

SANDY BROWN

Consultants in Acoustics, Noise & Vibration

16094-R21-C

20 August 2020

Kampus, New Build & Tower

Assessment of internal noise levels to discharge Planning condition 22

London, Manchester, Edinburgh, Birmingham, Belfast, Stevenage

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Consultants in Acoustics, Noise & Vibration

Version	Date	Comments	Author	Reviewer
A	17 Dec 19		Jessica Wright	Matthew Robinson
B	19 Dec 19	Minor amendments to Sections 4, 5 and 5.2	Jessica Wright	Matthew Robinson
C	20 Aug 20	Inclusion of Hann Tucker report	Jessica Wright	Matthew Robinson

Summary

Sandy Brown have been appointed by Mount Anvil to provide acoustic consultancy services in relation to Kampus, Manchester.

This report sets out relevant information to discharge planning condition 22 for the New Build and Tower. This section of the scheme is made up of 3 buildings:

- Block C – New build
- Block E – Refurbished tower
- Block F – New build.

The acoustic design and the installed facade as set out in this report meets the requirements of planning condition 22.

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1 Introduction

Sandy Brown have been appointed by Mount Anvil to provide acoustic consultancy services in relation to Kampus, Manchester.

This report sets out relevant information to discharge planning condition 22 for the new build and tower. This section of the scheme is made up of 3 buildings:

- Block C – New build
- Block E – Refurbished tower
- Block F – New build.

2 Planning condition 22

Planning condition 22 states the following:

'22. – Acoustics - The proposed development shall be carried out in accordance with the recommendations in Sandy Browns Acoustic Report dated 21 July 2016 and in line with comments from included in the Deloitte Kampus (Main Scheme) - Schedule of Consultee Comments July 2016 in relation to NSE1 and subject to the following:

(a) Prior to occupation of each block of the residential element of the scheme, a post completion report to verify that all of the recommended mitigation measures have been installed in the residential accommodation shall be submitted and agreed in writing by the City Council as local planning authority and any non compliance suitably mitigated in accordance with an agreed scheme prior to occupation.

(b) Prior to the first use of the commercial units, a scheme of acoustic insulation shall be implemented for the commercial units in accordance with the noise assessment prepared by Sandy Brown and the note from Deloitte stamped as received by the City Council, as Local Planning Authority, on the 21 July 2016 and 12 August 2016 respectively. The approved scheme shall be retained and maintained for as long as the development remains in use and any non compliance suitably mitigated in accordance with an agreed scheme prior to occupation.'

3 Basis of review

The review has been based on the following documents:

- Sandy Brown report 16094-R01-H *Planning noise report*
- Sandy Brown Stage 4 report 16094-R09-B *New Build & Tower - Technical design acoustic report*
- Sandy Brown memos 16094-M126-A and 16094-M162-A
- Chapman Taylor drawings
 - C049KAM-CTA-00-XX-DR-A-SK030
 - C049KAM-CTA-00-XX-DR-A-SK031
 - C049KAM-SK032-P03
 - C049KAM-CTA-00-XX-DR-A-SK030
- FGS drawing KAM-GS-BC-ZZ-DR-X-5052
- FGS technical submittal 36094-FGS-XX-XX-TS-0009
- Cole Jarman assessment 18-0399 M05-1 18.10.04
- Email correspondence with FGS and Chapman Taylor
- Hann Tucker report 25240-2-PTM-AGJ-R0.

3.1 Review of Hann Tucker report 25240-2-PTM-AGJ-R0

A review of Hann Tucker report 25240-2-PTM-AGJ-R0 has been carried out. This report sets out the internal noise level from building services to apartments. The results indicate that the building services internal noise criteria will be met in all locations.

4 Acoustic design requirements – Part (a) – Residential Accommodation

Planning condition 22 part (a) is in relation to the residential section of the scheme. The acoustic design requirements of this element are defined by Manchester City Council (MCC) internal noise criteria and the external noise level predicted at each facade.

4.1 External noise

The external noise levels predicted at the facades of the development are set out in Sandy Brown planning report 16094-R01-H. The external noise levels were predicted from a 3D environmental noise model based on measured noise survey data. From this the facade sound insulation requirements were assessed to meet the MCC internal noise criteria.

Design development subsequent to the planning report is set out in Sandy Brown Stage 4 report 16094-R09-B.

4.2 Internal noise criteria

The internal noise criteria for the development has been set in line with MCC guidance for internal noise and entertainment noise. This is presented in Sandy Brown Stage 4 report 16094-R09-B and is reproduced below.

4.2.1 Residential (background ventilation)

Manchester City Council (MCC) stipulates the criteria provided in Table 1 with regards to internal noise in residential developments.

Table 1 Manchester City Council internal noise criteria for residential developments

Internal space	Internal noise limit, L_{Aeq} (dB)	
	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
Living rooms	35	-
Bedrooms	-	30

It is also stipulates that individual noise events in bedrooms should not exceed L_{Amax} 45 dB by more than 15 times.

In addition, where entertainment noise is a factor in the noise climate, MCC states the following:

'Music noise levels in the 63Hz and 125Hz octave centre frequency bands should be controlled so as not to exceed (in habitable rooms) 47dB and 41dB (L_{eq}), respectively.'

These criteria apply to both music noise from existing premises in the surrounding area and from any non-residential units proposed as part of the development.

From discussions with MCC it is understood that the low frequency noise criteria only applies to bedrooms at night-time (23:00-07:00) for external noise ingress.

4.2.2 Residential (purge ventilation)

It is understood from discussion with MCC that the noise criteria in Section 4.2.1 do not apply during purge ventilation (ie when windows are open to get rid of cooking /paint smells, etc).

4.2.3 Residential (summertime cooling)

During rapid ventilation for summertime cooling, MCC permit a 5 dB relaxation on the criteria given in Section 4.2.1.

4.2.4 Building services noise limits

The maximum internal noise levels due to building services are set out in Table 2 and Table 3.

The noise limits in residential apartments assume equal noise contributions from external noise ingress and building services noise. Therefore the building services noise shall be 3 dB below the internal noise criteria when providing background ventilation (ie, L_{Aeq} 27 dB in bedrooms and L_{Aeq} 32 dB in living rooms).

Table 2 Maximum internal noise levels due to building services in residential apartments

Space	Maximum internal noise levels due building services	
	Background ventilation	Summertime cooling
Bedroom	L_{Aeq} 27 dB	L_{Aeq} 34 dB
Living room	L_{Aeq} 32 dB	L_{Aeq} 39 dB
Bathroom/en-suite	L_{Aeq} 40 dB	

Table 3 Maximum internal noise levels due to building services in other spaces

Space	Maximum internal noise levels due building services
Commercial units	L_{Aeq} 42 dB
Circulation/Stairs	NR 40
Stores	NR 45
Plant rooms	NR 70 (low frequency noise limit of 80 dB in 63 Hz and 125 Hz octave bands)

4.3 Block C

4.3.1 Facade sound insulation performance

The overall facade sound insulation performance requirements are set out in Sandy Brown Stage 4 report 16094-R09-B.

The most onerous overall facade sound insulation performance requirement is $R_w + C_{tr}$ 45 dB with the most onerous low frequency requirement being $R_{63\text{ Hz}}$ 27 dB and $R_{63\text{ Hz}}$ 26 dB.

Based on the external wall information, glazing information and ventilation strategy as set out in the following Sections, the most onerous facade sound insulation performance requirements can be achieved.

4.3.2 External wall constructions

The as built non-glazed facade systems are set out in Chapman Taylor drawings and in Sandy Brown technical memos and reports. A summary is set out in Table 4

Table 4 Summary of Block C facade construction drawings and review

Element	Chapman Taylor drawing ref	Sandy Brown document
Masonry build-up	C049KAM-CTA-00-XX-DR-A-SK030	16094-R09-B
Dutch Houses (with low frequency requirement)	C049KAM-CTA-00-XX-DR-A-SK031	16094-M126-A
Dutch Houses (typical)	C049KAM-CTA-00-XX-DR-A-SK031	16094-M126-A

4.3.3 Glazing

The glazing installed to the apartments is set out in FGS technical submittal *36094-FGS-XX-XX-TS-0009*. This has been reviewed in Cole Jarman assessment *18-0399 M05-1 18.10.04 Glazing Review* which was subsequently reviewed by Sandy Brown in 16094-M144-A.

It has been confirmed by FGS in an email dated 13 December 2019 that the same glazing configuration has been installed to external doors to apartments.

Pixel windows have glazing configuration with a thicker inner pane of 12 mm rather than 10 mm as with the other windows. The thicker inner pane thickness would not reduce the glazing sound insulation performance.

4.3.4 Ventilation strategy

Natural ventilation is not relied upon to provide background ventilation. The minimum overall sound insulation requirements should be able to be achieved with the windows closed.

4.3.5 Building services noise levels

As set out in Hann Tucker report *25240-2-PTM-AGJ-R0*, the noise levels expected from building services will meet the criteria set out in Section 4.2.4. The report is provided in Appendix A.

4.4 Block E

4.4.1 Facade sound insulation performance

The overall facade sound insulation performance requirement is set out in Sandy Brown Stage 4 report 16094-R09-B.

The worst case overall sound insulation requirement is $R_w + C_{tr}$ 45 dB with the most onerous low frequency requirement being $R_{63\text{ Hz}}$ 21 dB and $R_{63\text{ Hz}}$ 20 dB.

Based on the external wall information, glazing information and ventilation strategy as set out in the following Sections, the worst case sound insulation requirements can be achieved

4.4.2 External wall constructions

The as built non-glazed facade systems are set out in Chapman Taylor drawings and in Sandy Brown technical memos and reports. A summary is set out in Table 5.

Table 5 Summary of Block E facade construction drawings and review

Element	Chapman Taylor drawing ref	Sandy Brown document
Typical build-up	C049KAM-SK032-P03	16094-M126-A
Low frequency requirement build-up	C049KAM-SK032-P03	16094-M126-A

4.4.3 Glazing

The glazing installed to the apartments is set out in FGS technical submittal 36094-FGS-XX-XX-TS-0009. This has been reviewed in Cole Jarman assessment 18-0399 M05-1 18.10.04 Glazing Review which was subsequently reviewed by Sandy Brown in 16094-M144-A.

It has been confirmed by FGS in an email dated 13 December 2019 that the same glazing configuration has been installed to external doors to apartments.

Pixel windows have glazing configuration with a thicker inner pane of 12 mm rather than 10 mm as with the other windows. The thicker inner pane thickness would not reduce the glazing sound insulation performance.

4.4.4 Ventilation strategy

Natural ventilation is not relied upon to provide background ventilation. The minimum overall sound insulation requirements should be able to be achieved with the windows closed.

4.4.5 Building services noise levels

As set out in Hann Tucker report 25240-2-PTM-AGJ-R0, the noise levels expected from building services will meet the criteria set out in Section 4.2.4. The report is provided in Appendix A.

4.5 Block F

4.5.1 Facade sound insulation performance

The overall facade sound insulation performance requirement is set out in Sandy Brown Stage 4 report 16094-R09-B.

The worst case overall sound insulation requirement is $R_w + C_{tr}$ 45 dB.

Based on the external wall information, glazing information and ventilation strategy as set out in the following Sections, the worst case sound insulation requirements can be achieved

4.5.2 External wall constructions

The as built non-glazed facade systems are set out in Chapman Taylor drawings and in Sandy Brown technical memos and reports. A summary is set out in Table 6.

Table 6 Summary of Block F facade construction drawings and review

Element	Chapman Taylor drawing ref	Sandy Brown document
Masonry build-up	C049KAM-CTA-00-XX-DR-A-SK030	16094-R09-B

4.5.3 Glazing

The glazing installed to the apartments is set out in FGS technical submittal 36094-FGS-XX-XX-TS-0009. This has been reviewed in Cole Jarman assessment 18-0399 M05-1 18.10.04 *Glazing Review* which was subsequently reviewed by Sandy Brown in 16094-M144-A.

It has been confirmed by FGS in an email dated 13 December 2019 that the same glazing configuration has been installed to external doors to apartments.

Pixel windows have glazing configuration with a thicker inner pane of 12 mm rather than 10 mm as with the other windows. The thicker inner pane thickness would not reduce the glazing sound insulation performance.

4.5.4 Ventilation strategy

Natural ventilation is not relied upon to provide background ventilation. The minimum overall sound insulation requirements should be able to be achieved with the windows closed.

4.5.5 Building services noise levels

As set out in Hann Tucker report 25240-2-PTM-AGJ-R0, the noise levels expected from building services will meet the criteria set out in Section 4.2.4. The report is provided in Appendix A.

5 Acoustic design requirements – Part (b) – Commercial units

Planning condition 22 part (b) is in relation to the commercial units within the scheme. The acoustic design requirements of this element are defined by Manchester City Council (MCC) internal noise criteria and the external noise level predicted at each facade. This information is set out in Sections 4.1 and below.

5.1 Internal noise limits

The following noise limits have been taken from Sandy Brown Stage 4 report 16094-R09-B and reproduced below.

The maximum internal noise levels set out in Table 7 shall not be exceeded in the proposed ground and first floor retail and leisure units.

These are the cumulative levels from external noise ingress and noise from mechanical ventilation systems.

Table 7 Maximum internal noise limits for ground and first floor units

Unit type	Maximum internal noise levels, L_{Aeq} (dB)
Retail unit	45
Leisure unit	45
Residents' foyer	45

5.2 Facade sound insulation

5.2.1 Facade sound insulation performance

Based on the external noise levels at ground and first floor, an overall facade sound insulation performance of R_w+C_{tr} 30 dB shall be provided to the retail/leisure units at these levels.

The strategy set out below is consistent with achieving the facade sound insulation performance.

5.2.2 External wall construction

The commercial unit external wall build-up is set out in drawing *KAM-GS-BC-ZZ-DR-X-5052*. From correspondence with Chapman Taylor it is understood that this applies to Blocks E and F. It was recommended in an email from Sandy Brown dated 11 October 2019 that this build-up could be slightly reduced with one layer of 15 mm WallBoard to still achieve the minimum overall facade sound insulation requirements.

5.2.3 Glazing

The glazing installed to the commercial areas has been confirmed by FGS in an email dated 13 December 2019 as 13.52 mm SGG Stadip Silence Planiclear/16 mm cavity with Argon/12 mm SGG Securit Planiclear HST BS.

This glazing configuration is expected to achieve R_w+C_{tr} 30 dB, the minimum overall sound insulation performance requirement to commercial areas.

5.2.4 Ventilation strategy

Natural ventilation is not relied upon to provide background ventilation. The minimum overall sound insulation requirements should be able to be achieved with the windows closed.

5.3 Floor between Level 2 apartments and commercial areas

Sound insulation tests between commercial areas and Level 2 apartments have not yet been carried out for Blocks E and F. As such the sound insulation performance and operational noise limits are based on desktop assessments where appropriate.

5.3.1 Block C

A sound insulation test of the Block C commercial area floor was carried out and is set out in Sandy Brown report 16094-R20-A *Sound insulation test report ANC ref 141-58487-G*. The floor achieved a sound insulation performance of $D_{nT,w}+C_{tr}$ 58-61 dB. This meets the minimum requirements.

5.3.2 Block E

The installed floor construction is as follows:

- 32 mm Duraboard
- 60 mm resilient cradle and batten system to provide a minimum performance of ΔL_w 17 dB with 50 mm mineral fibre insulation within the cavity (30-60 kg/m²)
- Screed laid on top existing slab (minimum surface density ≥ 30 kg/m²)
- Existing waffle slab (crown depth of 35-40 mm).

This build-up is capable of achieving a sound insulation performance of $D_{nT,w}+C_{tr}$ 47-52 dB. This is set out in Sandy Brown memo 16094-M162-A.

5.3.3 Block F

Drawing *KAM-BHE-BF-02-DR-S-3152* shows a 250 mm thick slab to the Level 2 floor. This is capable of achieving a sound insulation performance 10 dB higher than ADE 2003 (ie, $D_{nT,w}+C_{tr}$ 55 dB) which is set out in Sandy Brown Stage 4 report 16094-R09-B.

5.4 Operational noise limits

Maximum internal noise limits within the ground floor commercial/amenity spaces are provided in this section based on the controlling noise transfer to the apartments above as well as noise egress to the nearby sensitive premises/apartments within the scheme.

5.4.1 Block C and F

The guidance maximum operational noise limits set out in Table 8 are based on the predicted sound insulation of the Level 2 floor and facade.

Table 8 Operational noise limit in commercial units based on controlling noise transfer to the dwellings above

	Octave-band centre frequency (Hz)						
	63	125	250	500	1000	2000	4000
Operational noise limit in commercial units, L_{eq} (dB)	73	71	83	86	89	90	90

5.4.2 Block E

Guidance maximum operational noise limits will be set based on the tested sound insulation performance of the floor and the estimated background noise levels in the apartments.

5.4.3 Setting operational noise limits

Electronic limiters will need to be used on amplification systems in each commercial unit. Limits on noise should be included in a tenant lease agreement to control noise transfer and minimise disturbance to the residents of the apartments above the commercial units. Final sound levels should be set during commissioning of electronic sound limiters in the commercial units to ensure the MCC requirements are met.

5.4.4 Possible tenant enhancement works

If the tenant would like produce noise levels higher than those noted above, they would need to carry out additional enhancement works in order that the MCC criteria are still met. Typical enhancement works would be expected to include:

- Independent lining to the external flanking walls – where it has not been provided
- Independent lining to all internal flanking elements (columns – where it has not been provided, existing walls running between floors)
- Provision of an additional sound insulating ceiling
- Secondary glazing to windows
- Lobbied external doors.

Appendix A

Hann Tucker report 25240-2-PTM-AGJ-R0



PROJECT TECHNICAL MEMORANDUM

Project : Kampus, Manchester
Our Ref : 25240/PTM2
Date : 28 July 2020
From : Andrew Jameson
To : Dan Whitley (Briggs & Forrester)

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RE: MVHR SYSTEMS – NOISE LEVELS WITHIN APARTMENTS

This memorandum presents our assessment of internal ambient noise levels in apartments from mechanical ventilation heat recovery (MVHR) systems serving apartments.

1.0 Criteria

Building services noise level criteria are set out in the Sandy Brown Associates (SBA) acoustic design reports referenced 16094-R10-A (listed refurbishment buildings) and 16094-R09-B (new-build). In apartments, the criteria are cumulative noise levels to be achieved by noise from building services and external noise break-in via the façade. To achieve these, SBA advise noise from building services shall not exceed the levels in Table 1 below within apartments.

Room Type	Maximum internal noise level from building services	
	Background ventilation	Summer Cooling (Boost)
Bedroom	27 dB L _{Aeq} (≈NR 22)	34 dB L _{Aeq} (≈NR 29)
Living Room	32 dB L _{Aeq} (≈NR 27)	39 dB L _{Aeq} (≈NR 34)
Bathroom/En-suite	40 dB L _{Aeq} (≈NR 35)	-

Table 1

Background ventilation is considered to be when MVHR units are providing the minimum whole dwelling ventilation rates set out in Building Regulations Approved Document F (i.e. trickle duty).

2.0 Scope

For each of the scheme's apartment types, Hann Tucker Associates (HTA) has assisted Briggs & Forrester in the design and specification of MVHR systems to satisfy the above noise criteria. This assessment presents calculation sheets to confirm noise output from the final 'as-installed' design solutions/selections. The calculations consider MVHR system-generated (in operation) noise levels to living rooms, index bedrooms and inbox bathrooms/en-suites, including:

- ductborne noise,
- unit casing noise transfer into rooms adjacent to utility cupboard, and
- noise breakout through wall of duct passing through rooms (typically in ceiling voids).



Our calculations use performance data published in formal technical literature obtained directly from the relevant product manufacturers, which were taken as being suitably representative with built-in tolerance for minor anomalies repeat manufacturer. For MVHR units, in-duct sound power levels are “maximum” values at their respective duties.

External noise flanking into apartments via MVHR façade openings (atmospheric inlets/outlets) form part of the façade sound insulation strategy by SBA.

3.0 Project Data

Our calculations are based on MVHR selections by Nuaire for the various apartments when running on trickle and boost duty, and ventilation layout drawings by Briggs & Forrester.

Nuaire units are fitted with MRXBOX-SIL2 ‘acoustic box’ attenuators with the following insertion losses.

Side	Minimum Insertion Loss (dB) for Nuaire MRXBOX-SIL2 at Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
Supply/Exhaust	11	10	9	14	23	26	20
FAI/Extract	8	10	9	10	22	24	16

Where required, in-duct sound attenuators are by Caice who have provided the following minimum silencer (Type 1) minimum insertion loss values.

Length	Minimum Insertion Loss (dB) for Caice Type 1 Attenuators at Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
620mm	3	4	7	13	21	38	45
920mm	4	5	10	19	30	47	49
1200mm	4	7	13	26	39	55	53

Pressure drops across attenuators have been limited to < 10 Pa to mitigate regenerated noise.

4.0 Casing Radiated (Unit) Noise Breakout

All MVHR units will be located in utility cupboards and mounted onto a non-sensitive wall (i.e. not a wall that backs onto a bedroom). Units come with built-in anti-vibration mounts to mitigate vibration. The cupboards are accessed via a door off living rooms.

Calculations of casing radiated noise transfer into a typical living room from the largest (loudest) MVHR unit – System D1 – operating at boost duty have been undertaken. These are detailed calculations using an in-house programme which considers the four types of direct/reverb sound paths and are not easily presentable. However, the key information used to inform our calculations, as well as the results, are given below.



Desc.	Sound Level, dB at OBCF, Hz						Broadband
	125	250	500	1k	2k	4k	
Unit Breakout (Boost) SWL L_w	57	54	53	45	41	30	
Cupboard size: 2m x 1.5m x 2.5m							
Receive room size: 6m x 4m x 2.5m							
Cupboard/Receive room RT: 0.5 s							
Radiating area: 2m x 2.5m							
Separating wall sound reduction, R'	18	25	33	42	45	48	
1xPB, 70mm stud							
Area: 3m ²							
Door sound reduction, R'	16	19	21	21	19	22	
Solid core door, well fitting, 10mm undercut							
Area: 2m ²							
Composite sound reduction to living room, R'	17	22	25	25	23	26	
Resultant Sound Level at 1.5m from door face in Living Room	35	26	22	14	12	<10	24 dBA (NR 18)

The calculated worst-case sound pressure level in the living room is 24 dBA (NR 18) which is more than 10 dB below the cumulative building services criteria.

5.0 System Generated Noise Breakout through Ductwork

Noise generated by the operation of the MVHR will transmit into the ductwork and, before reaching the grille, will be radiate to some degree through the walls of the intermediate ductwork. This ductwork typically runs through ceiling voids and are thus separated from the habitable space by a layer of plasterboard which will mitigate any concerns of noise breakout through the ductwork. However, in the listed building there are occasions where the ductwork is exposed as it traverses through a habitable room.

The MVHR ductwork is constructed from uPVC (rectangular) with thermal lagging to atmospheric side runs. Where there are no ceilings a decorative casing shall be provided in the form of circular standard gauge steel ducting..

SBA will have advised on the minimum requirements for the shell/attenuators/lagging in relation to the façade and control of external noise intrusion. For MVHR system generated noise, we have calculated noise breakout through exposed ducts (as below) which informed our acoustic specification for the decorative casing. This specification required the outer treatment to be a stiff material providing a minimum mass per unit area of 10 kg/m² (which the standard gauge steel ducting achieves) installed with an air gap between the boxing and uPVC duct (e.g. nominal 20mm clearance face to face) and sealed airtight to the full extent of the duct length.

Where required, system-side in-duct attenuators have been installed close to the MVHR units at the point where ductwork penetrates through the utility room wall. This reduces ductborne noise before ducts branch off and traverse through sensitive rooms.

Room: **Living Room**

Desc.	Value	63	125	250	500	1k	2k	4k		Notes
Induct Lw (dB)		55	59	58	53	39	34	30		
Attenuator insertion loss (dB)		-3	-4	-7	-13	-21	-38	-45		
ceiling void duct width (m)	0.21									
ceiling void duct height (m)	0.06									
length of duct in room, L (m)	5									
number of duct runs	1									
Transmission coefficient duct -10lg(1/T)		-16	-19	-22	-25	-29	-24	-30		uPVC - see separate calc below
SRL calculation corrections:										
Length effect		0.0	0.0	0.0	0.0	0.0	0.0	0.0		SRL
+10logL correction		7.0	7.0	7.0	7.0	7.0	7.0	7.0		
Lw breakout of duct, LwB:		43	43	36	22	-4	-21	-38		
Room width (m)	4									
Room length (m)	6									
Room height (m)	2.5									
Receiver distance (m)	1									
Reverberation time (s)	0.5									
Ceiling/casing loss (dB)		-5	-7	-10	-15	-18	-20	-20		10kg/m2 encasement
Room Corrections:										
Directionality (Q=2, tight up to soffit):		3.0	3.0	3.0	3.0	3.0	3.0	3.0		
+10lg((2r/L)tan-1(L/2r))		-3.2	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2		
+10lgN		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Direct Lp:		37.8	35.8	25.8	6.8	-22.2	-41.2	-58.2		
+10*log(T/V)+14		-6.8	-6.8	-6.8	-6.8	-6.8	-6.8	-6.8		
+10lgN		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Reverb Lp:		31.2	29.2	19.2	0.2	-28.8	-47.8	-64.8	dBA	NR
Total Lp in Room:		39	37	27	8	-21	-40	-57	23	17

Architectural Acoustics rectangular duct transmission loss calculation**Lp**

delta LTLio (min) =

duct L =

duct W =

a =

b =

l =

l (in feet) =

mass of duct wall

conversion

Cross Over

fL =

34	dB
200	duct length (mm)
60	duct width (mm)
7.87402	duct length (inches)
2.362206	duct width (inches)
5	length of duct in room (m)
196.8505	length of duct in room (feet)
1.826	kg/m2 (2mm of 913 kg/m3 PVC)
0.380416667	lb/sqft

1297 cross over freq from stiffness to mass

	63	125	250	500	1000	2000	4000
delta LTLio (< fL)	16	19	22	25	29		
delta LTLio (> fL)					18	24	30
Taken	16	19	22	25	29	24	30

The above calculation indicates noise breakout through acoustically treated ductwork (no ceiling) in the worst-case living room with MVHR on Boost is expected to produce a noise level of 23 dBA (NR 17) which is more than 10 dB below the criteria.

6.0 Ductborne Noise to Rooms

Ductborne noise contributions are the primary acoustic consideration as the dominant source of building services noise to apartments. For each apartment type, we have calculated ductborne noise levels to living rooms, index bedrooms and bathrooms from MVHRs running at trickle and boost duties. From this we determined the following sound attenuation requirements which Briggs & Forrester have incorporated into the 'as-built' solution for the listed buildings. The same exercise was repeated for new-build elements, excluded for brevity.



MVHR Systems: Nuaire
In-duct Attenuators: Caice (620, 920, 1220mm lengths)

Apartment Type	MVHR Roomside Duct	
	Supply	Extract
A	MRXBOX-SIL2 + 620mm attenuator	MRXBOX-SIL2
C	MRXBOX-SIL2	MRXBOX-SIL2
D1	MRXBOX-SIL2 + 620mm attenuator	MRXBOX-SIL2
D2	MRXBOX-SIL2 + 620mm attenuator	MRXBOX-SIL2
E	MRXBOX-SIL2 + 620mm attenuator	MRXBOX-SIL2
F	MRXBOX-SIL2	MRXBOX-SIL2
G	MRXBOX-SIL2	MRXBOX-SIL2
H	MRXBOX-SIL2 + 620mm attenuator	MRXBOX-SIL2
I	MRXBOX-SIL2	MRXBOX-SIL2
L	MRXBOX-SIL2	MRXBOX-SIL2
P1	MRXBOX-SIL2 + 620mm attenuator	MRXBOX-SIL2
Q	MRXBOX-SIL2	MRXBOX-SIL2
J	MRXBOX-SIL2 + 620mm attenuator	MRXBOX-SIL2
K	MRXBOX-SIL2	MRXBOX-SIL2
M	MRXBOX-SIL2	MRXBOX-SIL2
N	MRXBOX-SIL2	MRXBOX-SIL2
O	MRXBOX-SIL2	MRXBOX-SIL2

An example calculation sheet for Apartment Type A is attached. The resultant noise levels for all of the above apartment types are evaluated below.

System	Type	Trickle Duty			Boost / Summer		
		Living Room	Bedroom	Bathroom	Living Room	Bedroom	Bathroom
A	2-bed	26	<15	31	37	25	-
C	3-bed	13	<15	28	34	33	-
D1	2-bed	<15	18	34	28	30	-
D2	2-bed	<15	<15	33	27	27	-
E	1-bed	<15	<15	31	28	28	-
F	2-bed	20	21	23	28	29	-
G	1-bed	<15	<15	27	33	33	-
H	2-bed	18	16	34	27	25	-
I	2-bed	23	24	30	33	33	-
L	1-bed	15	15	25	30	30	-
P1	2-bed	25	24	28	25	24	-
Q	Studio	<15	-	27	33	-	-
J	2-bed	16	18	32	26	28	-
K	3-bed	15	<15	32	38	32	-
M	2-bed	22	23	26	28	29	-
N	1-bed	<15	<15	26	32	33	-
O	Studio	<15	-	30	33	-	-
Criterion		32	27	40	39	34	-

The results show resultant dBA noise levels achieve the SBA criterion in all cases.

For and on behalf of
HANN TUCKER ASSOCIATES

Andrew Jameson

A

	0	0	0	0	0	0	0	0	dBA	NR
lp in Room	27	26	36	31	16	9	5	-4	31	26