Comments On Environmental Noise Assessment

Barry Murray,
Director, Wilkinson Murray Pty Limited
(Member of the Association of Australian Acoustical Consultants)

Abstract: The ambient background noise level at most locations varies throughout the day and from day to day. In addition, noise levels emanating from an operating plant are also likely to vary from hour to hour and day to day. A method of allowing for these variations in setting environmental noise criteria which are related to community response has been proposed with the purpose of opening discussion on this issue.

It is widely accepted that the annoyance due to an intrusive noise relates to the difference between the noise level and the background noise level determined in its absence. This principal is accepted in such Standards as Australian Standard 1055 - 1989 *Acoustics - Description and Measurement of Environmental Noise.*

In New South Wales, the Environment Protection Authority (EPA) recommends a noise criterion of background noise level plus 5 dBA for such intrusive noise. Where the intrusive noise varies in level, EPA recommends the use of the L_{A10} level and the background noise level is defined as the L_{A90} of the ambient.

1. NOISE LEVEL VARIATIONS

It is common to measure the L_{A10} and the L_{A90} levels over 15 minute periods and, consequently, these levels may vary throughout the day and from day to day. The L_{A90} (background) noise level is likely to vary as a result of variations in road traffic flow in the surrounding area, variations in weather conditions (particularly temperature gradients and wind) and variations in noise levels emanating from other industrial noise sources. The plant (intrusive) noise level may also vary due to variations in operation throughout the day and variations in weather conditions. The net result is that the $L_{A10,\ 15\ min}$ noise level from the plant will vary over a period of time and so will the ambient $L_{A90,\ 15\ min}$ level.

Figure 1 shows a typical $L_{A90,15\ min}$ trace and a possible $L_{A10,15\ min}$ trace of plant operation (only) during a one day period. These traces are also likely to be different on other days.

With variations in plant noise and background noise, the question arises as to how to interpret the variations and how to determine the noise criterion.

2. COMMUNITY RESPONSE TO NOISE

The answer to the question above lies in the response of residential communities to noise. However, we have limited knowledge of this response.

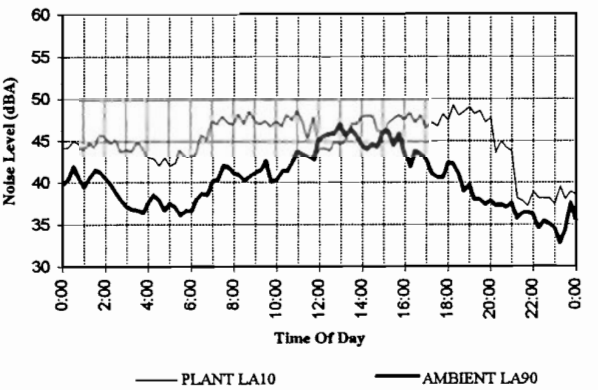

Figure 1. Possible relationship between plant alone and background noise.

Firstly, it appears important to divide the day into periods of different background noise level and periods of different operation. It is common for the day to be divided into three periods:

* Daytime 0700 - 1800 hours
* Evening 1800 - 2200 hours
* Night-time 2200 - 0700 hours

However, during each of these periods the background noise level can vary significantly on a relatively regular basis. For example, during the night time period (applicable for a 24 hour operation) the background noise level is likely to fall from 2200 hours to about 0100 hours and then remain constant to about 0500 hours. After this, the level is likely to increase. It therefore seems more appropriate to divide the day into shorter periods, the most important one for a 24 hour operation being 0100-0500 hours.

Each period must be treated separately in the assessment, although it is commonly found that one period is more critical than the others.

For each period, there is a natural tendency to want to average the background noise levels and also to average the

plant noise levels. However, I do not feel that this approach relates well to likely community reaction to noise. A community is likely to be more aware of the periods of high noise level than the periods of average noise level and it is likely to react in response to the high levels, rather than the average. This may be demonstrated by considering noisy domestic parties, where neighbours often complain after only hours of noise, despite the fact that the party complained about may be the first one held in 12 months. Particularly at night-time, residents can be quite intolerant of short-term noise.

My personal experience in carrying out a social survey to determine community response to aircraft noise also supports this view. Around Sydney Airport, some communities were affected by overflights and the consequent noise on some days only, as opposed to all days. When asked in an in-depth interview what their overall response to the average noise was, residents within these communities had considerable difficulty in providing a single (presumably average) response. They preferred to indicate their response during those days with overflights, paying no regard to those days without.

From experience, I have developed the view that it is necessary for the intruding noise to comply with the criterion during the period in question for at least 90% of the time to avoid reaction from the community. From a different perspective, one can say that the intruding noise can exceed the criterion for up to 10% of the time without a community reaction. This seems to imply that residents tend to ignore, or at least tolerate, slightly higher noise levels for up to 10% of the time, especially when the noise levels during that percentage of time are not substantially over the criterion.

3. PRACTICALITIES OF ASSESSMENT

Assuming the plant whose noise level is being assessed is currently in operation, one could theoretically measure plant noise levels over an extended period of time (such as one year) and also measure the background noise levels over a similar period of time. This would allow determination of the percentage of time that the plant noise level exceeds the criterion (say background noise level plus 5 dBA during the critical period of the day).

Accordingly, the assessment of the impact of the plant noise would then be clear. However, such an approach is unlikely to be practicable because of the large cost involved and also because many assessments are carried out before the plant is in operation. Particularly in the case where the plant being assessed is not in operation, it is only possible to carry out an approximate noise assessment along the lines indicated above. Firstly, it is meaningful to attempt to establish if there is some relationship between the background noise level and the plant noise, that is, to establish if plant noise and background noise are partly in phase. Where the main source of background noise and the plant are located a considerable distance from the assessment location, then it is likely that the noise levels of both will increase during a temperature inversion and decrease during a temperature lapse. Equally, if the two noise sources are in the same direction from the assessment location, they are both likely to increase with a breeze towards the assessment location and decrease with a breeze away.

Assistance in the assessment can therefore be gained from the measurement of wind speed and direction over a representative time period and from an estimate of the probability of temperature inversions.

If no wind or temperature gradient information is available, then I have established some basic rules of thumb which can assist in assessing the acceptability of a noise on the basis that the criteria can be exceeded for 10% of the time:

- Determine the *accumulated background noise level* in accordance with procedures developed by RTA Technology *(The Accumulation of Statistical Noise Levels*, Renzo Tonin, private communication) for the appropriate time period of the day. This level is basically the long term L_{A90} noise level, based on the relevant time periods and excluding extraneous measurement results. A preliminary analysis of some typical examples has indicated that the accumulated background noise level is approximately equal to the 75 percentile level of the L_{A90} (ie the $L_{A90,15min}$ level exceeded for 75% of the time) during the appropriate period.
- Estimate the probability of temperature inversions and breezes towards the assessment location during the assessment period.
- Estimate the probabilities of the noise producing operations at the plant and the overall noise emissions during each type of operation.
- Estimate the expected plant noise level (L_{A10} level for New South Wales) at the assessment location which is likely to be exceeded for say 40% of the time. This 40% figure is derived as follows. If the accumulated background noise level is used as the background level, then the level of a steady noise 5 dBA above this will just comply with the criterion for 75% of the time(ie the 75% of time when the background noise level is above the accumulated background noise level), but does not comply for 25% of the time. If we then assume that the plant noise level varies, we could make the 40 percentile level for the plant noise ($L_{A10,15min}$) equal to the assume background noise level + 5 dBA. The plant noise wound therefore be above this criterion for 40% of the time. Assuming a random relationship between background noise and plant noise, during the 25% of the time that the background noise level falls below the assumed level (accumulated background noise level), the plant noise would be above the criterion for 40% of the time. The plant noise is therefore likely to exceed the background noise level by an estimated 25% x 40% which is 10% of the time.
- Compare 40% level for the $L_{A10,15min}$ with the accumulated background noise level and check if the allowable difference between noise level and the background level is exceeded.

These rules of thumb are very approximate since the correct assessment would depend upon the profiles of background noise and plant only noise with time and also upon the degree of correlation between these two noises. They should also be applied carefully with due consideration of the particular circumstances; for example, it would be unreasonable to allow plant noise to exceed the criterion for the first year of a 10 year operation, even though this represents 10% of the total time.

4. CONCLUSION

The approach discussed above has been developed on the basis of experience over a period of time in an attempt to clarify the interpretation of the basic noise assessment procedures discussed in Standards and guidelines. However, it represents a first written attempt at such clarification with the objective of allowing debate on this issue. Comments and suggestions are welcome and can submitted to the editors of *Acoustics Australia.*