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A STUDY OF LOW FREQUENCY SOUND FROM POP CONCERTS

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1. INTRODUCTION

In 1976, the GLC published a Code of Practice for Pop Concerts[1] which provided one of the first authoritative guidelines for assessing noise from pop concerts for both environmental and hearing hazard aspects. Over the past seventeen years the guidelines have developed[2][3] with significant focus in recent years with the publication of the Health & Safety Executive's draft guide for the health, safety and welfare at concerts[4] and the Noise Council's draft code of practice for pop concerts[5].

Historically, the environmental guidelines have been developed on indices based on the 'A' weighting scale as it has been shown[2] that the level of complaints correlated with the increase of the 'A' weighted sound pressure level over the pre-existing background level. The latest Noise Council document has developed this concept from more recent studies[3], presenting maximum acceptable impact bands as a function of the number of events per year at a particular venue.

With the growing development of sound systems able to generate high levels of low frequency sound (a requirement of many artistes), the Noise Council working party recognised the problems of 'A' weighting the signal and hence reducing the sensitivity of the meter to assess low frequency sound. As recognised in 1988[6], little research has been carried out on the potential low frequency noise problems at concerts, and it was felt inappropriate to give objective guidance until further studies were completed, although the draft code does highlight the potential 'underestimate'.

To assist in the development of objective guidelines, this paper presents the results of a study of low frequency sound made during pop concerts at Wembley Stadium. The studies were made during several shows involving the band 'U2' who are well known for generating high levels of low frequency sound and indeed provoked complaints due to the low frequency 'bass beat'. Comparisons are also made with concerts involving the

artiste 'Madonna' where very few complaints of low frequency noise were reported.

2. FREQUENCY SPECTRA INSIDE THE STADIUM

Real time octave band measurements were made inside the Stadium during both the U2 and Madonna shows at the mixer position some 35 metres from the stage. Typical frequency spectra are shown in Figure 1. As the graphs show, the main sound energy occurs in the 31.5Hz to 125Hz octave frequency bands which is typical for pop concerts[7]. The results demonstrate the higher sound pressure levels generated by U2 at low frequencies. The octave band sound levels for U2 at low to mid frequencies were some 5 to 9dB higher than those recorded during the Madonna show apart from at 31.5Hz where the results were similar.

3. ASSESSMENT OF LOW FREQUENCY NOISE

Given that complaints due to low frequency were mainly due to the U2 shows with very few complaints during the Madonna concert, a comparison of the objective data has been made between the two concerts. It should be noted that although there was a significant difference in the level of complaints between the shows, the 'A' weighted environmental limits (increase of the concert level over the pre-existing background noise) as agreed and set by the local authority, were met throughout all the shows.

The comparisons have been made at distances in excess of 2Km from the venue as at Wembley Stadium, and probably other outdoor venues, complaints of low frequency noise generally occur from this distance and beyond. This is likely to be due to the increased attenuation due to air absorption etc. at high frequencies as compared with low frequency.

Complaints from long distances are also due to peoples' expectations. For example from discussions with complainants at various distances from the venue, it is clear that the perception of people living some distance from the Stadium is that they do not expect to hear any noise, while people living nearby are not surprised to hear the event.

4. SOUND LEVELS AT DISTANCES GREATER THAN 2KM FROM THE VENUE

Simultaneous real time octave band measurements (31.hz to 8KHz) were made both inside and outside the venue. Studies are continuing with regard to attenuation rates with frequency and distance. Typical frequency spectra for U2 and Madonna are shown in Figure 2 for measurements made at a distance of 3Km from the venue. For the U2 concert at this location, the bass was judged to be clearly audible with the mid to high range being just audible. For the Madonna event only the bass was just audible.

Both spectra show high levels of low frequency energy as a result of the concert particularly in the 63Hz and 125Hz octave bands. However, the difference between the two shows is significant with octave band sound pressure levels exceeding 80dB for U2, whilst the Madonna show only just exceeded 60dB in the 63Hz octave band. These spectra were typical of those recorded in excess of 2Km from the Stadium and give an indication of how the range in levels correlate with the range in the subjective community response.

A guideline based on linear or 'C' weighted level minus the 'A' weighted level has been suggested as being appropriate to assessing low frequency noise. The results in figure 2 however show the change in Lin-A to be similar for both concerts thus this assessment appears to be insensitive in this situation given the significant difference in subjective response between the two events.

Other suggestions[2] have been made to assess the impact of low frequency noise by the change in octave band sound pressure levels for the 'with' and 'without' concert situation. Figure 3 demonstrates this assessment for both concerts. The results show the significant increase over the background sound levels (around 20dB) in the 63Hz and 125Hz octave bands during U2, with only marginal increases (4dB) during Madonna. As would be expected, this objective assessment is sensitive to the subjective response.

5. CONCLUSIONS

Further work is continuing with the data recorded during these events to progress guidelines for assessing low frequency noise from open air pop concerts. Our interim findings are as follows:

i. At open air venues, the increase over background 'A' weighted criterion works well at minimising complaints near to the venue.

ii. The 'A' weighted criterion can underestimate annoyance at greater distances from the venue (in excess of 2Km) as the mid to high frequency energy is quickly attenuated with respect to low frequency and the expectation of people living some distance from the event being that the concert should be inaudible.

iii. Sound pressure levels in excess of 80dB in the 63Hz or 125Hz octave bands recorded in excess of 2Km from the concert, are likely to give rise to complaints of low frequency noise. Levels below 70dB are likely to be acceptable.

iv. Increases over the background sound level in the 63Hz and 125Hz octave bands of the order of 20dB are likely to give rise to complaints of low frequency sound whereas changes below 5dB are likely to be acceptable. A change of the order of 10dB in the relevant octave bands as discussed in an earlier study[2] may well provide reasonable protection for the community whilst not unduly restricting the entertainment value of the event.

6. ACKNOWLEDGEMENTS

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7. REFERENCES

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Figure 1 - Octave Band Frequency Spectra inside the Stadium

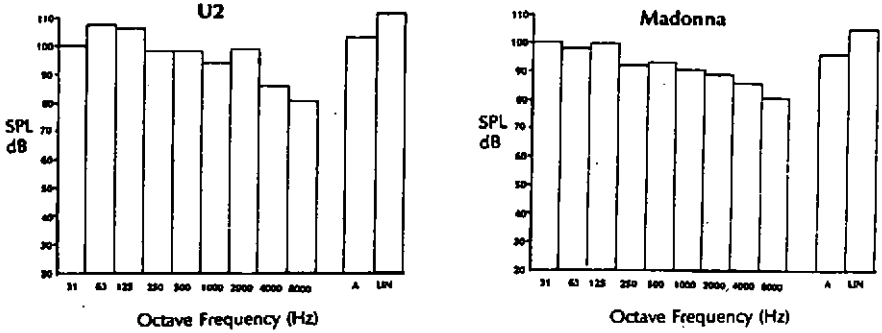

Figure 2 - Octave Band Frequency Spectra outside the Stadium (3KM)

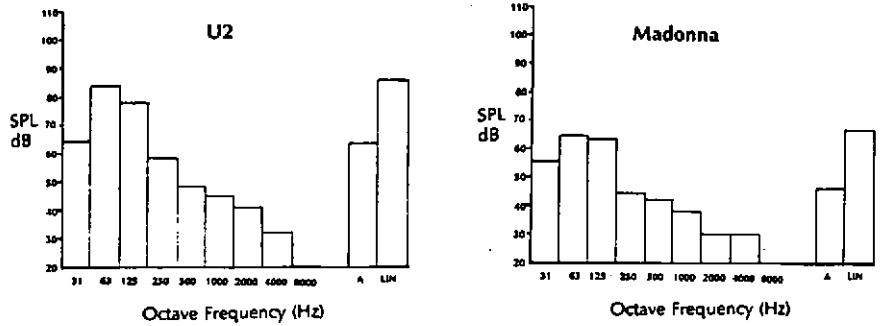

Figure 3 - Impact of Concert over the Background Level