Proceedings of The Institute of Acoustics

BS 4142 AND NOTIONAL BACKGROUND NOISE

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INTRODUCTION

The past twenty-five years have seen a steady increase in the importance of noise as an environmental pollutant until now noise is one of the biggest single causes of complaint amongst the population.

Government, at both national and local level, has responded by seeking to control the sources of environmental noise, and so requires standardised procedures for quantifying aural impact upon the local community.

The assessment of noise nuisance is a matter of subjective judgement based upon concepts of reasonableness and good neighbourliness. However, it is possible to make objective measurements which, in conjunction with relevant standards, can be helpful in supporting subjective assessment.

BS4142: 1967, Method of Rating Industrial Noise Affecting Mixed Residential and Industrial Areas is specifically intended to indicate whether noise from industrial or other fixed sources is likely to give rise to complaints. As such BS4142 is commonly quoted in legal proceedings and at planning inquiries.

BS4142 is a comparison method which requires measurement or estimation of the background noise (L90) present in the absence of the intruding noise. When it is not possible to directly measure the L90 level, BS4142 describes a procedure for calculating a "notional" background level.

This paper is an interim report on the efficacy of calculating this "notional" background noise according to BS4142. The presentation is the more topical because the Standard is now being re-written, and the calculation of notional background noise may require some refinement in view of the findings presented here and elsewhere.

MEASUREMENT SITES AND PROCEDURES

Data from ten rural and four suburban sites in the north-west Kent area is described. The sites were selected by means of a grid superimposed on an ordnance survey map of the area, and in this sense were selected at random. Such a selection method naturally gave a bias to rural sites and this is reflected in the data sets.

BS4142 defines the background noise level as the level exceeded for 90% of the "relevant time period". Appendix A of BS4142 defines three time periods - weekdays, night time and all other times. Equipment and staff limitations, however, restricted the measurements to continuous twenty-four hour periods on weekdays (Mondays to Fridays) only, with the L90 being calculated at one hour intervals.

Tables 1 and 2 show in histogram form the measured noise levels sub-divided into day, evening and night for the rural and suburban sites.

VARIATIONS FROM NOTIONAL BACKGROUND NOISE LEVEL

The comparison to be made was of the notional background noise level calculated according to BS4142, with all relevant corrections, and the actual measured level in the absence of the "source". The only corrections necessary were for the time of day and type of district.

Tables 3 and 4 show the measured and notional background noise levels for both sets of sites. For the rural sites the mean difference between notional and measured background noise levels was 10.1 dB(A) with a standard deviation of 4.6 dB(A), for the suburban sites the figures were respectively 9.1 dB(A) and 3.5 dB(A).

CONCLUSIONS

For the fourteen sites tested, the procedure in BS4142 for calculating a notional background noise level produces a figure which is consistently higher than the measured values, sometimes by as much as 17 dB(A). For the ten rural sites this under-estimation was statistically significant at the 2.5% level, and for the four suburban sites was also significant at the 2.5% level.

Further work is now being undertaken in mixed residential and industrial sites and results should be available shortly. Should the difference in measured and notional background levels show the same degree of statistical significance then some reappraisal of the method of calculating the notional background noise level would appear reasonable.

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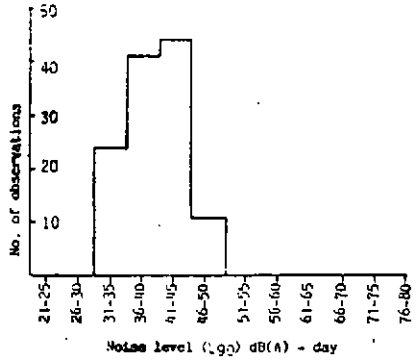
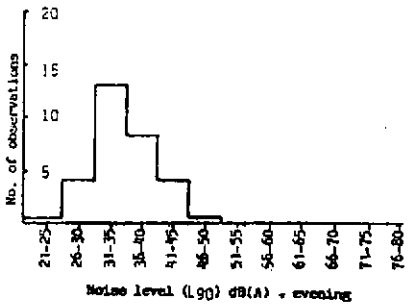
Table 1 MEASURED BACKGROUND NOISE LEVELS FOR TEN RURAL SITES - L90, dB(A), 1 HOUR PERIODS





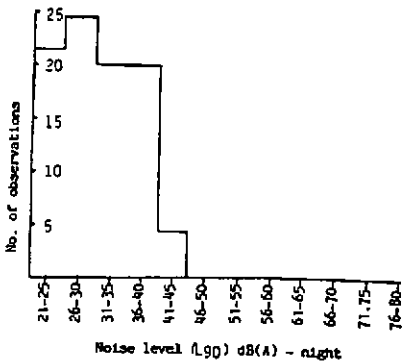


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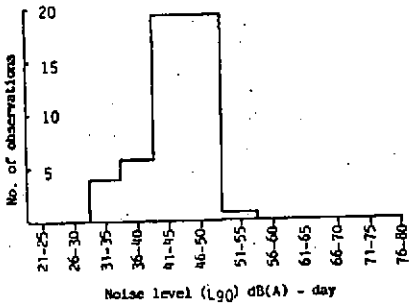
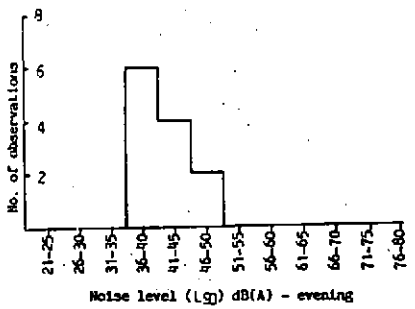
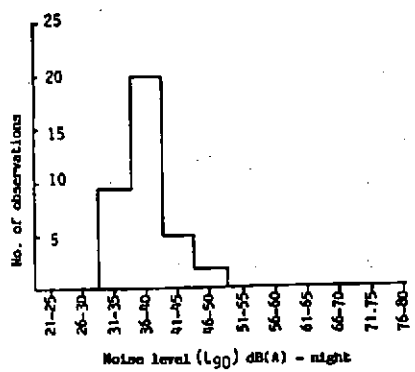
Table 2 MEASURED BACKGROUND NOISE LEVELS FOR FOUR SUBURBAN SITES - L90, dB(A), 1 HOUR PERIODS







BS 4142 AND NOTIONAL BACKGROUND NOISE

Table 3 COMPARISON OF MEASURED AND NOTIONAL BACKGROUND NOISE LEVELS FOR TEN RURAL SITES

Table 3(a) Day 07.00 - 19.00
Corrections to Notional Level; District -5dB(A), Time +5db(A)

Site	1	2	3	4	5	6	7	8	9	10
Notional Background Level, dB(A)	50	50	50	50	50	50	50	50	50	50
Measured Background Level, dB(A)	35	42	45	44	35	41	42	39	38	35
Difference	-15	-8	-5	-6	-15	-9	-8	-11	-12	-15

Table 3(b) Evening 19.00 - 22.00
Corrections to Notional Level; District -5dB(A), Time 0dB(A)

Site	1	2	3	4	5	6	7	8	9	10
Notional Background Level, dB(A)	45	45	45	45	45	45	45	45	45	45
Measured Background Level, dB(A)	28	31	44	38	29	33	41	37	32	34
Difference	-17	-14	-1	-7	-16	-12	-4	-8	-13	-11

Table 3(c) Night 22.00 - 07.00
Corrections to Notional Level; District -5dB(A), Time -5dB(A)

Site	1	2	3	4	5	6	7	8	9	10
Notional Background Level, dB(A)	40	40	40	40	40	40	40	40	40	40
Measured Background Level, dB(A)	25	30	37	27	26	30	40	36	28	25
Difference	-15	-10	-3	-13	-14	-10	0	-4	-12	-15

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Table 4 COMPARISON OF MEASURED AND NOTIONAL BACKGROUND NOISE LEVELS FOR FOUR SUBURBAN SITES

Table 4(a) Day 07.00 - 19.00
Corrections to Notional Level; District 0dB(A), Time +5dB(A)

Site	1	2	3	4
Notional Background Level, dB(A)	55	55	55	55
Measured Background Level, dB(A)	43	45	38	48
Difference	-12	-10	-17	-7

Table 4(b) Evening 19.00 - 22.00
Corrections to Notional Level; District 0dB(A), Time 0dB(A)

Site	1	2	3	4
Notional Background Level, dB(A)	50	50	50	50
Measured Background Level, dB(A)	40	39	41	46
Difference	-10	-11	-9	-4

Table 4(c) Night 22.00 - 07.00
Corrections to Notional Level; District 0dB(A), Time -5dB(A)

Site	1	2	3	4
Notional Background Level, dB(A)	45	45	45	45
Measured Background Level, dB(A)	36	35	39	41
Difference	-9	-10	-6	-4

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THE ASSESSMENT OF ENVIRONMENTAL NOISE IMPACT FROM INDUSTRIAL ACTIVITIES IN RURAL AREAS

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Introduction

In June 1985 the Council of the European Communities issued a directive (Reference 1) concerning the assessment of the effects of certain projects on the environment. This directive identifies certain types of project for which a developer must undertake an environmental impact assessment and other types of project for which member states may determine whether such an assessment is required. A three year period was given for member states to implement the measures necessary to comply with this directive, ie July 1988.

The UK government's policy is that the requirements of the directive can, in general, be met by the existing planning system, but for some projects determined under other legislation, some rationalisation of procedures would be required.

Some industries, eg the oil industry, have already been undertaking environmental impact assessments for major applications, and planning authorities have been seeking information on environmental issues as a basis for determining many planning applications.

1	Crude-oil refineries and certain gasification and liguiefaction installations.
2	Thermal and nuclear power stations.
3	Installations for storage or disposal of radioactive waste.
4	Integrated works for the initial melting of cast-iron and steel.
5	Installations for the extraction and processing of asbestos.
6	Integrated chemical installations.
7	Construction of motorways, railways and airports.
8	Certain trading ports and inland waterways.
9	Installations for the incineration, chemical treatment or land fill of toxic and dangerous wastes.

TABLE 1: Projects Subject to Mandatory Environmental Impact Assessment

An abbreviated list of projects for which the directive calls for an environmental impact assessment is given in Table 1.

Some of the projects listed, by their very nature must be located in areas away from major centres of population or existing industrial use. In addition the list of projects subject to discretionary assessment includes agriculture, extractive industries and infrastructure projects all of which may be located in rural areas. Whilst this restricts the size of population which might be impacted, the degree of impact may be more severe.

The assessment of environmental noise impact from such projects is the subject of this paper.

Noise Assessment Procedures

The consideration of planning applications is governed by the Town and Country Planning Act (Reference 2). In addition to the Act, the government issues circulars providing guidance on planning matters and, in the case of noise, Circular 10/73 (Reference 3) gives specific advice on planning and noise. For applications being determined by appeal to the Secretary of State, the government inspector is required to be guided by this circular. For noise of industrial origin, Circular 10/73 endorses the methodology of BS 4142 (Reference 4) and states that where, by the standards of BS 4142, noise *'is likely to give rise to complaint it will hardly ever be right to give permission'*.

The circular also states that *'There will however be times when it is appropriate or even desirable in order to meet other planning objectives to allow some farm or industrial or similar development near houses etc. Minerals have sometimes to be worked although there are houses nearby .... The need then is to take every precaution to ensure that noise emitted by the development in question does not on the whole make the area a less pleasant place to live'*.

BS 4142 states that complaints would be expected whenever the Corrected Noise Level exceeds the background (L_{90}) noise level by 10 dB(A) or more, with differences of 5 dB(A) being of marginal significance. A criterion for assessing industrial noise impact might therefore be that the noise from the industrial project, suitably corrected for character, intermittency and duration, should not exceed the pre-existing background noise levels in the area by more than 5 dB(A).

Both Circular 10/73 and BS 4142 are currently being reviewed with a view to being updated. The most significant likely change is expected to be the adoption of the Leq index for industrial noise which is now widely used for assessing environmental noise throughout Europe.

Some of the projects requiring assessment involve a significant construction period, the impact from which can be comparable or even

greater than the impact from long term operations. British Standard 5228 was first introduced to cover construction noise in 1975 and this was superseded in 1984 by a standard covering not only construction activities but also open industrial sites and mineral workings (Reference 5). This standard gives comprehensive guidance on noise prediction, control, assessment and working procedures. It endorses the use of the Leq index for noise assessment and monitoring and gives a framework for setting noise control targets. For assessing site noise, BS 5228 places less emphasis on the increase in noise level over the ambient since, whilst site noise will in general be more noticeable in quiet areas, the relationship between response and noise level difference may be less strong when it is known that the noise producing operations are of limited duration. Emphasis is placed on informing local residents when noise producing activities will take place and restrictions on the hours of working.

BS 5228 stops short of an absolute recommendation on acceptable noise levels, but states that evening noise limits may have to be as much as 10 dB(A) below the daytime limits, and very strict limits should be applied to any site which is to operate at night. It also states that for the periods when local residents are getting to sleep or just before they wake, noise limits may need to be as low as 40 to 45 dB(A) Leq.

So far we have considered only criteria for assessing the impact of noise of industrial origin on people in their houses. There may also be an impact on recreational and leisure activities, and on the wildlife population. There is no government guidance on acceptable levels of noise for recreational activities. Assessment must therefore be based on a comparison with the existing noise environment, and the industrial noise should not be out of keeping in terms of levels or character. With regard to wildlife, the effects are again difficult to quantify. There are many reported cases of wildlife adapting to changes in their noise environment, particularly where the noise is continuous. Impulsive or other short duration noises of high level are usually associated with the presence of man, and here visual stimuli and smell also contribute to the impact. Again impact assessment must be based on a comparison of the industrial noise with the existing environment.

Baseline Surveys

Environmental noise surveys are undertaken to establish a basis against which to assess the impact from a proposed project. A statistical analysis is usually performed to include background (L_{90}) noise levels and activity levels such as may be used to access road traffic levels (L_{10}), maximum or peak levels (L_1 is often used as per BS 5228) and L_{eq} values. The survey should cover day and night periods and a range of meteorological conditions to include calm or still air conditions when environmental noise levels are usually at their lowest.

Of equal importance to the measurement survey is an identification of the sources of noise in the area. In rural areas the background noise levels are usually controlled by distant road traffic. At locations well away from major roads, background (L_{90}) noise levels can be very low, as the previous paper has shown. Lowest levels usually occur between midnight and 0400 hrs). Figure 1 shows a typical distribution of noise levels measured over a 24 hour period.

Whilst background (L_{90}) noise levels may be very low, we must not think of the countryside as a peaceful picture postcard. Agricultural activities, animals and birds are all capable of generating high noise levels.

Prediction of Noise Emission

The preferred basis for predicting the noise from the industrial project under consideration is measured data on existing installations. For small industrial sources this may be noise measurements around the boundary of the installation from which the sound power radiated by the installation may be computed. Noise levels measured at large distances are not as useful since these will be site specific and are less reliably transferable to an alternative site. The sound power level of the installation may need to be determined for a range of operating and process conditions.

For larger installations it may be necessary to determine the sound power levels radiated by individual sources and these added to give the total output. A good reference procedure for determining the sound power radiated by a range of industrial machines and processes is contained in OCMA Specification No NWG 1 (Reference 6).

A feature of industrial activities in rural areas is that the noise producing equipment is often located outside with no attenuation from buildings. Low background noise levels and lack of shielding also necessitate the prediction of noise propagation over longer distances. Again the oil companies have done much work in this field and have published procedures covering atmospheric and ground attenuation and meteorological effects (References 6 and 7).

Impact Assessment

Impact assessment commences with a comparison of predicted noise levels with those measured during the baseline survey and comparison with the acceptability criteria discussed earlier. Attempts have been made to derive quantitative procedures for impact assessment, for example by compiling lists of residential properties subject to increases in noise level in 5 and 10 dB(A) bands. Such procedures have been used in assessing major road projects, but criticism has been made when applied to rural areas with few residential properties involved. Just because the number of residential properties affected may be small the impact, particularly in areas of low background noise levels, may be severe. For agricultural, mineral exploration and extraction processes, the plant is often in operation through the night when again background noise levels are at their lowest.

THE ASSESSEMENT OF NOISE IMPACT FROM INDUSTRIAL ACTIVITES IN RURAL AREAS

The previous paper has shown that at night in rural areas background noise levels seldom exceed 40 dB(A) L_{90}, and the majority of readings fall in the 20-30 dB(A) L_{90} range. This is commensurate with my own experience gained from over 50 rural sites, whereby noise levels generally fall to their lowest point between around midnight, when road traffic noise falls, and around an hour before daybreak in the summer months when the dawn chorus starts or 5 - 6 am in the winter. In practice noise levels are often below the threshold of noise measurement systems, and only by careful choice of microphone and analysis equipment can it be shown that levels of 15 dB(A) L_{90} or lower are possible. A typical distribution of ambient noise levels in a rural area over a 24 hour period is shown in Figure 1.

The widespread occurrence of low background noise levels brings into question the efficacy of using BS 4142 as an assessment procedure in rural areas. Does an increase in noise level of 5 or 10 dB(A) on a night-time background noise level of 20 dB(A) L_{90} really represent a significant impact?

In practice, at night, the main impact will be on people inside their houses trying to sleep. Here internal noise levels generated by central heating, fridge/freezers etc are often higher than outside. Even with windows open external noise levels may need to be more than 30 dB(A) to be audible inside a house, and even higher to be intrusive. Experience with numerous exploratory hydrocarbon drilling rigs in rural areas has shown that noise levels of 35-40 dB(A) can be generated outside residential properties with no reaction from the occupants.

Clearly then, in rural areas, it might be worthwhile introducing a threshold criterion for an industrial noise assessment. One suggestion that has been put forward is that the procedure of BS 4142 would remain valid if, when measured background noise levels were less than 35 dB(A) L_{90}, they were taken as 35 dB(A) L_{90} for assessment purposes. This is consistent with the most stringent criterion of BS 5228, which at night is 40-45 dB(A) L_{eq}.

A further difficulty if the industrial noise measured in terms of L_{eq}, is to be compared with the background noise in terms of L_{90}, is that for most environmental situations the L_{eq} is well above the L_{90} value. In Table 2 analysis of night-time (midnight to 0300 hrs) noise levels measured at ten rural sites picked at random from our files showed that on average environmental noise levels measured in terms of L_{eq} were 10 dB(A) above background, measured in terms of L_{90}. Any criterion based on a noise level in L_{eq} being 5 or even 10 dB(A) above the background would therefore be difficult to monitor.

	Measured Noise Levels dB(A)		Differences
	L_{90}	L_{eq}	
Range	19 - 46	22 - 62	1 - 38
Average	28	38	10

TABLE 2: Analysis of Measured Ambient Noise Levels at Ten Rural Application Sites (Total of 165 Samples)

Monitoring and Environmental Review

Assuming that the industrial project is given permission, noise monitoring will be required to demonstrate compliance with a planning condition and/or to assess the accuracy of noise level predictions undertaken as part of the impact assessment. In a wider sense it is essential that a review is undertaken of the whole project to compare predicted impacts with actual and to improve the data base for subsequent project analysis.

Whilst on the subject of monitoring, a cautionary note concerning the use of the L_{eq} index. L_{eq} is by definition an energy average of all noise events occurring during a sample period. Where noise limits have been set for a project these will, of course, be close to ambient levels if the impact is to be minimised. Measured values of L_{eq} will therefore include not only noise of industrial origin, but contributions from all other environmental sources (passing road traffic, bird-song, aircraft etc). Even if the measurement were witnessed it is difficult to discriminate, and automatic monitoring under such circumstances is worthless. For compliance purposes this may be overcome by agreeing an equivalent level at a position closer to the industrial source than the location being protected and hence improving the signal-to-noise ratio.

Conclusions

Environmental noise impact assessment is now becoming mandatory for a wide range of industrial projects and discretionary requirements are likely to widen this even further.

Current standards for noise assessment have some shortcomings in rural areas where background noise levels are very low.

The concept of a threshold criterion in rural areas where background levels are below 35 dB(A) L_{90} has much to commend it.

The adoption of L_{eq} for assessing environmental impact leads to particular problems with monitoring and subsequent control of projects in rural areas.

References

1 EEC Directive 85/337/EEC
On the Assessment of the Effects of Certain Public and Private Projects on the Environment
June 1985

2 Town and Country Planning Act 1971

3 Department of the Environment Circular 10/73
Planning and Noise
HMSO London

4 British Standard 4142: 1967 (as amended 1975, 1980 and 1982)
Method of Rating Industrial Noise Affecting Mixed Residential and Industrial Areas
British Standards Institution, London

5 British Standard 5228: 1984
Noise Control on Construction and Open Sites
British Standards Institution, London

6 Oil Companies Materials Association Specification No NWG 1 (Revision 2)
Noise Procedure Specification
March 1980
Hayden and Son Limited, London

7 The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighbouring Communities
Report No 4/81 Stiching CONCAWE, den Haag, May 1981

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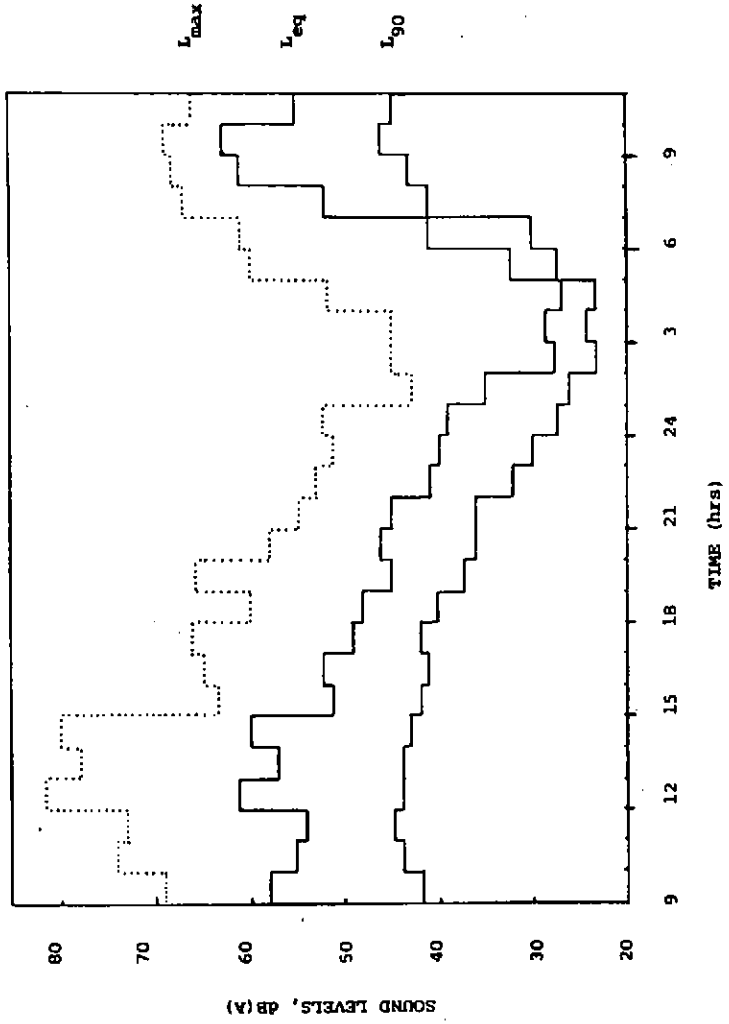

FIGURE 1: Environmental Noise Survey Over 24 Hour Period