteristics (transportation, music & entertainment, mechanical plant, neighbour & community, impulsive/tonal – including components of other source types) are used to differentiate source types. Similarly five receiver characteristics are used (sleeping, domestic room usage, other room usage eg cinemas to offices or factories, external domestic spaces eg gardens, external public spaces).

Clearly where the noise receiver category covers a broad range of situations, such as 'other room usage', more stringent criteria will be applied for more sensitive locations, however a consistent approach may be used to establish criteria and to assess the source noise. For example, when considering mechanical noise levels for 'other room usage' different criteria will apply for different room usage, so a suitable limit for a recording studio may be NR15, whereas NR30 or NR35 may be more suitable for an office environment. This fairly commonly encountered and hopefully uncontroversial example shows how the same principle can be applied for two similar, but significantly different situations.

Although the example matrix has twenty five combinations, there are only seven basic assessment methods. Each of these methods covers a range of sensitivities, extending the suitability to a wide range of situations, providing a simple but powerful way of consistently assessing a wide range of environmental noise applications.

5. EXAMPLE OF HOW A FRAMEWORK COULD BE APPLIED

This example of an environmental noise assessment shows how the approach can provide a consistent framework for environmental noise assessments. It is not claimed that any of the methodologies in the example are necessarily the optimal solution, as that would generate more discussion about specific methodologies rather than keeping focussed on the concept behind the principle. The aim of the example is simply to show how this method can be applied to a realistic situation, providing a consistent method for the assessment of environmental noise and simplifying the existing complicated, ambiguous and contradictory assessment arrangements.

This fictitious example is based on a proposed new warehouse opposite houses on a reasonably busy road, but with the loading docks at the rear of the building near to houses that are screened from the road traffic noise, producing a lower ambient noise level, but still with a significant contribution from road traffic noise. The warehouse operates 24 hours per day and has ventilation plant at the front and rear of the building.

At the front of the building the evening and night time delivery vehicle (transportation) noise level of 40dB(A) L_{Aeq} is compared (cells 1,6 of Assessment Matrix in Appendix 4) against the existing road traffic noise level of 55dB(A) L_{Aeq}, showing that this is not significant. At the rear of the building, the evening and night time delivery vehicle noise level of 45dB(A) L_{Aeq} (higher than at the front, due to manoeuvring in the yard) is compared (cells 1, 6) against the existing ambient noise level of 40dB(A) L_{Aeq}, indicating that this noise may need attenuating – possibly by 5dB(A) to match the ambient noise level and to prevent sleep disturbance.

In addition to this, the air brakes will produce maximum noise levels of 65dB(A) L_{AMax} outside the houses. During the night an internal sleep disturbance criterion of 45dB(A) equates to approximately 55dB(A) outside, giving an excess (cell 5) of 10dB(A). During the day the external ambient noise level at the houses to the rear is 50dB(A) L_{Aeq} with maxima of 60dB(A) L_{AMax} produced by vehicles on the road. The air brake noise will therefore exceed (cell 20) the ambient noise L_{AMax} and has different characteristics to the maxima produced by vehicles passing on the road. In addition to this, the loading and unloading activity will produce impulsive noise with L_{AMax} of between 60dB(A) to 70dB(A) outside the houses. These impulsive noise sources will therefore require attenuation, possibly by 10dB(A) or 15dB(A), in order to achieve a suitable noise level when compared with the existing day time ambient characteristics (cell 20) and to prevent sleep disturbance (cell 5).

Finally the L_{Aeq} of 35dB(A) from the ventilation fans produced at the houses to the front and rear of the building is compared (cell 18) against the front day time L_{A90} of 45dB(A) and 40dB(A) at the rear. At night, the L_{Aeq} of 35dB(A) is compared (cell 3) against an internal noise level of NR25 inside the bedrooms, equating to approximately 38dB(A) outside the houses (6-7dB for conversion from NR to dB(A) and 6-7dB for low frequency open window loss). Any tonal or impulsive characteristics of the ventilation system noise will also need to be considered (cells 5, 20) as part of this assessment.

6. CONCLUSION

This paper shows how an assessment methodology based on the characteristics of noise sources and sensitive locations, rather than considering specific noise source types, could enable a consistent approach to environmental noise assessment. Detailed consideration will need to be given to develop appropriate characteristics and criteria, but this method provides a way of keeping the number of combinations manageable, whilst retaining sufficient flexibility to deal with a multitude of environmental noise situations.

APPENDIX 1 – A FEW ACOUSTIC GUIDANCE DOCUMENTS

BS 4142 – Method for Rating industrial noise affecting mixed residential and industrial areas
Assessing the likelihood of complaints from residents

BS 5228 – Noise control on construction and open sites
Construction noise level calculation, control and limits

BS 8233 – Code of practice for Sound insulation and noise reduction for buildings
Noise control techniques, suitable noise levels for different building usage

Building Regulations Approved Document E: Resistance to the Passage of Sound
Airborne and impact sound transmission into, between (and within) dwellings

Calculation of Railway Noise - DETR
Methodology for the calculation and measurement of railway noise

Calculation of Road Traffic Noise - DETR
Methodology for the calculation and measurement of road traffic noise

Chartered Institute of Building Services Engineers - Guide to current practice (current edition)
Suitable noise levels for different building usage

Code of Practice on the Control of Noise from Pubs and Clubs [November 1999 – DRAFT]
Entertainment noise – complaints, amenity & planning

Code of Practice on Noise from Clay Target Shooting
Shooting noise level measurement, control and limits

Community Noise - World Health Organisation
Types of noise, effects of noise, recommended limits for different environments or effects

Environmental Protection Act 1990
Noise nuisance and health issues

MPG 11 – The Control of Noise at Surface Mineral Workings
Surface mineral workings noise level calculation, measurement, control and limits

Noise Act 1996
Entertainment noise – nuisance issues

Noise at Work Act 1989
Noise levels at work – Health & Safety implications

Noise Insulation Regulations 1975 & Noise Insulation (Amendment) Regulations 1988
Criteria for protection of dwellings against road traffic noise

PPG 24 – Planning & Noise
Transportation (and industrial) noise sources – planning issues for noise sensitive development.

APPENDIX 2 – NOISE SOURCES AND CHARACTERISTICS

t approach to environmental noise assessment. Is it realistic? – R A Collman

2.1 Noise sources

Amplified music & speech
- Amplified speech
- Bass dominated amplified music
- Various types of music without strong bass content

Industrial & commercial activity
- Construction
- Materials handling
- Mechanical plant & equipment

Neighbours & community noise sources
- Children playing
- Internal airborne noise from general domestic activity
- Internal airborne – music (see Amplified music & speech)
- Lawnmowers etc
- Parties / barbeques
- Pets
- Structural noise transmission such as light switches, doors slamming

Recreation
- Motorsport
- Play areas – pub gardens
- Public events – crowd (movement) noise
- Shooting
- Sports grounds

Transportation
- Fixed wing aircraft
- Helicopters, microlights
- Rail

Road

2.2 Acoustic characteristics of noise sources

Transportation noise – relatively slow rise and fall time (several seconds or longer)
Music & entertainment noise – typically amplified music, speech, crowd noise (see also Community)
Mechanical noise – relatively slow rise and fall time (excluding impulsive or tonal characteristics)
Community noise – wide range of neighbour's activities, pets, crowd noise

Impulsive and/or tonal noise – short rise or fall time, or tonal characteristics. Sources can include any of the above such as transportation noise eg. brake squeal, music, mechanical and community

APPENDIX 3 – NOISE RECEIVERS AND CHARACTERISTICS

t approach to environmental noise assessment. Is it realistic? – R A Collman

3.1 Noise receivers

Churches
Cinemas
Commercial/industrial premises
Conference venues
Domestic gardens and outdoor spaces – day/evening/night time
Dwellings – day/evening/night time indoors
Hospitals
Lecture rooms
Offices
Public open spaces such as parks
Recording studios
Schools

3.2 Acoustic characteristics of noise sensitive locations

Bedrooms, sleep disturbance
Domestic room usage (living areas to bathrooms/kitchens)
Other room usage (cinemas/studios to offices or commercial/industrial premises)
Outdoor domestic space (evening and daytime)
Outdoor public space (evening and daytime)

APPENDIX 4 – ASSESSMENT MATRIX

	Noise source characteristics				
	Transport	Music	Mechanical	Community	Impulsive or tonal
Sleep disturbance – bedrooms	1 A	2 C	3 B	4 G	5 E
Domestic rooms – lounges, kitchens	6 A	7 C	8 B	9 G	10 B
Other room use – cinemas, factories	11 A	12 G	13 B	14 G	15 B
External domestic space - gardens	16 A	17 D	18 F	19 A	20 G

External public spaces – parks	21 A	22 D	23 F	24 A	25 G

The number in each cell serves to identify which comparison is being used for a particular assessment, for example use cell 2 for assessing the suitability of music noise in bedrooms, or cell 19 when assessing the effect of community noise affecting a private garden.

The letter in each cell identifies the most appropriate assessment method for that particular combination of noise source and noise receiver characteristics.

t approach to environmental noise assessment. Is it realistic? – R A Collman A

\- Where a significant contribution to the ambient noise level at the noise sensitive location is similar to the source noise use a relative assessment. This is likely to be the case for most of these situations. For example compare new vehicular noise against existing vehicular noise, or new noise from patrons walking to a venue against existing noise from pedestrians. In this case new vehicular noise of 45dB(A) L_{Eq} is unlikely to be significant when compared with existing similar vehicular noise of 55dB(A) L_{Eq}, even though the exisiting L_{A90} may be 35dB(A).

Assess characteristics of the new noise source that are different to the existing ambient acoustic environment against absolute criteria such as L_{Eq} or L_{Max}. For example assess the noise from vehicles manoeuvring in the service yard of a new building during the night, in terms of suitable noise levels in the bedroom of a neighbouring house in a 'quiet rural location' with little existing night time road traffic. In this case suitable limits may be an L_{Eq} of 30dB(A) to 35dB(A) and an L_{AMax} not exceeding 45dB(A).

B - Similar to (A), although there is less likelihood that the new noise source characteristics will be similar to the existing ambient acoustic environment, so any relative assessment is a possibility rather than a likelihood.

C - Use objective criteria tending towards achieving inaudibility at the relevant noise sensitive location. As with other situations, the levels used will be more stringent during the night and criteria along the basis set out in the Draft Code of Practice on the Control of Noise from Pubs and Clubs provides a good starting point.

D - Use criteria similar to that for (C), but with some relaxation as these locations are less sensitive. In some cases it may even be felt that slightly audible music enhances the atmosphere of a location, so a sliding scale of difference between source noise and ambient noise may be more appropriate. Similarly, there is likely to be a difference between the criteria for an assessment of nuisance or for new development.

E - Sleep disturbance is the primary consideration for this assessment. In the case of impulsive type noise assess maximum levels such as L_{Max}. Alternatively where the source noise has tonal characteristics the assessment is likely to be similar to that for music, set out in (C).

F - Depending upon the noise source and existing ambient acoustic characteristics, it will be appropriate to use either absolute or relative (probably average) criteria. For example the BS4142 approach of comparing source L_{AEq} against existing L_{A90} may appropriate for the assessment of plant noise from a factory affecting the gardens of nearby houses during the day. Conversely, a comparison of source L_{Aeq} against existing ambient L_{Aeq} may be more appropriate for the assessment of plant noise from a shop, on the pavement in front of the same shop, in a busy town centre.

G - Use criteria similar to that for (F), or maximum levels if this is more appropriate, as may well be the case. The criteria for this assessment can also incorporate a penalty for 'impulsive' or 'tonal' noise characteristics.