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NEW STANDARDS FOR THE ACOUSTIC DESIGN OF BBC STUDIOS

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INTRODUCTION

In common with other broadcasting organisations, the BBC has for a long time applied acoustic specifications for noise and sound insulation to the building of studios and control rooms. The previous set of acoustic criteria were originally derived in 1967 and 1968 and although their application since then has been generally satisfactory, recently as the noise performance of other parts of the broadcasting network have been improved, the basic acoustic noise in the recording studio has become more obvious to the discerning listener.

With such problems in mind, the BBC decided to re-examine the basis on which the original criteria were set and to consider whether changes were justified.

BACKGROUND NOISE

Fig. 1 shows the background noise criteria as derived in 1967. The three curves were for different groups of studios and control rooms, with additional criteria (not shown) for other areas. Even at that time they were acknowledged to be a compromise between what would have been ideal and the cost of doing better.

The recent study [1] approached the problem from first principles with a view to finding the signal-to-acoustic noise ratio at the output of different classes of studio. A previous study had made measurements of the peak sound pressure levels in studios for non-amplified sounds, i.e. natural and dramatic speech, together with recital, orchestral and dance band music. For instance, "talks" programmes produced peak sound levels of between 76dB* and 89dB, whilst at the other extreme, dance band music produced levels of 100dB to 115dB. This data provided the "signal" information for the signal-to-noise ratio computations.

The noise side of the equation came directly from the existing background noise criterion for each area, being the noise level that would have existed at the microphone if the acoustic noise had at all frequencies just met the criterion. However, because of the way electrical signal-to-noise ratios are currently measured, the noise level had to be computed according to CCIR Recommendation 468 with its own specific weighting curve. This produced for criterion b, applicable to talks studios, a noise level of 32dB (w.r.t. 20μPa). Further corrections were then applied to allow for the directivity of conventional studio microphones, the use of peak programme meter rather than r.m.s. meter characteristics, the position of the measurement microphone and manual signal compression as normally applied to broadcast programmes.

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* Relative to 20μPa. Linear weighting

The end product was a series of signal-to-acoustic-noise ratios for the different programme classes; for instance, "talks" varied from 36dB4w to 49dB4w* and dance band music from 66dB4w to 88dB4w. These were then checked against programmes as they were being broadcast and, where the broadcast was limited by acoustic noise, the measured signal-to-acoustic-noise ratios fell within the computed ranges.

Comparison of these figures against typical signal-to-noise ratios for other parts of the broadcast chain showed just how poor the acoustic noise could be. Signal-to-acoustic-noise ratios varied as above. Analogue tape noise is typically 48dB4w without noise reduction or 58dB4w with noise reduction. 13-bit PCM produces 59dB4w signal-to-noise, whilst a reasonable VHF FM receiver is capable of better than 50dB4w. Thus the acoustic criteria were not sufficiently good and new criteria (Fig. 2) were recommended.

These were based on experience gained in a few areas which had background noise levels significantly below the old criteria. They were again a compromise between performance and cost, but the incidence of ventilation noise being audible on a broadcast should be significantly reduced.

SOUND INSULATION

Ventilation noise, however, represents a level of masking noise below which other sounds such as interference from adjacent areas are inaudible. Thus the provision of new noise criteria immediately implied that new sound insulation criteria would be essential [2]. This point was demonstrated in the case of one of the BBC's new studios at Manchester. In that particular case a centralised ventilation plant room meant that the distant studios were fed via long duct runs. Thus the achieved ventilation noise levels in Studio 4 were at all frequencies between 10 and 15 dB's below the noise criterion. The level of masking noise on which the previous insulation criteria were based was thus significantly reduced.

If, to illustrate the point, one adds the measured background noise level to the measured sound insulation achieved between Studio 4 and the adjacent drama control room cubicle 3, one gets a characteristic which is the maximum sound pressure level in the source area which will just fail to cause interference in Studio 4. This has been done in Fig. 3, curve (a) where it is plotted together with the sound pressure level probability curves for a drama cubicle. Thus it can be seen that in the 400Hz to 1.4kHz region the drama cubicle will produce audible interference in the talks studio for between 7 and 20% of the time, a situation which was intolerable. Fortunately, it was in this case very easy to improve the insulation and curve (b) shows the characteristic after improvement, where the probability of interference was reduced to zero at all frequencies and in practice, no further complains have been received.

*This is the BBC's form of presentation where the programme peaks to PPM6 whilst noise only peaks to PPM4, allowing 8dB greater headroom for noise peaks. Thus, other forms of presentation for the same signals could well appear numerically to be 8dB higher.

It is also interesting to plot the characteristic which would have been achieved for the same areas if the ventilation had just met the old criterion and the insulation had been as first measured. This is curve (c) and, as can be seen, the probability of interference would have been well under 1% at all frequencies.

The basis on which the new criteria were fixed was that the insulation between two areas should, at all frequencies, be equal to or better than the difference between the source sound pressure levels and the (masking) background noise criterion in the receiving room.

Areas were categorised into sixteen studio/control room groups and fourteen other areas. Using the appropriate new noise criterion and data on source sound pressure levels, the required sound insulation characteristic was computed for all 900 combinations. These characteristics had then to be reduced to a more manageable quantity of data.

Measurements and experience have indicated that different forms of partition produce idealised insulation curves of a particular slope:- a) Single leaf walls - 5dB/octave, b) Double leaf, small cavity - 8dB/octave, c) Double leaf, cavity greater than 300mm - 10dB/octave, d) Triple leaf - 15dB/octave. Against each curve of sound insulation were drawn four straight lines with the above slopes, together with a horizontal line indicating the maximum insulation. Thus, each curve could be reduced to a group of five numbers being:- a) The insulation at 63Hz, D_{63}, b) The level at which the 15 and 10 dB/octave lines intersect, $D_{15,10}$, c) The level at which the 10 and 8 dB/octave lines intersect, $D_{10,8}$, d) The level at which the 8 and 5 dB/octave lines intersect, $D_{8,5}$, e) The level at which the 5 and 0 dB/octave lines intersect, $D_{5,0}$. As a check, a sixth figure is included being the frequency, f_o, at which the 5 and 0 dB/octave lines intersect. Thus the new insulation criteria were reduced to a table as shown in part in Fig. 4.

CONCLUSIONS

New criteria have been derived for background noise and sound insulation in new broadcasting studio centres. They should not be considered to provide acoustically perfect conditions, but represent a manageable compromise between technical performance and building costs. Wherever possible the BBC intends to apply these criteria in the future.

REFERENCES

1. Meares, D.J. & Lansdowne, K.F.L. 1980 Revised background noise criteria for broadcasting studios. BBC Research Department Report No. 1980/8.

2. Walker, R. 1981 Revision of the sound insulation requirements in broadcasting studio centres. BBC Research Department Report No. 1981/1.

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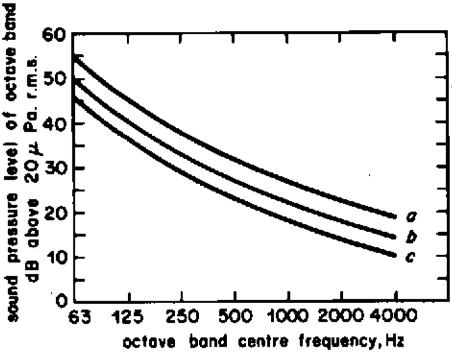

Fig. 1.- Original BBC criteria for permissible background noise in studios, from all sources (octave bands)

(a) Sound studios for light entertainment

(b) Sound studios (except drama). All television studios

(c) Sound drama studios

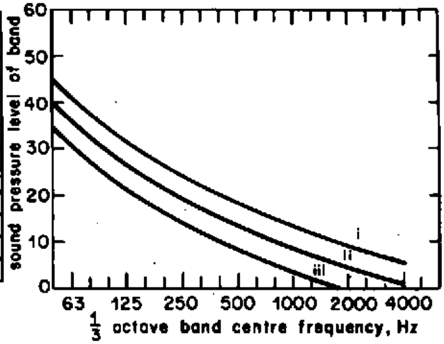

Fig. 2.- Revised BBC noise criteria Maximum tolerable background noise in studios from ventilation

(i) Radio — other than classes (ii) and (iii)

(ii) Radio — talks, continuity, recital. Television all categories

(iii) Radio — drama

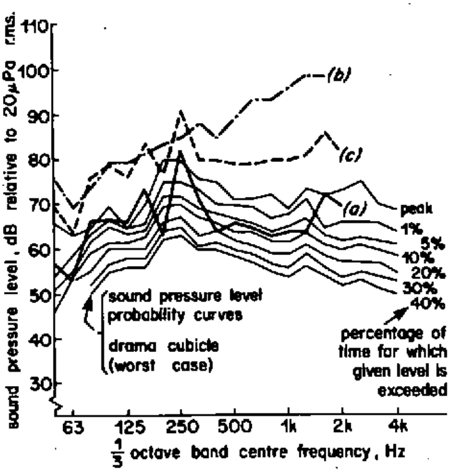

Fig. 3.- Interference probability levels, Manchester Cubicle 3 and Studio 4

(a) as constructed (b) after improvement in sound insulation

(c) as constructed, if the studio background noise level had been equal to the criterion

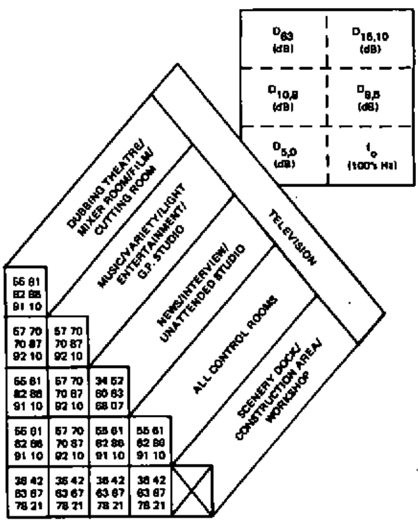

Fig. 4. - Sound insulation criteria