LOW FREQUENCY SOUND AT OUTDOOR CONCERTS – A NECESSARY NOISE.

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1 INTRODUCTION

The A-weighted decibel provides a reasonable approximation of the loudness of many environmental noises e.g. for transportation, commercial and industrial sources, but can underestimate the impact of sounds with substantial low frequency content such as the “bass” and “sub-bass” content of “modern popular music” played at outdoor concerts and music festivals.

The low frequency content is necessary for effective entertainment because, for example, it contributes to the sensation of loudness and provides the intangible, but vital impetus to dance/move rhythmically i.e. the “groove”[1, 2 & 3]. However, excessive low frequency “bass thump” beyond the venue can provoke adverse community responses.

The existing guidance on low frequency noise from concerts is limited in the range of frequencies covered and the advice provided is ambiguous which can be applied in an unduly onerous manner.

Vanguardia have for some time been recommending that the C-weighted Music Noise Levels (MNLs) are also considered as these can be more reactive to the low frequency content than A-weighted. This paper includes analysis of data where C-weighted MNLs are linked to community response and examines how these can be used to provide a cap on the low frequency impacts offsite, whilst permitting sufficient low frequency content and flexibility for the sound engineers so that the sound quality and entertainment/cultural impact of the event is not unduly compromised. The paper concludes with recommendations of guideline C-weighted MNLs both in terms of the differential in relation to equivalent A-weighted values and the overall absolute noise level.

2 LOW FREQUENCY CONTENT OF “MODERN POPULAR BEAT MUSIC”

2.1 “The Groove”

As noted above, low frequency sound has been a critical component of popular music since at least the early days of Jazz around the start of the 20th Century. Modern music trends[4] facilitated by advances in music technology, amplification, and loudspeaker design and construction mean that the very lowest “sub-bass” frequencies generated in recording studios by specialist “monitor” type equipment, which previously was unsuitable for touring or use outdoors, can now be economically and efficiently reproduced by acts with a touring PA and at outdoor events using equipment able to withstand the rigours of a “rock and roll” lifestyle.

Low frequency sound in modern popular music is normally associated with the repeated beats and rhythms of drums and bass guitars and the synthesized sounds from electronic instruments and other sources. Frequency analysis normally shows that energy is often greatest in the some of the low frequencies in the range from 31.5 Hz to 160 Hz 1/3 octave, with peak energy in different bands depending on the music genre and even the individual tune playing. The table and figure below provides representative typical source frequency profiles of several types of modern popular music.

Genre	LAeq dB	LCeq dB	LC-LA dB	31.5Hz 1/1 Oct dBZ	63Hz 1/1 Oct dBZ	125Hz 1/1 Oct dBZ	250Hz 1/1 Oct dBZ	500Hz 1/1 Oct dBZ	1KHz 1/1 Oct dBZ	2KHz 1/1 Oct dBZ	4KHz 1/1 Oct dBZ	8KHz 1/1 Oct dBZ
Pop	98	110	12	108	108	98	95	95	94	90	84	81
Alt & Rock	98	110	12	99	109	100	97	97	92	88	84	78
Urban	98	114	16	109	113	98	96	94	94	90	86	84
Dance	98	116	18	111	116	101	96	94	93	89	85	83

Table 1: Representative typical 1/1 octave band spectra (dBZ) for types of popular music normalised to 98 dBA.

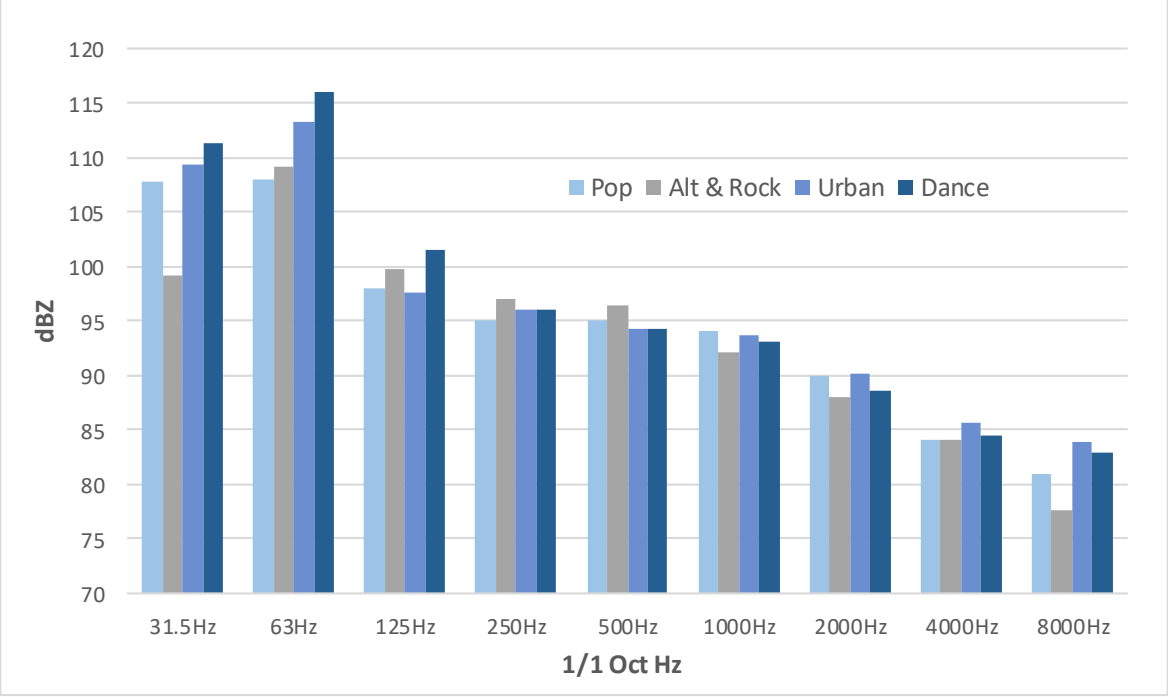

Figure 1: Representative typical 1/1 octave band spectra (dBZ) for types of popular music normalised to 98 dBA.

2.2 The Issue

The low frequency content of music noise from outdoor concerts is often the most common issue raised by complainants. This is due to factors including:

- Low frequency noise propagates more efficiently than mid to high frequency sounds.
- Low frequency noise penetrates buildings more readily than mid to high frequency sounds.

- The impulsive beat of low frequency "bass thump" can add to the adverse response compared to steady sounds of the same level[5].

The current code of practice[6] does not offer formal guidelines for low frequency concert noise at receptors beyond the event boundary. Instead, it notes that receptor levels in the 63 Hz and 125 Hz 1/1 Octave bands between 70 dB and 80 dB are generally satisfactory. This can create tension between the regulators and the event as the regulators can prefer 70 dB and the events favour 80 dB. Although the code omits this important detail, the levels in the study on which the note in the code is based were measured at a distance of 2 Km from concerts at Wembley stadium. So, if these values are used, they should apply at 2 Km from a venue[6A]. Clearly higher levels occurred at noise sensitive receptor locations closer than 2 Km to Wembley stadium during the study.

Another issue is that the comments in the code only cover sound in the 63 Hz and 125 Hz Octave bands. As the figure and table above show there is nowadays significant energy in the 31.5 Hz 1/1 octave band. Paradoxically, this means that rigid application of the comments in the Code of Practice could drive sound engineers to increase levels in the very lowest sub-bass frequencies to compensate for being unduly restricted at 63 Hz and 125 Hz 1/1 Octave bands, as there would be no such limits below 44 Hz (the lower limit of the 63 Hz 1/1 Octave Band).

In the last 10 years Vanguardia have, at first on an informal basis and more recently as part of licence conditions, used C weighting in conjunction with A-weighted measurements to control respectively low frequency and overall levels of noise from outdoor concerts. On an empirical basis it has been found that restricting C-weighted levels to no more than 20 decibels above the equivalent A-weighted value with an upper limit of 90 dB LCeq,T at the nearest sensitive receptors normally avoids excessive complaints, although as discussed in the next section of this paper a degree of complaint is inevitable whatever the control threshold selected.

3 COMPLAINTS AS INDICATORS OF IMPACT

Defra sponsored report research into attitudes to environmental noise from concerts[7] reports that:

- *"Whilst 9% of all respondents were fairly or very annoyed by the music noise, it should be noted that only 1% of residents actually complained about the noise disturbance.*

- *"The most common reasons for not making a complaint were that they "had nothing to complain about" (53%) or "event did not have sufficient impact to complain "(33%). This finding is similar to many other areas of impact where simply being annoyed does not necessarily trigger a complaint."*

- *"It also appears that a significant percentage of the population will form an opinion on the music's subjective annoyance irrespective of the actual level of music."*

Consequently, the number of complaints as an indicator of impact can be mis-leading.

Local Authority complaint statistics[8] invariably show that the substantial majority of noise complaints they receive are not evaluated as legal nuisances.

Furthermore, experience of 100s of outdoor concerts shows:

- There is a weak correlation between physical acoustic measures and the propensity to complain e.g. similar levels of the same music noise provoke wide variation in the numbers of complaints from equally affected but different areas; and complaints are often made at different locations with widely varying music noise levels.

- The number of complaints is usually a fraction of a percent of the large number of local residents invited to contact a dedicated telephone "hotline" or email address publicised by direct mailshot to 1000s of households and on community facing web sites.

- It is not unusual for proportionately more complaints to be made at the lower levels further from the festival than at the higher values closer to the event.

- Perception of sound, mis-conceptions of how sound propagates and attitudes to the event/venue/artistes/audience appear to be strong triggers for complaint in many cases rather than any public or statutory nuisance as defined by law.

- Complaints regarding noise are often linked to other elements e.g.

  - Access to free/discounted tickets.
  - Traffic management, parking and litter.
  - Perceptions of festival goers and their behaviour.
  - Opinions on festival organisers motivations.
  - Opinions on use of public spaces for events.
  - Perceptions on damage to public spaces and facilities.
  - A dislike of the music played.
  - No or low cultural or social value of the event to the complainant.
  - Dislike of the music played/preference of other music types.
  - Antipathy towards regulatory authorities' and their decision making.
  - Expectation of control over the conditions in a locality.
  - Local adverse publicity and/or campaigns against the events.
  - Social media post encouraging complaint.

The above indicates that although complaints may reflect the response of suitably motivated individuals, they are a weak indicator of wider community noise impacts, as they can be biased by highly variable personal subjective non-acoustic factors and external drivers unrelated to noise, and therefore over-estimate the magnitude of impact.

However, in the absence of a detailed social survey which can accommodate the evaluation of non-acoustic factors, checks against personal and methodological biases, and consistent with the study underpinning the existing code of practice. The next section of this papers presents a case study which examines complaint numbers against C-weighted Music Noise Levels measured at the nearest noise sensitive receptors from a case study of an event held over two consecutive three day weekends in successive years.

4 CASE STUDY

The charts below show the free-field A and C-weighted off-site MNLs measured at the nearest sensitive receptor against the equivalent noise level measured at the Front of House (FOH) location

onsite. The plotted graph is then coloured to highlight an instance where a number of complaints has been reported in that measurement interval (15 minutes). This data is from an event with multiple stages and a capacity of 40,000 persons held in a major UK city over two consecutive 3 day weekends in 2022 and again in 2023 i.e. 6 days in total.

Figure 2: A-weighted off site levels vs number of complaints for a music festival held in a major UK city over two consecutive 3 day weekends in 2022.

Figure 3: A-weighted off site levels vs number of complaints for a music festival held in a major UK city over two consecutive 3 day weekends in 2023.

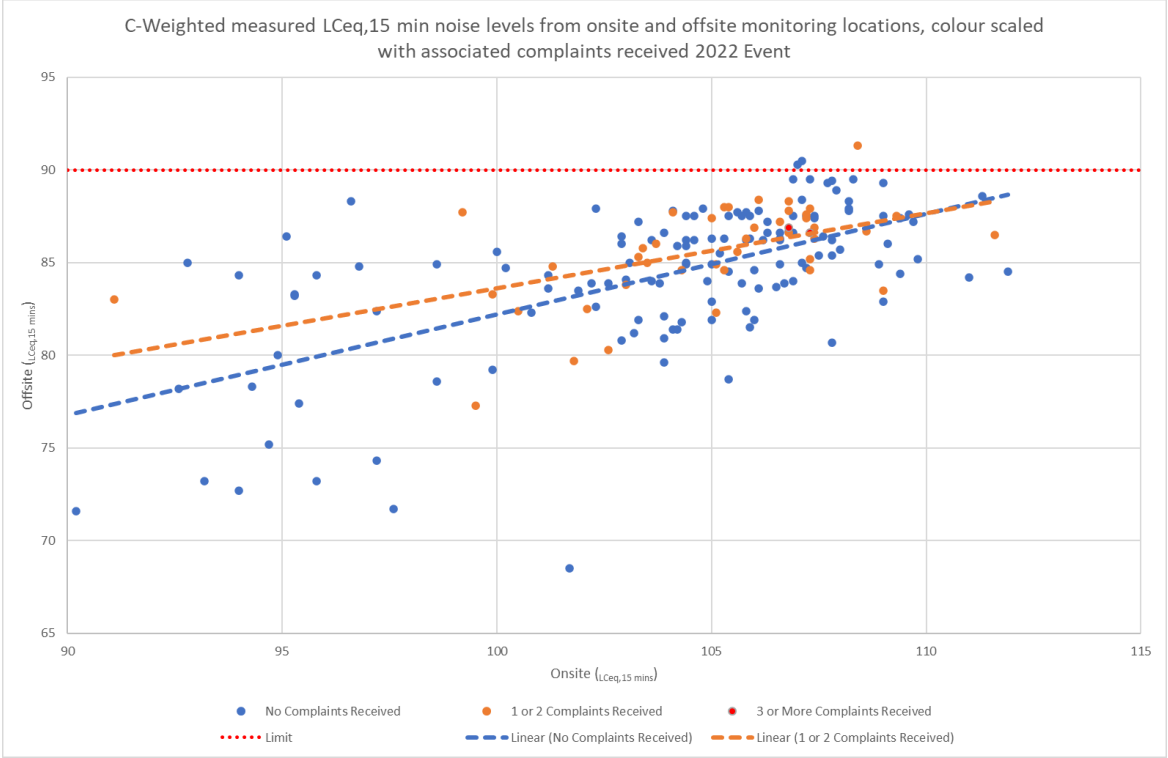

Figure 4: C-weighted off site levels vs number of complaints for a music festival held in a major UK city over two consecutive 3 day weekends in 2022.

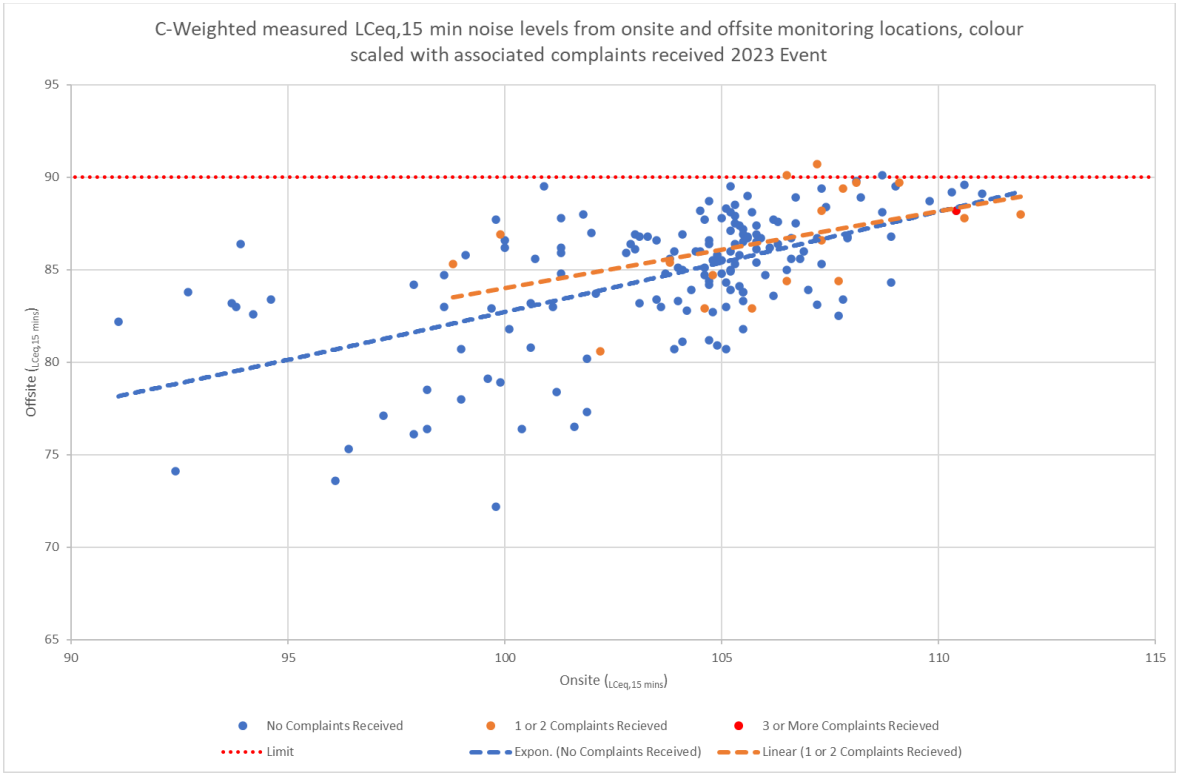

Figure 5: C-weighted off site levels vs number of complaints for a music festival held in a major UK city over two consecutive 3 day weekends in 2023.

5 DISCUSSION

The charts above show that, as is normal and as indicated by the Defra sponsored study[7], complaints can be made no matter the MNLs experienced by the complainant.

However, there is a trend in the data for an increase in complaints where the MNLs are in the range 85 to 90 dBC. Because complaints are a weak indicator of community impact, using the higher end of the range i.e. 90 dBC Leq,15 min as a control threshold is considered to better reflect community response.

Furthermore, as indicated in the charts above, Vanguardia have also found that managing music noise levels so that the difference between the simultaneously measured A - weighted and C - weighted levels is no more than 20 decibels is an effective way of controlling the impact of bass and sub-bass noise, subject to a lower limit of around 65 dBC and an upper limit of 90 dBC.

6 CONCLUSIONS

Low frequency music sound i.e. “bass” and “sub-bass” has been a vital component of modern music for many decades and is featured to a greater or lesser extent depending on the type and genre of music. Consequently, removing or over-managing the low frequency content of music renders it ineffective as entertainment.

Low frequency sound is made up of sound energy at longer wavelengths. These wavelengths are attenuated to a lesser extent by barriers, terrain, ground effects and air absorption compared to mid and high frequency sound. Consequently, low frequency sound can travel further from the source than other components of the music.

Although A-weighted measurements include the low frequency content of music to a degree, a better means of allowing effective entertainment but providing a cap on “bass” and “sub-bass” noise for those affected off-site is to use the C-weighted decibel which is more sensitive to low frequency noise.

Consequently, it is proposed that as well as an A-weighted limit, an additional C-weighted limit of X dBA+20 dB subject to a lower limit of around 65 dBC and an upper limit of 90 dBC under free-field conditions at noise sensitive premises beyond the site boundary, avoids significant adverse effects of low frequency noise from outdoor concerts in most circumstances.

The above proposal has been tested at multiple events over the last 10 years and found to be effective.

7 LIMITATIONS

The above conclusions are subject to the following limitations:

- Concentration of energy in the 31.5 Hz and 40 Hz 1/3 octave band, i.e. peak or near peak levels in these frequency bands, can result in a greater risk of secondary effects of low frequency noise induced resonance in lightweight building elements such as windows and doors which can rattle or shake. Damage is unlikely as the induced vibration levels are well below guidelines for such effects, but the subjective adverse response can be significantly

increased. This can be mitigated by reducing levels in these 1/3 octaves or reducing the overall C weighted level to no more than 85 dBC.

- As distance and/or screening from an event increases, the attenuation of sound at low frequencies tends to be less than for mid to high frequencies. This can lead to the differential between A and C weighting becoming more than 20 dB. On the face of it this indicates a low frequency problem, but in practice this normally occurs when the A and C-weighted levels are relatively low due to distance or screening and given the limited duration and occurrence of these types of events, the impacts are typically minor. Furthermore, when this happens it is common that both the A and C-weighted levels are controlled by the low frequency content of the sound and are therefore highly correlated so that even if the low frequency content is reduced, the A and C-weighted levels change by the same degree and the difference between them stays constant. Subsequently, a lower limit of 65 dBC to the application of the A-C differential of 20 dB is recommended.

8 REFERENCES

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