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Background Plus: The Universal Criteria

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ABSTRACT

In the desire to control noise, regulators are setting their sights on a form of quasi inaudibility, "Background Plus". If an acoustic environment is reduced to a single variable and the disturbance to that environment is controlled to be indiscernibly louder then noise nuisance will be controlled. There is a certainty and a proving about the calculation and the result. The approach works for both the regulators and the acoustician seeking to 'get a project up' within tight time constraints and desperately seeking to avoid an information request and a 20 day extension to an evaluation period. Gone are the discussions, queries and amendments about what measured values may actually mean and what effect the new variable will have on the environment. This paper sets out to explore where this universal criteria works and where it doesn't and the vast continuum between the 'certainties'.

INTRODUCTION

The ‘bread and butter’ of acoustic engineering is the evaluation of noise impacts on sensitive receivers. With confidence we calculate the impact of the sound of, say, a regulated appliance or a dog barking. We then compare this to a limiting value and opinion (never state) that the noise will comply with the limit and that no-one will be upset by it.

The purpose of this paper is not to set out the calculation methods that we use for the prediction but to focus on the limit itself and the conclusion reached by the application of the limit.

My objective in the presentation of this paper is to challenge the common, casual acceptance of our current limiting values and consider other ways of setting or considering limits.

LIMITS

Background

There has been some debate in the past about the terms used to describe what is measured by acousticians in the field. By virtue of common description a Sound Level Meter measures Sound. However, I shall be describing the measured quantity as noise, as generally, I shall be discussing unwanted sound and not noise.

The purpose of the limit is to allow the restriction of the noise to a level that is below a level that is going to cause upset. The limit is also required to:

- be easily measured;
- be easily understood; and
- give a clear pass/fail result.

The most commonly used descriptors for the limit are the Background and Ambient. Careful use of these terms by acousticians allows their meaning to be differentiated. However this is not always understood by those who receive reports.

The term ‘background’ is used to refer to a single descriptor of a minimum level of noise present in an environment. Most commonly, this is the $L_{A90\ 15minute}$ descriptor.

The term ‘ambient’ is used more generally to describe an (acoustic) environment via a number of descriptors chosen to present differing features of the environment.

The common term

For completeness; The Background Noise level has been defined Timms, 1996 as either:

- $L_{A90,T}$ being the A-weighted sound pressure level exceeded for 90% of the time period not less than 15 minutes, using fast response; or
- $L_{Abg,T}$, being the arithmetic average of the minimum readings measured in the absence of noise under investigation during a representative time period of not less that 15 minutes, using fast response.

It is my opinion that the increasing sophistication of our sound level meters and the ease of reading a single number rather than judging measurement intervals recording and calculating averages has resulted in the almost universal adoption of the first definition. Intrinsic in the definition are the assertions:

- that the absolute minimum is not representative of the background noise level;
- an arbitrary 15 minute period is;
- that the noises (sounds) present during the measurement are typical; and

- that the level exceeded 90% of the time will be accepted as being the same as the minimum.

A (limited) study of previous conference papers shows that the definition of (measurement of) background noise is subject to disagreement but, pragmatically, common use has been settled upon.

Commonly used limits

The presentation of this paper, and my professional life, would be easier if there was a 'commonly used limit'. However there is a typically used limit for environmental noise emission/reception limitation. This is usually expressed as per Table 1. The expression of limits in this way is known as "Background Plus".

Table 1: Noise emission limits: Background Plus

Period	Noise level at a Noise Sensitive place measured as the Adjusted Maximum Sound Pressure Level $L_{AMax,adj,T}$
Noise Limits at a noise sensitive place	
7am – 6pm	Background noise level plus 5 dB(A)
6pm – 10pm	Background noise level plus 5 dB(A)
10pm – 7am	Background noise level plus 3 dB(A)
Noise Limits at a commercial place	
7am – 6pm	Background noise level plus 10 dB(A)
6pm – 10pm	Background noise level plus 10 dB(A)
10pm – 7am	Background noise level plus 8 dB(A)

A basis for these figures may be found in BS4142:1997 where the likely level of complaints is related to the calculated excess of an intrusive noise, the *rating level,* above the background noise level.

> The greater this difference, the greater the likelihood of complaints.
> A difference of around +10 dB or more indicates that complaints are likely.
> A difference of +5 dB is of marginal significance.
> If the rating level is more than 10 dB below the measured background level then this is a positive indication that complaints are unlikely.

The assertion that a 5 dB difference is of marginal significance is interesting and questionable but not the subject of this paper.

A-WEIGHTING

This subject stands apart from the stated objectives of this paper but the use of the concept and the term is fundamental to the discussion.

A-weighting is a procedure that allows a multi-descriptor variable to be given a single value. In our case the variables are frequency and amplitude. The process is standardised by AS1259 and the process incorporated into all Sound Level meters. By its nature, information from the original measurement is lost when a weighting is applied. In most cases this information is lost forever, as when a measurement is recorded in dB(A).

A-weighting is now accepted in the industry, and in the courts, as the appropriate measure of noise. There is a significant discussion about the truth of this statement, and of the use of A-weighting in ways that were not intended at its inception. This was discussed in a paper presented at Noise Con 2004. The authors discussed the derivation of A-weighting and summarised as follows;

> .. there is a large amount of evidence that measuring A-weighted sound pressure level is not necessarily indicative of the loudness of noises. This is especially true when the noise is complex and/or composed of low frequency components. Genuit summarized the research as follows: "Measurement regulations applied in determination of noise have been based on the measurement of A-weighted sound pressure level using a microphone. While this kind of measurement is well adapted to the determination of objective threshold levels aimed at preventing physical damage to your hearing through sound, such a simple measurement technique is generally not equal to answering questions raised in relation to the annoyance caused by a sound event, or completing investigations into the general level of sound quality. "

COMMON CONCEPTS

What it means

In our day-to-day work we interact with council pollution officers and acquire an understanding of their meaning of the applicability of the limits, often by way of Requests for Information. It is apparent that, as a working standard, limitation of any new noise in an environment to the standards of Table 1 equates to inaudibility. This is particularly evident when a comparison of intrusive noise with ambient noise levels is rejected and Table 1 limits are imposed, often with a note that the ambient noise is of different character.

Inaudibility

The best way of ensuring that an intrusive noise introduced into an environment is not going to cause complaint, springing from a perceived loss of amenity by the complaint, is to require that it be inaudible at the sensitive location. Leaving aside the question about whether a sound is a noise if no-one is bothered by it, what does this mean? Fletcher and Munson in deriving their family of equal-loudness contour chose, or defined, a threshold curve below which a sound was inaudible. The ISO, in presenting the contours as ISO 226:2003 have retained a contour labelled "minimum level". It would be tempting to state that any noise (sound) below this level was inaudible. However ISO curves are true only for pure tones and the results are an average or testing of many individuals. I suggest that the results included results from test subjects with acute and some with dull hearings, and that the variations could be significant. From hearing testing performed on Palmer Acoustics staff, hearing threshold differences of up to 10 dB are apparent and therefore inaudibility values would vary by that amount if sampling relied upon our staff.

For a regulator to operate and attempt to enforce a standard that satisfied the responses of the sharpest hearing listener is not practicable. A common example of this difficulty is the situation of housing for the elderly where developers are wont to observe "they're all deaf anyway".

Regulating the outcome

If ensuring that an intrusive noise introduced into an environment is not going to cause complaint is our objective we, as investigating acousticians, and regulators should be considerate of the environment into which an intrusive noise is introduced. A sound will be 'inaudible' if it can't be distinguished from the already present sounds in an environment. I present this observation as a 'truth' or a common sense observation, without citation, and yet it is the basis of all our evaluation concerning noise.

Average

Regulators have apparently 'decided' that satisfying the needs of the average is adequate to fulfil their responsibilities. It is probably fair to say that the majority of acousticians are also prone to considering the average as representative of the whole.

An example of this approach is evident in a discussion concerning Aircraft noise and the ANEF contours presented at AAS Conference 1996 The Brisbane Aircraft Noise Survey. AS2021 2000 states:

> If the building site is outside the 20 ANEF contour, noise from sources other than aircraft may dominate: therefore, there is usually no need to proceed further in this Standard as the construction of the building need not specifically be designed to provide protection against aircraft noise intrusion.

The authors observed that:

> .. leading people to conclude that for an exposure to aircraft noise below ANEF 15, the impact is negligible. As Hede himself points out, that such a conclusion is invalid since 7% of people are seriously affected and 33% moderately affected at that level.

Here we see that the 'average' is seriously short of the mark.

WHEN THE STANDARD APPROACH WORKS

No complaints

It is perhaps reasonable to assume that the introduction of a new sound source into an environment is a success if there are no noise complaints. This approach may not be completely valid as, quoting again from the Brisbane Aircraft Noise Survey:

> Only about one person in eight has made a complaint… When those who had not complained were asked why, many said that there was no point in complaining because, short of changing the flight path or shifting house, nothing could be done.

If people disturbed by a noise evaluate the likelihood of a successful outcome before they complain, then the absence of a complaint may not be taken as a valid indicator of disturbance or otherwise.

However, valid or not, lack of complaint is considered success by many regulators.

Masking Noise

The author is aware of situations where the background noise level is so much lower than the ambient levels that introduced transient or intermittent noise, e.g. trucks starting, would be rendered indistinguishable against the already accepted noise levels. However the acceptability of the introduced noise is presumptive, based on a lack of complaint and without the benefit of specific follow-up of potentially affected residents.

WHEN THE STANDARD APPROACH FAILS

The reason this paper is presented relates to specific instances when the standard approach appears to fail. This is judged by instances where approvals were withheld in situations where it was considered that they were fully appropriate, or where approvals were granted when they should have failed.

The background level was not representative.

A commercial premises is located on the corner of a busy, skewed intersection of 8 lane carriage ways. The area was short of parking spaces and an application was made to the council for permission to locate additional spaces in the south western corner. The proposed location was 50m from the running edge of one of the roads. The criteria for noise from car parking activity was background plus. No night-time activity was expected. The evening background noise level was measured at 46 dB(A). Noise impact at the nearest residence was calculated at 57 dB(A) $L_{Amax\ adj}$. Clearly this is over the limit!

Figure 1: Skewed Intersection, location for a car park

But the limit is greatly affected by the traffic flows through the skewed intersection which creates quiet periods as the intersection clears and traffic flows from another direction. Further car parking sounds audible during the 'quiet' times are not of themselves noise as they are simply representative of the traffic noise present during the remaining 90% of the time. As stated in our response to the authority

> "it is appropriate to consider the context of his proposal. The developer is proposing to create a parking space less than 60m from two very busy roads and a very busy intersection. The parking bays are being placed where they are fully exposed to the traffic noise"

The background sound was not masking

A dog kennel was proposed to be located approximately 300m from a residence. The background noise level was measured and exceeded the predicted noise level at the residence. A simple case! However the background noise included considerable insect noise and there was very little else in the vicinity, no roads or other infrastructure. Frequency spectra showed that the dog barking contribution to the measured A-weighted noise level was not overwhelming, <5 dB. However it was clearly audible and would cause an issue with the neighbours.

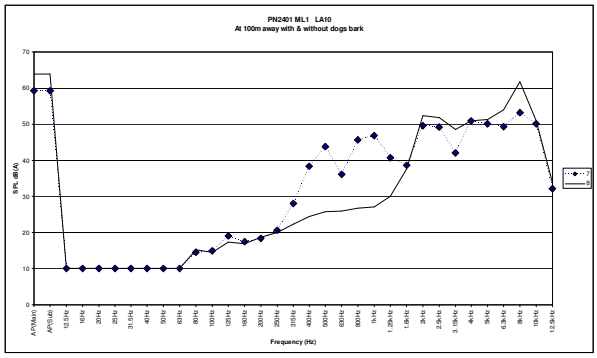

Figure 2: Spectrum of dog barking

SOMEWHERE INBETWEEN

I have been involved in a case where a complainant lives across a road from a TAFE (Technical School) and has been subjected to noise from the establishment since the school was established >10 years. The complainant block is subjected to a full range of 'typical' environmental intermittent noises including planes, trains and automobiles, and nearby day care and schools just for good measure. However the block is also subject to the mechanical plant noise from the TAFE. The background levels, measured of a 15 minute period can be as high as 50 dB. Subjectively, and confirmed by short Leq measures, the intermittent noise from the environment dominates the more steady state mechanical noise when it occurs. It is observed that the 15 minute L_{A90} measure is similarly dominated by the intermittent environmental noise. However the mechanical noise is clearly audible in the periods of relative quiet 'between automobiles'. This audibility of the TAFE noise is compounded by a lack of sympathetic response from the TAFE concerning noise intrusion. This has occurred over a number of years and the complainant is not quite sensitised to the noise.

A local council was seeking to establish a motocross track on a quarry site beside a major motorway. The nearest residents were located close to the motorway and on the other side of a busy feeder road and on-ramp. The feeder road features a light-controlled intersection between the proposed track and the residents. A suburban railway runs through the area, closer to the residents than the proposed track. The council proposed A-weighted 'background plus' as the appropriate criteria and the residents objected. Test racing on a likely track location showed that the noise was distinctly audible even during times where traffic was flowing through the adjacent intersection. At the whim of the lights the sound was more clearly audible as traffic slowed or stopped. It was also noted that residents on the opposite side of the highway found the noise audible during periods of light traffic. One-third octave analysis showed a clear region of the frequency spectra where the motocross noise was dominant. Here a noise already present in the environment, the occasional passage of a motorcycle did not create acceptance of the same noise when it as presented on a continuous basis, albeit for a limited time.

Figure 3: Motocross track location

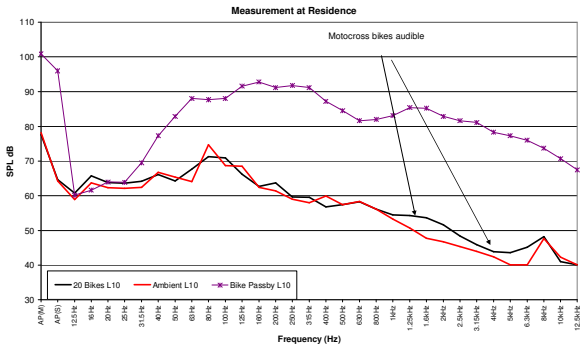

Figure 4:Spectrum of Motocross bikes v ambient

CONCLUSION

To reach a conclusion is a tacit assumption that I know how background noise should be measured and that I can define a suitable set of parameters that will ensure that nuisance is not caused. I wish I could.

I believe that the time of A-weighting is passing as the sole descriptor of background. The original studies and experience suggest that it is a good measure where the impacting noise is broadband in nature, or at least commonly known to the listener. Examples being fan and traffic noise. However I believe that the case for the use of A-weighting needs to be made on a case-by-case basis. While this may appear onerous, for a significant proportion of cases, perhaps the bulk of reports will use this measure appropriately. However I believe that the description of the background in octave or one-third octave is a good start to appropriate criteria.

One council in Queensland proposes a methodology based on comparing like parameters, an approach accepted by some other councils. Using this approach, the background is defined by a statistical parameter in dB(A) and the intrusive noise is to be kept to no more than 3 dB above this. There are significant problems with this approach but I mention it here for its positives. It gives the acoustician the flexibility to be able to suggest a wider range of comparisons and have them considered, rather than being rejected outright.

In the area of amplified music evaluation in Queensland there are methodologies that consider level above background in octave band. The liquor Licensing division of the Department Sport and Recreation set levels of 8 dB above individual octave band background levels (L_{10} over $L_{90,}$ 64 – 2 kHz) as their estimation of acceptable. The Brisbane City Council sets a level of 3 dB, 31.5 - 4 kHz as their acceptable level. It is one of the charming features of tight criteria that we have found that this limit can't be actioned in practice as normal environmental background levels L_{10} over L_{90} already exceed the 3 dB limit.

REFERENCES

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