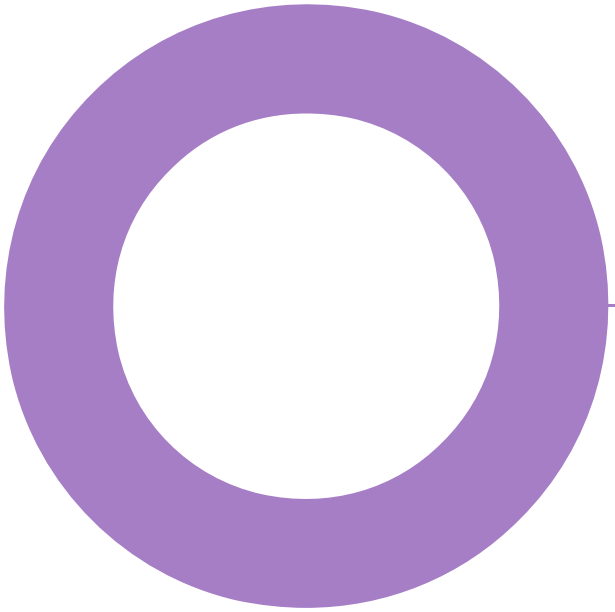
HOARE LEA

Elmsbrook Community Hub. Bicester.
A2Dominion.

ACOUSTICS
ACOUSTICS STRATEGY REPORT
DESIGN AND OPERATION
REVISION 4 – 29 NOVEMBER 2019



Audit sheet.

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1	27/09/2019	Issue for comment	KS	GV	GV
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Contents.

Executive summary

Guidance regarding satisfactory noise levels within residential dwellings has been reviewed and used to propose a set of design criteria for the building construction and the development of a Noise Management Plan for the proposed community hub with residential dwellings above

Although the large majority of activities will not produce high noise levels, sample calculations based on worst-case scenario for raised speech and occasional amplified sound have been carried out to assess internal noise transfer. Example calculations have been undertaken to demonstrate that the design criteria proposed can be achieved with: appropriate selection of the separating floor construction; and linings to other sound flanking paths.

It has also been demonstrated that noise breakout from the proposed community hub to external can be controlled by design and implementation of a Noise Management Plan. Mechanical ventilation to facilitate windows and external doors to remain closed with spaces with amplified sound is predicted to result in the contributions from subsequent break-in to the residential dwellings above being satisfactory.

Development of a Noise Management Plan by the developer / future operator to further minimise transferred noise and the implementation of an electronic noise limiter device, will be an important part for achieving satisfactory operating conditions.

1. Introduction.

A2Dominion propose to construct a new mixed use development, including a community hub with residential dwellings above, at the Elmsbrook Local Centre, northwest Bicester. Hoare Lea has been appointed to provide guidance on the acoustics design and operational strategy to control operational noise from the community hub to the residential dwellings.

This report outlines the following:

- Guidance from which the proposed design criteria have been collated;
- Proposed design criteria;
- Guidance strategy for achievement of the design sound insulation; and
- Example of noise management plan measures.

2. Proposed community hub.

The proposed community hub will occupy the ground floor level of the north block of the Elmsbrook Local Hub comprising:

- Reception area;
- Main Hall;
- Small Hall / Community Room;
- Café / Bar / Shop;
- Kitchen;
- Toilets; and
- Ancillary areas.

The community hub will be a flexible space with many different activities likely to take place within it. It is important to point out the Community Hub will not be used as a music venue. There may be occasional use of sound amplification such as for dance classes, event speeches or children's birthday parties but these do not represent the majority of daily community activities.

The community hub is only intended to operate between the hours of 07:00 and 23:00 ie daytime only.

At first floor and second floor levels there are proposed to be residential dwellings of one and two bedroom apartment formats. All the apartments will have their own private balcony.

The whole of the north block is intended by design to be fully mechanically ventilated, with the residential dwellings incorporating ducted MVHR units drawing fresh air from louvres above windows and venting exhaust air in the same manner.

3. Design guidance.

There are a few key guidance and regulatory documents from which the sound insulation design criteria can be derived. Those guidance documents forming the strategy for the proposed development are summarised below.

3.1 Approved Document E.

Approved Document E 'Resistance to the passage of sound' (2003 edition incorporating 2004, 2010, 2013 and 2015 amendments) (ADE) provides guidance on the minimum satisfactory levels of airborne sound insulation within residential buildings. Specific numerical guidance levels are provided of which the minimum between two new build adjacent residential dwellings is $D_{nT,w}$ + C_{tr} 45 dB. The actual requirement for sound separation is subjective stating that *'…flats…shall be designed and constructed in such a way that they provide reasonable resistance to sound from other parts of the same building and from adjoining buildings.'*

Where a non-residential use adjoins a residential dwelling, the following statement is made in ADE:

'A higher standard of sound insulation may be required between spaces used for normal domestic purposes and communal or non-domestic purposes. In these situations the appropriate level of sound insulation will depend on the noise generated in the communal or non-domestic space.'

Construction details for separating floors are contained in ADE However, these are designed for the separation of normal domestic noise and not enhanced for non-domestic noise sources.

3.2 BS 8233:2014.

BS 8233 'Guidance on sound insulation and noise reduction for buildings' 2014 (BS 8233:2014) provides guidance on suitable internal noise levels for residential dwellings generated by external noise sources. Table 1 provides a summary of the criteria contained in BS 8233:2014.

Location and Activity	Daytime (07:00 to 23:00 hours)	Night (23:00 to 07:00 hours
Living room (resting)	35 $L_{Aeq,16hour}$ dB	
Dining room/area (dining)	40 $L_{Aeq,16hour}$ dB	
Bedroom (sleeping, daytime resting)	35 $L_{Aeq,16hour}$ dB	30 $L_{Aeq,8hour}$ dB

Table 1 BS 8233:2014 internal noise guidance criteria for residential demises

The following points should be noted about the context of Table 1:

- the external noise is steady with no specific character; and
- the internal criteria are the sum total of structure-borne and airborne noise sources.

The criteria of Table 1 can also be increased by 5 dB with reasonable internal conditions still achieved, where a development is considered necessary or desirable, despite external noise levels being higher.

No guidance is provided in BS 8233:2014 on the magnitude of maximum noise levels from individual events.

3.3 BS 4142:2014

BS 4142 'Methods for rating and assessing industrial and commercial sound' 2014 (BS 4142:2014) provides a method for estimating the impact of a noise source. The method is based on comparing a rating level of the noise source to the background sound level without the noise source present at a receptor location. The difference is compared to the following scale for evaluation:

'Typically the greater the difference, the greater the magnitude of impact;
– a difference of around +10 dB or more is likely to be an indication of a significant adverse impact;
– a difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context; and
– the lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.'

3.4 Noise from Pubs and Clubs Final Report

The jointly produced *University of Salford and Hepworth Acoustics for Defra 'Noise from Pubs and Clubs Final Report' March 2005* (NfPC-FR) provides a review of available data on entertainment noise from pubs and clubs. It concludes that there are various methods of setting assessment criteria and methods of assessment in use. Listed below are outlines of the typical adopted methods.

- A typical criterion in use in the UK would specify a limit on L_{Aeq} and another L_{eq} limit on one or two specific low-frequency octave bands.
- Limits established based on absolute criteria, often expressed as L_{Aeq}.
- Limits established based on relative criteria, and set an excess L_{Aeq} exceeding or below the background level.

– An absolute criterion based on a Noise Rating (NR) curve, to which L_{eq}, L_{10} or L_{max} values might be compared.

No specific set of criteria or identification of any one better than another method is provided in NfPC-FR.

3.5 Noise from Pubs and Clubs (Phase II) Final Report

The jointly produced *BRE and Capital Symmonds for Defra 'Noise from Pubs and Clubs (Phase II) Final Report' May 2006* (NfPC-IIFR) contains the details and outcome of a study of a variety of different noise measurement methodologies and criteria along with subjective responses for entertainment noise from pubs and clubs. The following is a list of the pertinent outcomes:

'– *The majority of the members of the public reported the ability to tolerate a modest degree of intrusive audible entertainment noise in their home late at night for a "one-off" occurrence.*

– *…a modest degree of intrusive entertainment noise from a "one-off" occurrence was acceptable, and that the onset of audibility of the entertainment noise did not equate to a threshold of acceptability for intrusive entertainment noise in such circumstances. A lesser degree of intrusive entertainment noise was acceptable for more regular occurrences (i.e. once a week), and that for either scenario the onset of audibility of the entertainment noise did not equate to a threshold for enforcement action for intrusive entertainment noise in such circumstances.*
– *The results of the laboratory testing identified several methodologies and criteria, which gave reasonably good correlation with subjective response.*
– *The noise metric that provided the best overall prediction of subjective ratings of all the entertainment noise types tested by ordinary members of the public was the Absolute L_{Aeq}.*
– *However, during the field testing it was apparent that the "highest performers" from the laboratory testing all had clear disadvantages in use under real world conditions, so there is no clear best option for recommendation which combines optimum correlation with subjective response with ease and rapidity of use.'*

The following options are considered the best of the available options, in descending order of correlation with subjective response, each raising different issues regarding practicability of use:

'– *…the noise levels at which test subjects felt the noise was "just unacceptable" for a one off event within a habitable room with windows closed was at 34 dB $L_{Aeq,5\ minute}$. The range for the first two scores of unacceptability was $L_{Aeq,5\ minute}$ 34 to 37 dB.*

– *L_{A90} – L_{A90} (no music) – That is the difference between the $L_{A90,5minute}$ noise level with the intrusive entertainment noise and the equivalent $L_{A90,5minute}$ with no intrusive entertainment noise.*
– *L_{Aeq} – $L_{A99.95}$ or existing Noise Act methodology (L_{Aeq} – $L_{A99.8}$). These metrics include some consideration of the underlying noise level at the same time as any offending noise level is measured, without requiring a separate "no music" measurement to be made.*

3.6 Noise from Pubs and Clubs Annex

The Institute of Acoustics *'Good practice guide on the control of noise from pubs and clubs – Annex, Working Draft on Criteria, Measurement Guidelines and other Relevant Information' September2002* (NfPC-Annex) offers advice on objective noise criteria and associated measurement procedures. Three sets of assessment criteria are proposed for further research and practical feedback in use:

1. Where entertainment takes place less than 30 times per year, not more than once in a single week and ends by 23:00 hours.

   The $L_{Aeq,15minutes}$ dB of the entertainment noise ('the music noise level') should not exceed the representative background level L_{A90} dB (without entertainment noise) by more than 5 dB as measured 1 m from the external façade of a noise sensitive property.

2. Venues where entertainment takes place more than 30 times per year, not more than once in a single week and ends by 23:00 hours.

   The criteria is applicable for both external and internal assessments at noise sensitive properties. The L_{Aeq} dB of the entertainment noise should not exceed the representative background noise level L_{A90} dB (without entertainment noise) by more than 5 dB and the L_{10} of the entertainment noise should not exceed the representative background noise level L_{A90} dB (without entertainment noise) by more than 5 dB in each third octave band between 40 Hz and 160 Hz. If these criteria are met entertainment noise is generally audible but not overly intrusive inside noise sensitive properties.

4. Proposed design criteria.

To control noise emanating from the proposed community hub, the following aspects require design criteria:

1. The contribution to any of the residential dwellings from noise generated internally within the community hub during its operational hours.
2. The contribution to any of the residential dwellings from noise generated in external areas directly used by the community hub.
3. The contribution of noise to any of the residential dwellings from building services plant.

4.1 Internal residential noise criteria.

4.1.1 Daytime.

The worst case noise producing activity likely to take place will be amplified sound associated with functions or exercise classes. Therefore, the daytime criterion needs to provide a mechanism for the control of low frequency noise and the overall level produced.

During the daytime (07:00 hours to 23:00 hours) the guidance of NfPC-Annex is not directly applicable. The guidance of NfPC-IIFR similarly is not directly applicable. However, it can be derived that the noise level contribution to a residential dwelling will need to be lower than L_{Aeq} 34 dB, as this is the threshold for 'just unacceptable'. BS 8233:2014 states a total noise level of $L_{Aeq,16hour}$ 35 dB as being satisfactory for residential daytime resting for steady noise sources.

Consideration also must be given to the cumulative nature of noise contributions, for example, provisional allowance needs to be made for: general external noise break-in; external noise break-in from community hub activities; and internal noise transfer from community hub activities. Acoustically, where there are three contributions to account for, the overall noise target can be reduced by 5 dB to define an equal target for each contribution.

Therefore, applying the provisional allowance for the number of contributions to the NfPC-IIFR target of L_{Aeq} 34 dB, each contribution to a residential dwelling would be limited to a target of $L_{Aeq,16hour}$ 29 dB. This is an overall level that does not account specifically for the frequency content. To convert to a practical design criterion, the conversion approximation of BS 8233:2014 can be used to define an NR value from the L_{Aeq} dB level. The approximation is defined as NR ≈ L_{Aeq} – 6 dB. However, as this is an approximation and NR levels are not uniformly lower at every decibel, verifications would need to be carried out at a later stage.

The proposed design criterion for the daytime noise contributions from the community hub external noise break-in is therefore NR 23, measured inside any residential dwelling. Likewise, the proposed design criterion inside residential dwellings for the daytime noise contributions from internal noise transfer from the community hub is therefore NR23.

Table 2 below provides the NR 23 octave band frequency criteria. The acoustic measurement parameter being the $L_{eq,1hour}$ dB.

Hz	63	125	250	500	1000	2000	4000	8000
dB	54	42	33	27	23	20	17	16

Table 2 NR 23 octave band frequency values

5. Sound insulation feasibility.

There are two aspects of the design and operation that will determine the ability for the proposed community hub to integrate satisfactorily into the mixed use residential building:

1. The building structure and fabric must be capable of providing a sufficient level of sound insulation; and

2. there must be a management protocol to provide operational control of noise generated by staff, visitors and the activities.

With regards to the building structure and fabric sound insulation, there are many aspects that require consideration for the noise of activities to be sufficiently contained. These are reviewed in turn below.

5.1 Internal separating floor.

The nearest residential dwellings are located directly above the community hub at the first floor level. There will be a structural separating floor construction which is required to provide a primary barrier to noise transfer from the ground floor to the first floor.

ADE advises a higher level of sound insulation is necessary between a non-domestic space and a domestic space within the same building, depending on the noise levels generated in the non-domestic space. For this purpose, to provide enhanced airborne sound insulation, a separating criterion of D_{nTw} + C_{tr} 55 dB is advised. To control low frequency performance and achieve the proposed criterion, a heavyweight masonry structural floor combined with high performance floated floor and mass barrier ceiling will need to be considered by design.

A nominal numerical octave band frequency representation of a $D_{nT,w}$ + C_{tr} 55 dB performance is provided in Table 4.

Hz	63	125	250	500	1000	2000	4000	8000
D_{nT} dB	40	50	54	60	65	70	70	70

Table 4 $D_{nT,w}$ + C_{tr} 55 dB octave band frequency values

Sample calculations have been conducted to demonstrate that the floor performance of Table 4 above is satisfactory against the proposed design criteria for noise levels received within the residential dwellings above for both amplified sound and other raised voice speech type activities within the proposed community hub.

For amplified sound, the limited sound pressure level spectra of Table 6 (see Section 5.4) have been used. During the daytime (07:00 hours to 23:00 hours) the predicted maximum internal noise level in a residential dwelling is NR 23.. This satisfies the proposed design criteria of Table 2 and Table 3.

For raised speech of twenty visitors with no amplified sound in operation (see Table 5 below), the predicted noise contribution through the first floor construction is NR 9. This is significantly lower than the criteria proposed and should be negligible.

5.2 Internal flanking paths.

There are potentially a number of internal sound flanking paths that could reduce the effectiveness of the separating floor construction performance by bypassing it.

5.2.1 Facades.

Sound generated within the proposed community hub spaces will invoke sound energy in the external façade constructions, which could travel up to the first floor and breakout to residential dwellings. To avoid this effect being of significance, the following design aspects are advised to be allowed for based on the external facades being of a cavity masonry construction form:

- the structural separating floor must break the continuity of the inner leaf at the first floor junction;
- there must be a mineral wool based cavity closer in the horizontal plain fully closing off the vertical cavity at the first floor junction;
- double boarded independent wall lining in all areas where music will be played.
- external glazing or door should not be full height to the underside of the structural slab (or pre-cast concrete planks). They should be low enough for the mass barrier ceiling to be above the top of the frame.

5.2.2 Impacts on to the flooring.

In all areas of the proposed community hub that could be used for dancing/aerobics/fitness, it is advised to have an acoustically floating floor to reduce the impact energy from the footfalls or exercise equipment dropping. This could take a number of forms, including a timber sprung flooring or an isolated floating screed.

5.3 External flanking paths.

Consideration is required to the control of noise emanating out of the proposed community hub and potentially flanking back into residential dwellings above (i.e. the closest residential dwellings). There are multiple conditions to take into account as listed below:

- windows / external doors of the proposed community hub closed;
- windows / external doors of the proposed community hub open;
- windows / external doors of the residential dwellings closed; and
- windows / external doors of the residential dwellings open.

To narrow down the conditions to those of practical significance, the following reasoning has been applied:

- it is advised that when amplified sound is used , the windows and external doors of that room be in a closed position and ventilation provided by mechanical means.
- the residential dwellings are to be fully mechanically ventilated including a boost mode for control of summertime overheating. Therefore, the acoustic design can rely on the windows and external doors to the residential dwellings being in a closed position.
- it would be up to the choice of residential occupants if they open windows and doors and have higher internal noise levels.

Based on the above, two resulting scenarios have been considered. Scenarios 1 and 2 are for formal operational design :

1. Amplified sound breakout from the proposed community hub and subsequent external noise break-in to the residential dwellings, all based on windows and external doors in a closed position.
2. Other activities in the proposed community hub which might include raised speech at times is produced and subsequent external noise break-in to the residential dwellings..

5.3.1 Scenario 1 amplified sound.

A calculation has been undertaken to predict the received noise level inside any of the nearest residential dwellings above the proposed community hub and external to it. The amplified sound noise spectrum used is provided in Table 6 (see section 5.4 below)..

During the daytime (07:00 hours to 23:00 hours), the result indicates an external noise level in the order of $L_{Aeq,1hour}$ 33 dB at a distance of approximately 4 m from the façade of the proposed community hub. The received internal noise contribution from the external amplified sound noise break-in at a residential dwelling is predicted to be up to NR15 depending on the room type, which is in compliance with the criterion of NR 23.

5.3.2 Scenario 2 other activity.

A calculation has been undertaken to predict the received noise level inside any of the nearest residential dwellings above the proposed community hub and external to it. The raised speech sound power levels used are provided in Table 5 below.

Hz	63	125	250	500	1000	2000	4000	8000
L_w dB	63	66	70	74	75	70	60	50

Table 5 Raised male voice sound power levels

The calculation has assumed ten visitors using raised voices simultaneously in any of the spaces of the proposed community hub.

During the daytime (7am to 9pm), the result indicates an external noise level in the order of $L_{Aeq,1hour}$ 53 dB at a distance of approximately 4 m from the façade of the proposed community hub. This is in compliance with BS8233 guidance of 55dBA in external amenities and balconies.

Within the residential dwellings the predicted internal noise level with windows / external doors open is $L_{Aeq,1hour}$ 43 dB. This is greater than the BS 8233:2014 guidance internal noise levels for external noise break-in. Under the design condition of windows / external doors closed in the residential dwellings, the internal predicted noise contribution is $L_{Aeq,1hour}$ 24 dB in Living Rooms and $L_{Aeq,1hour}$ 18 dB in Bedrooms, which are all in compliance with BS 8233:2014.

5.4 Electronic noise limiter.

It is advised that the use of electronic sound amplification can only be used through a hard-wired electronic noise limiter device within the proposed community hub. This provides the management with a guaranteed method of control over internal noise levels generated. Table 6 below provides the maximum limiting sound pressure levels at octave band frequencies that satisfy the design criteria of Table 2 and Table 3 above based on the initial calculations to demonstrate feasibility. As the design constructions are developed the noise limits will need to be adjusted accordingly to suit the final conditions. They can also be adjusted in-situ once the construction is built to provide appropriate control.

Hz	63	125	250	500	1000	2000	4000	8000
L_p dB (Daytime)	94	92	87	87	88	90	87	86
L_p dB (Night)	90	89	84	83	84	86	83	82

Table 6 Maximum limits for amplified sound noise in any part of the proposed community hub

6. Operational noise management plan.

A2 Dominion will work with the local community organisation to agree how the Community Hub passes to them and how it is managed.

The Noise Management Plan will be worked up with the agreement of the community building operator to include the following points:

- Signage to be located adjacent external doors internally to inform visitors to leave quietly and respect the residential nature of the local area and that rowdy behaviour within the community hub will not be tolerated at any time.

- Staff and regular facilitators of activities to be inducted and formally informed of the Noise Management Plan and its contents and their responsibility to enforce the actions in their general duties.

- Use of external areas is only permitted between 07:00 hours and 21:00 hours.

- Ensure that all windows and doors for spaces with amplified sound remain in a closed position (excepting emergency situations, and ingress/egress) at all times.
- There shall be no use of sound systems located externally.

- All sound or speech amplified sound system shall be routed through an electronic noise limiting device at all times, or other means of warning that noise is in excess of an agreed level is provided to staff so action can be immediately taken to reduce the noise level.

- There shall be no charging of bins and handling of glass bottles outside between 21:00 hours and 07:00 hours.

- Inform local residents of the noise complaint contact details and protocol (to be developed by the operator). All noise complaints should be recorded, along with the action taken to resolve.

- A2 Dominion will assist The Community Organisation in preparing and adopting the Noise Management Plan.

7. Building services plant.

The design selection for building services plant associated with the proposed community hub has not been made at this stage. In order to control the noise from external plant items (and internal plant venting to / from external) it is proposed that standard practice following BS 4142:2014 methodology is implemented. The combined operation of buildings services plant at design duty, will be limited to a 'free-field' Noise Rating level of the prevailing background noise level $L_{A90,T}$ minus 5 dB. The applicable location would be at 1 m from any nearest residential demise window.

8. Conclusions.

Hoare Lea has reviewed the proposed community hub building with residential dwellings above and considered the typical uses that could occur.

Design guidance for satisfactory noise levels in residential dwellings due to external noise break-in and amplified sound has been identified, reviewed and used to form design criteria for the proposed development of the community hub. Although amplified sound will not be of regular occurrence this has been used as a worst-case scenario assessment.

It has been demonstrated that with appropriate selection of the separating floor construction and linings to other sound flanking paths, that internal noise transfer of the worst case activities, amplified sound and raised speech levels can achieve the design criteria proposed.

Similarly, it has been demonstrated that noise breakout from the proposed community hub to external can also be controlled by design (mechanical ventilation to facilitate windows and external doors to remain closed) and that the contributions from subsequent break-in to residential dwellings above is satisfactory.t has been advised that a Noise Management Plan be prepared by the developer / future operator to further minimise transferred noise.

A key component of the design will be an electronic noise limiting device through which all amplified sound systems must be routed. Example noise limiting levels have been used to demonstrate the feasibility of the mechanism to control noise transfer.

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