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Memorandum

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From:	Rewa Satory, Acoustic Engineering Services
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Pages:	4

Meeting ☐ Telephone ☐ Memorandum ☑ File Note ☐

Further to our review of Acoustic Insulation in Commercial and Mixed-use zones (AES File Reference: AC22354 – 02 – F1 dated the 1st of February 2023) we have reviewed additional questions from the DCC with regard to Variation 3 of the 2 GP as requested. Please find our analysis below (queries reproduced in green text).

1.0 ADDITIONAL QUERIES WITH REGARD TO VARIATION 3

1. Is the (DnT,w + Ctr) metric the most appropriate metric for managing entertainment noise?

Concerns have been raised that the C_{tr} spectrum that is used to determine insulation requirements does not consider frequencies below 100hz. Amplified music will include frequencies associated with bass and drum sounds that are lower than 100hz. Please provide advice on the effectiveness of acoustic insulation resulting from the application of the (DnT,w + C_{tr}) metric in addressing the effects of entertainment noise. Please consider and advise if there are other metrics or standards that would be more appropriately applied to determining acoustic insulation requirements to effectively mitigate the effects of entertainment noise.

A number of metrics have been developed to quantify the noise reduction provided by façade elements. The metrics that are used commonly in New Zealand include $D_{tr,2m,nT,w}$ + C_{tr}, $D_{nT,w}$ + C_{tr} and $D_{tr,2m,nT}$. None of these metrics directly consider sound below 100 Hz.

There are however some examples in District Plans in New Zealand where Rules have attempted to extend the frequency range to lower frequencies, such as some zones in the Auckland Unitary Plan where a specific reduction in noise level is required in the 63 and 125 Hz octave bands for buildings housing sensitive activities. Similarly, the Hurunui District Plan provides a source spectrum down to 63 Hz and a maximum internal noise level for noise from frost fans at 63 Hz, therefore requiring low frequency sound insulation analysis to be conducted.

Generally, we consider such embellishments to the traditional metrics to be inappropriate as reliably predicting both the sound insulation of building facades, and the sound field within rooms is problematic below 100 Hz. This is because the wavelength of sound is long at those frequencies, and so all of the analytical theories which underly those predictions do not hold (specifically – that the panel size is large compared to wavelength of sound, and that the sound field within the receiving room is diffuse). Supplementing predictions with measurements is also problematic at those frequencies, as laboratory measurements of sound transmission loss will vary significantly and depend on the size of the sample tested, and noise levels measured within rooms will vary significantly from point to point, due to room modes. Therefore, while it initially seems logical to provide an approach which ensures a good level of low frequency façade performance (and that may be an outcome of acoustic engineers attempting to implement such a Rule), a direct quantitative requirement is problematic. Verification measurements are likely to show significant and unpredictable variations, when compared to the attempted desktop analysis.

In our review we noted that an increased $D_{nT,w} + C_{tr}$ rating is also likely to indirectly provide improved performance at lower frequencies, i.e. a façade designed to meet a 35 dB $D_{nT,w} + C_{tr}$ requirement is very likely to provide higher performance at the 63 Hz band than a façade that achieves only 30 $D_{nT,w} + C_{tr}$. In order to specifically target a further improvement at 63 Hz, 'high mass only' constructions would be required – whether directly dictated via say an explicit high surface mass design requirement, or as the result of a technically questionable 'direct' 63 Hz and 125 Hz sound insulation requirement.

Whatever the approach, a balance between protecting occupants and over engineering the façade to protect against all eventualities must be achieved. Considering that traffic noise is not subject to any limits and that the spectrum of the entertainment noise is not fixed, there is always an element of uncertainty when designing a rule to protect occupants. We have considered a number of scenarios below and how likely it is that a specific rule would protect occupants of bedrooms. Cells are shown in green where the façade is likely to protect sleep, orange where the outcome is uncertain and red where the façade is not likely to adequately protect sleep.

Figure 1.1 – Traffic light graphic to illustrate likelihood of occupant disturbance

External noise source / Façade design requirement	Single music source without distinctive bass beat resulting in 60 dB L_{Aeq} outside a bedroom	Multiple music sources without distinctive bass beat resulting in 63 dB L_{Aeq} outside a bedroom	Multiple music sources with distinctive bass beat resulting in 63 dB L_{Aeq} outside a bedroom	Multiple music sources without distinctive bass beat, and traffic noise resulting in 65 dB L_{Aeq} outside a bedroom	Multiple music sources with distinctive bass beat, and traffic noise resulting 65 dB L_{Aeq} outside a bedroom	Multiple music sources with distinctive bass beat, and traffic noise resulting in greater than 65 dB L_{Aeq} outside a bedroom
30 $D_{nT,w} + C_{tr}$						
35 $D_{nT,w} + C_{tr}$						
35 $D_{nT,w} + C_{tr}$ with additional specific 63 Hz protection						

As figure 1.1 shows, a façade which achieves 35 $D_{nT,w} + C_{tr}$ is likely to protect the sleep of occupants in most situations, and is a notable improvement from the current 30 $D_{nT,w} + C_{tr}$ requirement.

2. Should Appendix 9A include details of construction standards for internal building elements or should other changes be made to deal with room-to-room noise transmission?

The schedule of building construction presented in Appendix 9A will need to be updated to achieve the proposed standard of DnT,w + Ctr > 35. The schedule applies to external building elements in rooms covered by Rule 9.3.1.3 and concerns have been raised that sound transmission from a room not covered by Rule 9.3.1 into a habitable area could occur and impact on the effectiveness of the acoustic insulation installed in the building (e.g., a hallway next to a bedroom if it is not be subject to any specific insulation requirements could act as a weak point in the acoustic insulation of the bedroom; or floors running through buildings transmitting noise). Please advise whether the Appendix 9A needs to be revised to address flanking transmissions from rooms or hallways that are not required to be provided with acoustic insulation to achieve the acoustic insulation performance standard. If improvements are needed, please provide recommendations on appropriate changes to Appendix 9A or other options to address the issues.

We are not aware of a similar District Plan rule which attempts to address this issue, and it is unclear how that would be accommodated within the current Rule structure.

Technically, noise transmission via an open window into a living area, could then travel via an open internal door into a bedroom, thus 'short-circuiting' the façade sound insulation requirement. Other scenarios seem less likely – such as an open window in a common hallway, travelling via an open apartment door into a living area, and then into a bedroom via an open door between the living area and bedroom. In all of those scenarios, if the window and door(s) were closed, the combined sound insulation provided by this path would be likely to be high enough so as to not meaningfully increase noise levels within the bedroom (i.e. even with single glazed windows, and hollow core doors with no seals). That is, while the $D_{nT,w} + C_{tr}$ concept was not intended to be applied to the performance of a 'transmission path', it is likely the external to internal sound insulation to a bedroom via an adjacent room that does not have specific insulation requirements will effectively be equivalent toa $D_{nT,w} + C_{tr} > 35$ rating when windows and doors are closed.

It is not practical to require via a District Plan rule, that windows and doors must remain closed (or are prohibited), and the opening of those elements (as opposed to the level of sound insulation provided by building elements) is the cause of the possible issue, building occupants will be best placed to manage those situations – and the current Rules at least ensure that an adequate environment is achievable within bedrooms, once the bedroom door and any external windows or doors of connected spaces are closed.

3. Should the ventilation requirements in Rule 9.3.1.5 clarify that the ventilation must not compromise the required level of acoustic insulation?

Rule 9.3.1.5 requires that adequate ventilation be provided. However, the design of such ventilation is not covered in the rule or in Appendix 9A. Ventilation usually introduces a hole in the building façade and, unless implemented properly it could have a negative effect on the insulation performance of the wall. Concerns have been raised that there is insufficient control on the installation of ventilation or suitable guidance provided within the rules and Appendix 9A to ensure that the installation of ventilation avoids impacting on acoustic insulation performance. Please provide advice on the significance of this issue and recommend rule improvements if appropriate.

If a 100 mm hole were cut in a wall achieving 35 $D_{nT,w} + C_{tr}$ the performance is likely to drop to in the order of 30 $D_{nT,w} + C_{tr}$. However, in our experience it is unlikely that a ventilation system would have an arrangement that simple (for example, there would often be a length of ductwork which would travel via a ceiling cavity), and we have not been involved with a situation where flanking via that path proved to be an issue in practice.

Nevertheless, it would be straightforward to add a requirement that the ventilation system is designed so that the façade performance is not compromised, such as the following:

- *Rooms to which this acoustic insulation standard applies must be supplied with a positive supplementary source of ventilation that achieves a minimum of 7.5 litres per second per person, and does not compromise the performance of the façade, to enable adequate ventilation when windows are closed.*

We have considered whether a system which meets this requirement could be included in Appendix 9A. There are many possible configurations of such a system, but one option for possible wording is:

- *Minimum 3 metre length of solid ductwork with 50 mm internal acoustic absorption lining, travelling within the bedroom ceiling cavity between the penetration in the building envelope, and a ceiling grille.*

We trust this information is of assistance. Please do not hesitate to contact us to discuss further, as required.

Kind regards,

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