

1-15 Queen Victoria Street & 147-148 Friar Street, Reading

Noise Impact Assessment Report
Report 21827.NIA.01 Rev B

Thackeray Estates Reading Investments Limited

Report 21827.NIA.01			
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1.0 INTRODUCTION

KP Acoustics Ltd has been commissioned by Thackeray Estates Reading Investments Limited, to assess the suitability of the site at 1-15 Queen Victoria Street & 147-148 Friar Street, Reading, for a mixed-use development comprised of hotel use on the upper floors and retail use at ground floors in accordance with the provisions of the National Planning Policy Framework and the Noise Policy Statement for England (NPSE).

This report presents the results of the environmental survey undertaken in order to measure prevailing background noise levels and outlines any necessary mitigation measures.

2.0 SITE SURVEYS

2.1 Site Description

The site is bounded by Friar Street to the north, Queen Victoria Street to the east, and existing commercial and retail units to the south and west. At the time of the survey, the background noise climate was dominated by road traffic noise from Friar Street, as well as some local road works on Station Road to the north.

2.2 Environmental Noise Survey Procedure

Noise surveys were undertaken on the site as shown in Figure 2.1. The locations were chosen in order to collect data representative of the worst-case levels expected on the site due to all nearby sources.

Continuous automated monitoring was undertaken for the duration of the survey between 11:17 on 08/01/2021 and 10:22 on 11/01/2021.

Weather conditions were generally dry with light winds and therefore suitable for the measurement of environmental noise. The measurement procedure complied with ISO 1996-2:2017 Acoustics '*Description, measurement and assessment of environmental noise - Part 2: Determination of environmental noise levels*'.

2.3 Measurement Positions

Measurement positions are as described within Table 2.1 and shown within Figure 2.1.

Icon	Descriptor	Location Description
	Noise Measurement Position 1	The microphone was installed on a window on the second floor of the north façade, as shown in Figure 2.1. A correction of 3dB has been applied to account for non-free field conditions
	Noise Measurement Position 2	The microphone was installed on a window on the second floor of the north façade, as shown in Figure 2.1. A correction of 3dB has been applied to account for non-free field conditions
	Noise Measurement Position 3	The microphone was installed on a railing on the external walkway (approx. 4th floor height) to the rear of the building, as shown in Figure 2.1

Table 2.1 Measurement positions and descriptions



Figure 2.1 Site measurement positions (Image Source: Design and Access Statement)

2.4 Equipment

The equipment calibration was verified before and after use and no abnormalities were observed. The equipment used is described within Table 2.2.

Measurement instrumentation		Serial no.	Date	Cert no.
Noise Kit 9	Svantek Type 958A Class 1 Sound Level Meter	45578	15/07/2020	14012950
	Free-field microphone PCB 377B02	169770		
	Preamp PCB 426E01	128280		
	Svantek External windshield	-	-	-
Noise Kit 10	Svantek Type 971 Sound Level Meter	55541	03/09/2020	14012949-01
	Aco Pacific 7052E Free-field microphone	70821		
	Preamp Svantek SV18	75770		
	Svantek External windshield	-	-	-
Noise & Vibration Kit 2	Svantek Type 958A Class 1 Sound Level Meter	36655	28/01/2020	14014834-1
	Free-field microphone MTG MK250	10877		
	Preamp Svantek 2v12L	33695		
	Svantek External windshield	-	-	-
Larson Davis CAL200 Class 1 Calibrator		8932	11/02/2020	04624/2

Table 2.2 Measurement instrumentation

3.0 RESULTS

3.1 Noise Survey

The L_{Aeq} : 15min, L_{Amax} : 15min, L_{A10} : 15min and L_{A90} : 15min acoustic parameters were measured throughout the duration of the surveys. Measured levels are shown as time histories in Figures 21827.TH1-3 for noise monitoring positions 1, 2 and 3 respectively.

Measured noise levels are representative of noise exposure levels expected to be experienced by all facades of the proposed development, with logarithmically averaged levels for daytime and night-time shown in Table 3.1.

Time Period	Average ambient background noise level $L_{Aeq, T}$ dB(A)		
	Noise Measurement Position 1	Noise Measurement Position 2	Noise Measurement Position 3
Daytime $L_{Aeq, 16\text{hour}}$	66	61	51
Night-time $L_{Aeq, 8\text{hour}}$	58	56	49

Table 3.1 Site average noise levels for daytime and night time

Representative background noise levels at each measurement position are shown in Table 3.2 for daytime and night-time.

It should be noted that the representative background noise level has been derived from the most commonly occurring $L_{A90, 15 \text{ min}}$ levels measured during the environmental noise survey undertaken on site.

Time Period	Representative background noise level L_{A90} dB(A)		
	Noise Measurement Position 1	Noise Measurement Position 2	Noise Measurement Position 3
Daytime	58	52	49
Night-time	48	46	47

Table 3.2 Representative background noise levels

4.0 NOISE ASSESSMENT GUIDANCE

4.1 Noise Policy Statement For England 2019

The National Planning Policy Framework (NPPF) has superseded and replaces Planning Policy Guidance Note 24 (PPG24), which previously covered issues relating to noise and planning in England. Paragraph 170 of the NPPF states that planning policies and decisions should aim to:

- preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans

In addition, Paragraph 180 of the NPPF states that *'Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should':*

- Mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life
- Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason

The Noise Policy Statement for England (NPSE) was developed by DEFRA and published in March 2010 with the aim to 'Promote good health and good quality of life through the effective management of noise within the context of Government policy on sustainable development.'

Noise Policy Statement England (NPSE) noise policy aims are as follows:

Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

- *Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvement of health and quality of life*

The Noise Policy Statement England (NPSE) outlines observed effect levels relating to the above, as follows:

- NOEL – No Observed Effect Level
 - This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.
- LOAEL – Lowest Observed Adverse Effect Level
 - This is the level above which adverse effects on health and quality of life can be detected.
- SOAEL – Significant Observed Adverse Effect Level
 - This is the level above which significant adverse effects on health and quality of life occur.

As stated in The Noise Policy Statement England (NPSE), it is not currently possible to have a single objective based measure that defines SOAEL that is applicable to all sources of noise in all situations. Specific noise levels are not stated within the guidance for this reason, and allow flexibility in the policy until further guidance is available.

4.2 BS8233:2014

BS8233:2014 '*Sound insulation and noise reduction for buildings*' describes recommended internal noise levels for various spaces.

Section 7.7.5.1.1 of the standard notes that the recommendations for ambient noise in hotel bedrooms are similar to those for living accommodation, with these levels being presented in Table 4.1.

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Rooms	35 dB(A)	-
Dining	Dining Room/area	40 dB(A)	-
Sleeping (daytime resting)	Bedrooms	35 dB(A)	30 dB(A)

Table 4.1 BS8233 recommended internal background noise levels for residential use

The standard also notes that '*...several large chains of hotels have developed their own criteria for insulating rooms against intrusive noise.*' Examples are presented in the standard as guidance only, and reflect commercial judgements dependent on the nature of the accommodation provided, e.g. budget or luxury.

For reference, the general guidance presented within BS8233 with regards to internal ambient noise levels within bedrooms is presented in Table 4.2, which covers the main hotel operator guidance.

Activity	Location	Noise level
Daytime (07:00-23:00)	Hotel bedrooms	30-40dB $L_{Aeq,1 \text{ hour}}$
Night-time (23:00-07:00)	Hotel bedrooms	25-35dB $L_{Aeq,1 \text{ hour}}$
Night-time (23:00-07:00)	Hotel bedrooms	45-55dB L_{Amax}

Table 4.2 BS8233 recommended internal background noise levels for hotel use

At this stage it is not known which operator would run the hotel, and as such the external building fabric would be designed to meet the levels outlined in Table 4.1 for guest rooms.

4.3 BS4142: 2014 'Methods for rating and assessing industrial and commercial sound'

British Standard BS4142:2014 'Methods for rating and assessing industrial and commercial sound' describes a method for rating and assessing sound of an industrial and/or commercial nature, which includes:

- Sound from industrial and manufacturing processes
- Sound from fixed installations which comprise mechanical and electrical plant and equipment
- Sound from the loading and unloading of goods and materials at industrial and/or commercial premises, and
- Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes.

Relevance to this project would be any external plant unit installations proposed, including hotel kitchen equipment, heating/cooling systems, and ventilation systems.

This Standard compares the Rating Level due to the noise source/s under assessment for a one-hour period during the daytime (07:00 – 23:00 hours) and a fifteen-minute period during the night-time (23:00 – 07:00 hours) with the existing background noise level in terms of an L_{A90} when the noise source is not operating.

It should be noted that the Rating Level is the Specific Sound Level in question (L_{Aeq, T_r}), including any relevant acoustic feature corrections, as follows:

- **Tonality** – *‘For sound ranging from not tonal to prominently tonal the Joint Nordic Method gives a correction of between 0dB and +6dB for tonality. Subjectively, this can be converted to a penalty of 2dB for a tone which is just perceptible at the noise receptor, 4dB where it is clearly perceptible, and 6dB where it is highly perceptible’*
- **Impulsivity** – *‘A correction of up to +9dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level. Subjectively, this can be converted to a penalty of 3dB for impulsivity which is just perceptible at the noise receptor, 6dB where it is clearly perceptible, and 9dB where it is highly perceptible’*
- **Intermittency** – *‘If the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3dB can be applied’*
- **Other sound characteristics** – *‘Where the specific sound features characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual acoustic environment, a penalty of 3dB can be applied’*

Once the Rating Level has been obtained, the representative background sound level is subtracted from the Rating Level to obtain an initial estimate of the impact, as follows:

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

NOTE: Adverse impacts may include but not be limited to annoyance and sleep disturbance. Not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact.

The initial estimate of the impact may then be modified by taking consideration of the context in which the sound occurs.

4.4 Local Authority Guidance

Guidance from Reading Borough Council with regards to noise assessments notes the following:

Noise assessments should be prepared by suitably qualified acousticians. They should usually outline the existing noise environment, the potential noise sources from the development, or the noise sources likely to affect the development, together with any mitigation measures. BS4142 assessments should include information about: the sound power level and the likely resultant noise level of equipment at the site boundary for all noise-producing machinery such as extract ventilation systems, refrigeration equipment etc. that is likely to be installed; where any noise-generating plant or equipment will be located and installed so as to reduce noise impacts on neighbouring properties; delivery times and opening hours for commercial premises within noise sensitive areas; details of waste collection for example pubs/clubs where glass collection could be noisy.

5.0 EXTERNAL BUILDING FABRIC SPECIFICATION

Sound reduction performance calculations have been undertaken in order to specify the minimum performance required from glazed and non-glazed elements in order to achieve the recommended internal noise levels shown in Table 4.1, taking into account average and maximum noise levels monitored during the environmental noise survey.

As a more robust assessment, L_{Amax} spectrum values of night-time peaks have also been considered and incorporated into the glazing calculation in order to cater for the interior limit of 45 dB L_{Amax} for individual events, as noted in Table 4.2 above.

5.1 Non-Glazed Elements

It is understood that the non-glazed building façade is comprised of the elements as shown within Table 5.1. The anticipated sound reduction index has been calculated and would be expected to provide the minimum figures shown in Table 5.1 when tested in accordance with BS EN ISO, 140-3:1995.

Element	Octave band centre frequency SRI, dB					
	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz
Brickwork Cavity Wall	41	43	48	50	55	55

Table 5.1 Assumed sound reduction performance for non-glazed elements

5.2 Glazed Elements

Glazing performance calculations have been based both on average measured daytime and night-time noise levels as well as verified against the L_{Amax} spectrum of individual events in order to comply with a maximum internal noise level of 45dB(A). The combined most robust results of these calculations are shown in Table 5.2.

In addition to the noise levels measured on site currently, considerations have also been given to the proposal, specifically the proposed 'Market Square' to the rear of the site. Section 4 of the Design and Access Statement presents the proposed 'Market Square' area and terrace. The DAS notes that *'the outdoor space will benefit from high quality landscape design that will compliment the daily use by cafe and retail operators but will also be suitable for regular events such as local farmers markets and screening of sporting events'*. Therefore, noise levels currently measured at the rear of the site would not be representative for the future situation including the Market Square. Glazing calculations would therefore also consider this future activity to ensure that the amenity of hotel guests is protected at all times.

Minimum octave band sound reduction index (SRI) values required for all glazed elements to be installed are shown in Table 5.2. The performance is specified for the whole window unit, including the frame. Sole glass performance data would not demonstrate compliance with this specification.

Elevation	Octave band centre frequency SRI in Hz, dB						Overall Performance $R_w(C;C_{tr})$, dB
	125	250	500	1k	2k	4k	
North Elevation (Friar Street Elevation)	27	26	25	34	35	38	32 (-1;-3)
East Elevation (Queen Victoria Street Elevation)	22	20	26	36	39	31	31 (-1;-4)
Rear Elevations (Overlooking proposed Market Square)	32	30	35	41	43	50	39 (-0;-3)

Table 5.2 Required glazing performance

The nominated glazing supplier should verify that their proposed window system meets the attenuation figures shown at each centre frequency band in Table 5.2.

Example glazing types that would be expected achieve the above spectral values are shown in Table 5.3.

Elevation	Example glazing type
North Elevation (Friar St Elevation)	SG 5/6/5mm system
East Elevation (Queen Victoria St Elevation)	SG 4/12/4mm system
Rear Elevations (Overlooking proposed Market Square)	SG Phonip 13/10/6mm system

Table 5.3 Example glazing types

All major building elements should be tested in accordance with BS EN ISO 140-3:1995.

Independent testing at a UKAS accredited laboratory will be required in order to confirm the performance of the chosen system for an 'actual' configuration.

Note that the glazing specifications outlined in Table 5.2 should also be met in the case of the windows within the listed section of the building. As these windows cannot be replaced and

will be retained, they should be upgraded internally with a secondary glazing system, as follows:

- Selectaglaze Slimline secondary glazing system (this can be either a vertical sliding, horizontal sliding, hinged casement, or fixed panel system)
- The chosen system should be installed at a minimum distance of 50mm from the primary window system
- The glass within the new secondary glazing system should be 4-6.4mm glass

The above secondary glazing system would provide a performance of at least 39dB R_w *, therefore surpassing or meeting the performance requirements outlined in Table 5.2.

**Note: Vertical and horizontal sliding systems would provide 39dB R_w performance, with hinged casement and fixed panel systems providing 41dB R_w*

5.3 Ventilation Strategy

It is understood that a mechanical ventilation system compliant with Approved Document F would be installed to ventilate all hotel areas. Systems should be designed to meet the internal noise levels as defined in CIBSE Guide A (2015), as shown in Table 5.4.

Room Type	Noise Level
Bedrooms	NR 30
Bathrooms	NR 45
Corridors	NR 40
Hotel Restaurant / Café / Bar	NR 40
External to Hotel Bedroom Windows	45dB(A) at 1m

Table 5.4 Noise levels for mechanical building services

6.0 INTERNAL BUILDING FABRIC SPECIFICATION

As retail units are proposed across the ground floor with hotel rooms proposed above, the floor separating these uses should be designed to ensure that sufficient airborne sound insulation is provided.

6.1 Proposed Floor Upgrade

It is understood that the existing floor is comprised of timber joist system. The ceilings within the retail units are unknown, but it is assumed that nominal quality systems are installed. It is also assumed that as many of the retail units are currently occupied and operational, that the ceilings would not be replaceable due to the disruption it would cause.

Therefore, in order to address the airborne sound insulation for the single joist system, we would recommend the following:

- Removal of all current floorboards within the First Floor. If these need to be replaced due to the listed status of the building, they should be removed carefully and numbered to ensure they are replaced in the same manner they were removed.
- It is recommended that the joist void is cleared of all current debris and enhanced by the installation of CMS Quietslab, which is comprised of a 3mm polymeric mass barrier (mass 10kg/m²) sandwiched between 2x50mm mineral wool slabs (density 60kg/m³)
- Direct fixing of 1x18mm Versapanel cementitious board on the joists if the floorboards are to be replaced, or installed over the existing floorboards if they are to be retained
- 50mm resilient battens as a floating layer with 25mm mineral wool (60kg/m³ density) within the formed void
- Direct fixing of 1x18mm Versapanel cementitious board to the top of the battens, which can accommodate the end walking surface

The above floor system would be expected to achieve an airborne sound insulation performance well in excess of the Building Regulation requirement, and ensure that any noise generated within the retail units is non-intrusive within the hotel rooms above.

7.0 PLANT NOISE IMPACT ASSESSMENT

7.1 Noise Emissions Criterion

In order to ensure that noise emissions from any proposed plant have no adverse impact upon the neighbouring properties or proposed hotel windows, we would propose that it does not exceed a level of 5dB below the representative background noise level at 1m from the closest noise sensitive windows. As noted in Section 4.3, *‘where the rating level does not exceed the background sound level, this is an indication of the specific sound having a low impact, depending on the context’*. In this case, a level of 5dB below the representative background noise level would ensure that the existing background noise of the area broadly masks any noise from the plant at the closest receivers.

Furthermore, as all nearby receivers are office or commercial spaces, and the hotel receivers themselves would not open the windows due to mechanical ventilation. This criterion would therefore ensure that the amenity of all nearby receivers is protected.

As the proposed plant could be used at any time of the day or night, the criterion has been set as shown in Table 7.1 in order to comply with the above requirements.

Time period	Noise Criterion at Nearest Residential Receiver
Night-time (23:00 to 07:00)	41 dB(A)

Table 7.1 Proposed noise emissions criterion

Note that the criterion set is based on the lowest representative background noise level established over night-time hours across the three noise measurements positions to ensure the criterion is robust.

7.2 Noise Impact Assessment

It is understood that the proposed plant installation is comprised of the following units:

Main Plant Enclosure

- 4 No. Daikin RYYQ 20U VRV+heat pump units
- 2 No. Mitsubishi CAHV-P500YB-HPB ASHP
- 2 No. Swegon Gold PX 008 AHUs

Secondary Plant Enclosure

- 3 No. Daikin RYYQ 20U VRV+heat pump units

The plant enclosures noted above are as shown in Figure 7.1.

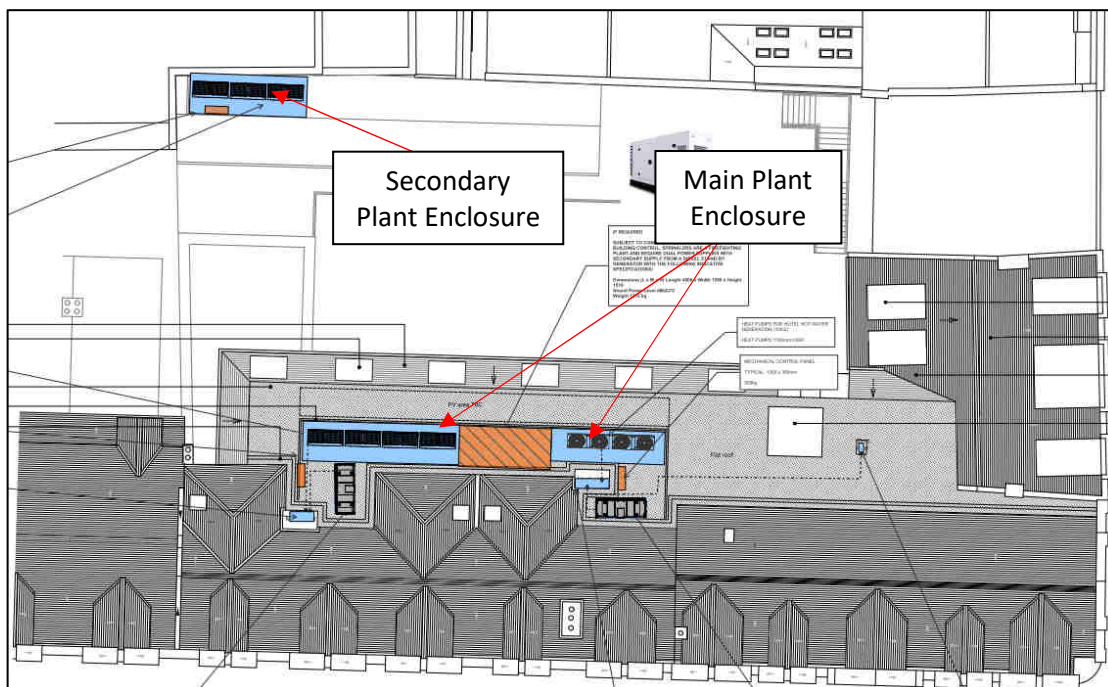


Figure 7.1 Proposed louvred plant area

The noise emission levels as provided by the manufacturer for the units are shown in Table 7.2.

Unit	Descriptor	Octave Frequency Band (Hz)								Overall (dBA)
		63	125	250	500	1k	2k	4k	8k	
Daikin RYYQ 20U	SPL@1m (dB)	71	65	66	63	59	54	53	47	65
Mitsubishi CAHV-P500YB-HPB	SPL@1m (dB)	70	65	60	57	52	46	49	45	59
Swegon Gold PX 008 (Outdoor air/intake)	Sound Power Level	67	60	59	47	40	37	35	37	53
Swegon Gold PX 008 (Exhaust)	Sound Power Level	73	68	68	66	67	67	62	59	73

Table 7.2 Plant Units Noise Emission Levels as provided by the manufacturer

7.3 Closest Noise Sensitive Receiver

The closest noise sensitive receiver to the proposed installation location has been identified as being a hotel window of the development site, located on the floor below the plant enclosure.

It should be noted the proposed plant unit would be out of line of site of the receiving window due to screening from the building envelope and louvred acoustic screen.

7.4 Calculations

The 'Rating Level' of each plant unit installation has been calculated at 1m from the closest receiver using the noise levels shown in Table 7.3, and corrected due to different acoustic propagation features such as distance, reflective surfaces, screening elements, etc.

Detailed calculations for each plant unit installation are shown in Appendix B.

Receiver	Criterion	Noise Level at 1m From the Closest Noise Sensitive Window
Closest hotel window of development site	41dB(A)	33dB(A)

Table 7.3 Predicted noise level and criterion at nearest noise sensitive location

As shown in Appendix B and Table 7.3, transmission of noise to the nearest sensitive windows due to the effects of the plant unit installations satisfies the emissions criterion of Reading Borough Council, providing that the mitigation measures outlined in Section 7.5 are implemented.

7.5 Noise Control Measures

In order to control the noise emissions from the proposed plant, we would recommend that the louvres of the plant enclosure proposed provide the minimum insertion loss levels shown in Table 7.4.

Unit	Insertion Loss Levels (dB) in each Octave Frequency Band							
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Louvres of acoustic enclosure	4	3	4	6	11	13	12	10

Table 7.4 Insertion loss figures to be provided by acoustic enclosure

We would recommend the following suppliers of the aforementioned louvres:

- Kingfisher acoustic louvres
- Environmental Equipment Corporation
- Waterloo Acoustics
- Wakefield Acoustics

8.0 CONCLUSION

An environmental noise survey has been undertaken at 1-15 Queen Victoria Street & 147-148 Friar Street, Reading allowing the assessment of daytime and night-time levels likely to be experienced by the proposed development.

Measured noise levels allowed a robust glazing specification to be proposed which would provide internal noise levels for all internal environments of the development commensurate to the design range of BS8233.

Proposals have been outlined to ensure that sufficient sound insulation is provided between the ground floor retail units and hotel use on first floor.

Manufacturer's noise data of proposed plant units has been used to obtain Specific and Rated Noise Level at the nearest noise sensitive receiver in accordance with British Standard BS4142:2014 for compliance with Local Authority requirements. The rating level was compared with the representative background noise level to assess the likelihood of impact considering the environmental noise context of the area as per the requirements of BS4142:2014. It has been concluded that noise emissions from the proposed plant units would not have an adverse impact on the nearest residential receivers provided that the noise control strategy presented in Section 7.5 is followed.

147-148 Friar Street, Reading
Environmental Noise Time History
From 08 January 2021 To 11 January 2021

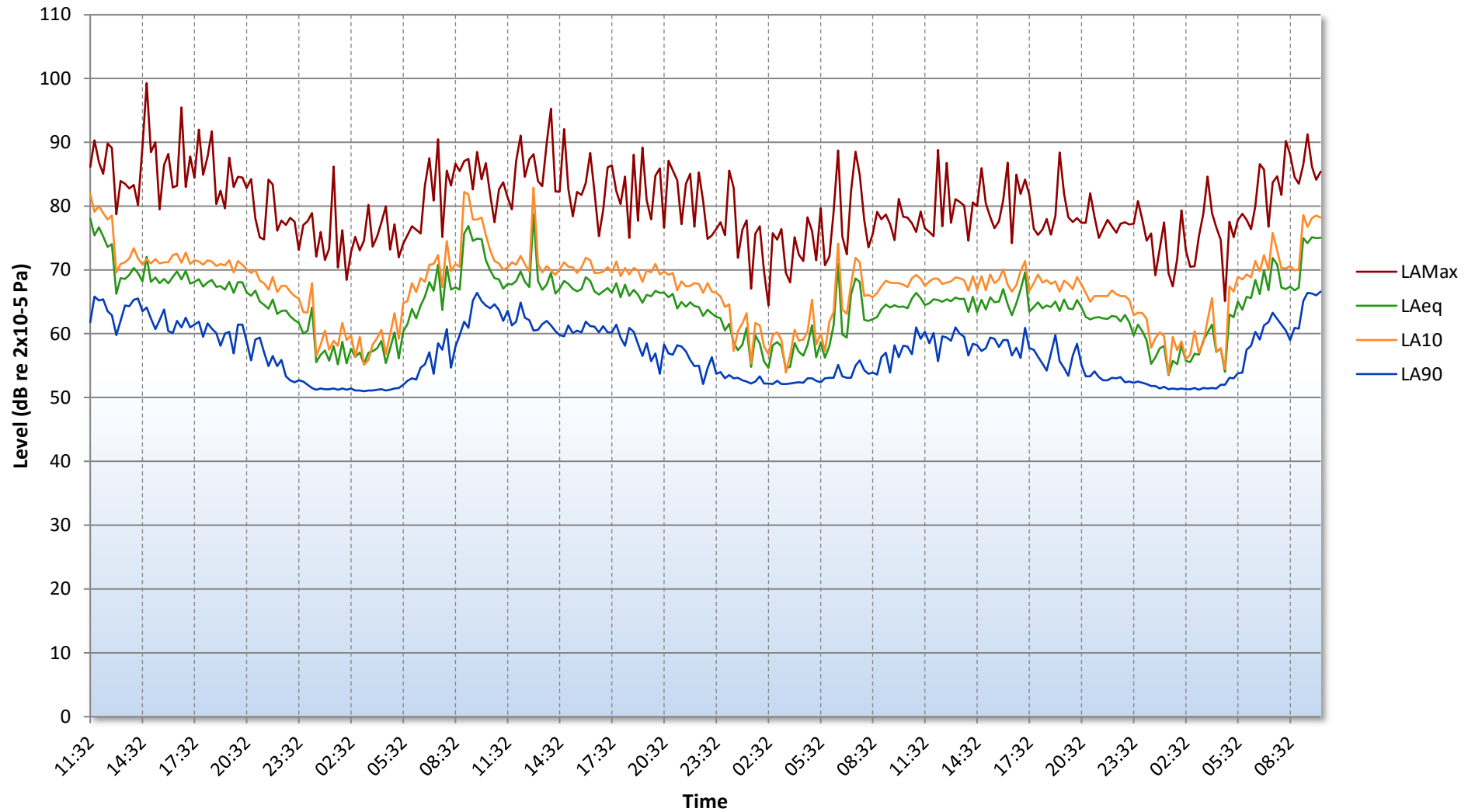


Figure 21827.TH1

1-15 Queen Victoria Street
Environmental Noise Time History
From 08 January 2021 To 11 January 2021

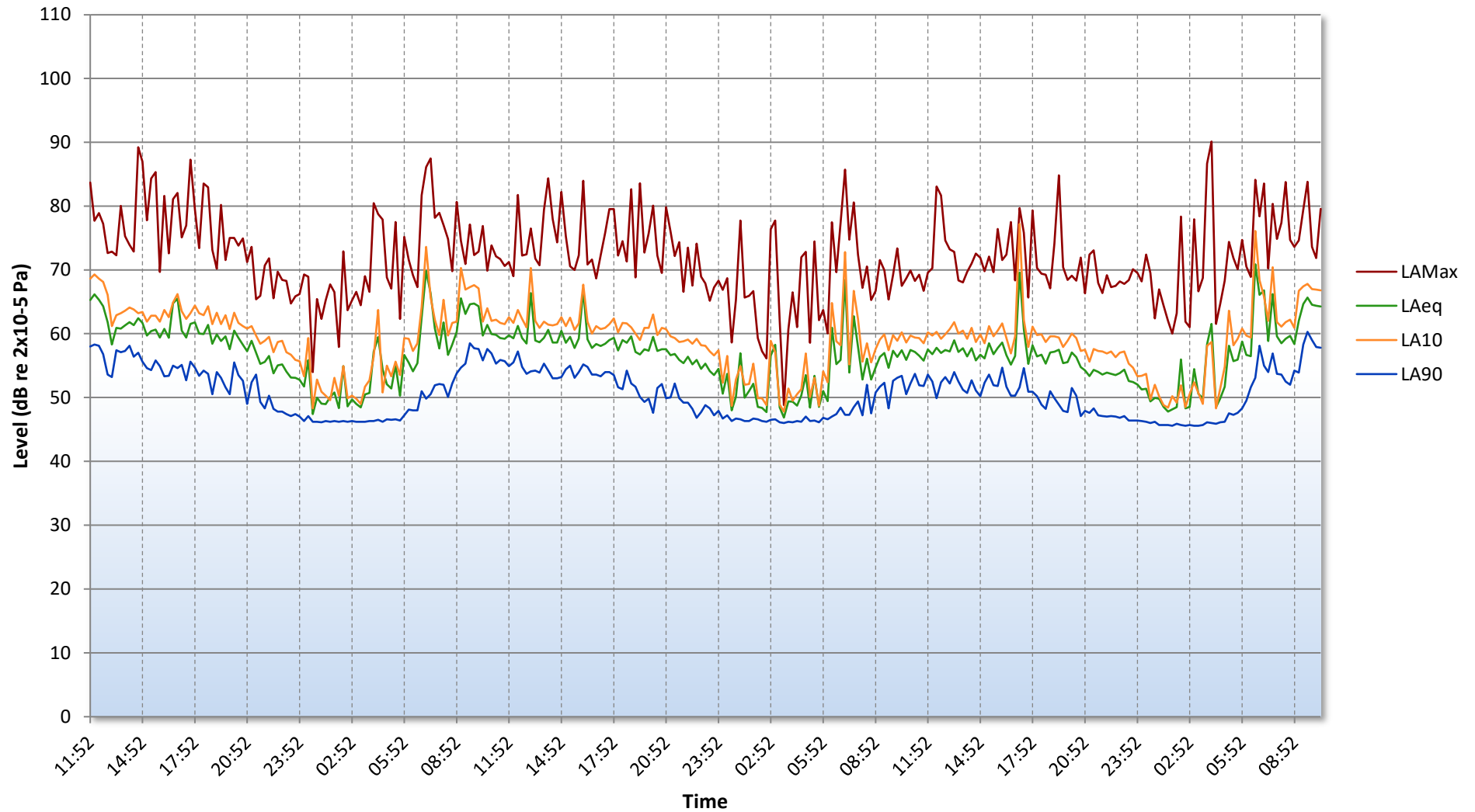


Figure 21827.TH2

Rear of 1-15 Queen Victoria Street & 147-148 Friar Street, Reading
Environmental Noise Time History
From 08 January 2021 To 11 January 2021

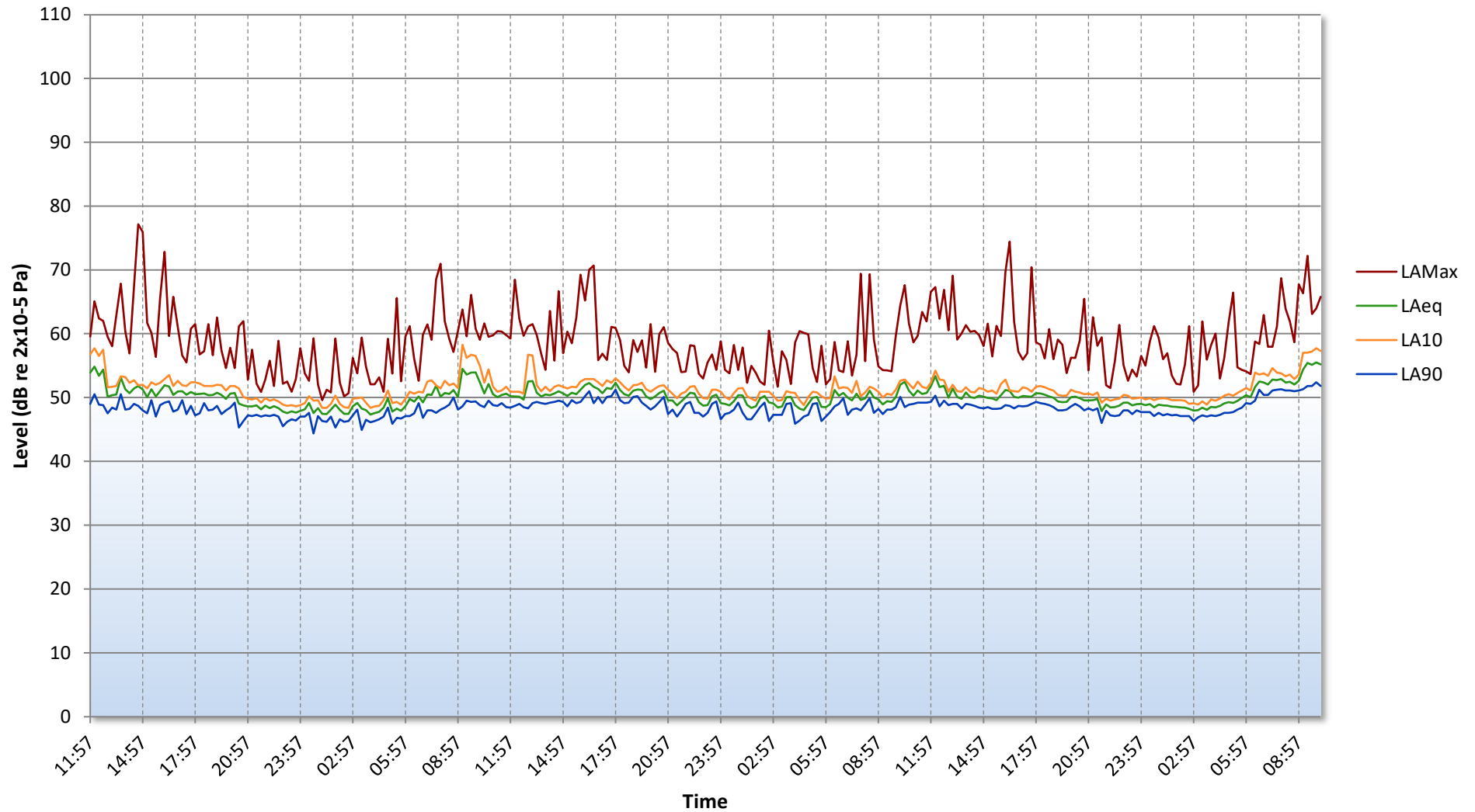


Figure 21827.TH3

GENERAL ACOUSTIC TERMINOLOGY

Decibel scale - dB

In practice, when sound intensity or sound pressure is measured, a logarithmic scale is used in which the unit is the 'decibel', dB. This is derived from the human auditory system, where the dynamic range of human hearing is so large, in the order of 10^{13} units, that only a logarithmic scale is the sensible solution for displaying such a range.

Decibel scale, 'A' weighted - dB(A)

The human ear is less sensitive at frequency extremes, below 125Hz and above 16Khz. A sound level meter models the ears variable sensitivity to sound at different frequencies. This is achieved by building a filter into the Sound Level Meter with a similar frequency response to that of the ear, an A-weighted filter where the unit is dB(A).

L_{eq}

The sound from noise sources often fluctuates widely during a given period of time. An average value can be measured, the equivalent sound pressure level L_{eq} . The L_{eq} is the equivalent sound level which would deliver the same sound energy as the actual fluctuating sound measured in the same time period.

L_{10}

This is the level exceeded for no more than 10% of the time. This parameter is often used as a "not to exceed" criterion for noise.

L_{90}

This is the level exceeded for no more than 90% of the time. This parameter is often used as a descriptor of "background noise" for environmental impact studies.

L_{max}

This is the maximum sound pressure level that has been measured over a period.

Octave Bands

In order to completely determine the composition of a sound it is necessary to determine the sound level at each frequency individually. Usually, values are stated in octave bands. The audible frequency region is divided into 11 such octave bands whose centre frequencies are defined in accordance with international standards. These centre frequencies are: 16, 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000 and 16000 Hertz.

Environmental noise terms are defined in BS7445, *Description and Measurement of Environmental Noise*.

APPLIED ACOUSTIC TERMINOLOGY

Addition of noise from several sources

Noise from different sound sources combines to produce a sound level higher than that from any individual source. Two equally intense sound sources operating together produce a sound level which is 3dB higher than a single source and 4 sources produce a 6dB higher sound level.

Attenuation by distance

Sound which propagates from a point source in free air attenuates by 6dB for each doubling of distance from the noise source. Sound energy from line sources (e.g. stream of cars) drops off by 3dB for each doubling of distance.

Subjective impression of noise

Hearing perception is highly individualised. Sensitivity to noise also depends on frequency content, time of occurrence, duration of sound and psychological factors such as emotion and expectations. The following table is a guide to explain increases or decreases in sound levels for many scenarios.

Change in sound level (dB)	Change in perceived loudness
1	Imperceptible
3	Just barely perceptible
6	Clearly noticeable
10	About twice as loud

Transmission path(s)

The transmission path is the path the sound takes from the source to the receiver. Where multiple paths exist in parallel, the reduction in each path should be calculated and summed at the receiving point. Outdoor barriers can block transmission paths, for example traffic noise. The effectiveness of barriers is dependent on factors such as its distance from the noise source and the receiver, its height and construction.

Ground-borne vibration

In addition to airborne noise levels caused by transportation, construction, and industrial sources there is also the generation of ground-borne vibration to consider. This can lead to structure-borne noise, perceptible vibration, or in rare cases, building damage.

Sound insulation - Absorption within porous materials

Upon encountering a porous material, sound energy is absorbed. Porous materials which are intended to absorb sound are known as absorbents, and usually absorb 50 to 90% of the energy and are frequency dependent. Some are designed to absorb low frequencies, some for high frequencies and more exotic designs being able to absorb very wide ranges of frequencies. The energy is converted into both mechanical movement and heat within the material; both the stiffness and mass of panels affect the sound insulation performance.

APPENDIX B

1-15 Queen Victoria Street & 147-148 Friar Street, Reading

PLANT NOISE EMISSIONS CALCULATIONS

Source: Rooftop plant installation Receiver: Ground floor window of 70 Eaton Terrace	Frequency, Hz								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Main Enclosure									
Daikin RYYQ 20U VRV+heat pump units	71	65	66	63	59	54	53	47	
Correction for number of units (4),dB	6	6	6	6	6	6	6	6	
Correction due to surface reflections (1), dB	3	3	3	3	3	3	3	3	
Minimum attenuation due to building envelope, dB	-11	-14	-16	-16	-16	-16	-16	-16	
Minimum attenuation provided by distance (10m), dB	-20	-20	-20	-20	-20	-20	-20	-20	
Minimum attenuation of proposed louvres, dB	-4	-3	-4	-6	-11	-13	-12	-10	
Total Specific Level of Daikin RYYQ 20U units	45	37	35	30	21	14	14	10	31
Mitsubishi CAHV-P500YB-HPB ASHP	71	65	66	63	59	54	53	47	
Correction for number of units (2),dB	3	3	3	3	3	3	3	3	
Correction due to surface reflections (1), dB	3	3	3	3	3	3	3	3	
Minimum attenuation due to building envelope, dB	-11	-14	-16	-16	-16	-16	-16	-16	
Minimum attenuation provided by distance (21m), dB	-26	-26	-26	-26	-26	-26	-26	-26	
Minimum attenuation of proposed louvres, dB	-4	-3	-4	-6	-11	-13	-12	-10	
Total Specific Level of Daikin RYYQ 20U units	36	28	26	21	12	5	5	1	22
Air Handling Unit - Noise Emissions from Air Exhaust Outlet									
Swegon Gold PX 008 (Sound Power Level)	73	68	68	66	67	67	62	59	
Conversion to SPL@1m	-11	-11	-11	-11	-11	-11	-11	-11	
Correction due to surface reflections (1), dB	3	3	3	3	3	3	3	3	
Minimum attenuation provided by the building envelope, dB	-11	-14	-16	-16	-16	-16	-16	-16	
Minimum attenuation provided by distance (10m), dB	-20	-20	-20	-20	-20	-20	-20	-20	
Minimum attenuation of proposed louvres, dB	-4	-3	-4	-6	-11	-13	-12	-10	
Total Noise Emissions from AHU Outlet, dB	30	23	20	16	12	10	6	5	19
Air Handling Unit - Noise Emissions from Air Supply Inlet									
Swegon Gold PX 008 (Sound Power Level)	67	60	59	47	40	37	35	37	
Conversion to SPL@1m	-11	-11	-11	-11	-11	-11	-11	-11	
Correction due to surface reflections (1), dB	3	3	3	3	3	3	3	3	
Minimum attenuation provided by the building envelope, dB	-11	-14	-16	-16	-16	-16	-16	-16	
Minimum attenuation provided by distance (10m), dB	-20	-20	-20	-20	-20	-20	-20	-20	
Minimum attenuation of proposed louvres, dB	-4	-3	-4	-6	-11	-13	-12	-10	
Total Noise Emissions from AHU Inlet, dB	24	15	11	-3	-15	-20	-21	-17	5
Secondary Enclosure									
Daikin RYYQ 20U VRV+heat pump units	71	65	66	63	59	54	53	47	
Correction for number of units (3),dB	5	5	5	5	5	5	5	5	
Correction due to surface reflections (1), dB	3	3	3	3	3	3	3	3	
Minimum attenuation due to building envelope, dB	-11	-14	-16	-16	-16	-16	-16	-16	
Minimum attenuation provided by distance (15m), dB	-24	-24	-24	-24	-24	-24	-24	-24	
Minimum attenuation of proposed louvres, dB	-4	-3	-4	-6	-11	-13	-12	-10	
Total Specific Level of Daikin RYYQ 20U units	40	32	30	25	16	9	9	5	26
Total Specific Level of all Plant Unit Installations	47	39	37	32	23	17	16	13	33
BS4142 Acoustic Feature Corrections									
Tonality									0
Impulsivity									0
Intermittency									0
Total Rating Noise Level of all Plant Unit Installations at Receiver									33

Design Criterion	41
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