



The Castings, Manchester

Noise and Vibration Assessment Report

For Packaged Living

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EXECUTIVE SUMMARY

Hydrock has carried out a noise and vibration assessment to discharge the pre-commencement elements of planning Conditions 16 and 17, for The Castings, Manchester.

The results of the assessment found that, as at RIBA Stage 3 of the design, the proposals for acoustic mitigation are sufficient in controlling the external airborne noise ingress to acceptable levels within residential flats.

An assessment of reradiated noise from ground-borne vibration associated with nearby tram movements has been carried out. The results of the assessment indicate that reradiated noise will not significantly impact the proposed development and therefore no specific mitigation measures are required.

Assessments have been carried out to provide scheme for acoustically insulating the development to reduce the potential noise impact associated with proposed ground floor uses, for example a bar/restaurant and/or commercial premises, on existing and proposed noise sensitive receptors.

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1. INTRODUCTION

1.1 Overview

Hydrock has been instructed to provide acoustic engineering services to support the development of The Castings, at Heyrod Street, Manchester.

The proposed development is for the erection of a part 25, part 21, part 7 storey building comprising 39 studios, 77 one-bed, 227 two-bed and 9 three-bed (Use Class C3), with ground floor commercial space within four units for Class A1 (shop), A2 (financial and professional services), A3 (café and restaurant), A4 (drinking establishment), A5 (hot food takeaway), B1 (office) and D1-2 uses, ancillary indoor and outdoor amenity space (including 1st and 21st floor external areas), car parking for 20 vehicles, cycle parking and associated hard and soft land scaping, following demolition of existing buildings.

A planning application was submitted with a noise and vibration ES chapter, and the application was approved with planning Conditions (application reference: 127317/FO/2020).

The planning Conditions relating to acoustics are as follows:

Condition 15

Prior to occupation of

(A) The residential accommodation; and,

(B) The ground floor commercial units

A scheme for the acoustic insulation of any externally mounted ancillary equipment associated with the development to ensure that it achieves noise level of 5dB below the existing background (L_{A90}) at the nearest noise sensitive locations shall be submitted to and approved in writing by the City Council as local planning authority in order to secure a reduction in the level of noise emanating from the equipment. The approved scheme shall be completed before the premises is occupied and a verification report submitted for the approval by the City Council as local planning authority and any non compliances suitable mitigated in accordance with an agreed scheme prior to occupation. The approved scheme shall remain operational thereafter.

Reason - to secure a reduction in noise in order to protect future residents from nuisance, pursuant to policies SP1, H1 and DM1 of the Core Strategy.

Condition 16

Before the development commences a scheme for acoustically insulation and mechanically ventilation the residential accommodation against noise from adjacent roads and the adjacent tram and any mitigating vibration and reradiated noise levels associated with the operation of the adjacent tram line shall be submitted to and approved in writing by the City Council as local planning authority.

The approved noise insulation scheme and vibration and reradiated noise mitigation measures shall be completed before any of the dwellings are occupied.

The following noise criteria will be required to be achieved:

Bedrooms (night time - 23.00 - 07.00)

30dB L_{Aeq} (individual noise events shall not exceed 45dB, $L_{Amax,F}$ by more than 15 times)

Living rooms (daytime – 07.00 – 23.00)

35dB L_{Aeq}

Garden and terraces (daytime)

55dB L_{Aeq}

Where entertainment noise is a factor in the noise climate the sound insulation scheme shall be designed to achieve internal noise levels in the 63Hz and 125Hz octave centre frequency bands so as not to exceed (in habitable rooms) 47dB and 41dB, respectively.

Prior to occupation a post completion report to verify that all of the recommended mitigation measures have been installed and effectively mitigate any potential adverse noise impacts in the residential accommodation shall be submitted and agreed in writing by the City Council as local planning authority. Prior to occupation any non compliance shall be suitably mitigated in accordance with an agreed scheme

Reason – To secure a reduction in noise in order to protect future residents from noise nuisance, pursuant to policies SP1, H1 and DM1 of the Core Strategy.

Condition 17

Before the development commences a scheme for acoustically insulating the ground floor commercial to ensure that there is no unacceptable level of noise transfer from the ground floor uses to the residential accommodation shall be submitted to and approved in writing by the City Council as local planning authority.

Where entertainment noise is proposed the L_{Aeq} (entertainment noise) shall be controlled to 10dB below the L_{A90} (without entertainment noise) in each octave band at the façade of the nearest noise sensitive location.

The approved noise insulation scheme shall be completed before any of the approved uses commence.

Prior to occupation a post completion report to verify that all of the recommended mitigation measures have been installed and effectively mitigate any potential adverse noise impact in adjacent residential accommodation arising directly from the proposed development shall be submitted and agreed in writing by the City council as local planning authority. Prior to occupation any non compliance shall be suitable mitigated in accordance with an agreed scheme.

Reason – to secure a reduction in noise in order to protect future residents from noise nuisance, pursuant to policies SP1 and DM1 of the Core Strategy and saved under UDP Policy DC26.

This report has been prepared to address the pre-commencement elements of the above Conditions, in particular for part of Condition 16 and Condition 17.

This report details the results of a survey and assessment carried out in accordance with Planning Policy British Standards, and with reference to the latest development framework, as at RIBA Stage 3 of the design. The assessment findings and acoustic mitigation are set out herein.

1.2 Context

Hydrock has carried out both an ES, for the planning application, and a RIBA Stage 3 Acoustic Design Strategy Report, for the development.

The assessments and resulting specification for acoustic insulation in both of these reports have been supported by an acoustic survey carried out at the site, and therefore Hydrock hold archived noise data in the vicinity of the site, and are also aware design details, to date.

1.3 Technical Terminology

This report is technical in nature; therefore, a glossary of acoustic terminology is provided in **Appendix A** to assist in understanding this report.

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2. ASSESSMENT METHODOLOGY

2.1 Assessment Brief

An assessment has been carried out to identify how the existing noise climate will impact the sensitive areas of the proposed development site in accordance with Condition 16. Noise has been considered particularly from Great Ancoats Street, to the north east of the site, and from the New Islington to Piccadilly tram line, to the north west. Existing noise data has been used to support the specification of acoustic insulation to mitigate these sources of noise at sensitive areas of the development.

Reradiated ground-borne noise from the movements of the trams has also been considered. An assessment has been carried out based on the results of an additional survey carried out at the development site.

An assessment of the internal noise transfer has also been carried out between the bar/music venue and commercial premises located on the lower floors, and the upper floor residential premises, in accordance with Condition 16 and Condition 17.

An assessment has also been carried out to provide a scheme of reducing the noise level from the bar/music (entertainment) premises to below 10dB below the background noise level at the façade of each noise sensitive receptor in accordance with Condition 17.

2.2 Consultation with Local Planning Authority

The proposed scope of works and assessment methodology were sent to Ms. Sue Jones, within the Environmental Protection team at Manchester City Council (MCC).

In relation to Condition 16, Ms. Jones was in agreement with our proposed noise and vibration assessment methodology for road traffic and rail. Ms. Jones confirmed that scheme of insulation should be determined via the more rigorous calculation methods in BS8233.

She further commented that due to the proposed MVHR ventilation strategy, and the location of the intake/extract points and position of the MVHR units, the internal guideline criteria will need to be validated.

In relation to Condition 17, Ms. Jones comments that the acoustic scheme should include break-out to the NSRs.

2.3 Policy, Standards and Guidance

The assessment carried out considers the following policy, standards and guidance documents:

- National Planning Policy Framework, 2019 (NPPF);
- Noise Policy Statement for England, 2010 (NPSE);
- Planning Practice Guidance – Noise, 2019 (PPG);
- BS8233: 2014 – Guidance on Sound Insulation and Noise Reduction for Buildings (BS8233);
- Manchester's Local Development Framework – Core Strategy Development Plan Document, July 2012;
- Manchester City Council's Planning and Noise Technical Guidance Document, 2015.

A review of the relevant planning policy, standards and guidance is found in **Appendix B**.

2.3.1 Assessment of Noise from Ground-borne Vibration

The conversion of ground-borne vibration to noise has been carried out in accordance with the Kurzweil formula, adopted in PD ISO/TD 14837-31: 2017 'Guideline on field measurements for the evaluation of human exposure in buildings'. The Kurzweil formula is as follows:

$$L_p = L_v - 27$$

L_p is the RMS noise level of a train pass event; and,

L_v is the RMS vibration velocity level of the floor in dB re $1 \times 10^{-9} \text{ ms}^{-1}$

The formula is for the conversion of ground-borne vibration to noise as measured in the same receiving room. However, it is generally considered that the formula is robust when converting free-field vibration, due to free-field vibration being generally higher than structure-borne vibration.

English field research¹, in particular measurements near the London Underground Central Line, showed that applying a factor of 27 to free field vertical vibration rather than floor vibration is sufficient in predicting ground-borne noise levels internally.

There are currently no British or international standards setting criteria for the assessment of noise from ground-borne vibration. In the absence of such standards, assessments of noise from ground-borne vibration are based on early proposals for maximum acceptable levels of ground-borne noise published in the USA by the American Public Transit Association (APTA)² in the 1880s, which were later developed by The Federal Transit Administration (FTA)³.

The recommended ground-borne noise impact thresholds for residential environments are provided in **Table 1** below. These impact thresholds are based on the early research papers, as adopted for HS2 and similar schemes.

Table 1: Recommended Ground-Borne Noise Levels

Impact Threshold	dB $L_{A_{Max,S}}$
Lower Threshold	35
Upper Threshold	45

It is generally considered that 40dB represents a good standard level of reradiated noise, however, in some cases local authorities request a lower limit of 35dB. Where there is no view to the source of vibration, the lower threshold of 35dB is usually considered applicable (adopted by Crossrail and others). However, where there is a view to the source, a higher criteria is usually applied as occupants will have a visual cue, and airborne noise ingress is likely to take aural precedence over the level of noise arising from structure-borne vibration.

45dB $L_{A_{Max,S}}$ is considered to represent the upper noise level limit for reradiated noise from vibration within a residential setting. This value also corresponds to the guideline night time maximum noise levels permitted with bedrooms, as recommended by health-based guidance BS8233 and WHO

¹ Greer, R.J. 1993, Methodology for the prediction of reradiated noise in buildings from trains travelling in tunnels, proceedings of Inter-Noise '93.

² American Public Transit Association, Guidelines for Design of Rapid Transit Facilities, 1981

³ US Department of Transportation, Transit noise and vibration impact assessment, (2006) Report FTA-VA-90-1003-06

Guidelines for community noise. Noise levels above 45dB should be mitigated and reduced to a minimum.

2.4 Acoustic Modelling

Noise prediction modelling has been carried out using CadnaA which uses OS mapping, terrain data, and details of existing and proposed structures to create a 3D study area of the site. Predictions are carried out in accordance with current standards, including CRTN and ISO 9613-2. Details of the proposed development and existing sound sources have been integrated into the model to predict noise levels at the development.

2.5 Receptors

The pre-commencement element of Condition 17 requires entertainment noise to be 10dB below the background noise level at noise sensitive receptors.

We would consider the development itself, and the adjacent Victoria house, to be the closest receptors to bar/music noise. Only proposed receptors have been considered as they would be closer to the development than any existing receptors. The receptors identified for this assessment are in **Table 2** below.

Table 2: Receptors for Assessment

Existing Receptor	Address	Coordinates		Bearing from Site
		X (Easting)	Y (Northing)	
PSR1	The Castings, Heyrod Street	385249	398036	N/A
PSR2	Victoria House	385287	398072	North-East

3. NOISE AND VIBRATION SURVEYS

3.1 Survey Methodology

At all noise monitoring locations (MLs) a Class 1 sound level meter was used. In accordance with British Standard 7445, the A-weighted, time-equivalent, one-third octave band sound pressure levels have been measured, where appropriate, together with the L_{min} , L_{Fmax} , L_{10} and L_{90} indices. All noise measurements were carried out with an integrating sound level meter with the microphone placed vertically on a tripod, approximately 1.5m above ground and at least 3m away from any other reflective surfaces.

The sound level meters were calibration both prior and on completion of the surveys. No drift in calibration occurred greater than 0.5dB.

Vibration measurements were taken using a 01dB ORION triaxial transducer. At all locations the meter was levelled with the x axis pointed towards the source of vibration. Measurements recorded both the peak particle velocity (PPV) and acceleration for vibration does value (VDV).

All surveys were carried out during appropriate weather conditions.

3.2 Survey Overview

A noise survey was carried out at the development site by Hydrock to support an assessment of noise for the planning application.

Details of the monitoring locations during the first site survey are set out in **Table 3** below, and are illustrated on **Figure 1**.

Table 3: Summary of Monitoring Locations (1st Site Survey)

Monitoring No.	Location	Time Period	
		Start	End
ML1	To the north east of the site adjacent to Great Ancoats Street	≈0830hrs 02/11/2018	≈0730hrs 05/11/2018
ML2	To the north east of the site, screened from Great Ancoats Street, with direct line of sight to the local road network and nearby commercial premises to the east and south of the Site	≈0830hrs 02/11/2018	≈0730hrs 05/11/2018
ML3	Adjacent to the northern corner of the site boundary, at the adjacent Victoria House site, closest to the Metrolink line between Piccadilly and New Islington stations	≈1000hrs 17/01/2020	≈1000hrs 20/01/2020

A further two noise monitoring locations were carried out on both 27th August and 4th September 2020, to support the RIBA Stage 3 Acoustic Design Strategy by obtaining spectral noise data for the dominant sources of noise adjacent to the site.

Details of the monitoring locations during the second site survey are set out in **Table 4** below, and are illustrated on **Figure 1**.

Table 4: Summary of Monitoring Locations (2nd Site Survey)

Monitoring No.	Location	Time Period	
		Start	End
ML1	Located to the north west of the development site adjacent to the metrolink tram line	≈0945hrs 27/08/2020	≈1100hrs 27/08/2020
ML2	To the north-east of the site adjacent to Great Ancoats Street	≈0700hrs 04/09/2020	≈1000hrs 04/09/2020

3.2.1 Vibration Survey

A third site survey has been carried out Hydrock to support the discharge of the planning conditions. Vibration monitoring was carried out at three locations. At each location the meter was placed close to foundations of the existing structure.

Monitoring was carried out between the peak-transportation times during the morning period (0700-100hrs). A total of 36 tram passes were recorded going east and westbound, which included both single and double carriages. Monitoring was carried out at three separate points to evaluate how the depth of the rail line, and distance to the receptor, would affect the measured levels of vibration at different points of the development site.

Details of the monitoring locations during the third site survey are set out in **Table 5** below, and are illustrated on **Figure 1**.

Table 5: Summary of Monitoring Location (3rd Site Survey)

Monitoring No.	Location	Time Period	
		Start	End
ML1	Located to the north western boundary of the site at the point where the tramline runs a maximum distance beneath the ground	≈0700hrs 19/03/2021	≈0800hrs 19/03/2021
ML2	Located to the north western boundary of the site at the point where the tramline runs moderate distance beneath the ground	≈0800hrs 19/03/2021	≈0900hrs 19/03/2021
ML3	Located to the north western boundary of the site at the point where the tramline runs at ground level	≈0900hrs 19/03/2021	≈1000hrs 19/03/2021

3.3 Noise and Vibration Monitoring Results

3.3.1 Noise

The result of the first site survey have been integrated into a CadnAa acoustic model to inform the noise impact for the planning application.

In the absence of a full daytime and night-time noise measurement adjacent to the tram line during the first survey, data has been obtained from a survey carried out in the vicinity of the site (application ref:

113363/FO/2016). However, an additional supplementary noise survey was carried out 27th August 2020, in order to obtain specific octave band noise levels associated with tram movements adjacent to the site.

The results of the noise modelling have been appended to this report for reference, **Appendix C**. The model has been checked for accuracy against the levels of noise and spectral data attained from second site survey.

3.3.2 Vibration

The maximum measured levels of PPV and the predicted reradiated noise levels, at each monitoring location, have been set out in **Table 6**. The predicted reradiated noise levels have also been set out fully in **Appendix D**.

Table 6: Summary of Maximum Measured PPV and Predicted Reradiated Noise at each Monitoring Location

Monitoring No.	Z - Axis	
	PPV mms^{-1}	$L_{pAmax,S}$ dB
ML1	0.23	33
ML2	0.12	26
ML3	0.17	39

4. NOISE AND VIBRATION ASSESSMENT

4.1 Assessment of Airborne Noise Levels

4.1.1 External Living Areas

The development holds a small number of balconies and two roof top terraces, one on the 1st floor and the other on the 21st floor. The recommended guideline noise level may be exceeded in these areas, particularly at first floor level, however, the guidance set out in BS8233 and ProPG is clear, in that the guideline values may not be achievable in all circumstances where a development might be desirable, such as in city centres.

In such an instance, the guidance states that practical acoustic design should be considered, and furthermore that a development should not be prohibited on the basis of the noise levels exceeding the guideline thresholds.

The plans indicate a glazed screen between the rooftop terrace on the first floor and sources of noise on Longacre Street, and also a part brickwork façade between the rooftop terrace on the 21st floor and sources of noise. These elements will aid to screen the terraces from sources of noise, and so therefore a practical acoustic design has been considered.

BS8233 further states that external areas such as balconies, rooftop gardens and terraces are also important in residential development where normal external amenity space is limited or not available, and therefore specification of noise limits is not necessarily appropriate.

4.1.2 Daytime Noise Levels within Habitable Rooms

The recommended guideline noise level for living rooms and bedrooms during the daytime period is 35dB $L_{Aeq,16hour}$.

The daytime ambient noise levels in the vicinity of the site and incident on the facades of the development is shown in **Appendix C**.

The minimum composite sound reduction required for facades to achieve appropriate internal daytime noise levels, in accordance with BS8233, are summarised in **Table 7**.

Table 7: Daytime Façade Noise Levels at the Proposed Development and Required Attenuation

Proposed Sensitive Receptors	Daytime Façade Level, $L_{Aeq, T}$ dB	Required Composite Sound Reduction of Façades, D_w , dB
Proposed sensitive receptors on the north eastern façade of the Development	72	37
Proposed sensitive receptors on the north western façade of the Development, adjacent to Longacre Street, and closest to the existing Metrolink Line.	68	33
Proposed sensitive receptors on the eastern façade of the Development	65	30

Proposed sensitive receptors on the south western façade of the Development	64	29
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4.1.3 Night-time Noise Levels within Habitable Rooms

The recommended guideline noise level for bedrooms during the night-time period is 30dB $L_{Aeq,8hour}$, and 45dB $L_{Amax,F}$.

The night-time ambient and maximum noise levels in the vicinity of the site and incident on the facades of the development is shown in **Appendix C**.

The minimum composite sound reduction required for facades to achieve appropriate internal night-time noise levels, in accordance with BS8233, is summarised in **Table 8**.

Table 8: Night-time Façade Noise Levels at the Proposed Development and Required Attenuation

Proposed Receptors	Night-time Façade Level, $L_{Aeq,T}$ dB	Maximum Night-time Façade Noise Level, $L_{Aeq,T}$ dB	Required Composite Sound Reduction of Façades, D_w , dB
Proposed sensitive receptors on the north eastern façade of the Development	67	80	37
Proposed sensitive receptors on the north western façade of the Development, adjacent to Longacre Street, and closest to the existing Metrolink Line.	63	79	34
Proposed sensitive receptors on the eastern façade of the Development	62	79	34
Proposed sensitive receptors on the south western façade of the Development	56	72	27

To determine the internal ambient noise level within sensitive rooms, calculations have been undertaken in accordance with the 'more rigorous' method outlined in BS8233, i.e. BS12354-3, using the level of noise and spectrum at the facades. The calculations consider a worst-case noise sensitive room type, with respect to the distance to the road, the glazing to brickwork ratio and the internal volume.

4.2 Assessment of Ground-borne Noise

The predicted ground-borne noise levels at all MLs, on the vertical axis (z), as shown in **Table 6** and **Appendix D**, are predicted to be below the 45dB $L_{Amax,S}$ upper limit at the ground floor level. This is considered to represent a low impact, and therefore no specific mitigation is required.

The maximum predicted ground-borne noise level at ML3 on the vertical axis is above between 35dB $L_{A_{Max,S}}$ at ground floor level. This is considered to be worst-case as for some of the time the reradiated noise levels would be below 35dB $L_{A_{Max,S}}$.

Furthermore, the predicted noise levels at ML1 and ML2 are below the lower limit of 35dB, which represents a negligible impact. At ML3, the maximum predicted noise level is 39dB, which is below the 40dB level, typically considered to represent a good standard within a residential setting.

Generally reradiated noise levels associated with tram movements would be lower than the maximum values presented in **Table 6**.

This maximum predicted level is above the lower threshold, however flats located closest to the tram line have some line of sight to the tram line. Occupants will therefore have a visual cue of the reradiated and airborne noise associated with tram movements; airborne noise ingress is likely to take precedence.

Furthermore, it is generally understood that levels of vibration reduce from free-field to foundations⁴, whereby the heavier the building the greater the coupling loss. This suggests that the in-situ noise levels are likely to be lower than the predicted levels. This indicates that the impacts predicated herein are robust and include an element of safety.

The development framework indicates that the ground floor use is non-residential, and therefore the vibration should be considered at residential areas on the 1st floor of the development. Literature⁵ suggests a further 1 to 2dB reduction in ground-borne noise can be achieved for each consecutive storey.

In addition to the above, the trams typically operate between 0600-000hrs. Therefore, the potential effect of reradiated noise on sleep disturbance is limited to these operational hours, and potential health effects are significantly reduced.

Finally, the proposed outer building structure will comprise a steel frame system which is more resilient to vibration than concrete based structures, due to the higher stiffness of steel. A number of similar developments, together with masonry-based building constructions existing within similar proximity to the tram line, with no known reported issues e.g. Crusader Mill.

In summary, reradiated noise levels will typically be present but not intrusive and below the LOAEL in accordance with NPSE and PPG – Noise. Therefore, no specified mitigation measures are required.

Should any significant changes to proposed construction be implemented by the Contractor, the design should be reviewed and confirmed by a suitably qualified acoustician on their behalf.

4.3 Noise from Bar/Restaurant and Commercial Premises

The pre commencement elements associated with bar/music noise, state that noise must not be over 47dB and 41dB in the 6Hz and 125Hz octave bands, respectively, in noise sensitive rooms. The noise must be 10dB below the background sound level (L_{90}), at the location of noise sensitive receptors. The nearest noise sensitive receptors to the development are set out in **Table 2**.

The measured background sound levels at ML2, during the first site survey, were approximately 55dB L_{A90} during the daytime and 52dB L_{A90} during the late evening period, which is likely to be representative of the background sound level in the vicinity of the site. Assuming the bar/music premises would not

⁴ Association of Noise Consultants: Measurements and Assessment of Groundborne Noise and Vibration, 2020

⁵ Federal Transit Administration: Transit Noise and Vibration Impact Assessment Manual, 2018

operate during the quiet-night period i.e. (after 0100hrs), noise levels must not exceed 45 L_{Aeq} and 42dB L_{Aeq} at the nearest noise sensitive receptors.

The pre commencement elements associated with the commercial premises, simply state that a method for mitigating the internal noise transfer should be set out, without any given criteria. It is therefore assumed that the scheme of insulation should mitigate commercial noise so as to achieve the BS8233 guideline levels in residential areas but with reference to the noise rating curves (NR).

The NR level is approximately 5dB lower than the average noise level $L_{Aeq, T}$. Therefore, NR ratings which are relative to guideline levels set out in BS8233 and WHO are NR30, NR25 and NR40, for the day, night-time and night-time max, respectively.

Hydrock are not aware of the exact use of the premises at this stage of the design, and under the proposals the retail units would have permission to operate under Class A1 to Class A5 use, together with Class B1, D1 and D2 use. As such, the final use and pertaining noise levels may vary.

As a result, it is not possible to give accurate specifications to mitigate either noise break-out to existing receptors or the internal noise transfer. However, as Hydrock understand, Class D2 use does not encompass night-clubs, and so it can be assumed that any noise associated a bar/restaurant will be low to moderate in nature.

To inform the requirements for acoustic insulation for a bar/restaurant, Hydrock have used archived data of reverberant noise levels inside a given bar and restaurant premises in operation. They are set out in **Table 9** below.

Table 9: Typical Reverberant Noise Levels within a Bar/Restaurant Premises

Location	Sound Level (dB) at Octave Band Centre Frequency (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Restaurant	66	69	73	77	74	70	65	58	79
Kitchen	69	66	69	74	72	69	65	60	76
Bar/Restaurant Venue	80	85	80	80	80	75	75	75	85

Generally, spaces used under A1 Class are not expected to generate high levels of noise. Based on the proposed use of A1 spaces, it is anticipated that the worst-case retail use with respect to noise levels would be a convenience store. Noise levels previously measured by Hydrock in a use similar to that anticipated are set out in **Table 10**.

Table 10: Typical Reverberant Noise Levels within a Commercial Premises

Location	Sound Level (dB) at Octave Band Centre Frequency (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Supermarket Shop Floor	65	64	67	65	61	57	55	47	67

Recommendations for acoustically insulating the façade, to mitigate noise break-out to the receptors, and for acoustically insulating the separating floor, for these uses have been set out within the Acoustic Design Strategy section below.

5. ACOUSTIC DESIGN STRATEGY

5.1 External Airborne Noise Ingress

The noise levels as measured and modelled indicate that insulation is required to mitigate the airborne noise ingress.

A scheme for acoustically insulating the development from external noise has been set prepared based on the design as at RIBA Stage 3. The specifications have been made as a result of noise break-in calculations.

5.1.1 External Wall

There are three wall types for the development, wall type 1 and 2 have a greater sound reduction due to brick cladding and greater internal cavities. Wall type 3, however, has a smaller cavity with an aluminium cladding, which has less sound reduction.

The majority of the wall types at residential facades of the development will be either type 1 or type 2. However, to ensure a robust scheme for acoustic insulation, the calculations consider the external wall build up type 3, as specified as Callison RTKL. It is understood to be a SFS system with either a brick or aluminium cladding. The building up is as follows:

- 2 x 15mm plasterboard (min. 10.5kg/m³);
- 125mm SFS stud fully filled with mineral wool insulation (10-30kg/m³);
- 12mm sheathing board
- 80mm rigid insulation;
- Cavity; and,
- 13mm aluminium cladding.

The plasterboard liner should be, at a minimum, 10.5kg/m³, i.e. British Gypsum Soundbloc.

As a minimum, the sound reduction indices of wall type 3 should perform as outlined in **Table 11**.

Table 11: Minimum Sound Insulation Performance of External Wall

Building Element	Required Sound Reduction (dB) at Octave Band Centre Frequency (Hz)							R _w
	63	125	250	500	1000	2000	4000	
External Wall	17	32	45	52	54	54	61	53

5.1.2 Glazing

The required sound reduction performance for glazed elements and lightweight cladding elements i.e. spandrel panels, but excluding structural glass/curtain walling, depending on the level of façade noise exposure, are summarised in **Table 12** below. Note: the below sound reduction performance values should be achieved by the whole window set including the frame.

Table 12: Minimum Glazing Requirements and Corresponding Façade Noise Exposure

Specification No:	Example Glazing	Required Sound Reduction (dB) at Octave Band Centre Frequency (Hz)							Rw
		63	125	250	500	1000	2000	4000	
1	10/6 - 16/6 Double Glazing	18	24	24	32	37	37	44	35
2	6/16 argon/8.8 Double Glazing	20	25	27	38	48	47	55	41

A façade mark-up of the development proposals corresponding to the configurations are set out in in **Figure 2**, and is representative of each floor of the development.

In all cases, it is essential that the system is tested in accordance with BS EN ISO 10140-22 and rated to BS EN ISO 717-1.

5.1.3 Ventilation

All apartments are to be mechanically ventilated with heat recovery (MVHR) units providing background ventilation. The ventilation will be installed to comply with *The Building Regulation Approved Document F: Means of Ventilation* and *British Standard BS5925 1991: Code of Practice Ventilation Principles and Designing for Natural Ventilation*.

It is understood that MVHR units will have an automated and manually operable boost setting to assist with cooling and purge ventilation. This will allow windows to remain closed to mitigate noise impacts whilst reducing the potential for an overheating condition. Notwithstanding the above, windows will remain openable to allow for additional means of purge ventilation.

The MVHR units shall be designed to:

- The noise and vibration requirements for noise sensitive rooms; and,
- Provide sufficient sound insulation to maintain the acoustic integrity of the façade

We don't anticipate the ductwork of the MVHRs to require inline attenuation, as they're not likely to compromise the acoustic integrity of the façade. However, to achieve the latter, MVHRs atmospheric side terminations and associated duct-runs can be reviewed in detail once that detail is available. At this stage, it is advised that provisions are made to ensure they achieve the minimum weighted element normalised level difference as outlined in **Table 13**. When tested in accordance with BS EN ISO 10140-2 and rated to BS EN ISO 717-1.

Table 13: Required Attenuation – MVHR Ventilators

Specification No	Minimum Specification $D_{n,e,w}$ (dB)	Likelihood of Required In-duct Attenuation
1	35	Unlikely
2	44	Unlikely

5.2 Bar/Restaurant Noise

The internal reverberant octave sound pressure levels within a bar/restaurant venue are shown in **Table 9**.

5.2.1 Façade Noise Break-out

To mitigate the bar/restaurant noise to below the background sound level, the performance of façade elements must be suitably specified to reduce the potential for noise breakout. The level of noise at the receptor can be calculated as follows:

$$L_R = L_{In} - SRI + 10\log(S) - 20\log(R) - 14$$

L_r is the noise level at the receiver

L_{in} is the internal reverberant sound level

S is the surface area of the wall

R is the distance to the receiver

The surface area of radiating wall associated with the retail area is approximately 21m² on the south-eastern façade, and between approximately 60-80% of this is glazing. The calculation should consider the composite reduction index of the entire façade, however, to ensure a robust calculation, only the glazed element has been considered. A distance of 5m has been used to the nearest noise sensitive receptor, which for the purpose of this assessment is the development itself.

A calculation has been carried out to determine the level of noise breaking-out to the receptor location with the glazing and associated window frame providing the one-third octave sound reduction indices outlined in **Table 14**.

Table 14: Minimum Sound Insulation Performance of Glazing Element

Building Element	Required Sound Reduction (dB) at Octave Band Centre Frequency (Hz)							R_w
	63	125	250	500	1000	2000	4000	
Glazing	23	28	31	42	45	50	58	44

An example configuration for this would be 10mm/16mm argon/8.8mm glazing. Note doors to the ground floor units should achieve a minimum performance of 40dB R_w so as to achieve the required composite performance of the façade.

A calculation has been carried out to determine the level of noise breaking out with this level of sound reduction, the calculation is set out in **Table 15**.

Table 15: Calculation of Bar/Restaurant Noise at a given Receptor Location

Description	Sound Level (dB) at Octave Band Centre Frequency (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Bar/ restaurant Venue, L_{in}	80	85	80	80	80	75	75	75	85

SRI	-23	-28	-31	-42	-45	-50	-58	-58	
+ 10Log(s)	+13	+13	+13	+13	+13	+13	+13	+13	
– 20log(r)	-14	-14	-14	-14	-14	-14	-14	-14	
Diffuse + Directivity Correction (-14)	-14	-14	-14	-14	-14	-14	-14	-14	
Lr	42	42	34	23	20	10	2	2	30

An assessment of the one-third octave band noise level has been carried out against the one-third octave noise levels at 52dB_{L_{A90}}, representative of the background noise levels during the late evening period. The results are shown in **Table 16**.

Table 16: Title Assessment of Bar/Restaurant Noise Levels Against the Existing Background Noise Levels

Description	Sound Level (dB) at Octave Band Centre Frequency (Hz)							dB(A)
	63	125	250	500	1K	2K	4K	
Existing Ambient (L ₉₀)	56	52	49	47	49	41	30	52
Threshold Criteria (L _{eq})	46	42	49	37	39	31	20	44
Predicted Bar/Restaurant (L _{eq})	42	42	34	23	20	10	2	33

The results of the calculation and assessment indicate that, with a typical level of noise within a bar/restaurant, and with a sound reduction of a glazing element is equal to or greater than the octave band sounds reduction indicies of the glazing specification set out in **Table 15**, the noise level at given receptor would be approximately 30dB(A). This noise level is significantly less than 10dB below the background sound level, in each octave band, during both the daytime and late evening periods.

5.2.2 Separating Floor

To mitigate the internal sound transmission of the bar/restaurant noise an adequate ceiling should be provided to uprate the acoustic insulation of the floor. The equation to determine the level of noise one room adjacent to a source room is as follows:

$$L_1 = L_2 - SRI + 10\log(S) - 20\log(A)$$

L₁ is the noise level at the receiving room

L₂ is the noise level at the source room

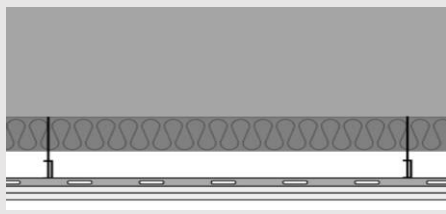
S is the surface area of the ceiling/floor

A is the absorption

A floor area in a receiving room located above an allocated space for retail use is 59m². A 0.5 second reverberation time is also assumed for most modern builds, which equation to approximately 4.5A.

A ceiling has been proposed to uprate the acoustic performance of the separating floor between a bar/restaurant and residential receptor and is presented in **Table 17** below.

Table 17: Floor Detail between a Bar/Restaurant and Residential

	• 250mm concrete slab (min. 2,300kg/m³) • Suspended light steel grid (150mm x 45mm) • 150mm cavity filled with 75mm unfaced, medium-density rockwool (30 kg/m³); • Two layers of 15mm dense homogenous Plasterboard (12.5kg/m²).
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A calculation has been carried out to determine the level of noise breaking through to the receptor location with the above detail. The calculation is set out in **Table 18**.

Table 18: Calculation of Bar/Restaurant Noise within Residential Receptors

Description	Sound Level (dB) at Octave Band Centre Frequency (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Bar/Restaurant Venue Noise, L ₁	80	85	80	80	80	75	75	75	85
Predicted SRI (Insul)	54	60	63	70	77	81	95	95	
Anticipated SRI ^[1]	44	50	53	60	67	71	85	85	
+10logs(S)	18	18	18	18	18	18	18	18	
-20logs(A)	13	13	13	13	13	13	13	13	
Receiving Room, L ₂	41	40	32	25	18	9	<0	<0	28

^[1] - A correction of -10dB has been applied to the predicted SRI from Insul to account for prediction error, flanking transmission, workmanship.

An assessment of the internal noise levels in the 63Hz and 125Hz one-third octave bands has been carried out and is shown in **Table 19**.

Table 19: Assessment of Bar/Restaurant Noise in the 63Hz and 125Hz One-Third Octave Bands

Description	ESR1	
	63Hz	125Hz
MCC Noise Level Limit	47	41
Internal Noise Level	41	40

The results of the calculation and assessment indicate that, based on typical noise levels within a bar/restaurant, and with a separating floor providing the predicted SRI outlined in **Table 18**, the noise within the flats would be below the target levels in the 63Hz and 125Hz octave bands and would also be below 30dB(A).

5.3 Commercial Noise

The internal reverberant octave sound pressure levels within a convenience store, which were previously measured in a convenience store, are shown in **Table 10**.

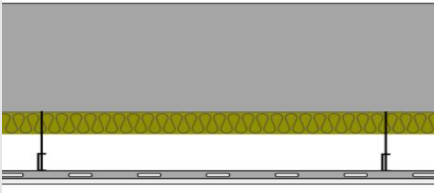
5.3.1 Separating Floor

To mitigate the internal sound transmission of commercial noise an adequate ceiling should be provided to uprate the acoustic insulation of the separating floor. The equation to determine the level of noise one room adjacent to a source room is set out in 5.2.2.

A floor area in a receiving room located above an allocated space for retail use is 59m². A 0.5 second reverberation time is also assumed for most modern builds, which equated to 4.5A.

A ceiling has been proposed to uprate the acoustic performance of the separating floor between a commercial and residential receptor and is presented in **Table 20** below.

Table 20: Floor Detail between Commercial and Residential

	• 250mm concrete slab • Suspended light steel grid (150mm x 45mm) • 150mm cavity filled with 50mm unfaced, medium-density fiberglass (22 kg/m³); • One layers of 12.5mm dense homogenous Gyproc wallboard (640 kg/m²).
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A calculation has been carried out to determine the level of noise breaking through to the receptor location with the above detail. The calculation is set out in **Table 21**.

Table 21: Title Calculation of Commercial Noise within Residential Receptors

Description	Sound Level (dB) at Octave Band Centre Frequency (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Commercial Noise, L ₁	65	64	67	65	61	57	55	47	67
Predicted SRI (Insul)	-41	-55	-62	-70	-78	-84	-89	-89	
Corrected SRI ^[1]	-31	-45	-52	-60	-68	-74	-79	-79	
+10log(S)	+18	+18	+18	+18	+18	+18	+18	+18	
-20logs(A)	-13	-13	-13	-13	-13	-13	-13	-13	
Receiving Room L ₂	39	24	20	10	<0	<0	<0	<0	16

^[1] - A correction of -10dB has been applied to the predicted SRI from Insul to account for prediction error, flanking transmission, workmanship.

In the absence of assessment criteria from MCC, the predicted internal noise levels have been compared against the noise rating curves. The assessment is shown in **Appendix E**.

The results of the assessment indicate that, based on typical noise levels within a convenience store, and with a separating floor providing the predicted SRI outlined in **Table 21**, the predicted internal noise levels are below NR25, which equates to below 30dB(A).

5.4 Recommendations

The following best practice management measures should be employed in order to ensure that noise impact from the bar/restaurant and commercial noise is minimised:

- Limit of amplified music noise within bar/restaurant so that the internal reverberant sound pressure levels in each octave band, repeated in **Table 22**, are not exceeded. This could be achieved with an electronic noise limiter.
- Commercial premises, in particular convenience stores, should limit night-time operations, i.e. 2300-0700hrs. Commercial stores should service all equipment regularly so as to reduce the potential for increased levels of reverberant noise. If wheeled cage trolleys are to be used, care should be taken to avoid generating excessive vibration. This would be assisted by having a smooth rolling surface and level transitions at thresholds. The use of this equipment should be avoided during anti-social hours.

Table 22: Internal Reverberant Noise Limits for a Bar/Restaurant

Description	Sound Level Limit (dB) at Octave Band Centre Frequency (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Bar/Restaurant Venue	80	85	80	80	80	75	75	75	85

It should be noted it is the responsibility of tenants to ensure that noise levels do not exceed the above criteria. If tenants anticipate exceeding these levels, it will be their responsibility to uprate the acoustic performance accordingly.

6. CONCLUSION

Hydrock has carried out a noise and vibration assessment to discharge the pre-commencement elements of planning Conditions 16 and 17, for The Castings, Manchester.

The scope of work and assessment methodology has been discussed with Ms. Sue Jones on behalf of the Environmental Protection team at MCC. Ms. Sue Jones agreed with the assessment methodology principles herein.

The assessments in this report draw upon two previous noise surveys carried out at the development site. A further vibration survey has been carried out specifically to support the assessment of reradiated noise.

An assessment has been carried out to determine the noise impacts at the proposed development with the current design proposals and acoustic mitigation as at RIBA Stage 3 of the design. The results of the assessment have shown that the proposed scheme of insulation is sufficient in controlling internal noise levels to achieve appropriate design criteria, as outlined in Condition 16.

An assessment of reradiated noise from ground-borne vibration, associated with nearby tram movements, has been carried out. The results of the assessment found that reradiated noise will not significantly impact the proposed development and therefore no specific mitigation measures are required. The results of this assessment satisfy the pre-commencement elements of Condition 16.

Calculations have been carried out to determine a scheme for mitigating both the noise break-out and internal transfer from a bar/restaurant premises. The scheme sets out the required sound reduction for the glazing element of the facade at ground floor level, and for the separating floor/ceiling between ground and 1st floor levels.

The calculations indicate external noise levels associated with ground floor uses at nearby receptors can be controlled to an appropriate level via the inclusion of suitable insulation scheme. The implementation of the insulation scheme and noise limits provided herein would ensure noise levels are controlled to 10dB below the existing L_{90} in each octave band externally and below the MCC limits in the 63Hz and 125Hz octave bands, internally for adjacent residential properties. These schemes of insulation satisfy the pre-commencement elements of Condition 16 and 17.

Calculations have also been carried out to determine a scheme for mitigating the internal noise transfer from a commercial premise. The implementation of the insulation scheme would ensure that internal noise levels within adjacent residences would achieve BS8233 design criteria. This scheme of insulation satisfies the pre-commencement element of Condition 17.

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