THE USE OF THE $L_{Aeq\ 24\ hour}$ TO DESCRIBE BASELINE NOISE ENVIRONMENTS

Dr R A Hood

Ashdown Environmental Limited

Introduction

Environmental assessment studies have to be undertaken for a range of major projects which are defined in Annex 1 of the EC Directive 85/337/EEC. The purpose of this work is to quantify the environmental impact that may be caused by the project. The problem is always how to define "a significant environmental impact". In the UK there have been a number of methods used in environmental assessment work to describe the noise impacts and in most of these methods, the noise of the proposed facility is compared against a baseline noise level. This paper examines the various methods that have been used to quantify baseline noise levels which have been defined by reference to various noise indices and time periods. Some of these methods will be reviewed and assessed in terms of their suitability for providing the decision maker and the public with readily comprehensible information, by which the impact of a scheme can be easily understood.

Under the EEC Regulations all annexe 1 projects, which include power stations over 300 megawatts and new high speed railways, have to be assessed in terms of their environmental significance by the production of an Environmental Statement (ES). Latterly the Department of the Environment has extended the range of projects for which an ES must be produced to include many other types of development such as trout farms and motorway service areas. The purpose of the ES is to assess the likely impact upon the environment of the proposed development. In particular a description of the likely significant direct and indirect effects on the environment is required. Where significant adverse effects are identified, a description of mitigation measures is also required.

Receptors

The problem for acousticians is how to define a significant environmental effect. For example, what criterion levels should be applied to schools, hospitals, churches, public open space and other noise sensitive locations such as theatres and recording studios.

In addition if two areas have the same ambient noise environment and are effected by a proposal to the same degree, but one is a leafy suburban area with sparsely scattered detached large expensive housing and the other is a local authority housing area, should the same criterion apply to both locations ?

The problem of ascribing a value to the quality of the receptor of the impact is compounded by arguments relating to their national, regional and local significance. In more general terms, how is the acoustician to trade off the impact on say 10 residential properties with the impact on a school.

The above examples of the type of "trade offs" that have to be made when undertaking environmental impact analysis on major projects are given because I believe it underlines the necessity for using the simplest methodology available. With complex methods too much data is presented which, together with uncertainties regarding the quality of receptors, makes for a very confusing decision making framework.

In most of the work we undertake, the impact is defined by reference to the number of people who are adversely affected by the scheme. As it is not always possible to identify the number of people living in properties adjacent to the scheme, the number of residential units are used as a surrogate for the number of people adversely affected. This method overcomes the problem of ascribing values for the quality of receptors as it only relates to residential property. Other facilities have to be evaluated separately.

Assessment

In the UK there have been three main methods used to assess the noise impact of new schemes. These have been based on:

a) Absolute levels (does the noise exceed a certain critical level);
b) A BS 4142 type assessment (does the noise from a proposal exceed the ambient L_{A90} by a predetermined amount).
c) Noise change (is there a significant change to the noise environment);

Absolute Levels

Methodologies based upon absolute level do not require an assessment of baseline conditions and are therefore beyond the scope of this paper.

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BS4142

It can be argued that the chalk and cheese philosophy of BS 4142 i.e. comparing the corrected L_{Aeq} from a proposal with the existing L_{A90} noise level is not a system that should be adopted for the identification of an impact in an ES as it does not give any indication of a change in the environmental noise condition. For industrial projects in the UK this method of assessment is the most widely accepted way of identifying the possibility of complaints due to noise. It is therefore used on a regular basis for assessing the environmental impact. However in addition to the fundamental problem of not identifying changes in the environmental condition, there is also the uncertainty relating to the stability of the measured and/or calculated L_{A90} noise levels. I shall return to this problem later.

Noise Change

The environmental impact assessment process, in requiring the identification of the impact of the proposal on the environment, inevitably leads to the adoption of a noise change philosophy. Providing of course that the final noise level achieved is not above a value that is considered unacceptable. For such an approach to be valid it is imperative that the existing environmental condition is accurately quantified. It is well known that environmental noise levels are rarely steady and vary from second to second, minute to minute, hour to hour, day to day. It is known that the subjective response to existing noise sources such as the noise from road, rail and aircraft noise correlates reasonably well with the $L_{Aeq\ 24\ hour}$ although it should be noted that other competing indices i.e. the L_{A10} 18 hour (for traffic noise) or the period L_{Aeq} (for other types of noise) predict the subjective response just as well or badly as the $L_{Aeq\ 24\ hour}$.

Not only does the $L_{Aeq\ 24\ hour}$ have general applicability to the subject of response to noise it also happens to be one of the most stable indices. In order to assess the stability of the various indices noise measurements were undertaken at one site over a period of six weeks, where measurements of the L_{Aeq} L_{A90}, L_{A10} and L_{Amax} were monitored every hour of the period. From these results we have examined the stability of the indices during the time periods. The results of this analysis are contained in the table below:

Time Period	L_{Amax}	L_{10}	L_{A90}	L_{Aeq}
Daytime 1 hour	4.41	3.12	3.35	2.73
12 hour	1.77	2.10	2.71	1.73
Evening 1 hour	6.46	5.82	5.89	5.05
3 hour	4.35	5.33	5.65	4.34
Night 1 hour	7.46	7.67	6.02	6.86
9 hour	1.48	1.77	2.76	1.69
24 hour	1.33	1.61	2.33	1.38

TABLE: STABILITY OF VARIOUS NOISE INDICES MEASURED IN TERMS OF THE STANDARD DEVIATION OF THE MEASURED VALUES IN dB(A)

As can be seen from the table, the variation in the $L_{Aeq\ 24\ hour}$ produced a standard deviation of 1.38, this indicates that there is a 10% chance that a $L_{Aeq\ 24\ hour}$ would differ from a long term average by up to ± 2.7 dB(A). This stability enables consistent and repeatable measurement of the ambient noise environment to be made and, most importantly of all, readily checked.

Night Time Noise

The noise change methodology of assessing the impact of a scheme by reference to the change in the $L_{Aeq\ 24\ hour}$ is only suitable where the diurnal variation of the noise from the new facility is similar to that of baseline, ie the noise from the new facility falls by at least 8 dB(A) during the night time hours. If however the noise from the proposal does not conform to the above criterion, then the noise change system using the $L_{Aeq\ 24\ hour}$ needs to be monitored. An example of such a situation is a power station where the noise emission can be constant throughout a 24 hour period. In these situations there are many possible methods of assessing the impact. However two of the more frequently used methods are:

a) A single adjusted number to take into account peoples greater sensitivity during the evening by time period. Units such as L_{DEN} and L_{DN} could be considered; could be considered;

b) Separate day, evening and night time analysis;

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Single Adjusted Number

With the L_{DEN} a 5 dB(A) correction is applied to the evening hourly noise levels and a 10 dB(A) correction to the night time L_{Aeq} hourly noise levels. These levels are then logarithmically averaged to get the L_{DEN} over the 24 period. For the L_{DN} a 10 dB(A) correction was applied only to the night time noise level. It is interesting to note that neither of these two indices are in general use in the UK at this present time.

Should the L_{DEN} and L_{DN} type indices, be used to describe the future noise from a development, then they should also be used to describe the baseline noise condition, otherwise no direct comparison can be made between the baseline and the future situation. However the significance of any numbers obtained from this methodology is not really apparent due to the hidden nature of the effect of the weightings.

Separate Day, Evening and Night Time Analysis

To overcome the problems of aggregated hourly L_{Aeq} values, some of which have been corrected for evening and night time period, impact assessments have been attempted in terms of those three periods and the results of these analysis presented separately. There are a number of practical problems for this type of methodology, not least of which is the large amount of data that needs to be given with regard to the noise impact, ie: three sets of baseline noise information; three sets of noise information indicating the noise from the new source and three sets of noise impact plans.

Another major source of concern is the reduction in consistency of the assessment of the baseline noise condition during these periods. From the table it can be seen that the 3 hour average L_{Aeq} evening noise level measured over a period of six weeks had a standard deviation of 4.3 dB(A) indicating that there was a 10% chance that an individual would differ from the long term average by up to ± 8.7 dB(A). In order to obtain a reliable assessment of the evening time noise level, the duration of ambient noise measurements would have to stretch into months rather than days, which for most environmental impact assessments is not practical.

The measured night time $L_{Aeq\ 8\ hour}$ noise level was however relatively stable with a standard deviation of 1.69. If therefore night time noise is a potential problem, the solution to the assessment of that problem may be to undertake a $L_{Aeq\ 24\ hour}$ noise change assessment to arrive from 24 hour noise measurements and calculations, and to supplement this with a night time noise assessment which based on an extended night time noise survey which averages the noise over a number of night time periods.

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Summary

The environmental assessment process, which culminates in the writing of an ES, identifies significant changes in the environmental condition caused by the proposal. For noise, I would suggest that the most accurate and simplest way of identifying significant changes is by reference to the changes in the $L_{Aeq\ 24\ hour}$. If however night time noise is a significant factor, then in addition to the 24 hour noise change assessment, an assessment of the change in the noise in the environment over the night time noise period needs to be undertaken. However, in order to obtain a reliable measure of night time noise levels, a survey has to be carried out over a number of night time periods.

There is no one simple method of assessing the impact of a scheme, not only is there uncertainty with regard to assessing the quality of the receptors, there is also no simple number that can be ascribed to define the noise impact. The simplest method we have so far determined in assessing the impact on residential property is by reference the change in the $L_{Aeq\ 24\ hour}$ but even this simple methodology needs to be modified if there are particular factors that affect the assessment. As with most environmental issues it is not just the determination of an accurate and repeatable number that is the essence of the assessment, but an experienced interpretation of what the numbers mean.