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Music venue noise: a development planning case-study examining the application of the 'Agent Of Change' principle, a novel legal mechanism, and noise control design issues

Lotinga, Michael J B[1]
WSP, Bristol, UK

Lewis, Toby[2]
WSP, Cambridge, UK

Taylor, Tim[3]
Foot Anstey, Exeter, UK

ABSTRACT

'Grassroots' music venues play an important role in supporting a rich cultural mix of musical entertainment, which provide community benefits in terms of leisure and wellbeing. However, music events can disturb neighbours and prompt complaints, which may lead to consequences for licensees, and the closure of venues.

Recent changes to development planning rights in the UK resulted in residential encroachment on land previously used for other purposes. In some cases, this created problems for music venues nearby, with new residents moving into the area. The reaction from the industry prompted the Government to amend those development rights and, more recently, to incorporate the 'Agent of Change' (AoC) principle into planning policy. Whilst incorporation of AoC was intended to reinforce protection for established venues, the policy itself may fail to provide this in practice.

The implementation of the AoC principle has been explored in a recent case-study involving a celebrated grassroots venue. This paper summarises (i) the background and relevant planning issues, (ii) a novel legal mechanism used to enhance the protection of the venue from future action taken by new residents, and (iii) acoustical design and mitigation issues raised during the study, including evaluation of relevant international criteria.

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1. INTRODUCTION

The UK music industry is estimated to contribute £4.5bn to the economy annually, of which nearly a quarter is now generated by live music [1]. 'Grassroots music venues' (GMVs, as defined by their cultural and social role, as well as specific commercial and operational approaches [2]), provide a crucial platform for new and emerging talent, yet many have found themselves struggling under the

[1] michael.lotinga@wsp.com
[2] toby.lewis@wsp.com
[3] tim.taylor@footanstey.com

threat of closure in recent years – in London, it was shown that 35% of the city's GMVs had closed between 2007 and 2015 [3]. In response, an investigation was launched and a Rescue Plan drawn up, highlighting the key factors critical to slowing the further decline in the industy. One of the main threats identified was the development planning and licensing framework, alongside the enforcement of environmental protection legislation; this left some established venues facing noise abatement action due to complaints about noise from people moving into new residences constructed nearby.

In reaction to this threat, a campaign was launched by UK GMVs, represented by the Music Venue Trust (MVT), for full recognition within the planning system of the so-called 'Agent of Change' (AoC) principle. Essentially, the AoC principle attaches responsiblity for the costs of a change in the *status quo* to the party that is responsible for proposing the change. As far as existing venues are concerned, that means, 'if you bring new residents near to us, you will have to pay for their protection from the noise we make as part of our business'.

There are no definitive noise criteria applicable to entertainment noise in the UK. The primary applicable objectives set out in the UK Government's 2018/19 National Planning Policy Framework (NPPF) [4] [5] are to avoid "*significant adverse effects*", to minimise "*other adverse effects*", and to ensure that "*existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established*". Where it is recognised that the operation of an existing music venue could have a 'significant adverse effect' on proposed noise sensitive development, the AoC principle applies and "*the applicant (or Agent of Change) should be required to provide suitable mitigation before the development has been completed*" [4].

2. BACKGROUND

2.1 Agent of Change principle – application to noise

In relation to venue noise, the AoC principle has steadily gained political traction since appearing in Australian planning policy in 2014 [6] [7] [8]. In the UK, the 2012 NPPF recognised that existing businesses should not be 'unreasonably' restricted due to nearby land use changes, but stopped short of stipulating how such restrictions should be prevented, or of mentioning the AoC application to noise [9]; this was only introduced in the 2018 revision.

2.2 Music venue perspective

The MVT is a charity which aims to protect and improve GMVs in the UK. It was founded in 2014 following concerns about music venues being threatened by the conversion of nearby offices to flats, and subsequent noise complaints from the residents. These conversions were permitted by the General Permitted Development Order (GPDO) 2013 [10], which had been intended to stimulate development, but had failed to provide any protections for existing noise-generating commercial premises against the risk posed by encroachment of new, noise-sensitive residential developments in their vicinity.

The MVT campaign that followed led to the inclusion of commercial noise as a consideration in the GPDO 2016 [11] and resulted in an AoC Bill being read, unopposed, in the UK Parliament (John Spellar's Private Members Bill, January 2018). It was against this backdrop that the UK Government consulted on the proposed wording of the revised NPPF in 2018.

It became clear during the revised NPPF consultation that there was uncertainty about what threshold should be adopted as a trigger for noise mitigation by the AoC principle. The consultation draft referred to the potential for "*effects that could be deemed a statutory nuisance in the light of the new development*" [12] rather than 'significant adverse effects', but the use of statutory nuisance in this context was considered to be inappropriate by consultees [13].

The determination of a statutory nuisance in the UK involves a complex balancing of rights, based on evidence and a range of common law precedents. Speculative statutory nuisance assessments as part of a planning application or determination would not have been practicable or, indeed, possible in many cases, which made its inclusion in the AoC planning policy irrational. Unfortunately, it is this same nuisance law that is often applied in the investigation of noise complaints once encroaching residential developments have been occupied, and which fundamentally disregards the principle of AoC in its legal enforcement.

There are a number of options open to residents who wish to complaint about noise from a venue. These include the right to:

1. Complain to the local planning authority (LPA) that the noise is causing them a statutory nuisance;
2. Seek a nuisance abatement order from the Magistrate's Court;
3. Take private nuisance proceedings;
4. Seek a licence review on the grounds that the venue is causing a public nuisance;
5. Complain to the LPA that licence conditions are being contravened; and
6. Complain to the police that the noise amounts to anti-social behaviour.

Any of these actions could potentially result in the enforced curtailment of activities at a venue where the potential noise impacts were considered to fall below that of 'significant adverse effect' at the planning stage and where the residential developer was therefore not obliged to incorporate any mitigation according to the NPPF AoC policy.

2.3 Planning Context

Unfortunately, the lack of any definitive metric defining which might constitute a 'significant adverse effect' for entertainment noise, and a general paucity of guidance on the subject, leads to uncertainty for operators, assessors and decision makers in determining when the AoC principle might apply. The UK Govt's noise Planning Practice Guidance [14], sets out an example outcome describing a significant adverse effect as follows:

"*The noise causes a material change in behaviour and/or attitude, eg avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed for most of the time because of the noise. Potential for sleep disturbance resulting in difficulty getting to sleep, premature awakening and difficulty getting back to sleep. Quality of life diminished due to change in acoustic character of the area*"

In the absence of objective criteria, it is to this description that some turn to consider whether or not a significant adverse effect is anticipated. In the event that an impact may be of a lesser magnitude, there is arguably no policy justification for refusing a proposed residential encroachment nor any obligation for the developer (or AoC) to provide any mitigation. Under these circumstances, the introduction of unprotected residential receptors adjacent to or adjoining, entertainment venues may be permitted, to the detriment of the venue operators.

Continuing cases of impending GMV closures due to complaints associated with the encroachment of residential developments (such as the Star Inn, Guildford

[15]), demonstrate that there remains a need to augment the planning policies with effective legal measures, which will reduce the risk of further venue closures caused by new residential development.

3. DEED OF EASEMENT

It is important to understand the legal context in which these issues are played out. Like all noise-generating properties, there is a risk that noise generated from a loud venue might amount to a legal nuisance. If a nuisance is shown to exist, the party generating that noise can be legally required to reduce the noise to a level which does not constitute a nuisance.

In the UK, there are two basic types of legal nuisance - common law and statutory - both of which consist of private nuisance and public nuisance.

No person may lawfully commit a statutory nuisance, and there are powers available to local authorities for enforcing breaches of the statutory provisions, such as a positive obligation for local authorities to investigate complaints and to serve notices where it is satisfied that a nuisance exists. The relevant statutory nuisances are those prescribed in the Environmental Protection Act 1990 (EPA) [16] and the Noise Act 1996 [17].

The assessment of whether nuisance has been caused will include subjective elements, such as the character of the neighbourhood, the activities permitted under a planning permission, the conflicting interests of adjoining owners and occupiers etc.

Unlike the EPA, the Noise Act prescribes an objective standard for permitted levels of noise affecting residential occupiers at night. If a complaint is made, the Council can investigate whether the levels have been exceeded, having regard to the levels specified in the prevailing regulations.

In contrast to the statutory nuisance provisions, common law nuisance is a tort, ie a wrongful act or an infringement of a non-contractual right, leading to legal liability for that wrongful act. It is often caused by someone doing something on their own land which they are entitled to do but which becomes a nuisance when it adversely affects their neighbours' enjoyment of their land. The nuisance is usually ongoing or repeated. It can be committed by using a property in a way which produces audible noise, such as in the case of music venues, that unacceptably disturbs the property of another person. An action in common law (private) nuisance is an action brought by one person with a proprietary interest against another person with a proprietary or possessory interest, whereas an action in common law (public) nuisance does not require the claimant to have a proprietary or possessory interest. In practice, common law actions in public nuisance are rare because the statutory regime offers a quicker and cheaper alternative.

A key to understanding the private tort of nuisance is the 1879 case of *Sturges v Bridgman* [18]. In Sturges, a confectionery business had operated from a kitchen in Wigmore Street, London for over 60 years, during which toffees and other confectionery had been ground down and hammered out without complaint. In 1873, a doctor bought the adjoining property and built a consulting room adjoining the confectionary room in the neighbouring property. The inevitable then happened and the doctor complained about the noise from the business, saying that it disturbed his patients. The doctor was successful in his action. The Court of Appeal held that the noise from the business was not a nuisance until the doctor moved in next door and built his consulting room. At that point, the noise became a nuisance and was unacceptable in its extent. The key message from *Sturges* can be put as simply as this: 'being there first' is no defence to a private action in nuisance.

In a nutshell, the problem for that poor confectioner in 1879 is exactly the same as the problem facing pubs and clubs in 2019. Despite having operated their businesses for perhaps many years, the fact that 'we were here first' is not a robust legal basis for resisting a private nuisance claim, if someone complains about noise from the venue. And whilst the AoC principle has helped to move on the debate, its current UK planning policy incarnation falls short of actually delivering the legal protection that these venues both crave and deserve.

In the absence of a formal and effective change in policy, an interim answer to this problem lies in the newly-developing area of deeds of easements of noise. In short, the effect of the deed is to prevent there being in law an actionable nuisance arising from the currently existing levels of noise emanating from the venue. The only circumstances in which there could be such an actionable private nuisance would be if the levels of noise increase above those stipulated in the deed.

The way it works is quite simple. The deed is entered into between the developer, the venue and (if appropriate) the Council. In the deed, a right is granted by the owner of the development site to the venue to allow noise from the venue to pass over the neighbouring development site, up to the levels agreed to be representative of its established use. By operation of law, the future owners of the new residential dwellings will then become bound by the deed when they acquire their interest in the new dwelling. The deed is registered against the title and is enforceable as a property right, in the same way as any other property right (such as a right of light, right of support etc.).

The deed cannot, nor does it attempt to, prevent a future resident from complaining about noise from the venue. However, if that resident does decide to bring a claim, it would inevitably fail in the court (assuming noise levels prescribed in the deed had not been exceeded), as the resident has already accepted at purchase to be bound by the right of the venue to pass its sound waves at those levels across the dwelling. Therefore, there can be no private nuisance unless the prescribed levels are exceeded (and it should be noted that the onus would be on the claimant, eg a complaining resident, to demonstrate that there had been such exceedances), as there has been neither a wrongful act nor an infringement of a non-contractual right. In effect, the argument that 'we were here first' finally has some legal teeth.

This is the main advantage of a deed of easement (DoE) for noise; it recognises the position before the new development came along, recognises the importance of ensuring that the established use can continue, and provides a legal mechanism for ensuring both can coexist moving forward.

This addresses the risk of *private* nuisance action. Under the EPA, a *statutory* nuisance means an actionable nuisance in the sense that it is understood at common law. Accordingly, the reason why there is no actionable private nuisance is also the reason why there cannot be a successful prosecution under the EPA on the ground that noise emitted is a statutory nuisance.

With regard to the Noise Act, the noise levels experienced at the dwelling must be measured with the doors and windows closed. Accordingly, as long as the permitted levels in the CVNL are being met with all openings shut, there is no possibility of a successful prosecution under the Noise Act.

The DoE does not eliminate the chance of someone complaining about noise from a neighbouring venue. Moreover, the fact that a complaint has been made is likely to be a significant concern for the venue operator, notwithstanding the legal protection of the DoE. However, the operator can nevertheless take comfort from the likelihood that any complaint, whether in private or statutory nuisance, would inevitably fail in the Magistrates Court (subject to the venue operating within the terms of the deed), and that public nuisance would be rarely applicable in an urban context. It is for this reason that, unless and until the AoC principle is significantly strengthened in national noise policies, the DoE should be adopted as a planning requirement by all LPAs when asked to consider new residential developments adjoining or adjacent to existing noise-generating venues. In this way, the AoC principle can be placed on its proper legal footing: a legal mechanism to ensure that urban areas get the housing they require, whilst retaining the night-time business that makes those same areas thrive.

The DoE approach has been previously applied to venue noise in the case of the redevelopment of Eileen House, London. Eileen House was a high-profile encroachment case as it brought new residential development near to the Ministry of Sound (MoS), a world-famous nightclub. The case was eventually called in for review by the Mayor of London, which finally led to permission being granted, subject to stringent noise intrusion conditions and a DoE protecting the MoS' right to emit agreed noise levels [19] across the development. The case served to highlight the development planning problem faced by UK venues, and its resolution coincided with the instigation of the London GMV Rescue Plan [3].

4. CASE-STUDY

The George Tavern (GT) is a celebrated pub located in the East End of London, whose building dates to the 19th century (see Figure 1); a pub has existed at this location since the mid-17th century. It has operated as a GMV and film/photography location for over fifteen years. Performances run throughout the week until 12am, and up to 3am on Fridays and Saturdays. The styles of music played vary extremely widely, including both live bands and DJ performances of music of all imaginable styles.

In 2016, a planning application was registered with the local Council to redevelop an adjacent commercial-use (office) building into residential use (also indicated in Figure 1) [20].

The GT has been faced with previous planning applications for redevelopment of another adjacent site, from commercial into residential use [21] [22]. The applications were refused by the local Council but the developer persisted in appealing, and permission was eventually granted on appeal for a revised application. The consent was overturned following a judgement in the UK High Court and then finally refused again in a further appeal. The noise arguments and the associated risk to the GT (combined with the inadequate noise mitigation in the proposed development) formed a key part of the grounds for the eventual failure of these applications. The authors provided acoustic advice and representation for the GT at various stages of this process, which went on for nearly ten years, and was the subject of a publicity campaign endorsed by well-known performing arts luminaries [23].

Figure 1: The George Tavern

The 2016 application was considered in a fundamentally different way, in which the principle of the AoC was made paramount, and the Council facilitated the close involvement of the GT in the planning process, to help ensure that the proposals would not lead to future conflict and the risk of closure of the venue.

The developer employed a planning and architectural design team, including specialist acoustic advisors, while the Council were advised by their own noise consultant. The authors acted on behalf of the interests of the GT, however, in line with the AoC principle, their involvement in that capacity was financially supported by the developer.

4.1 Draft Deed of Easement

It was proposed that a DoE could be agreed as an upfront measure to provide assurance to the GT. The 'current venue noise level' (CVNL) enshrined within the draft DoE were considered to be a crucial component, as they will represent the yardstick to which the GT could be held in the event of any future noise complaint. It was therefore critical that the CVNL reflected the loudest events held at the venue, in order to avoid placing potential restrictions on its future ability to continue hosting such performances. Accordingly, considerable attention was paid to defining and agreeing the CVNL values. It was found that the CNVL levels initially proposed by the developer would have been exceeded by the sound levels generated by a past event (which comprised live bands and DJs) which had been monitored by the authors on behalf of the GT. An alternative CVNL was therefore drawn up, and the definition revised to represent a reasonable worst case for event noise. The agreed CVNL definition was based on a statistical analysis of measured event levels, utilising the 90th percentile of the $L_{10,5min}$ measured within a 4-hour period during an event. This approach outputs a high-weighted aggregate, which ensures that any exceedances of the CVNL should only occur for short periods; this definition was carried through into the DoE to ensure the venue levels were adequately represented.

4.2 Design proposals

It was recognised that it would be better to avoid any noise complaints in the first place, than to have to rely solely on the legal protection of the DoE, and so it was considered important to ensure that the mitigation proposals for the development design would minimise the risk of noise disturbance.

The most effective mitigation for venue noise would normally be to install or improve sound insulation measures at the venue itself, in which case the application of the AoC principle could entail the residential developer providing the funding for suitable measures to be integrated into the venue. In this case however, the GT's status as a listed Grade 2 category historic building (which constrains the nature and extent of modifications that can be made to its material structure and appearance [24]) imposed fundamental restrictions on the potential introduction of such measures. These limitations, combined with the relatively small venue size (capacity approx. 150), rendered tangible venue sound insulation measures unfeasible in this case. The mitigation measures would therefore need to be incorporated into the proposed residential development.

The developer's proposed design incorporated façade mitigation comprising enhanced performance secondary glazing. The development was also designed with mechanical ventilation systems to minimise reliance on the use of openings in the building envelope for this purpose.

The authors reviewed the developer's acoustic assessments and design proposals and negotiated improvements, with a view to increasing the level of protection for the future occupants and reduce the risk of noise complaints. This was a dynamic and protracted process and some of the key lessons learned are summarised below.

4.2.1 Noise impact design criteria

In determining target criteria for design work, several factors should be considered, including the characteristics of the source (both acoustical and operational), the potential effect(s) of exposure in relation to the sensitivity of the receptor, and the value of avoiding future issues caused by inadequate design.

There were two noise sources of concern at the GT (as is often the case for venues): (i) the music breakout from the bar and internal performance space, and (ii) attendees interacting in the outdoor area. Although the GT programme is highly variable, the music performances tend to be contemporary in style, typically comprising combinations of live amplified musicians with recorded music played in between performances. Sounds that convey information, such as music and speech, inherently attract greater attention and result in increased distraction compared with other noises [25]. It is recognised that modern, amplified music performance is relatively bass-heavy [26], and events hosted at the GT conform to this norm. Low-frequency noise (LFN) poses particular difficulties in terms of causing disturbance [27], and increased annoyance compared with other noises [28]. In addition, most contemporary musical styles are characterised by both repetitive drum beats and highly dynamic bass sounds, typically concentrated in the 63 Hz and 125 Hz octave bands. Fluctuations or impulsivity in noise attract attention and increase negative responses [29] [30], while music noise with impulsive, rhythmic characteristics has been shown in tests to be one of the types of LFN that tends to be rated most annoying [31]. On this basis, the key music source characteristics to consider are: i) the high content of low-frequency energy, ii) the fluctuating and impulsive character, and iii) the nature of the sound as an information-carrier. This last aspect is particularly problematic, as, in consequence, "*music is often difficult to ignore and can readily induce antipathy in the listener when it is unwanted. There are strong indications that exposed people…automatically 'tune in' even when louder background noise is present*" [6].

Typical sounds from patrons outside also share some of the same attention-attracting acoustical characteristics as the music, that of information-conveyance, fluctuation and, potentially, impulsiveness (eg shouting).

Operationally, the licensed events at the GT tend to take place from around 7pm until 3am (when music amplification is switched off) on weekend evenings. Weeknight music events take place with an earlier closing time. There are generally 4-5 evening events taking place every week throughout the year. Listening tests indicate that (unsurprisingly) music noise is increasingly annoying at night-time [31], so this operational profile indicates a higher risk of disturbance.

In terms of potential effects, the most likely initial outcomes of noise intrusion caused by inadequate design would be impacts on residential amenity, notably annoyance, interference with relaxation, and sleep. The source characteristics described above represent a 'toxic brew' in the sense that such noise is likely to elicit the strongest negative reactions, and events regularly take place during the most sensitive periods of the day and night, when people typically intend to rest and recuperate.

In addition to the sound character, important non-acoustic moderators are also likely to play a significant role in annoyance responses – for example, it is probable that the annoyance effect of a disturbing noise will be enhanced when it is perceived to be caused by strangers enjoying themselves at the expense of those who are disturbed by it. These sorts of factors have been shown to have considerable influence on reactions to noise, equivalent to tens of decibels in sound level [32]. Sensitisation can also occur in the long-term whereby observed responses may become more extreme relative to the same exposure [28].

One of the key factors to be balanced in this type of planning case is the value of the venue, in terms of commercial, employment and cultural worth, and the importance of protecting this value. Another is that a new residential development offers the opportunity to 'get it right' from the very beginning, using feasible design measures, thus avoiding the potential future costs of 'getting it wrong'. These costs might include reduced quality of life for residents, costs to the Council for investigating complaints, and the costs of retrospective mitigation (either for the development, or for the venue), which could be both prohibitively expensive and technically impracticable. The combination of these factors illustrates the importance of setting rigorous, well-informed design criteria suitable for addressing the specific difficulties posed.

Although often-referred to, the WHO guidelines for community, night-time and environmental noise are of no assistance in determining suitable criteria in this type of case. This is because none of the evidence reviews supporting these guidelines has examined the relevant psychological effects (annoyance and sleep disturbance) of community exposure to music venue noise [33] [34] [35]. Furthermore, the guidelines are defined only in terms of A-weighted levels, which has been shown to be inadequate to describe annoyance responses to noise dominated by low frequency energy [26] [27] [28] [36] [37].

In 2003, the UK Institute of Acoustics (IoA) published a Good Practice Guide (GPG) to the Control of Noise from Pubs and Clubs. This document, while useful in providing general information, lacked any specific objective noise impact criteria [38]. While objective criteria had been included in the draft version [39], these were omitted from final publication, with the reason given as a lack of "*satisfactory validation*" [38].

The IoA 2003 GPG advises that in developing suitable criteria, the objective should be to ensure that music noise should not be audible inside neighbouring dwellings. There are differing views on the merit of references to 'inaudibility' for use in defining criteria with which to evaluate music venue noise. One view is that 'inaudibility' itself is insufficiently defined in objective terms to be useful. In support of this view, reference is usually made to a UK High Court judgement, which found that a noise condition requiring inaudibility without specifying what was meant by the term (in decibels) was unenforceable, and thus, unlawful [40]. The judgement does not suggest however that the concept of inaudibility itself in planning conditions is unlawful, but only that it requires objective clarification in order to be enforceable.

The starting point for defining an objective measure of audibility would logically be the threshold of hearing – while this varies between individuals, it is reasonable to determine a threshold value that represents the majority of people. Human hearing thresholds (HTs) determined from audiological testing are set out in ISO 226 [41]. There are limitations to these standardised thresholds, however. Firstly, they are the median values for an age-group of adults expected to have near-optimal hearing (18-25). More importantly they represent HTs for detection of discrete, individual, steady tones. The human auditory system is more sensitive to multi-tonal sounds and complex noises than to single tones, with lower HTs evident for many common environmental noises than those indicated in ISO 226 [42] [43]. Testing of the HTs for complex sounds demonstrates this fact, as indicated in Figure 2a, which shows low-frequency HTs derived from two studies investigating both multi-tones [44] and complex noise [45], compared with the ISO 226 single-tone HTs; in short, the more complex and broadband the sound, the lower the threshold for which it will be detectable.

These HTs are determined in near-silence. In practice, the second factor determining audibility of a noise is the presence of any masking sound, ie how far the noise protrudes from the sonic background. Laboratory tests with artificial sounds meanwhile indicated a margin (above background) of 12-16 dB for audibility of low-frequency tones, while low-frequency multi-tones were audible when the exceedance reached 7-11 dB [44]. Meanwhile, the results of preliminary headphone-based listening tests specifically addressing audibility of real music noise in recorded background sound indicated that, depending on the type of background sound environment, the music noise may become audible when the L_{10} level in the highest third-octave band (TOB) reaches 0 to 10 dB above the background sound L_{90} [46]. In these tests, the *overall* music level (L_{A10}) became audible around -13 to -15 dB below the background (L_{A90}), which is in agreement with the observations of Craik [47]. These results appear consistent with the behaviour of the HT in near-silence, ie audible detection over masking sound for complex noises occurs at a lower level than for tonal noises.

A further common criticism against the use of inaudibility-based criteria is that inaudibility is too stringent a requirement, on the basis that i) it is often difficult for existing and new venues to achieve inaudibility at existing dwellings, and ii) if a sound can be heard, that does not necessarily mean it cannot be tolerated, ie some audibility of a sound could be acceptable. In respect of i), the use of a subjective inaudibility criterion in licensing conditions in Edinburgh, Scotland, was the subject of a campaign by existing venues, seeking to have it prohibited from standard council conditions. This was because it was felt to be stifling venues in the city from hosting music, in fear of having their licences revoked [48]. However, in the case of new residential receptors proposed near to existing venues, it could be argued that planning to achieve inaudibility would be both reasonable and achievable, given that the development could be designed accordingly.

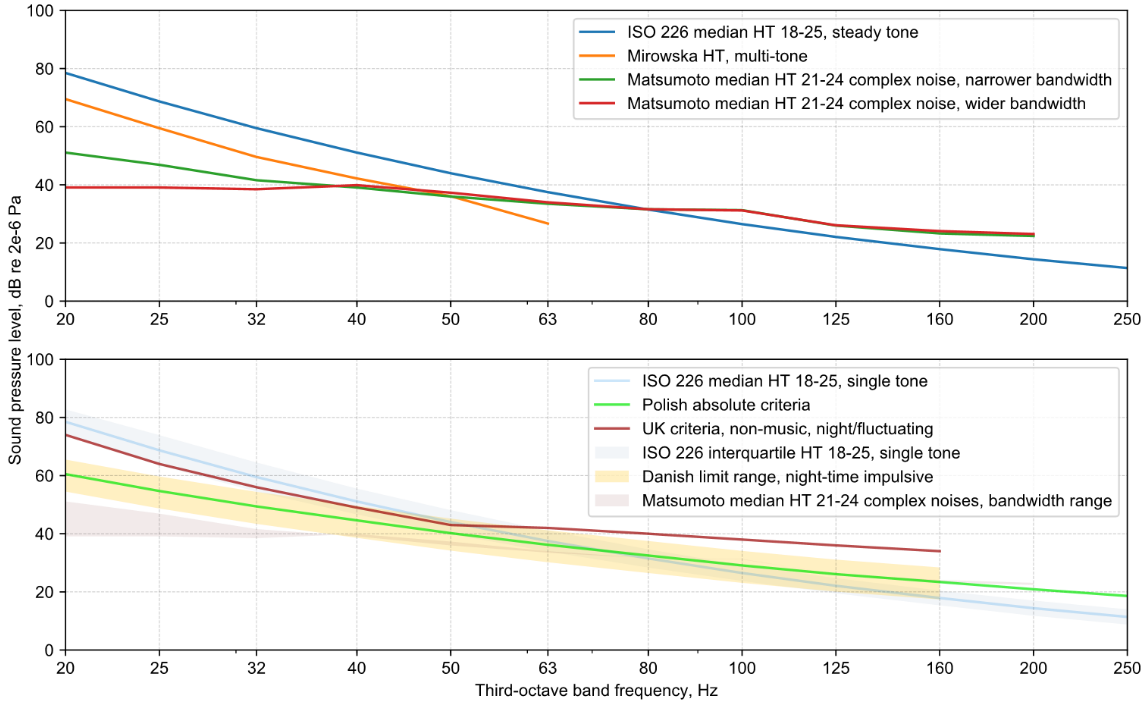

Figure 2: (a, top) Hearing thresholds in quiet for tones, multi-tones and complex noises; (b, bottom) acceptability/disturbance/annoyance absolute limit criteria from national guidelines, compared with hearing thresholds [41] [44] [45] [49] [50] [51] [52]

In relation to argument ii), several national authorities have developed 'unacceptability/disturbance/annoyance' criteria for LFN, which typically comprise threshold curves defined in TOBs. Detailed reviews of criteria for human response to LFN have been conducted by Poulsen [51], Davies et al [53], Moorhouse et al [52], and Caniato et al [54]; the discussion below focuses on the selected aspects considered to be of most relevance, as summarised in Table 1.

Table 1: Example low frequency noise human response / acceptability criteria

Origin	**Key ref**	**Basis**	**Metric**	**Descriptive comments**
UK (Defra)	[52]	Controlled listening tests with artificial and industrial noise	TOB $L_{eq,5min(10\text{-}160Hz)}$	Comprises an absolute 'disturbance' threshold curve (see Figure 2b). Listening test sample included a proportion of LFN-sensitive subjects. Music noise was specifically excluded from the development of the criteria, although a 5 dB 'fluctuation' character penalty was included. The curve runs slightly below the single-tone median HT at frequencies up to 50Hz, rising more steadily above the HT up to 160 Hz.

Origin	Key ref	Basis	Metric	Descriptive comments
Poland (Building Research Institute)	[44]	Controlled listening tests with artificial and industrial noise	TOB $L_{p(10\text{-}250Hz)}$ (averaging unspecified)	Comprises an absolute annoyance threshold curve (see Figure 2b), and an 'exceedance above background sound' threshold of 6 dB (broadband noise) or 10 dB (tonal noise); both sets of threshold criteria must be exceeded for the noise to be deemed annoying. The absolute threshold curve runs within the middle of the Danish threshold range throughout the spectrum, but extends to 250 Hz. There is no penalty for fluctuation or impulsive sound character. The metric and averaging are not specified by Mirowska et al [44], however Caniato et al [29] assume that, similar to other methods, this should be $L_{eq,T}$.
Denmark (EPA)	[51]	Controlled listening tests with industrial and music noise	$L_{Aeq,10min(10\text{-}160Hz)}$	Comprises an absolute limit based on the total A-weighted low-frequency TOB sum. In practice this means that the applicable TOB values depend on how tonal or broadband the noise is – a tone fitting into a single TOB would have a higher limiting value than a broadband noise spread across all the TOBs; these extrema can be used to define the range of the Danish limits across TOBs. The total limit for night-time, impulsive-type sounds (including rhythmic music) affecting dwellings is 15 dB $L_{Aeq,10min(10\text{-}160Hz)}$, and the TOB limit range determined from this value is shown in Figure 2b – the range curve lies between the single-tone and complex noise HTs up to around 50 Hz, and gradually rises above the single-tone HTs between 63 and 250 Hz.

The UK criteria, while useful for comparison, do not address music noise, although fluctuating LFN is included. The objective test for fluctuation examines the difference between the L_{10} and L_{90} of the signal, alongside the rate of short-term level changes [52].

The Polish criteria are based on assessing both the absolute LFN levels, and the exceedance of the LFN above the background level [44]. While conceptually sound, this feature makes it difficult to apply in planning-stage situations, unless an accurate prediction of the expected background sound can be made – this would become feasible during the detailed design of the systems proposed to provide mechanical-ventilation for the dwellings.

The Danish criteria are the only set considered here that specifically consider music noise; laboratory tests indicated that when results for rhythmic music are analysed, the Danish criteria have the closest correlation with subjective annoyance out of a wide range of international LFN acceptability curves [51]. The 5 dB penalty adjustment applied in the Danish approach for impulsive noise characteristics is consistent with the UK method. Interestingly, the LFN assessment approach developed for the state of Queensland, Australia also adopts a method for evaluating acceptability of non-tonal LFN that is almost identical to (and clearly based on) Denmark's guideline [55]. Relevant results from the underpinning lab tests for the Denmark guideline are shown alongside the Danish limit for night-time impulsive LFN in Figure 3.

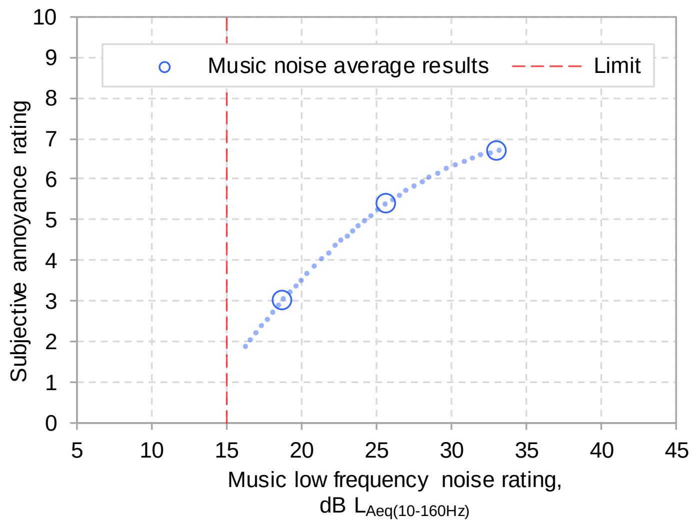

Figure 3: Exposure-response results from listening tests underpinning Denmark low frequency noise guideline [51] (trend line added; Danish guideline limit indicated as vertical red line)

The type of metric employed to characterise music noise is also an important consideration when defining criteria. For music noise, use of the L_{10} considered in octave bands (OBs) has been found in listening tests to have slightly better correlation with acceptability than other OB statistical measures, including L_{eq}, with the best results for modern 'dance' music styles (featuring high, dynamic relative energy in the 63 Hz octave band) [56].

To design noise attenuation measures such as glazing, it is necessary to specify the spectral performance. This requires design target criteria to be defined over the relevant frequency range, and it is typical at the planning stage for this to be expressed in OBs. In this case study, the use of OB Noise Rating (NR) curves was proposed, which covered the key music noise frequencies of 63-125 Hz [57].

The Danish guideline limits can be converted into NR (L_{eq}) curves by ensuring that the sum of A-weighted OBs centred on 63 Hz and 125 Hz is no more than the given threshold value. The NR (L_{eq}) OB values can then be converted into NR (L_{10}) OB values by adding the level differences between L_{eq} and L_{10} – this difference is of course specific to the sound source, and in this case the measured sound data indicated the typical L_{10}-L_{eq} level difference for GT music noise was 4-5 dB in the 63-125 Hz frequency range. The converted NR values relating to the Danish guideline limits are summarised in Table 2.

Table 2: Denmark low frequency noise guideline conversion to Noise Ratings

Denmark EPA guideline LFN limits	**Equivalent NR (L_{eq})**	**Equivalent source-specific NR (L_{10})**
15 dB $L_{Aeq(10\text{-}160Hz)}$	NR 5 (L_{eq})	NR 11 (L_{10})
20 dB $L_{Aeq(10\text{-}160Hz)}$	NR 11 (L_{eq})	NR 17 (L_{10})

The proposed design target criteria for music noise ingress to the development are summarised in Table 3. These criteria were based on consideration of the converted Danish guideline, alongside the objectives of UK planning policy, which requires the avoidance of noise impacts exceeding the 'significant observed adverse effect level' (SOAEL), and the minimisation of impacts exceeding the 'lowest observed adverse effect level' (LOAEL). Since the Polish absolute threshold values coincide with the centre of the Danish range, this indicates that the Danish guideline limit is set close to the expected perception thresholds. In fact, the test data in Figure 3 indicate that the subjective annoyance rating for music noise at the level of the Danish limit would be (on average) less than 2 over the 11-point scale. While this may be interpreted as the approximate onset of annoyance responses to low frequency music noise (ie a LOAEL in UK policy terms), the policies do not mandate that noise is limited to meet LOAELs. In this case, the Council's advisor took the view that the design target applied should be somewhat higher than what might constitute a LOAEL under UK planning policy, on the basis that this would be more 'reasonable'.

In response, two levels of criteria were suggested; an 'aspirational' target to be achieved if possible and a 'fallback' target intended to be complied with as a minimum. This compromise approach reflected the outcome of negotiations between the authors (on behalf of the venue), the developer and the Council. It responded to the developer's concerns about the feasibility of the mitigation measures within the development design, the council's concerns about the enforceability of the proposed conditions, the pressure for more housing in the area (and the apparent lack of suitable sites for residential development), as well as the need to protect the GT as a venue. Figure 3 suggests that the NR target criteria in Table 3 would be equivalent to expected subjective annoyance ratings of around 3.5 (for NR 17 L_{10}) and 4.6 (for NR 20 L_{10}) on the 11-point scale.

Table 3: Proposed development design targets for music noise ingress to habitable rooms

Target	**Design target**
Aspirational	NR 17 ($L_{10,5min}$)
Fallback	NR 20 ($L_{10,5min}$)

The 'aspirational' target is to be adopted in the first instance, and achieved wherever reasonably practicable. The 'fallback' target is intended to be adopted for rooms in which the achievement of the aspirational criterion was not practicable. Application of the fallback criterion should be justified with reference to sustainable development principles and the practicability of the measures considered. This 'two-tier' criterion approach is conceptually consistent with existing UK codes of design for general environmental noise ingress to dwellings, which allow a degree of relaxation where development is considered necessary and desirable [57]. This flexibility reflects the challenges faced in UK residential development planning due to the lack of urban space.

The target criteria are compared with the Denmark guideline range (raised by 5 dB for conversion into source-specific L_{10} equivalent values) in Figure 4. It should be noted that in some cases, such as nightclubs, the low frequency range of concern would extend further – at least down to the 25 Hz TOB and possibly lower, depending on the venue sound system capabilities. However, it is unusual for laboratory acoustic performance test data to extend to a similar range, and accurate testing at such low frequencies is difficult.

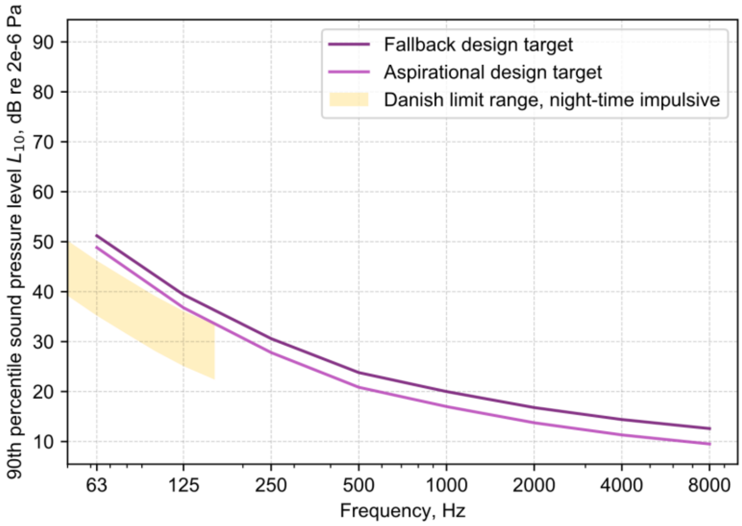

Figure 4: Proposed development design target spectral limits for music noise ingress to habitable rooms with Danish low frequency noise guideline range (adjusted for conversion from L_{eq} to source-specific L_{10})

4.2.2 High performance glazing

The design of the glazing system was the subject of careful scrutiny. The developer's original design assumed that the proposed acoustic specification for glazing would be sufficient to reduce low frequency sound levels to meet the design targets. However, analysis of the specification against laboratory test data for high-performance glazing indicated that the specification would not be achievable. Figure 5a compares the acoustic specification with tests on secondary glazing systems incorporating large air cavities and enhanced laminated panes; the expected shortfall in performance in octave bands lower than 500 Hz can be seen to be of the order of 5-10 dB. It was suggested by the developer's advisors that the deficit could be made up by designing a bespoke system with larger air cavities to increase the low frequency attenuation. In practice, however, the overall depth of the glazing would be limited by design constraints, such as the available wall depth. Further analysis of the potential effects of increasing the air cavity depths was carried out, as summarised in Figure 5b. This analysis highlights the 'diminishing returns' achieved from increasing the cavity depth of secondary glazing; while a large benefit is gained by increasing the cavity depth from 50 to 100 mm, a smaller benefit is achieved by a further increase to 150 mm, and an almost-negligible benefit when increasing from 150 to 200 mm. With a design wall depth of 300 mm, this indicated that it was unrealistic to expect the developer's acoustic specification to be achieved by an in-wall glazing system alone.

As a consequence, the authors recommended that the design should incorporate further mitigation against low frequency noise intrusion. Balconies enclosed with glazing (aka winter gardens), for example, are an option for noise mitigation in urban areas, especially where the desire for 'private outdoor' amenity areas conflicts with available space, high noise levels, and poor air quality. Importantly in this case, winter gardens would also provide an additional buffer, increasing the total sound attenuation effective for more sensitive parts of a dwelling. Accordingly, it was suggested that the balconies connected to the rooms subject to the highest levels of incident music noise should be enclosed in this way to maximise the low frequency noise mitigation.

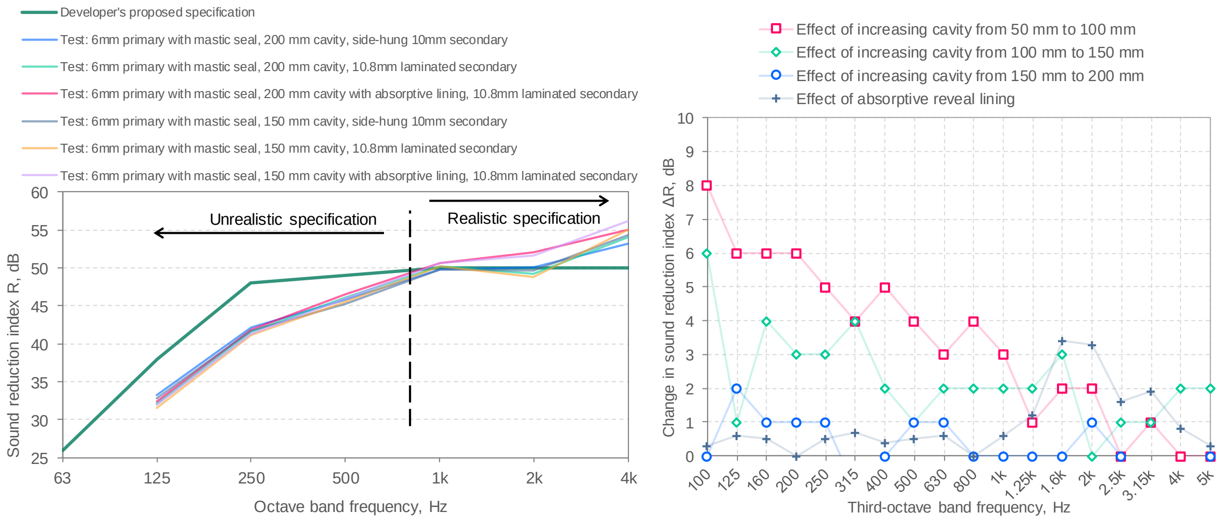

Figure 5: Analysis of development glazing design proposals; (a, left) comparison of developer's proposed specification with tested systems; (b, right) improvements in secondary glazing performance with increasing cavity depth and acoustic lining

This example illustrates the value of detailed reviews of proposed acoustic specifications prior to determination, to ensure that recommended performances are likely to be achievable when subject to practical design constraints. A planning consent condition specifying criteria that are in reality unachievable would fail the validity tests set out in the NPPF [4] and therefore be vulnerable to subsequent challenge and variation or removal, reducing the levels of protection anticipated by those who approved the application.

4.3 Planning conditions

The last layer of noise protection is contained in the conditions for planning consent. These were drafted by the authors for agreement with the council and the developer. The draft conditions required approval of a design scheme to limit music noise intrusion using the two-tier criterion system devised. The appropriate source noise levels and sound prediction parameters were also specified in the condition, to avoid underestimation of music noise levels at the proposed development. A further condition required the implementation of the mitigation to be checked and approved by a qualified acoustician. Finally, another condition was imposed to ensure that the noise from the internal ventilation systems would be neither too high (to disturb residents) nor too low (to ensure the background sound in the rooms would provide a degree of masking sound for any residual music noise transmitted into the building.

5. FUTURE RESEARCH AND DEVELOPMENT

The review and case study discussed in this paper suggests there is a strong need for guidance and objective criteria to help manage noise from entertainment venues in the UK to inform planning decisions and design proposals. A planned update to the IoA 2003 GPG has been in draft since 2016, although this is due to be published for consultation in 2019. It is hoped that the revised GPG presents a clear and evidence-based approach, which can be appropriately endorsed to provide greater certainty for GMVs in the future.

Further exposure-response data specific to music venue noise emissions would be valuable. It is acknowledged that it may be difficult to achieve this through field studies, due to the relatively small number of people affected by venue noise compared with other environmental noise sources. However, the pool of research from laboratory studies also appears to be small, and the lack of available information impedes the agreement and adoption of suitable criteria for use in planning decisions.

The target design criteria developed in this study have been based on NR curves, a system that has developed from practical convention rather than robust scientific study. The NR has the distinct advantage of specifying noise limits across the frequency range, however a shortcoming is that NR is not very well-balanced as a spectral criterion. In building envelope noise attenuation, achievement of the NR limits at low-frequency OBs may lead to over-attenuation of higher frequencies and an unbalanced spectrum, which could increase listener perception of the low end of the frequency range, exacerbating responses to LFN. An alternative system may be more effective to use for the design of music venue noise attenuation, such as the 'low frequency NR' curve proposed by Broner et al [58], although its practical application in venue planning issues is not known to have been tested. The state of South Australia advises that a limit of 43 dB L_{eq} in the TOB range 31.5-125 Hz should be applied to "*encroaching residential development*" near an existing music venue [59]. This criterion would be approximately equivalent to 48 dB in terms of the venue source-specific L_{10} considered, which Figure 4 shows would be very close to, but marginally more stringent than the aspirational NR17 criteria at 63 Hz, and less stringent at 125 Hz. The success, or otherwise, of the implementation of the South Australia guideline in achieving good planning and design practice is unknown.

6. CONCLUSIONS

6.1.1 Planning policies

Despite the shift towards an AoC principle-informed approach, the UK NPPF currently fails to provide adequate protection within the planning system for GMVs. This is because it sets the threshold for integration of development noise mitigation at a level of impact that is too high, potentially allowing a considerable degree of disturbance to occur, and leading to a continuing risk of conflict arising between new residential occupiers and established venues.

6.1.2 Deed of Easement

The DoE mechanism is believed to represent an effective legal approach to addressing some of the shortcomings of the policy framework. Properly and carefully defined, a DoE can temper the expectation of new residents and provide some assurance to venues that, even if their new neighbours do complain, any resulting punitive action will be unlikely to succeed. This approach is less than ideal, however, as it does not avoid noise disturbance or complaints from occurring, and its effectiveness in conferring immunity for venues has not been tested in the courts.

6.1.3 Music noise mitigation design and criteria

Given the particular features of music venue noise, ie the low-frequency spectral content, the dynamic character, its nature as an information-carrier, and the typicality of its emission during sensitive diurnal periods, disturbance may occur at noise levels that are relatively low. At the planning stage, it is important to avert noise disturbance (which may lead to annoyance and sleep disruption), by setting suitably robust development design criteria, and by ensuring that mitigation measures are both feasible, and can provide the required level of performance, when subjected to the reality of practical design constraints.

In this case study, a set of design criteria were developed from an exposure-response study specific to music noise. A compromise two-tier approach was proposed: more stringent aspirational targets intended to be met wherever feasible, with fallback targets to be applied where it would not be reasonably practicable to achieve the aspirational values.

The planning conditions drafted in response to the application required details of the mitigation scheme that would achieve the devised criteria, and specified the source noise levels and modelling parameters to be used for predictions of music noise emissions and propagation. Further conditions required the completed scheme to be approved by an acoustician, and for noise from ventilation systems to be designed to provide masking background sound within the development.

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