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NOISE CRITERIA IN THE MODERN OFFICE DEVELOPMENT HOW DO THESE COMPARE WITH BS 8233 : 1987

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1. INTRODUCTION

The majority of speculative office Developers and their ultimate tenants now retain the services of an acoustic consultant as a member of the Professional Team. This has meant that such consultants have been able to influence to a great extent the acoustic design parameters for buildings considering on the one hand the cost of achieving such parameters and on the other their suitability for the use of the building.

With office rents in the City of London approaching £100 per square foot, the "letability" of a building is very dependent on the internal acoustic environment and a tenants perception of it.

This paper discusses the design criteria in current use by acoustic consultants and Developers and how these relate to those proposed in BS 8233 : 1987 ("Code of Practice for Sound Insulation and Noise Reduction for Buildings"). (1)

The nature of developments has changed considerably in the last ten years. Traditionally, the NR35 criterion used for office developments applied to both noise from building services such as air conditioning; lifts; plantroom noise breakout etc., and all other external sources such as road traffic noise; railway noise; aircraft noise etc. This lead to the majority of buildings having fairly substantial constructions and secondary or triple glazing to control the low frequency noise problem. Whilst this achieved the design criteria required by the development market, it caused in itself, other problems with speech privacy within the fashionable "open plan office". The secondary windows to control the low frequency noise, completely eliminated any high frequency noise intrusion which might assist with speech masking.

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The introduction of variable volume air conditioning systems in the majority of projects, also meant that the air conditioning systems would be designed to achieve the NR35 criterion at their maximum volume. In practice, this maximum volume would only be reached on perhaps two or three days per year except in a very exceptional summer. For the majority of the office usage, therefore, the background noise was at a level of about NR30 or below. This in conjunction with the problems noted above in respect of high frequency intrusive noise further exacerbated the problem of speech privacy.

Consultants such as ourselves were always unhappy with these situations, but our level of influence at that time was very small in comparison with the position today. As it turned out, the solution to these problems came about largely with the need to reduce building costs, which normally work against the specialist consultant.

With the introduction of American "Fastrack" building technology ie. lightweight slabs on metal decking; lightweight steel structures; and curtain walling, achieving the required low frequency sound insulation values to maintain the NR35 criterion became impractical and in some instances impossible. Some of the larger developers began to listen to what their acoustic consultants were saying in the realisation that it would actually save them building costs and different criteria arose to reflect this change in attitudes. It should be stated also, that the design of high performance sealed double glazing units notably by Messrs. Pilkingtons also enabled relatively lightweight structures to be built in locations where they would not previously have been possible, such as many of the major routes within the City of London.

The criteria adopted generally by the development industry are discussed below and how they relate to BS 8233 and Section 11 of that document in particular.

2. AIR CONDITIONING NOISE

The internal noise criterion generally used for office developments within London and other major cities is that the ambient noise level should not exceed NR38. Where the air conditioning system is of the variable volume type (VAV), this criterion should be achieved at 80% of the maximum air volume from the VAV boxes.

The above criterion ensures that the ambient noise level is typically about NR38 within the development, but during a few days every year increases to about NR40 when the thermal conditions require a 100% volume. Such a level has been found to be a good compromise being acceptable for both open plan and cellular offices. In Figure 1, typical spectra for offices with variable volume (VAV) and fan coil air conditioning systems are shown compared to (ISO) NR curves. These spectra to the nearest whole number, equate to the following levels:-

VAV system - 1.5 metres from source - 44dB(A)
Fan Coil system - 1.5 metres from source - 42dB(A)

Whilst BS 8233 does not specifically refer to air conditioning noise, it refers to ... "maximum intrusive noise levels" ... expressed as an L_Aeq. These are:-

a.	private offices, conference rooms	40-45dB
b.	large offices	45-50dB

The statement in respect of "intrusive noise levels" is not precise, but it is assumed that this means noise not generated by the occupants or their equipment, nor noise entering from outside. In most offices, such noise would generally relate to the air conditioning noise level.

The development levels given above fall between 40-45dB. As we have indicated, such levels are acceptable for both cellular and open plan offices. The levels of 45-50dB recommended by BS 8233 for "large offices" would not be acceptable in today's commercial environment in and around the City of London. Additionally, the document bears no relationship to publications by the Chartered Institute of Building Services Engineers (CIBSE) whose Design Guide (2) uses the NR criterion exclusively for background noise levels.

4. ROAD TRAFFIC NOISE

At low frequencies, interference with speech is less likely and it is therefore, acceptable to have a higher noise level than would be allowed by the strict NR rating used for the air conditioning noise.

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The annoyance caused to the occupants of an office is also tempered by the fact that unlike noise from an air conditioning grille which is fixed in the suspended ceiling, individual cars in the stream of traffic are transitory and the noise radiated by them is perceived in the same way. People will, therefore, tolerate more noise from traffic than they would from an air conditioning grille, since they feel they have no control over it.

The above factors together with the problems associated with the overkill of high frequency noise using triple glazing solutions, has led to the development of other criteria for traffic noise.

To rate traffic noise intrusion, consultants use criteria which are basically related to the L_{A10} level or a modified NR curve using L_{10} octave band levels. Hann Tucker use a modified NR curve to rate such intrusion which has been called TNR or traffic noise rating. From experience, a level of TNR40 has been found to be the maximum acceptable for high quality office accommodation. In Figure 2, we show a comparison between NR40 and TNR40 for information.

In Figure 3, we indicate some noise levels (L_{10}) measured on one of the busiest roads in the City of London, compared to the predicted internal noise level using a curtain walled building facade and Pilkington RW40 glass (10/12/6.4 laminated). The TNR40 curve is also indicated in Figure 3.

It will be seen that the residual noise level touches the TNR curve at 250Hz octave centre frequency. Had there been an incline or traffic lights, the low frequency residual noise level would have been closer to the TNR curve at low frequencies.

The residual noise level indicated in Figure 3 equates to a L_{A10} figure of 47dB. In BS 8233, reference is made to "Designing offices against road traffic noise" (3) a BRE Current Paper. The document suggests that L_{A10} noise levels between 45dB and 55dB are acceptable. For high quality office accommodation, such a wide range of criteria would not be acceptable to either Developers or their subsequent tenants. As we have indicated, the use of a family of curves rather than a single dB(A) value gives much more control over the residual frequency content which has been found to be important with regard to annoyance to tenants.

5. RAILWAY NOISE

There are as far as we are aware, no standards which relate to railway noise intrusion in commercial offices. The survey carried out by Fields and Walker (4) relates to residential property and to the annoyance over a 24 hour period. In an office environment, the criterion is one of speech interference, that is, can a conversation be carried on during a train pass-by, in a satisfactory manner.

The criterion used by most practising acoustic consultants, who have to assess these problems continually, is that the $L_{A}max$ level during a typical train pass-by should not exceed 55dB internally. At such a level, train pass-bys are audible, but have been found to be acceptable and cause little disturbance. In Figure 4, the external and internal levels for a curtain walled building close to the Docklands Light Railway are shown.

In BS 8233, there is no reference to the annoyance caused by train pass-bys, except in relation to residential accommodation where some criteria are discussed.

6. AIRCRAFT NOISE

In the UK, the annoyance caused by aircraft noise has been assessed by the use of the Noise Number Index (NNI). In due course, it is expected that NNI will be replaced by $L_{A}eq$. In a similar manner to that indicated for railway noise above, neither of these criteria is relevant to the problems caused by the aircraft noise in commercial offices.

The problem in offices is essentially one of speech interference and is related to individual aircraft movements.

In order to control such noise sources in commercial premises, therefore, some Local Authorities specify the sound reduction which should exist across the facade of the building. The London Borough of Hillingdon for example, requires a 40dB(A) reduction across the facade during an aircraft take-off. This is incorporated into the Planning Permission requirements.

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Where there is no specific control over such requirements, consultants generally try to limit the peak aircraft noise levels to between 10-15dB(A) above the background sound level. In the example given in section 3 above, this would mean an L_Amax (slow) level during a flyover of between 54-59dB. As an individual practice, Hann Tucker use a maximum of 55dB (L_Amax (slow)) as a criterion.

In Figure 5, a typical aircraft noise spectra incident on a Development is shown, close to Heathrow Airport for take off noise (L_Amax (slow)) and the predicted internal noise level.

In BS 8233, criteria are referred to in terms of NNI related to residential accommodation. A recommendation of what sound insulation will be required versus NNI values is the only information in the document. No specific criterion exists for commercial premises.

7. CONCLUSIONS

In BS 8233, the criteria given for noise levels in offices do not correspond to what is considered good practice within the Commercial Office Development market.

The traffic noise criterion are quoted via a BRE Current Paper. Only the lowest of the suggested noise level range is relevant to the noise which is the maximum, considered acceptable in modern office developments.

There is some correlation in respect of air conditioning background noise levels, but these are specified in a manner which is not consistent with the criterion used by the Development Industry which are based on the CIBSE Design Guide.

There are no criteria in BS 8233 in respect of railway and aircraft noise as they relate to the disturbance caused to occupants of offices during a noise event.

When the British Standard 8233 is revised/amended, it is recommended that consideration be given to including the criteria which are considered "good practice" by the Development Industry. Such criteria are on the whole more strict than those presently included in the document and can only serve to improve the environment within commercial offices.

REFERENCES

(1) BS 8233:1987 British Standard Code of practice for Sound Insulation and noise reduction for buildings.

(2) Chartered Institute of Building Service Engineers (CIBSE) Design Guide - Fifth Edition 1986. Table A1-10, A1-17.

(3) BRE Current Paper CP6/73. Designing offices against road traffic noise 1973.

(4) Fields, J.M. and Walker, J.G. The response to railway noise in residential areas in Great Britain. Journal of Sound and Vibration, 85(2), 177-255.

(5) Parkin P.H. Humphreys H.R. and Cowell J.R. Acoustics, Noise and Buildings. Faber & Faber 1979.

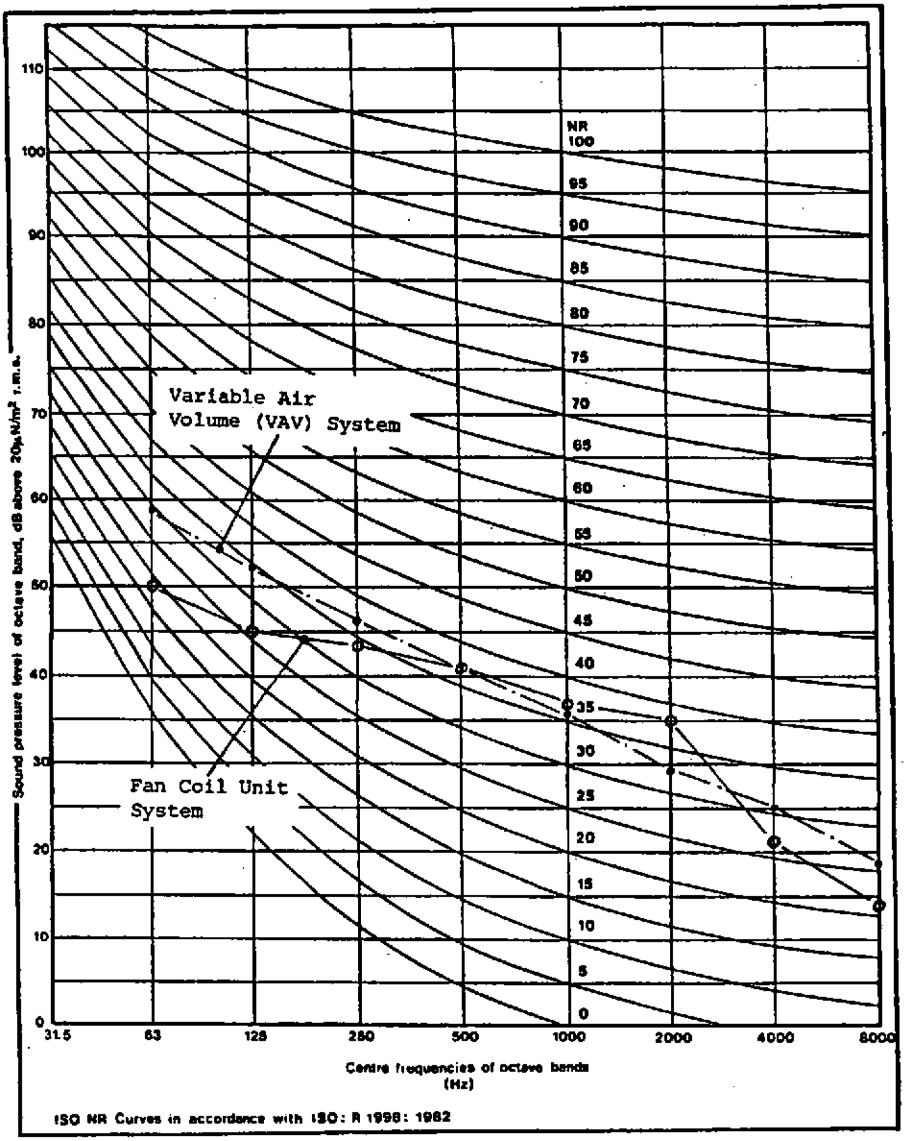

FIG 1 Typical air conditioning noise levels in offices

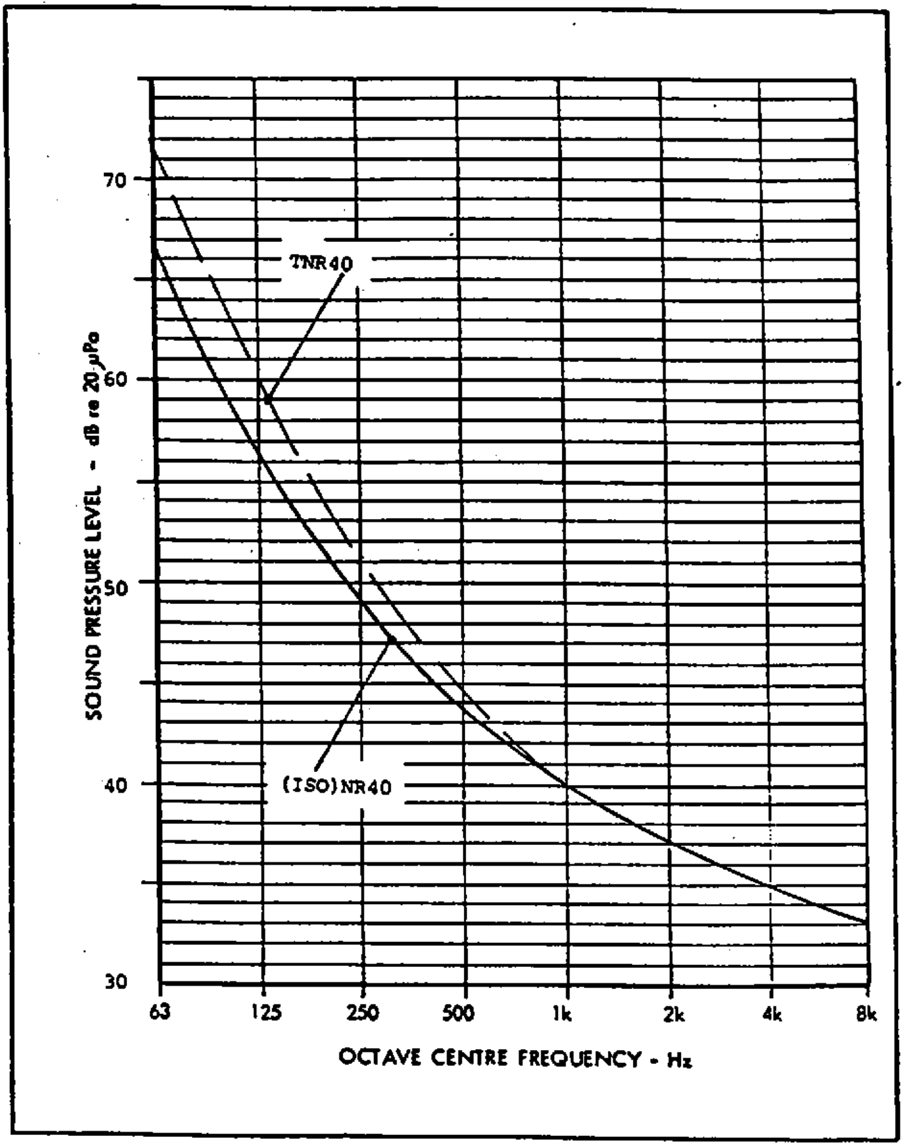

FIG 2 Comparison between (ISO)NR40 & TNR40 (traffic criterion)

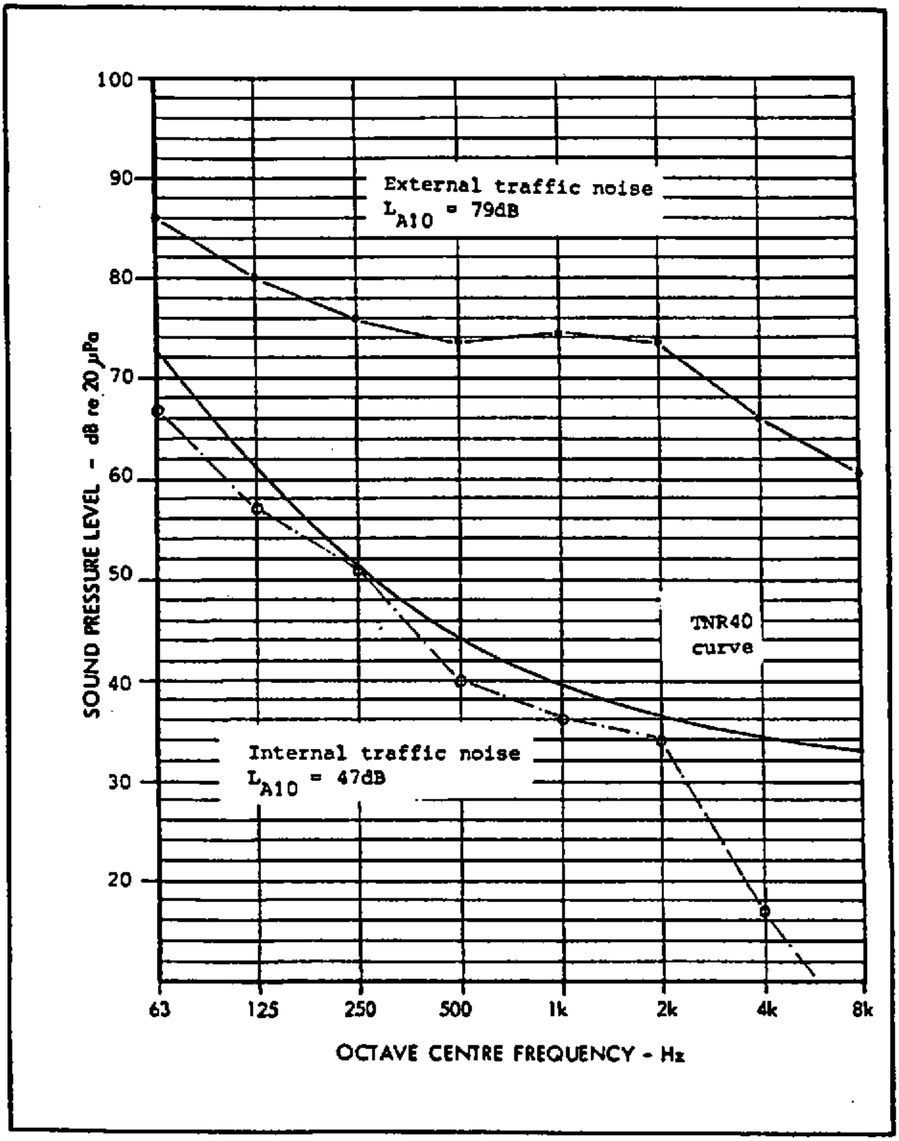

FIG 3 Showing typical traffic noise levels in the City of London and the predicted internal noise level with a Pilkington Rw40 glass, curtain walled building.

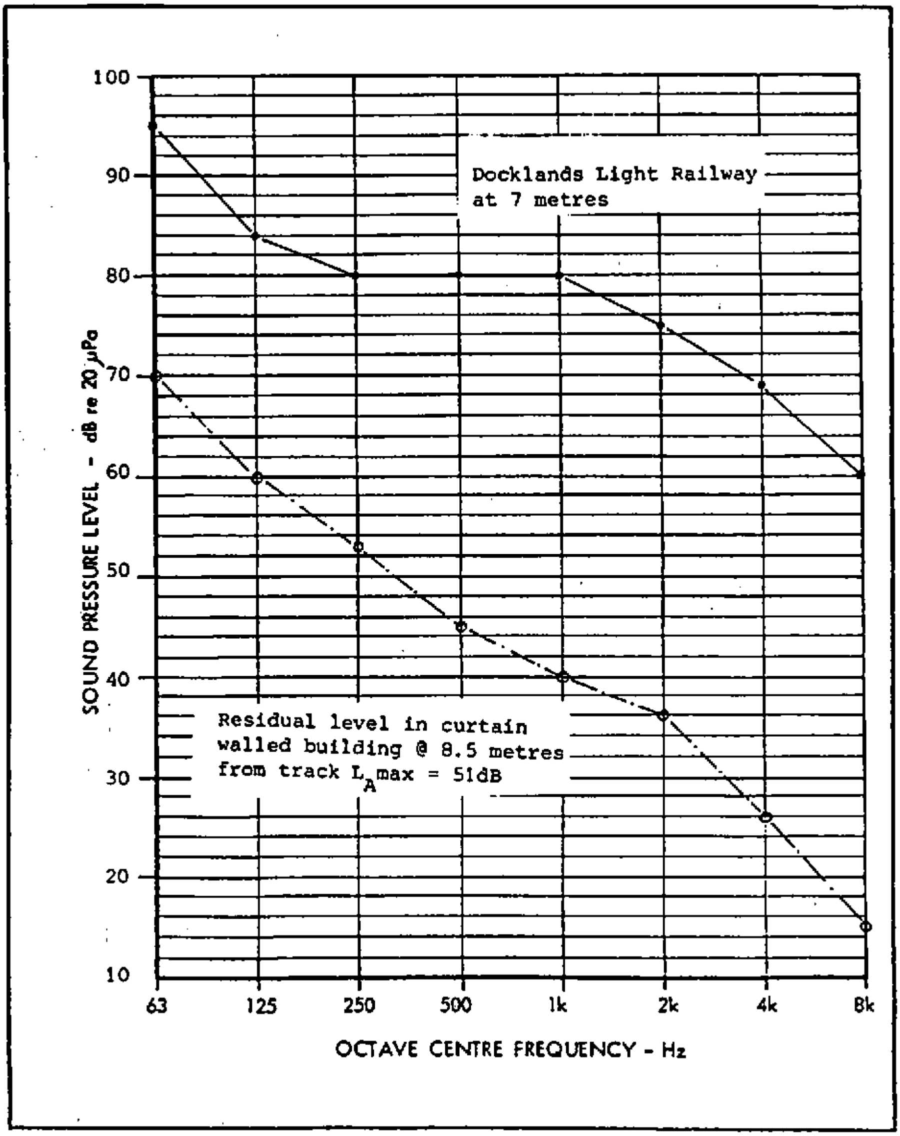

FIG 4 Docklands Light Railway noise on elevated section and residual levels inside adjacent building

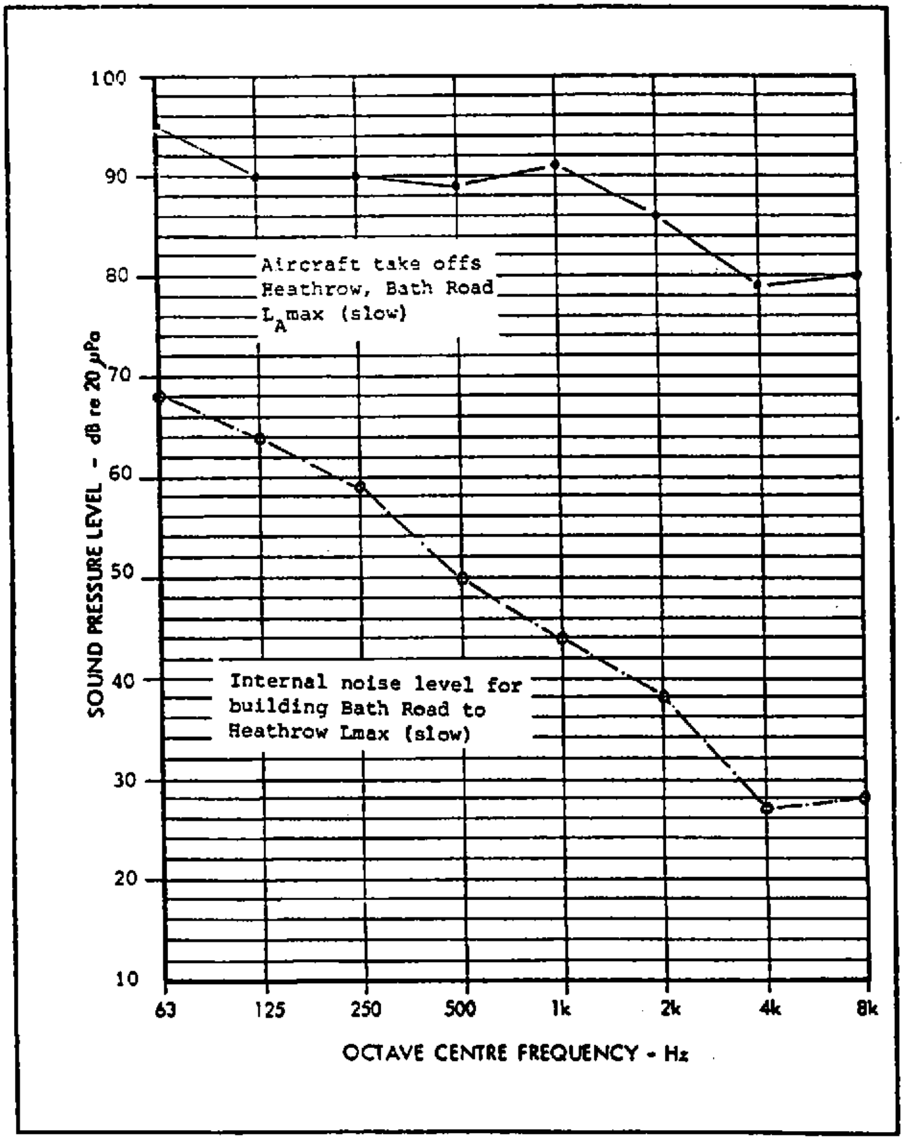

FIG 5 Showing external and internal levels for building of traditional construction close to Heathrow Airport