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AMPLIFIED MUSIC WITHIN RESIDENTIAL BUILDINGS

K. Ratcliffe

ISVR Consultancy Services, Institute of Sound & Vibration Research,
University of Southampton.

1. INTRODUCTION

The paper describes a slightly unusual project involving the conversion of an old 3 storey building which has on the ground floor a wine bar, in which amplified music is played on two evenings each week. The upper floors are unused but an application for planning permission has been made for the conversion of these floors to provide Housing Society residential accommodation in the form of flats. The local environmental health officer has supported the application and required an L_{Aeq} (1 hour) noise level limit within the flats of 35 dB. In addition it was stipulated that the noise from music in the wine bar as heard in the flats should not exceed the background L_{90} noise level by more than 10 dB(A).

The architect responsible for designing the flats needed advice on the aspects which would affect the transmission of noise between the wine bar and the flats. In its existing state, the floors of the first floor area were in a poor state, some floorboards had been lifted and one section was concreted. Hence it was impossible to obtain a reliable measure of the sound transmission loss.

The landlord had a commitment to reduce noise to acceptable levels and has granted the Housing Society the power to impose any reasonable noise restrictions on the wine bar. A statement to this effect was included in the Planning Application.

One of the main problems in such cases is that there is a considerable variation in the response of individuals to noise in general and to noise from music in particular. This makes the setting of "acceptable" limits very difficult.

2. CONSIDERATION OF THE 35 dB(A) LIMIT

The discussion with the Environmental Health Officer centred on the setting of a noise level limit for the flats and it was agreed that this should be set using the criterion of sleep disturbance. This is dealt with in a number of references, the best known of which is 'Environmental Health Criteria 12 Noise' published by the World Health Organization [ref 1]. This states in its section 1.1.3.3/:

> "Based on the limited data available, a level of less than 35 dB(A) L_{eq} is recommended to preserve the restorative process of sleep."

It was agreed to use 35 dB(A) as the appropriate limit in terms of the L_{eq} noise level, also that the noise from music in the wine bar as heard in the flats should not exceed the background noise in the flats by more than 10 dB(A). These limits were set after consideration of the recommendations of the Neighbour Noise Working Party [ref 2] in March 1995 para 5.6 of which states:

> "Be based on a decision by an officer of the local authority as to whether a particular noise gave reasonable case for serious disturbance, evidence of which would include assessment that the noise exceeds 35 dB(A) and exceeds the background noise level by at least 10 dB(A)"

It should be noted that there is no qualification of the 35 dB(A) level eg. is it an L_{Aeq} or a maximum level?

A feature of noise from amplified music is that it can include low frequency components which are not always fully taken into account by the dB(A) noise level. It is more informative to measure the noise in individual frequency bands as well as in terms of the dB(A) level. In particular, this is of value when considering the effectiveness of a given means of reducing the noise such as by the architectural design features between spaces where the noise is produced and where it is heard. In this paper, the frequency components of noise from music recorded in the wine bar and that received in the first floor above, are illustrated as well as the overall dB(A) levels.

3. CONSIDERATION OF BACKGROUND NOISE LEVEL AND INAUDIBILITY

The Environmental Health Officer stipulated that in addition to meeting the L_{eq} limit of 35 dB(A), the noise should not exceed the background level by more than 10 dB(A). This is a common means of assessing environmental noise outside premises although its use for noise within dwellings is less common. It can underestimate the reaction of people to noise from amplified music. The Local Authority in Edinburgh have investigated this and their findings are given in a paper presented to the Institute of Acoustics [ref 3]. In summary, this work describes attempts to limit the noise using the standard accepted methods, including:

i) the Wilson Report [ref 4] which recommends that L_{10} noise levels within the house should not exceed 35 dB(A);
ii) BS 4142 [ref 5] which stipulates a 10 dB(A) excess noise over the background level. This standard was devised for noise outside buildings;
iii) NR curves - used in this report;
iv) inaudibility - this is highly subjective and is dependent on the listener and type of music. Used for 24% of the cases in Scotland from 1978 to 1982. It is a very stringent criterion and can be extremely difficult to meet.

3.1 Inaudibility

Despite the difficulties inherent in the assessments, the criterion of inaudibility has been accepted by the Secretary of State for Scotland as part of the planning regulations. The Licensing Board has also seen fit to impose on a standard condition on all applications for a licence a clause that:

> "all music or vocals, must be controlled to the satisfaction of the Director of Environmental Health so that no noise is audible within any neighbouring premises."

4. VISIT TO PREMISES

A preliminary inspection of the first floor showed that some of the flooring is of concrete, the remainder being a conventional wooden floor above 4" joists. In some areas some of the floorboards

were partly raised, hence there were weaknesses in terms of sound insulation. This limited the positions at which noise measurements could be taken. Three locations were selected: one on the concrete section, one on the wooden floor and one at the top of the stairs at second floor level.

Considering the building in its existing condition, noise from voices and music in the wine bar could be clearly heard at the first floor level. Traffic noise from nearby streets was also clearly audible. The distinct audibility of music, singing and spoken voices indicated that a considerable improvement in the sound transmission loss between the wine bar and the first floor would be necessary in order to meet a noise level based on the criteria for residential accommodation.

5. NOISE MEASUREMENTS

Noise levels were recorded and also obtained by direct observations using a B & K Type 2231 sound level meter connected to a Sony DAT tape recorder. An initial measurement was made between 8.30 pm and 9.00 pm when the musicians were testing their instruments during the 'warm-up' period. Following this, measurements were made at all three locations with some repeats to check on the repeatability of noise levels when different songs were being sung in the wine bar. On completion of the measurements, further readings were obtained in one representative location in the wine bar at a distance of about 10m from the band. It was noticeable that the noise levels at the first floor and in the wine bar did not vary significantly at different positions, nor did it change greatly from one song to the next. As a result it has been possible to simplify the analysis by considering two results, one representing the noise at the first floor and one in the wine bar.

6. RESULTS

6.1 Measured Levels

Figures 1 and 2 are one third octave band spectra of noise measured at the first floor and in the wine bar respectively. In overall terms, the directly measured L_{eq} noise level at the first floor and in the bar were 51 dB(A) and 85 dB(A) respectively. Figure 3 shows the two spectra, simplified into octave bands, and plotted against a reproduction of the family of NR curves. The lower spectrum is equivalent to a total level of 54 dB(A), or 51 dB(A) in terms of L_{eq}. In order to meet an L_{eq} limit of 35 dB(A) the spectrum would need to be about 16 dB lower at the following frequencies:

Frequency (Hz)	125	250	500	1k	2k

6.2 Attenuation

The spectrum would then meet the NR 35 curve at the dominant frequency of 250 Hz. It was noticeable that there was no heavy 'beat' from the music and hence the improvements required are mainly in the mid frequency range.

An examination of the frequency spectrum suggests that in order to limit the effect of any tonal noise, the noise level in the octave band centred on 250 Hz should be limited to 39 dB as measured in the flats. This would have the effect in dB(A) terms of reducing the L_{Aeq} level to approximately 33 dB(A) in place of 35 dB(A). It is assumed that the frequencies in the lower two octave bands (63 Hz and 125 Hz) of 39 and 42 dB would be acceptable since, subjectively, the low frequency noise was not considered to be intrusive. The limiting linear spectrum would therefore be:

									Total	
OB Frequency	63	125	250	500	1k	2k	4k	dB Lin	dB(A)	L_{Aeq}
SPL (dB)	39	42	39	35	29	22	16	45	36	33

7. POTENTIAL FOR NOISE REDUCTION

In general, where a noise source produces noise at a receiver location where the effect must be reduced, the solution can be considered in three separate parts:

i) reducing the noise at source,
ii) increasing the 'sound transmission loss' between source and receiver,
iii) reducing the noise at the receiver location.

7.1 Noise at Source

Since the Landlords are able to regulate noise emissions through their lease and have indicated their willingness to cooperate to reduce noise to the required levels this would be controllable at source. This could be achieved by installing an electronic limiting system to control the output of the electronic instruments. The music was not considered to be unreasonably loud in the context of entertainment in a wine bar and some of the noise was from the voices of customers. There was no 'rowdyism' but voices are naturally raised in such a 'party' atmosphere.

7.2 Sound Transmission

In all buildings there is inevitably a certain amount of 'flanking transmission' of sound between rooms whether on the same floor or vertically between rooms on different floors. At present the overall difference in the measured L_{eq} noise levels between the wine bar and the first floor is 34 dB(A) (85 dB(A) − 51 dB(A), see section 6.1 above). If this could be increased by the 16 dB referred to in section 6.1 there would be an overall sound transmission loss, in terms of dB(A), of 50 dB(A). This constitutes in practice the maximum likely to be obtained in conventional buildings.

It is estimated that the architect's design of the conversion would provide about half of the required 16 dB(A) overall increase in transmission loss required to attain the level of 35 dB(A) in the flats. Therefore a further improvement of the order of 8 to 10 dB(A) would be necessary and probably this could be achieved by incorporating a high transmission loss ceiling in the wine bar.

7.2.1 Suspended High Sound Transmission Loss Ceiling to Wine Bar

This has already been discussed between the architect and the owner of the property. It would entail adding acoustic insulation to the structural soffit of the wine bar above the existing suspended ceiling. In order to achieve a significant increase in the sound transmission loss of the existing ceiling/floor arrangement it would be necessary to provide a relatively heavy layer suspended about 100 mm below the soffit so that a gap would be formed. This 100 mm gap would be filled with a low density absorbent material such as mineral wool or fibre glass blanket to reduce reverberation in the cavity so formed and to obtain the maximum sound transmission from the heavy layer. This could be typically of plasterboard 25 mm to 50 mm in thickness and with the smallest possible gaps at the edges to minimise flanking transmission.

7.3 Reducing Noise at Receiver Location in the Flats

The noise measurements were made with the first and second floor areas empty of any furnishings. If they are converted into flats there would be a significant amount of acoustically absorbent material in the form of soft furnishings, carpets and curtains. This would have the effect of reducing the reverberant sound level in the lounges and bedrooms by typically 3 to 5 dB(A). Hence any estimate of the noise transmitted to the flats from the wine bar should be reduced by at least 3 dB(A). It is considered that this reduction should be used as a 'safety factor' in view of the fact that, despite the 35 dB(A) limit required by the Local Authority, it is known that the public response to noise from music is very difficult to judge and that individuals vary considerably in their acceptance of it.

8. MEASUREMENT METHOD

The method makes reference to BS4142 (Ref 4) purely for technical reasons since this method is widely accepted and is familiar to Environmental Health Officers. The standard describes a method for measuring and rating noise outside buildings but many of the definitions can be used generally.

A measurement method has been recommended in order to enable practical monitoring of the noise in the flats to be carried out when they are ready for occupation. A sound level meter capable of registering simultaneously the octave band sound pressure levels with the meter on the L_{eq} setting could be used to monitor the spectrum levels given in section 6.2. If the meter frequency characteristic is set to the 'A' weighting and the time characteristic 'slow', the limiting spectrum would become:

OB Frequency (Hz)	63	125	250	500	1k	2k	4k	dB(A)	L_{Aeq}
SPL (dB)	23	26	30	32	29	23	17	36	33

Hence the total dB(A) level and the L_{Aeq} could be obtained at the end of any given test of several minutes duration.

9. CONCLUSIONS

In order to attain an L_{eq} noise level of 35 dB(A) in the first floor flats there are two measures to be considered. These are based on the level of 85 dB(A) measured in the wine bar on 24 May 1995.

i) Incorporate the high transmission loss ceiling in the wine bar as described in 8.2.1.

ii) Control the L_{eq} noise level in the wine bar. The actual noise level in the wine bar required to ensure that the limits in the flats are not exceeded will not be known until the conversion is completed. However, the Landlords commitment to the reduction in noise to acceptable levels should ensure no practical problems will occur. An electronic limiting system will need to be installed to control the output of electronic instruments in the wine bar.

A practical method of monitoring the noise levels in the flats when the conversion is completed is given and should ensure, as far as possible, that noise levels can be controlled to acceptable limits.

10. REFERENCES

[1] Environmental Health Criteria 12 Noise. World Health Organization (1980).
[2] Neighbour Noise Working Party. Review of the Effectiveness of Neighbour Noise Controls - Conclusions and Recommendations. Department of the Environment Welsh Office and Scottish Office March 1995.
[3] Amplified Music as a Noise Nuisance. J.R. Stirling and R.J.M. Craik. Proceedings of Institute of Acoustics Vol. 8 Part 4 (1986).
[4] Noise Final Report. Cmnd 2056 (1963) 'The Wilson Report'.
[5] BS 4142:1990. Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas.

Figure 1 - Noise at First Floor

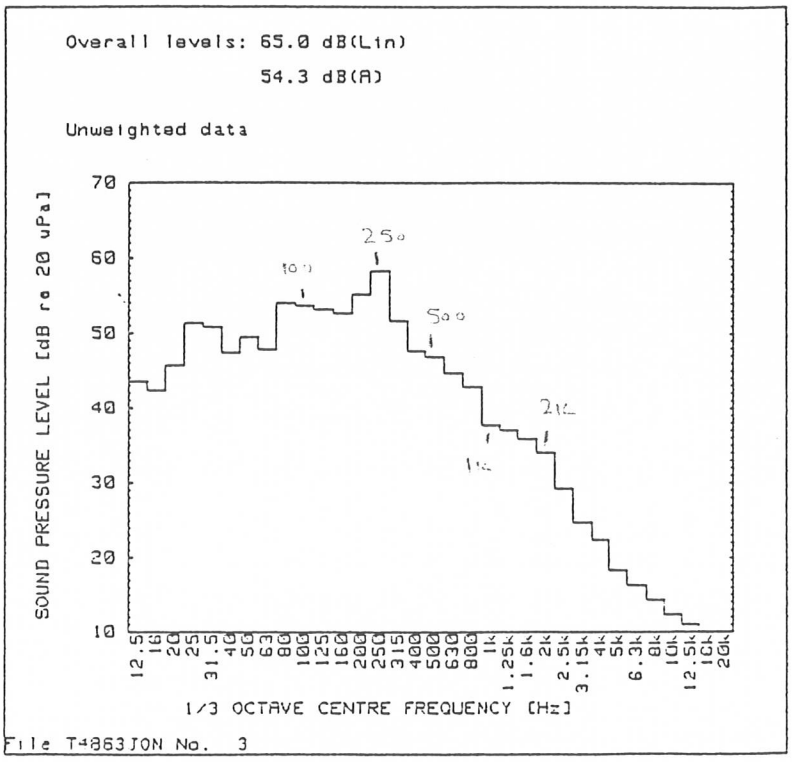


Figure 2 - Noise at Wine Bar

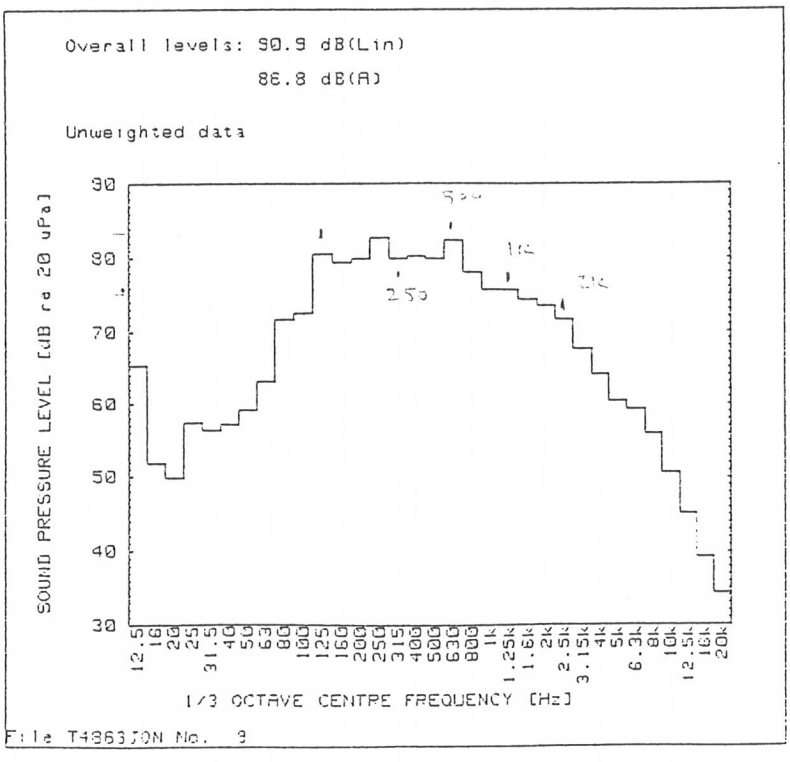
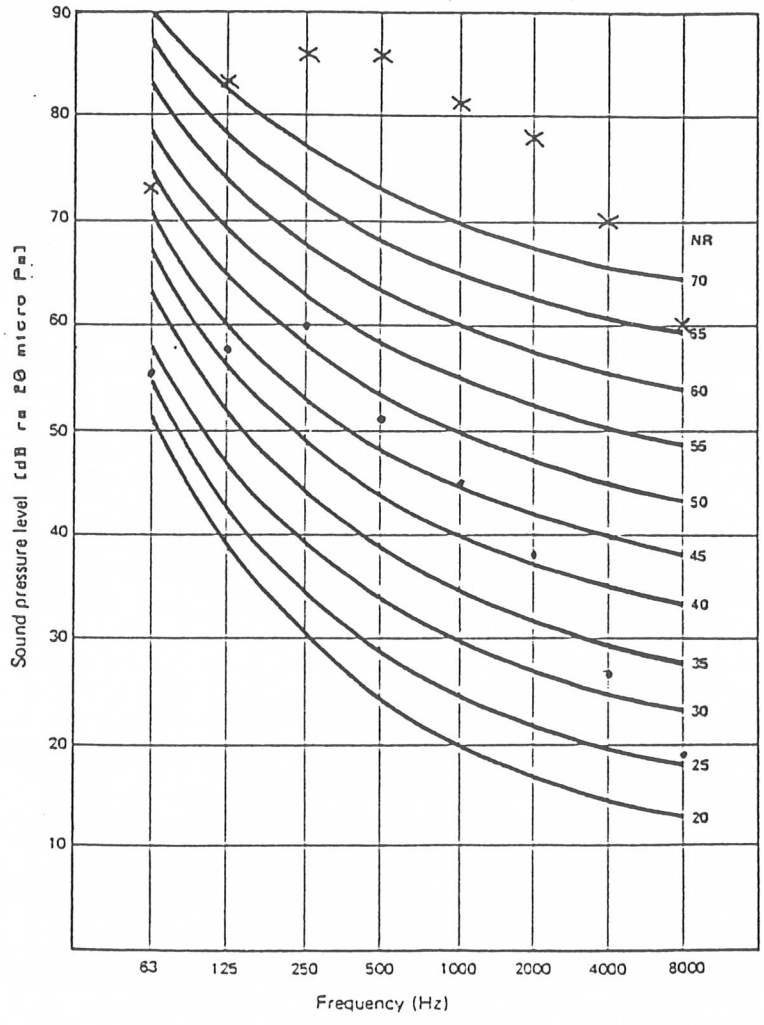


Figure 3

X Noise in Wine Bar

● Noise at First Floor



1. It is difficult to design a building on the basis of inaudibility without exceeding a reasonable level of costs.

2. If an audible noise is both outside the control of the listener and is caused by someone else, especially if they can be identified, it is likely to cause a greater degree of annoyance.

3. The information content of the noise is an important factor in determining whether or not it causes annoyance.

4. The basis on which any noise limit is set, whether it is subjective or objective, must be reasonable and must be seen to be so. There must be a sensible balance between those who might wish for inaudibility and those who, for a number of reasons, must make noise or who actually wish to do so.

5. English Land Law has for many centuries laid stress upon the entitlement of lawful occupiers to, what is termed, "quiet enjoyment". They should be protected against unjustifiable interference from outsiders.