

Kenavon Drive

Noise Breakout Assessment

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Glossary

Term	Definition
Ambient Noise (as defined in BS 4142:2014+A1 2019)	Totally encompassing noise in a given situation at a given time; it is usually composed of noise from many sources, near and far.
Background Noise (as defined in BS 4142:2014+A1 2019)	A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90% of a given time interval, T, measured using the Fast time weighting and quoted to the nearest whole number of decibels.
C _{tr}	Spectrum adaptation term calculated using traffic noise as described in BS EN ISO 717-1:2013. This term is provided with weighted single values such as D _{nT,w} or R _w to match with particular requirements (building acoustic or traffic noise spectrum).
Decibel, dB	Decibel (dB) is a dimensionless unit commonly used to demonstrate sound levels. It is derived from the logarithm of the ratio between the measured level and the reference value. For sound pressure level (L _p) the reference value is 2x10 ⁻⁵ pascals. For sound power (L _w) reference value is 1x10 ⁻¹² Watts.
Frequency	Number of cycles per second, measured in hertz (Hz), related to sound pitch.
IANL	Indoor Ambient Noise Level. For schools Table 1 in BB93 (2015) specifies the upper limit for indoor ambient noise levels within teaching areas. The design criteria is set for a 30-minute average level (i.e. L _{Aeq,30mins}). However, where there is negligible change in the noise level, BB93 states that a much shorter time period (e.g. L _{Aeq,5min}) can be used. BB93 also states that for rooms identified having limits of L _{eq,30min} 35 dBA or less, the noise should not regularly exceed L _{1,30min} 55 dBA.
L _{90,T} (L _{A90,T})	Sound pressure level exceeded for 90% of the measurement period. Referred to as background noise level.
L _{A,r,T}	Rating Noise Level (as defined in BS 4142:2014+A12019), the specific noise level plus any adjustment for the characteristic features of the noise.
L _{eq,T} (L _{Aeq,T})	The equivalent continuous noise level of a time-varying noise. It is the steady noise level which, over the period of time under consideration, contains the same amount of sound energy as the time-varying noise over the same period of time.
L _{Fmax,T} (L _{Afmax,T})	The maximum sound pressure level measured during the measurement period T using the fast time constant.
L _p	Sound pressure level, in decibels, of a sound is 20 times the logarithm to the base of 10 of the ratio of the sound pressure to the reference pressure (2x10 ⁻⁵ pascals). The reference pressure shall be explicitly stated and is defined by standard.
Reverberation Time (RT)	Time required for the steady sound pressure level in an enclosed space to decay by 60 dB, measured from the moment the sound source is switched off. Reverberation time is described in ISO 354:2003.
Specific Noise Level (as defined in BS 4142:2014+A1 2019)	The equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval.
T _{mf}	Mid Frequency Reverberation Time: Within BB93, the reverberation time criteria are set in terms of the averaged value of the 500 Hz, 1000 Hz and 2000 Hz frequency bands. The various levels for T _{mf} are specified within Table 6 of BB93 (2015) and are generally upper limits. Usually the specified mid-frequency reverberation times are for ‘finished but unoccupied and unfurnished rooms’.
Vibration	Force which oscillates about some specified reference point. Vibration is commonly expressed in terms of frequency such as cycles per second (cps), Hertz (Hz), cycles per minute (cpm) or (rpm) and strokes per minute (spm). This is the number of oscillations which occurs in that time period. The amplitude is the magnitude or distance of travel of the force.

Weightings (as defined in BS EN 61672:2013):	A-Weighting: Frequency weighting devised to attempt to take into account the fact that human response to sound is not equally sensitive to all frequencies; it consists of an electronic filter in a sound level meter, which attempts to build in this variability into the indicated noise level reading so that it will correlate, approximately, with human response.). C-Weighting: One of the frequency weightings corresponding to the 100-phon contour and the closest to the linear or un-weighted value.
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1 Executive Summary

Buro Happold has been appointed by Berkeley Homes (Western) to provide acoustic consultancy on the Kenavon Drive residential led, mixed-use development. The development is located at the site of the former Huntley Warf commercial development, which is bound by Kenavon Dr. to the north, Frobury Rd to the west, Blake’s Wharf and the river Kennet to the south and Gas Works Rd to the east.

The development provides residential apartments across three core buildings (West, Middle and East blocks). Amenity spaces are available to residents through a landscaped site and apartments containing balconies, whilst ancillary spaces will contain car parking areas for residents.

The development also provides shell and core spaces for future commercial fitouts on ground and mezzanine floors. A1, A3, B1, C1 and D1 type business classifications are expected.

This report provides a focused assessment of noise associated with the operation of the fixed mechanical plant serving the development. A 3D noise model assessment has been used to specify the noise mitigation works required to satisfy Local Planning Authority guidance generally and Planning Condition 33 specifically.

Section 4 shows the design level targets can be achieved with all plant operational, on implementation of the noise mitigation actions proposed within the report.

If the noise mitigation requirements set out in Section 4 are met in full, the noise assessment demonstrates that Planning Condition 33 can be discharged.

2 Noise Breakout – Design Guidance

2.1 Introduction

The design of the development is informed by the Reading Borough Council’s local planning policy and project specific planning conditions. This section provides a review of the planning policy and conditions, drawing upon other relevant standards to set the desirable and required acoustic criteria for noise break-out from the Kenavon Drive development.

2.1.1 Noise break-out

Figure 2—1 identifies the limiting noise levels for plant (noise generating equipment) at the development from the Reading Borough Council’s local planning policy.

The criteria is in line with BS 4142:2014+A1:2019 and sets a rating noise limit ($L_{A,r,Tr}$ dB(A)) that is 10 dB below the existing background noise level ($L_{A90,T}$ dB(A)). As noted in the planning policy, this level difference avoids the potential of ‘background creep’ – where new plant installations cause incremental increases to background noise climate of an area.

The Kenavon Drive development is also subject to specific planning conditions relating to noise break-out. Condition 33 is shown in Figure 2—2.

Planning condition 33 stipulates a further requirement on the Kenavon Drive development, to design to all ‘sensitive façades’. Whilst considering existing NSRs, the assessment in this report also applies the design levels the façades of sensitive residential receivers within the proposed development itself.

Noise Generating Equipment

EN17: NOISE GENERATING EQUIPMENT

Where noise generating equipment is proposed, the noise source specific⁶¹ level (plant noise level) should be at least 10dBA below the existing background level as measured at the nearest noise sensitive receptor.

Figure 2—1 Reading Borough Council’s local planning policy. EN17: Noise Generating Equipment background level limits

Condition 33

No mechanical plant shall be installed until a noise assessment of the proposed mechanical plant has been submitted and approved by this Council. The assessment shall be carried out in accordance with BS4142:2014 methodology. The predicted specific sound level ($L_{Aeq,TR}$) as measured at a point 1 metre external to sensitive facades shall be at least 10dB below the existing background sound level, $L_{A90,T}$ when all plant/equipment (or any part of it) is in operation. The predicted rating level, $L_{A,r,Tr}$ (specific sound level plus any adjustment for the characteristic features of the sound) as measured at a point 1 metre external to sensitive facades shall not exceed the existing background sound level, $L_{A90,T}$ when all plant/equipment (or any part of it) is in operation. The plant shall thereafter only be installed in accordance with the assessment and maintained as approved thereafter.

Figure 2—2 Kenavon Drive planning condition 33

3 Noise Breakout Assessment

3.1 Introduction

This section highlights the 3D environmental noise modelling carried out to calculate the façade noise levels incident across the various elevations of the building. The calculated sound pressure levels inform the plant noise mitigation required to achieve acceptable noise levels at existing and proposed NSRs.

To determine noise propagation across the proposed development site, CadnaA 2019 acoustic modelling software was used in conjunction with Google Earth mapping data. The model accurately maps how noise impacts on the proposed façades, considering factors such as distance attenuation, natural and man-made barrier attenuation, reflections and source directivity. Typically, an uncertainty within a range of approximately +/- 3 dB could be expected from any computer noise modelling approach.

3.2 Site Overview

The development is located at Kenavon Drive, Reading. It is bounded by the following as shown in Figure 3—1:

- Kenavon Drive to the north;
- Forbury Road (A329) to the west;
- Blake’s Wharf and the River Kennet to the South; and
- An existing residential development to the east.

The noise breakout assessment within this report aims to design plant to achieve suitable noise levels 1m from the facades of the existing NSR and future Kenavon Drive dwellings.

3.3 Kenavon Drive Plant Noise Breakout - Design Levels

Table 3—1 shows the design level limits for daytime and night-time periods based on planning condition 33 (most onerous design level target) and Reading Borough Council’s local planning policy.

The representative background noise environment was identified from in-situ noise survey measurement data (provided for reference in Appendix A of this report) collected near the existing NSRs at measurement position 1 in Figure 3—1. The background noise climate at this position was taken to be an arithmetic average of $L_{A90,15\text{minute}}$ values measured during representative, worst-case (lowest level) day and night-time periods. It is acknowledged that averaging statistical quantities interferes with their statistical basis, however, it is proposed that this practice has merit in representing a typical value for use in assessment.



Figure 3—1 Image showing the Kenavon Drive site and NSRs for the noise breakout assessment

Table 3—1 Daytime and night time design level limits for the Proposed Development plant items

Design Level Period	Background noise level measured on-sight - $L_{A90,T}$ dB(A)	Plant noise level limits 1m from sensitive façades $L_{A,T,r}$ dB(A)
Daytime (07:00-23:00)	45	35
Night-time (23:00-07:00)	39	29

*The noise survey data forming the requirements above has been extracted from the 'Kenavon Drive Stage 4 Acoustics Report' (issued 8th June 2020) for reference in Appendix A of this report.

3.4 Building Services Plant Types and Locations

The following plant items are included in the noise assessment at the site of the Proposed Development.

3.4.1 Energy centre plant and exhaust flues

Located on the ground floor of the development (recessed 1.4 metres from ground level) in the central block (Core M3)

Energy centre air is mechanically supplied via a rectangular duct system that is connected to an external termination of the development by a 2.4m x 2.9m louvre. Noise breakout through the supply ducts can potentially adversely affect the proposed developments residential and commercial (nursery) spaces

Energy centre air is mechanically extracted through a 4.5m x 0.9m metre plenum. The extract efflux point is located in the non-noise sensitive car parking area

Boiler and CHP exhaust gases escape from the plant compound by flues that terminate at roof level of middle block (Core M2, ~40 metre efflux termination height)

Energy centre plant sound power levels (unsilenced) are provided in Table 3—2

Energy flue gas sound power levels (unsilenced) are provided in Table 3—3

Nuaire air supply / exhaust fan sound power data (unsilenced) are provided in Table 3—4.

3.4.2 Substation plant

Located on the ground floor of the development in the middle block (Core M4) and East block (Core E4)

East Block contains a 1500kVA substation and the Middle Block contains a 1000kVA substation

Kenavon Drive substation sound power levels (unsilenced) are shown in Table 3—5.

3.4.3 Commercial plant

It is understood that the development contains five future fit-out spaces for commercial units (Source: Kenavon Drive, Phasing, Block & Plot Plan, Drawing Number: O.446.ENG.001)

Within this assessment, plant limits will be set to attain suitable noise levels 1m from sensitive facades for an extract fan in the restaurant space, and air handling units ducted to the front of the commercial unit facades.

Table 3—2 Energy centre internal plant sound power level data (unsilenced)

Plant Equipment	Number of Operational Plant Units	Frequency Band (Hz) Sound Power Levels – dB								Broadband level - dB(A)
		63	125	250	500	1k	2k	4k	8k	
Hoval Ultra Gas 1150 – Boilers	3	90	85	77	74	80	74	69	62	82
Hovel PowerBloc - CHP	1 – Daytime Only	72	70	70	74	74	78	72	61	81*
Magna1 65-150F Boiler Circulating Pumps	3	65	57	52	53	50	44	45	49	56*
Pressurisation Unit	1	58	58	58	58	58	58	58	58	65**
Secomak 576 CHP Gas Booster	1 – Daytime Only	80	80	80	80	80	80	80	80	87**
Grundfos Distribution Pumps	3	54	56	58	65	65	60	61	63	70*

**Manufacturer specification data for the proposed plant unit only contains a broadband sound power level value. Octave band data has been calculated using equivalent spectrums to similar plant units previously used on Buro Happold projects.*

***Manufacturer specification data only contains a broadband sound power level value. Flat frequency response data has been assumed for these pump products.*

Table 3—3 Energy centre flue gas sound power level data (unsilenced)

Plant Equipment	Number of Efflux Terminations	Frequency Band (Hz) Sound Power Levels – dB								Broadband level - dB(A)
		63	125	250	500	1k	2k	4k	8k	
Hovel PowerBloc – CHP Flue	1 – Daytime Only	85	86	88	90	99	95	89	80	101*
Hoval Ultra Gas 1150 – Boiler Flue	3	87	88	78	72	76	72	66	60	79

**Manufacturer specification data for the proposed plant unit only contains a broadband sound power level value. Octave band data has been calculated using equivalent spectrums to similar plant units previously used on Buro Happold projects.*

Table 3—4 Energy Centre air supply / exhaust fan sound power levels when running at required duty (unsilenced)

Plant Equipment	Number of Operational Plant Units	Frequency Band (Hz) Sound Power Levels – dB								Broadband level - dB(A)
		63	125	250	500	1k	2k	4k	8k	
Nuaire AM62ES Fan Inlet	2	87	80	69	70	63	60	56	54	71
Nuaire AM44ES Fan Outlet	2	82	84	82	82	73	74	74	60	82

Table 3—5 Kenavon Drive substation sound power levels (unsilenced)

Plant Equipment	Frequency Band (Hz) Sound Power Levels – dB(A)								Broadband level - dB(A)
	63	125	250	500	1k	2k	4k	8k	
Middle Block 1000kVa substation	23	27	38	37	35	40	42	11	46*
East Block 1500kVA substation	29	33	44	43	41	46	48	17	52

**Manufacturer specification data for the proposed plant unit only contains a broadband sound power level value. Octave band data has been calculated using equivalent spectrums the 1500kVA substation plant.*

3.4.4 Corridor and core ventilation

As the greater levels of duty by the fans would be in emergency scenarios only, it is typically considered best practice to limit noise emissions associated with emergency plant to a noise level that is 10 dB above the representative background noise level. No specific guidance is contained within the Reading Borough Council’s Local Planning Policy.

For corridors in the proposed development, typical ventilation is understood to be attained through openable louvres and natural vent smoke shafts, therefore are not included as a source within the desktop noise assessment.

3.4.5 Car park plant

3.4.5.1 Air circulation

It is understood that pulse fans are proposed in the Kenavon Drive car park areas for air circulation. Whilst car parks are non-sensitive noise spaces, the recommended plant criterion for noise comfort is NR 55 or a background noise level of 60 dB(A) $L_{Aeq,T}$ (Source: Environmental Design: CIBSE Guide A, Table 1.5, page 33).

Shown in Table 3—7, the 355mm diameter jetfan proposed for use in the Kenavon Drive car parking areas should meet the CIBSE criteria under normal operating conditions.

Whilst these devices are cable of running at 1.9m³/s with a sound pressure level of 66 dBA ($L_{Aeq,T}$ at 3m), it is understood from MEP engineers that this operating condition is likely to only happen in the event of a fire or the annual life safety equipment test.

3.4.5.2 Ventilation

The car parks are proposed to be mechanically ventilated using Sabina EC 160mm (Compact) Fans.

The in-duct sound power level performance data for the middle and east block plant units under normal daytime operation (07:00-23:00), is provided in Table 3—6.

The external efflux termination points for the ventilation ducts is understood to be podium top vents directly above the car park areas. The desktop noise assessment within this report, provides the in-duct silencer and louvre insertion loss performance targets required against Planning Condition 33. The model assesses the typical daytime duty in Table 3—6, against the 35 dB $L_{A,T}$ daytime noise level threshold.

It is understood from MEP engineers that the 10ACH operating condition for the Sabrina EC fan is likely to only happen in the event of a fire or the annual life safety equipment test. As this is an emergency condition, it has not been assessed for noise impact.

3.4.6 Current acoustic mitigation proposals

Intake and extract fan attenuators have been specified by Kenavon Drive MEP engineers for the energy centre and car park spaces. The insertion loss performance data is shown in Table 3—8.

Table 3—6 Car park Sabrina EC ventilation fan sound power levels under normal operation (6ACH) (unsilenced)

Plant Equipment	Number of Operational Plant Units	Frequency Band (Hz) Sound Power Levels – dB(A)								Broadband level - dB(A)
		63	125	250	500	1k	2k	4k	8k	
Inlet Fan Duty Noise Levels	2 per ventilation podium	64	72	79	85	88	85	81	77	92
Outlet Fan Duty Noise Levels		61	68	86	88	92	91	94	91	94

Table 3—7 ‘STANDARD’ car park Pulse fan sound pressure level data (unsilenced)

Operational Scenario	Broadband $L_{Aeq,T}$ Sound Pressure Levels at 3m - dB(A)
Normal Fan Duty Operation (0.97m³/s)	48
Emergency Fan Duty Operation (1.9m³/s)	66

Table 3—8 Air intake and extract insertion loss performance data for existing Kenavon Drive attenuator proposals

Kenavon Drive Location	Attenuator Location	Frequency Band (Hz) Insertion Loss – dB							
		63	125	250	500	1k	2k	4k	8k
Energy Centre	Intake Duct Room Side Attenuation	6	12	19	30	45	39	33	22
	Intake Duct Atmosphere Side Attenuation	8	16	25	40	54	48	45	31
	Exhaust Duct Room Side Attenuation	9	15	23	32	41	29	26	16
	Exhaust Duct Atmosphere Side Attenuation	13	21	32	43	49	44	36	25
	CHP Intake Attenuation	9	17	28	44	55	50	48	32
	CHP Exhaust Attenuation	12	20	31	42	44	37	32	22
Car Park	900mm Cylindrical Silencer Attenuator	4	5	9	17	19	15	14	13

3.5 Noise Breakout from Internal Spaces

Calculations have been undertaken to predict the internal noise level (both direct and reverberant) within the Energy Centre and Substation plant rooms.

Calculations assume the room is highly reflective with hard masonry surfaces (average absorption coefficient of 0.08). The calculations utilise octave-band sound power level (L_w dB) data for the plant items as outlined in Table 3—2 and Table 3—5.

The final row in each figure titled “total L_p at louvre ($L_{p,rev}+L_{p,dir}$ room side)” specifies the calculated IANL spectrum used to assess noise breakout within the desktop noise model assessment.

3.5.1 Energy centre internal ambient noise levels

The internal ambient noise level has been calculated in the under two different scenarios:

- Day-time noise levels with all operational plant running
- Night-time noise levels with no operational CHP plant and one operational boiler.

3.5.1.1 Assessment of daytime noise

Project name	Kenavon Drive							
Room or space	Kenavon Drive Energy Centre							
Date	16/10/20							
PLANT ROOM DIMENSIONS AND CHARACTERISTICS								
Plant room width (m)	20							
Plant room length (m)	12.5							
Plant room height (m)	4							
Area of façade louvre (m2)	10							
Width or Height of Louvre (m)	3.5							
Horizontal or vertical angle to noise sensitive receptor (degrees)	0							
Distance to noise sensitive receptor (m)	1							
Volume (m3)	1000							
Plant Room Alpha	"Live room" (α=0.08)							
PLANT ITEMS								
	Lw OBCF (Hz)							
	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
Hoval Ultra Gas 1150 - Boilers (3 operational plant units)	69.0	74.0	73.0	76.0	85.0	80.0	75.0	66.0
Hovel PowerBloc - CHP (1 operational plant unit - Daytime)	46.0	54.0	61.0	71.0	74.0	79.0	73.0	60.0
Magna1 65-150F Boiler Circulating Pumps (3 operational plant	44.0	46.0	46.0	55.0	55.0	50.0	51.0	53.0
Pressurisation Unit (1 operational plant unit)	32.0	42.0	50.0	55.0	58.0	59.0	59.0	57.0
Secomak 576 CHP Gas Booster (1 operational plant unit -	54.0	64.0	72.0	77.0	80.0	81.0	81.0	79.0
Grundfos Distribution Pumps (3 operational plant units)	33.0	45.0	54.0	67.0	70.0	66.0	67.0	67.0
Lp,rev Reverberant Calculation								
Rc	66.1							
Lp,rev	57.0	62.3	63.6	68.2	74.4	72.7	70.5	55.4
Lp,dir Direct Calculation (room side)								
Lp,dir at louvre due to plant item 1	50.0	55.0	54.0	57.0	66.0	61.0	56.0	47.0
Lp,dir at louvre due to plant item 2	27.0	35.0	42.0	52.0	55.0	60.0	54.0	41.0
Lp,dir at louvre due to plant item 3	25.0	27.0	27.0	36.0	36.0	31.0	32.0	34.0
Lp,dir at louvre due to plant item 4	13.0	23.0	31.0	36.0	39.0	40.0	40.0	38.0
Lp,dir at louvre due to plant item 5	35.0	45.0	53.0	58.0	61.0	62.0	62.0	60.0
Lp,dir at louvre due to plant item 6	14.0	26.0	35.0	48.0	51.0	47.0	48.0	48.0
Total Lp at louvre (Lp,rev+Lp,dir room side)	57.8	63.0	64.0	68.6	75.0	73.2	70.7	56.2

Figure 3—2 Calculation of the Internal Sound Pressure Level L_p dB(A) in the Energy Centre during daytime period with all plant operational

3.5.1.2 Assessment of night-time noise

Project name	Kenavon Drive							
Room or space	Kenavon Drive Energy Centre							
Date	16/10/20							
PLANT ROOM DIMENSIONS AND CHARACTERISTICS								
Plant room width (m)	20							
Plant room length (m)	12.5							
Plant room height (m)	4							
Area of façade louvre (m2)	10							
Width or Height of Louvre (m)	3.5							
Horizontal or vertical angle to noise sensitive receptor (degrees)	0							
Distance to noise sensitive receptor (m)	1							
Volume (m3)	1000							
Plant Room Alpha	"Live room" ($\alpha=0.08$)							
PLANT ITEMS								
	Lw OBCF (Hz)							
	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
Hoval Ultra Gas 1150 - Boilers (1 operational plant unit)	64.0	69.0	69.0	71.0	80.0	75.0	70.0	61.0
Magna 65-150F Boiler Circulating Pumps (1 operational plant	44.0	46.0	46.0	55.0	55.0	50.0	51.0	53.0
Pressurisation Unit (1 operational plant unit)	32.0	42.0	50.0	55.0	58.0	59.0	59.0	57.0
Grundfos Distribution Pumps (3 operational plant units)	33.0	45.0	54.0	67.0	70.0	66.0	67.0	67.0
Lp,rev Reverberant Calculation								
Rc	66.1							
Lp,rev								
Lp,dir Direct Calculation (room side)	51.9	56.9	57.0	60.4	68.3	63.4	59.8	50.7
Lp,dir at louvre due to plant item 1	45.0	50.0	50.0	52.0	61.0	56.0	51.0	42.0
Lp,dir at louvre due to plant item 2	25.0	27.0	27.0	36.0	36.0	31.0	32.0	34.0
Lp,dir at louvre due to plant item 3	13.0	23.0	31.0	36.0	39.0	40.0	40.0	38.0
Lp,dir at louvre due to plant item 4	14.0	26.0	35.0	48.0	51.0	47.0	48.0	48.0
Total Lp at louvre (Lp,rev+Lp,dir room side)	52.7	57.7	57.8	61.0	69.0	64.2	60.4	51.6

Figure 3—3 Calculation of the Internal Sound Pressure Level L_p dB(A) in the Energy Centre with non-operational CHP plant

3.5.2 Substation internal ambient noise levels

The internal ambient noise level has been calculated within the Middle and East substation plant rooms.

3.5.2.1 Middle block

PLANT ROOM FAÇADE BREAKOUT NOISE CALCULATION									
Project name		Kenavon Drive							
Room or space		Kenavon Drive Substation (M)							
Date		16/10/20							
PLANT ROOM DIMENSIONS AND CHARACTERISTICS									
Plant room width (m)		4.8							
Plant room length (m)		3.7							
Plant room height (m)		4							
Area of façade louvre (m2)		9.6							
Width or Height of Louvre (m)		3.5							
Horizontal or vertical angle to noise sensitive receptor (degrees)		0							
Distance to noise sensitive receptor (m)		1							
Volume (m3)		71.04							
Plant Room Alpha		"Live room" (α=0.08)							
PLANT ITEMS		Lw OBCF (Hz)							
		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
1000kVA Transformer		23.0	27.0	38.0	37.0	35.0	40.0	42.0	11.0
0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lp,rev Reverberant Calculation									
Rc		9.0							
Lp,rev		19.5	23.5	34.5	33.5	31.5	36.5	38.5	7.8
Lp,dir Direct Calculation (room side)									
Lp,dir at louvre due to plant item 1		18.0	22.0	33.0	32.0	30.0	35.0	37.0	6.0
Total Lp at louvre (Lp,rev+Lp,dir room side)		21.8	25.8	36.8	35.8	33.8	38.8	40.8	10.0

Figure 3—4 Calculation of the Internal Sound Pressure Level Lp dB(A) in the middle block substation plant room

3.5.2.2 East block

Project name	Kenavon Drive							
Room or space	Kenavon Drive Substation (E)							
Date	16/10/20							
PLANT ROOM DIMENSIONS AND CHARACTERISTICS								
Plant room width (m)	4.84							
Plant room length (m)	3.6							
Plant room height (m)	4							
Area of façade louvre (m2)	9.6							
Width or Height of Louvre (m)	3.5							
Horizontal or vertical angle to noise sensitive receptor (degrees)	0							
Distance to noise sensitive receptor (m)	1							
Volume (m3)	69.696							
Plant Room Alpha	"Live room" (α=0.08)							
PLANT ITEMS								
	Lw OBCF (Hz)							
	63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz
1500kVA Transformer	29.0	33.0	44.0	43.0	41.0	46.0	48.0	17.0
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lp,rev Reverberant Calculation								
Rc	8.9							
Lp,rev	25.5	29.5	40.5	39.5	37.5	42.5	44.5	13.6
Lp,dir Direct Calculation (room side)								
Lp,dir at louvre due to plant item 1	24.0	28.0	39.0	38.0	36.0	41.0	43.0	12.0
Total Lp at louvre (Lp,rev+Lp,dir room side)								
	27.9	31.8	42.8	41.8	39.8	44.8	46.8	15.9

Figure 3—5 Calculation of the Internal Sound Pressure Level Lp dB(A) in the east block substation plant room

3.5.3 Energy centre in-duct noise levels at efflux terminations

The energy centre will be entirely mechanically ventilated, supplying and extracting air through fan powered duct systems. Noise will break-out of the energy centre at the air supply and exhaust efflux points.

Noise emissions from the intake and extract efflux points will consist of contributions from the internal ambient noise level within the energy centre, as well as the Nuaire fan sound power levels outlined in Table 3—4. As indicated on Figure 3—6 attenuators have been proposed within the duct systems room and atmosphere side of the fan selections – the insertion loss performances of the attenuators are detailed in Table 3—8.

The desktop noise model assesses noise breakout from the energy centre intake duct. The sound propagation path is indicated in Figure 3—6 and the external efflux termination is shown in Figure 3—7. The model does not consider breakout from the exhaust duct, as the efflux termination is located in the non-noise sensitive car park area.

The following worst noise case calculation in the energy centre (daytime, all operational plant internal ambient noise level) indicates suitable noise levels (<50 dBA $L_{Aeq,T}$) should be attained in the car park with the current duct attenuator proposals. The recommended plant criterion for noise comfort is NR 55 or a background noise level of 60 dB(A) $L_{Aeq,T}$ (Source: Environmental Design: CIBSE Guide A, Table 1.5, page 33).

Project name	Kenavon Drive									
Room or space	Energy Centre Exhaust Duct									
Date	16/10/20									
PLANT ROOM DIMENSIONS AND CHARACTERISTICS										
Plant room width (m)	20									
Plant room length (m)	12.5									
Plant room height (m)	4									
Area of façade louvre (m2)	7									
Width or Height of Louvre (m)	3.5									
Horizontal or vertical angle to noise sensitive receptor (degrees)	0									
Distance to noise sensitive receptor (m)	1									
Volume (m3)	1000									
Plant Room Alpha	"Live room" (α=0.08)									
PLANT ITEMS										
		63Hz	125Hz	250Hz	500Hz	1000Hz	2000Hz	4000Hz	8000Hz	
Worst Case Internal Ambient Energy Center Noise Level		58.0	63.0	64.0	69.0	75.0	73.0	71.0	56.0	
Nuaire Extract Fan		56.0	68.0	73.0	79.0	73.0	75.0	75.0	59.0	
Lp,rev Reverberant Calculation										
Rc	66.1									
Lp,rev		47.9	57.0	61.3	67.2	64.9	64.9	64.3	48.6	
Lp,dir Direct Calculation (room side)										
Lp,dir at louvre due to plant item 1		39.0	44.0	45.0	50.0	56.0	54.0	52.0	37.0	
Lp,dir at louvre due to plant item 2		54.0	66.0	71.0	77.0	71.0	73.0	73.0	57.0	
Total Lp at louvre (Lp,rev+Lp,dir room side)		55.1	66.6	71.5	77.5	72.1	73.7	73.6	57.6	
Lw incident on louvre		63.5	75.0	79.9	85.9	80.5	82.2	82.1	66.1	
Atmosphere side duct silencer attenuation		-13.0	-21.0	-32.0	-43.0	-49.0	-44.0	-36.0	-25.0	
Correction inside (diffuse) to outside (free-field) (dB)		-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	
Directivity correction (dB)		3.5	4.0	4.5	4.5	4.5	4.5	4.5	4.5	
Distance attenuation loss to NSR (dB)		-8.0	-8.0	-8.0	-8.0	-8.0	-8.0	-8.0	-8.0	
Resulting Lp in Car Park (dB)		40	44	38	33	22	29	37	32	
dB(A) without louvre		14	28	30	30	22	30	38	31	
</										

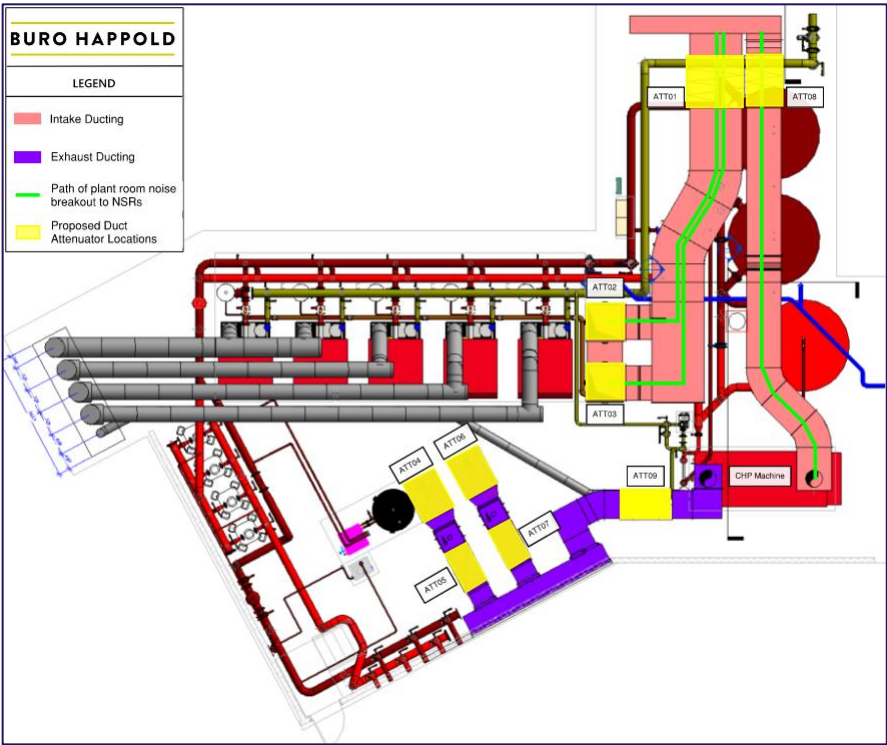


Figure 3—6 Schematic showing noise propagation route from the plant room to the atmosphere near Noise Sensitive Receivers (Image Source: RM Design Solutions 1928-RMD-EC-0-BIM, Revit 2019 Model)

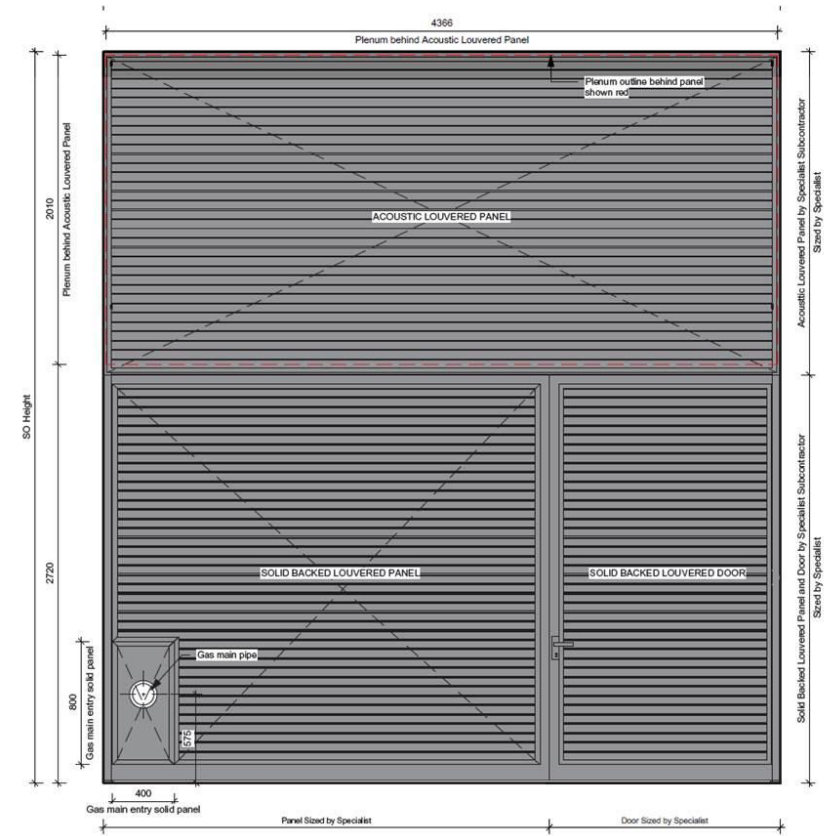


Figure 3—7 Schematic of the energy centre air intake louvre, near sensitive noise receiver locations

3.6 Rating Level

It is a requirement of BS 4142 that rating levels ($L_{A,r,T}$) are considered when assessing the likely impact at nearby noise sensitive receivers. Penalty corrections are required for noise sources with acoustically distinguishable features (whilst considering the existing residual sound climate). If selections include plant with tonal, impulsive or intermittent noise features, noise levels must be adjusted accordingly.

Buro Happold have considerable experience of mechanical plant, and all Buro Happold staff are degree-qualified engineering consultants in acoustics or a related discipline. All (acoustics) staff members involved in this assessment are corporate members of the Institute of Acoustics and are therefore considered suitably qualified to make the following assessments.

3.6.1 Tonality

BS 4142:2014+A1:2019 provides the following guidance with respect to assessing the tonality:

- The level differences between adjacent one-third-octave bands that identify a tone are:
- 15 dB in the low-frequency one-third-octave bands (25 Hz to 125 Hz);
 - 8 dB in middle-frequency one-third-octave bands (160 Hz to 400 Hz);
 - 5 dB in high-frequency one-third-octave bands (500 Hz to 10 000 Hz).

For the plant items discussed in Section 3.2. the ventilation, flue and fan components are not typically tonal in nature, given that the sound generation is typically associated with air movement and therefore includes sound associated with the motor, air displacement and turbulence. No corrections for tonality are therefore considered to be required for these elements.

Substations transformers do have the capacity for tonal characteristics, therefore an assessment for the presence of prominent, discrete-frequency spectral components was undertaken in line with the BS 4142 criteria shown above.

Tonality was identified at the 200Hz 1/3 Octave Band causing a +3dB penalty to be applied to the substation plant item rating levels. The tonality assessment has been provided in Appendix B for reference.

3.6.2 Impulsivity

Whilst pumps in the energy centre could contain steep ‘ramp up’ levels / features which rapidly interrupt the sound generation, the level of noise generation of these items is low in comparison to other elements and the total sound energy within the energy centre. On this basis, no corrections for impulsivity are considered to be required.

3.6.3 Intermittency

The CHP plant in the energy centre is understood to ramp down at night and then back up during the day, in response to the reduced load demand during night-time periods. However, due to the infrequency of this event and the high level of specific sound within the energy centre, intermittency is not considered to be issue with the plant items.

3.6.4 Summary table – rating level

Table 3—9 provides a summary of the plant items requiring corrections for the various sound features given above. As can be seen, only the substations are considered to require a +3dB correction due to the presence of tonality at the 200Hz frequency band.

Table 3—9 Plant rating level corrections

Value	Correction dB	Plant Item
Tonality correction	+ 0	-
Impulsivity correction	+ 0	-
Intermittency correction	+ 3	Middle and East Block Substations

4 CadnaA Desktop Noise Breakout Assessment

4.1.1 Proposed energy centre noise mitigation

Figure 4—1 and Figure 4—2, illustrate the attenuated noise levels emanating from the façade of the energy centre onto the proposed Kenavon Drive dwellings (energy centre NSR).

Compliance with Planning Condition 33 requires the highest calculated façade noise levels to be below 35 dB $L_{A,T}$ during the day-time operating conditions (all plant operational, Figure 4—1) and below 29 dB $L_{A,T}$ during night-time operating conditions (no CHP and one boiler plant unit operational Figure 4—2).

To achieve this, an additional energy centre silencer is required (additional to the silencer specified in Table 3—8) within the intake ducts. The insertion loss spectrum is shown in Table 4—1.

Table 4—1 Additional energy centre intake duct silencer insertion loss performance spectrum

Attenuator Description	Frequency Band (Hz) Insertion Loss – dB							
	63	125	250	500	1k	2k	4k	8k
Energy Centre Intake Duct, Additional Silencer Section	7	13	19	31	48	41	35	25

In addition to the mitigation option above, the solid backing and entrance door (shown Figure 3—7) must have a sound insulation performance of R_w 45 dB. This should make the duct termination point on the energy centre façade the weakest element in terms of noise source propagation.

Based on the attenuation measures applied above, suitable noise level should be achieved in line with planning condition 33, this is illustrated in a screengrab from the 3D acoustic model in Figure 4—1 and Figure 4—2.

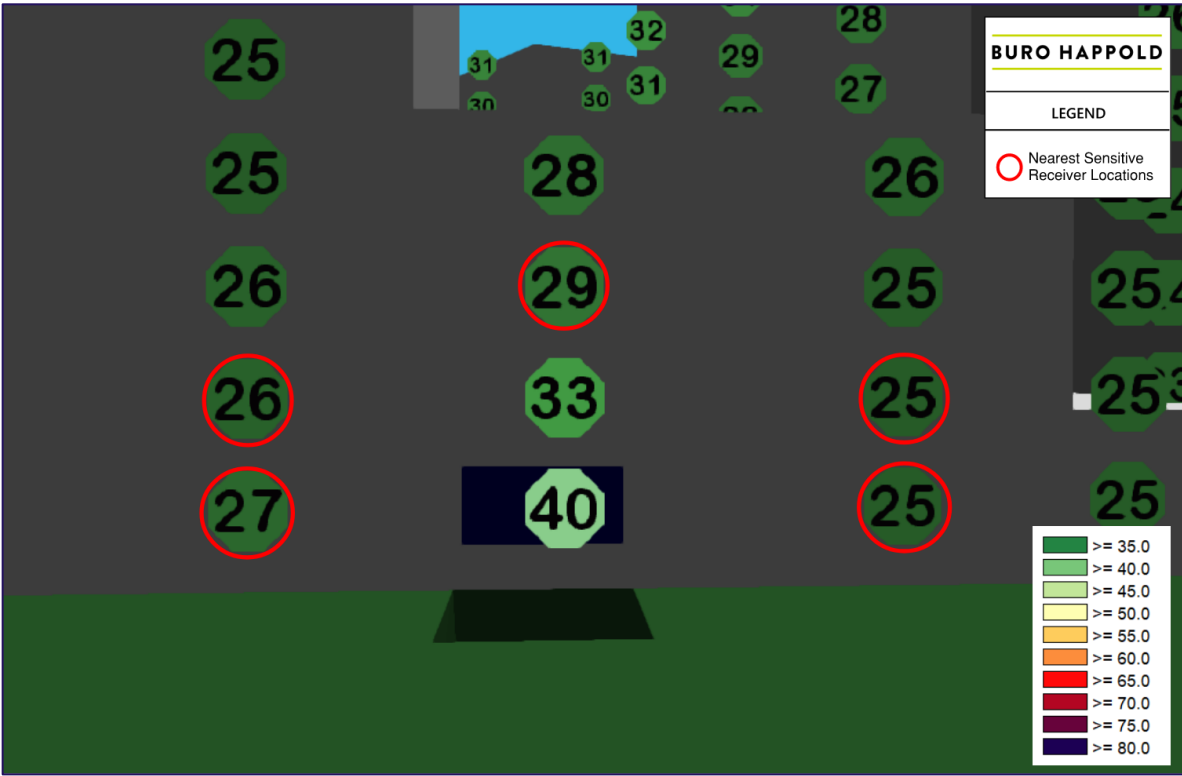


Figure 4—1 Highest calculated $L_{A,T}$ noise levels 1m from the Kenavon Drive Façade - during day-time energy centre operation condition when incorporating the allway acoustics 300mm deep louvre or increased silencer attenuation. Target $L_{A,T}$ 35 db(A).

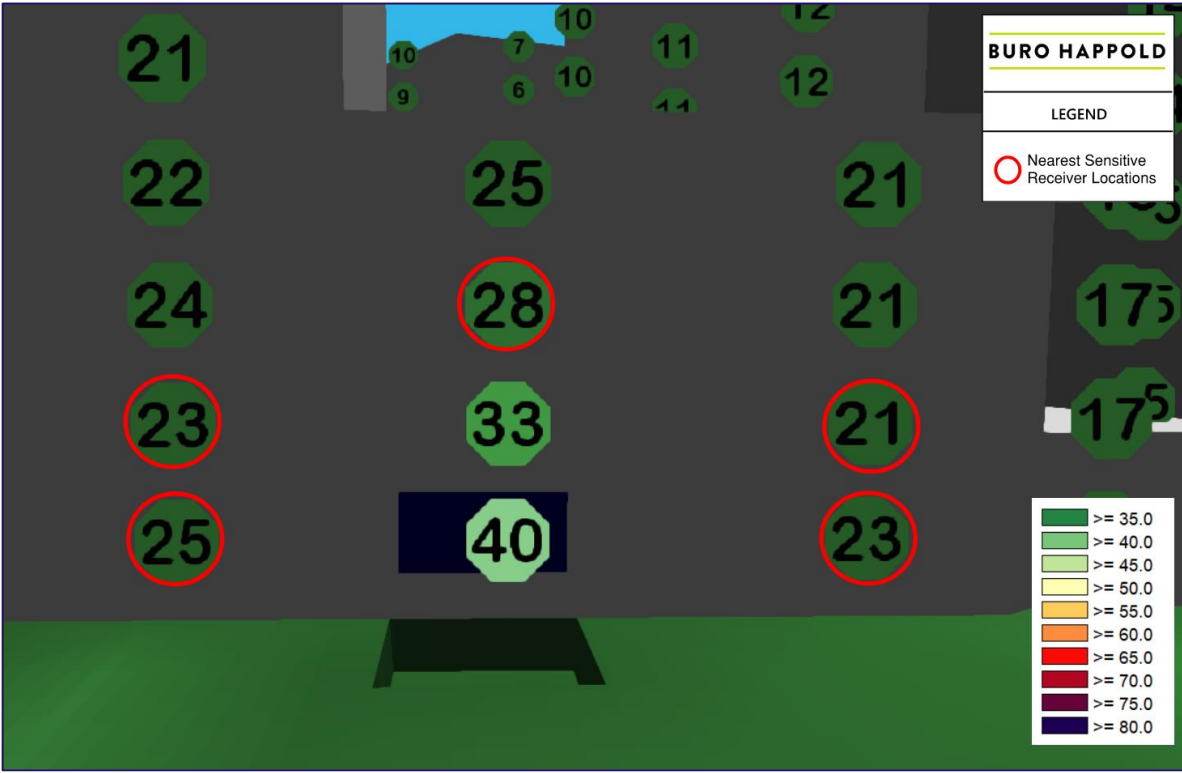


Figure 4—2 Highest calculated $L_{A,T}$ noise levels 1m from the Kenavon Drive Façade - during the night-time energy centre operation condition when incorporating the allway acoustics 300mm deep louvre or increased silencer attenuation. Target $L_{A,T}$ 29 db(A).

4.2 Energy Centre Flue Noise Breakout

4.2.1 Assessment Scenarios and Design Targets

It is understood from the project MEP engineers that during the daytime (0700:23:00) 3 boiler flues and a CHP flue could be simultaneously operational. Planning Condition 33 dictates that the design level for this scenario is to attain 35 dB $L_{A,T}$ at the nearby sensitive receivers, which includes Kenavon Drive residential dwellings and the existing residential NSRs to the east of the development site.

During the night-time (23:00-07:00) it is understood from the project MEP engineers that the CHP will not be operational and only one boiler will be supplying the reduced demand from residents. The design level is to attain 29 dB $L_{A,T}$ at the nearby sensitive receivers.

4.2.2 Proposed energy centre flue noise mitigation

To attain the daytime and night-time design levels, the following plant mitigation is proposed:

Boiler Flues: to attain night-time targets at the NSRs indicated in Figure 4—3, noise from the boiler flues should be limited to a 43dB(A) $L_{A,T}$ sound pressure level at one metre from the flue termination point. Silencers with the following insertion loss performance targets are required in each of the boiler flues.

Table 4—2 Required insertion loss performance of energy centre boiler flue silencers

Attenuator Description	Frequency Band (Hz) Insertion Loss Performance Targets – dB							
	63	125	250	500	1k	2k	4k	8k
Boiler Flue Silencer	11	22	21	20	27	24	19	10

CHP Flue: A silencer should be incorporated into the CHP flue design in order to reduce the sound pressure level to a resultant $L_{A,T}$ sound pressure level of 45dB(A) at one metre from the flue termination point. The following table provides example insertion loss performance figures for the silencer.

Table 4—3 Required insertion loss attenuation of energy centre combined heat power unit flue silencer and acoustic louvre barrier

Attenuator Description	Frequency Band (Hz) Insertion Loss Performance Targets – dB							
	63	125	250	500	1k	2k	4k	8k
CHP Flue Silencer	10	21	31	39	51	48	42	31

Figure 4—3 and Figure 4—4 illustrate that with the plant limits above, design levels should be achieved 1m from the façade of the Kenavon Drive and existing NSRs (to the east of the project site).



Figure 4—3 Highest calculated $L_{A,T}$ noise levels 1m from the Kenavon Drive and NSR façade during night-time energy centre operation conditions. Proposed boiler flue silencers are incorporated in the CadnaA model. Target $L_{A,T}$ 29 db(A).

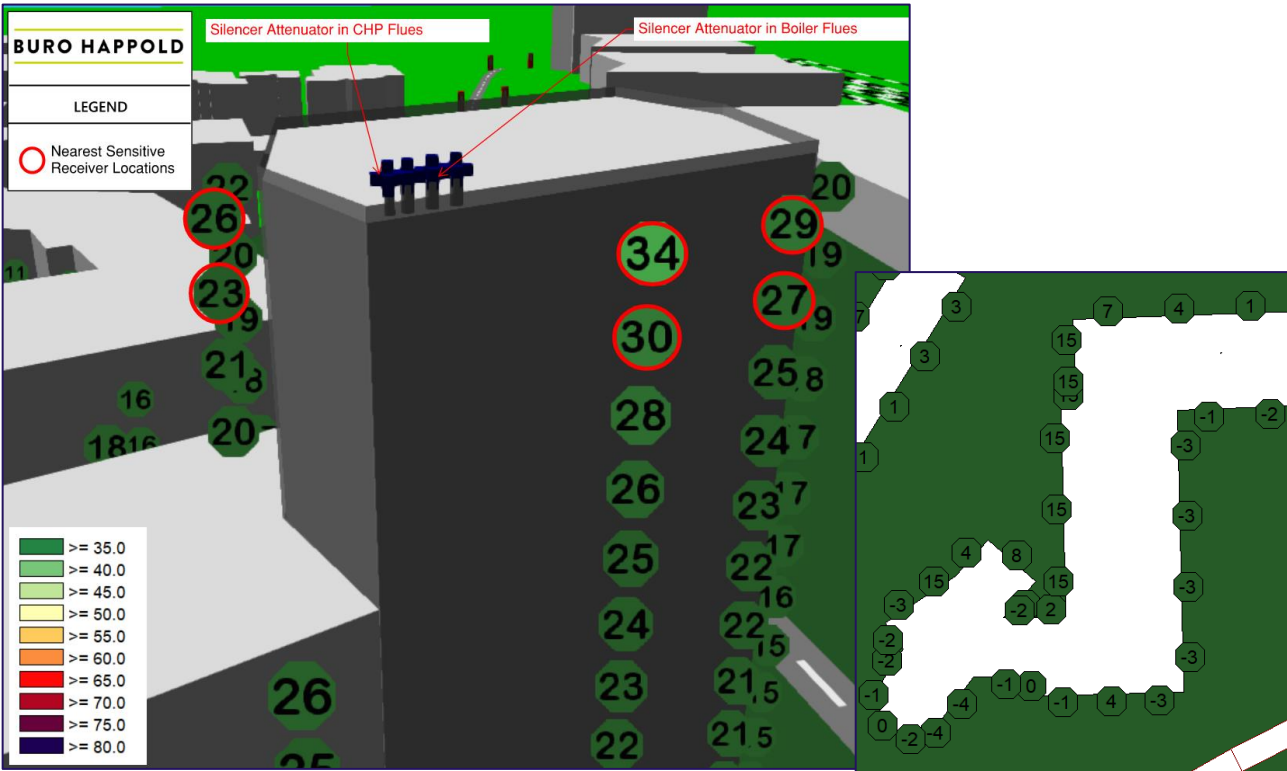


Figure 4—4 Highest calculated $L_{A,T}$ noise levels 1m from the Kenavon Drive and NSR façade during daytime energy centre operation conditions. Proposed boiler and CHP flue silencers are incorporated in the CadnaA model. Target $L_{A,T}$ 35 db(A).

4.3 Substation Noise Breakout

The middle and east block substation plant compounds are to run 24 hours a day. The efflux terminations of these compounds are therefore bound to the 29 dB $L_{A,T}$ night-time design level criteria 1m from the facades of the Kenavon Drive and existing NSR dwellings.

4.3.1 Proposed substation louvre insertion loss requirements

The substations are to be ventilated via façade louvres. These are recognised as the weakest acoustic element in terms of noise source propagation to the NSRs from the Substations.

The following insertion loss performance values are required at each octave band to control the noise breakout from the middle and east block substations.

*Note a +3dB noise rating penalty was applied in CadnaA software to account for the tonality of the transformers at 200Hz.

Table 4—4 Substation louvre insertion loss performance requirements

Kenavon Drive Substation Location	Insertion Loss (dB) at octave band centre frequencies (Hz)							
	63	125	250	500	1K	2k	4k	8k
Middle Block	0	0	3	7	8	14	16	0
East Block	0	0	6	10	11	17	19	0

The 300mm deep Allaway acoustics louvre shown in Appendix C is suitable for attaining the insertion loss performance targets in Table 4—4.

Figure 4—5 and Figure 4—6 demonstrate the calculated noise levels 1m from the Kenavon drive and NSR façades when implementing the insertion loss attenuation values shown in Table 4—4. These are calculated to be below the night-time design level target.



Figure 4—5 Highest calculated $L_{A,T}$ noise levels 1m from the Kenavon Drive façade with attenuated middle block substation noise levels

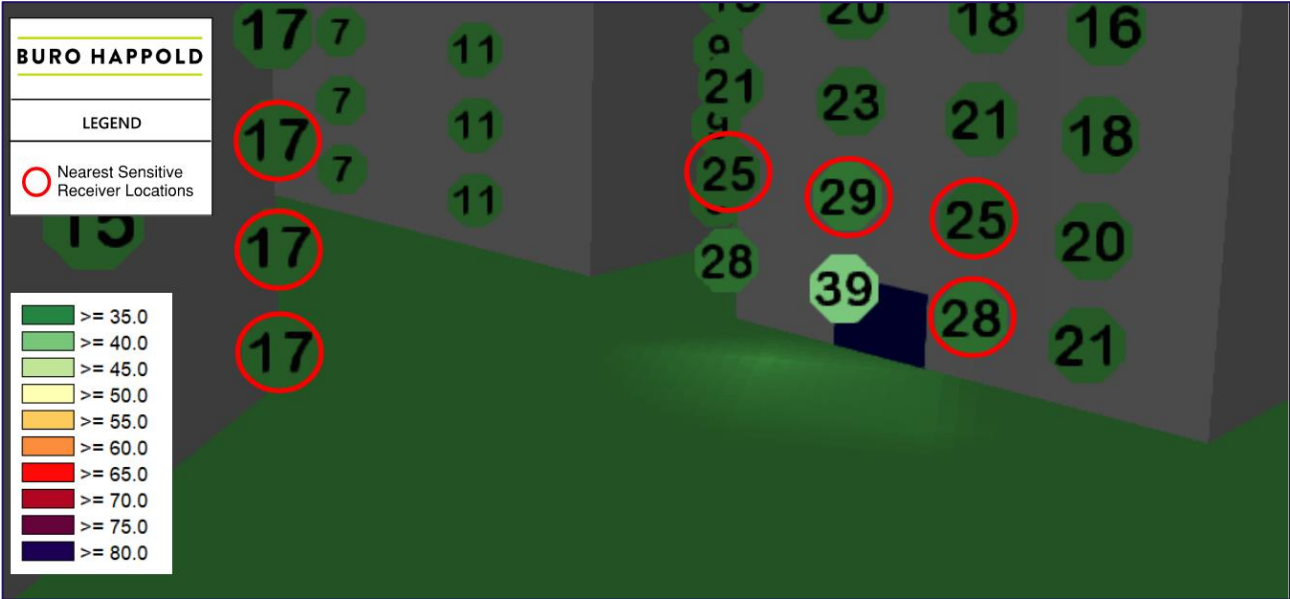


Figure 4—6 Highest calculated $L_{A,T}$ noise levels 1m from the Kenavon Drive and NSR façade with attenuated east block substation noise levels

4.4 Car Park Noise Breakout

Within the car park areas of Kenavon Drive, Sabina EC 160mm (Compact) fans are used to extract air and waste gases. It is understood that intake efflux terminations are located in the car parking areas, with external podium top vent exhausts that are located directly above the middle and east block car parks.

For the intake duct noise breakout into the car park areas, CIBSE recommended design levels for noise comfort is NR 55 or 60 dB(A) $L_{Aeq,T}$ at 1m (Source: Environmental Design: CIBSE Guide A, Table 1.5, page 33). The required silencer insertion loss performance is assessed in Section 4.4.1.

The desktop noise assessment within this report (Section 4.4.2) identifies the required in-duct silencer and louvre insertion loss performance targets. The model assesses the typical daytime fan duty (6ACH sound power levels provided in Table 3—6), against the 35 dB $L_{A,T}$ daytime noise level threshold at the Kenavon Drive NSRs (as required by planning condition 33) and a 55dBA $L_{Aeq,T}$ threshold in resident amenity spaces, as per the World Health Organisation guidelines for community noise:

“it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments”

4.4.1 Car park insertion loss – assessment for acoustic comfort in car park areas

Table 4—5 outlines the insertion loss attenuation that should attain the CIBSE NR 55 rating in the car park areas. The table specifies the required insertion loss of a new silencer product, capable of attaining the required insertion loss in place of the existing silencer proposal (specified in Table 3—8).

Figure 4—7 outlines the considerations for fan noise attenuation due to frictional duct losses and end reflections. Without the acoustic mitigation in Table 4—5, a 68 dB(A) $L_{Aeq,T}$ noise level is expected from the car park intake ducts when the East block fan is running at its typical 7.2m³/s duty. This is considered the worst-case assessment as middle block fans have a lower fan duty requirement and subsequently lower sound power levels.

Table 4—5 Internal car park ventilation insertion loss performance requirements

Mitigation Scenario	Scenario	Insertion Loss (dB) at octave band centre frequencies (Hz)							
		63	125	250	500	1K	2k	4k	8k
1	Required insertion loss performance of a new silencer proposal (in place of the existing silencer)	0	9	16	22	25	24	22	21

CALCULATING SOUND POWER TO THE OUTLET												
Fan Duty:	m^3/s			SWL	63	125	250	500	1k	2k	4k	8k
	7.2			Spectrum	90	88	88	88	88	84	80	78
Type	Index	Mtrs/No. off		Dimension								
Circular Duct	CIRC DUCT	0.3		1000	0	0	0	0	0	0	0	0
Own Data	Current Silencer Attenuator	1		1000	4	5	9	17	19	15	14	13
Grille size:		2500	mm X	1500 mm	Grille location:		2	Flush				
End Reflection Loss:			3.75	m^2	1	0	0	0	0	0	0	0
Sound Power Leaving:					85	83	79	71	69	69	66	65
Sound Power to Outlet:		7.2	m^3/s	100	%	0	0	0	0	0	0	0
Distance to Listener:		2		m	-17	-17	-17	-17	-17	-17	-17	-17
Directivity Factor:			3.75	m^2	7	8	8	9	9	9	9	9
Direct SPL:					75	74	70	63	61	61	58	57
Resultant SPL:					75	74	70	63	61	61	58	57
NR Level Required:				NR55	79	70	63	58	55	52	50	49
Attenuation Required:					0	4	7	5	6	9	8	8
dBA Correction:					-26	-16	-9	-3	0	1	1	-1
A-Weighted Equivalent:					49	58	61	60	61	62	59	56
Resultant dBA Level (with no attenuation):					68							dBA

Figure 4—7 Ducted plant noise breakout east block calculation sheet

4.4.2 Car Park Insertion loss requirements – assessment at NSR façades and amenity spaces

From Berkeley, Kenavon Drive Podium Car-Park Vent, Drawing number O446-AA5990C-SW-ZZ-A-6270, the effective louvred area of podium top vent exhausts is calculated to be 6.44m² in the middle block and 6.9m² in the east block. These louvre areas have been incorporated into the desktop noise breakout assessments shown in Figure 4—8 and Figure 4—9.

Figure 4—8 and Figure 4—9, demonstrate that suitable noise levels can be achieved at nearby NSRs and amenity spaces under typical car park extract fan duty. The calculated values in Figure 4—8 and Figure 4—9 are in line with planning condition 33 (<35 dB L_{A,r,T} at NSR façades) and WHO guidelines for community noise (<55 dB(A) 1m from the podium louvres).

To achieve the levels calculated in the model, a 150mm deep Allaway acoustics L60E louvre was incorporated into the podium top vent design, in addition to the silencer specified in Table 3—8. Table 4—6 outlines the existing (extracted from Table 3—8) and additional insertion loss performance values required to attain suitable insertion loss performance values.

Table 4—6 External car park ventilation outlet insertion loss performance requirements

Attenuation Description	Suitable Proposed / Potential Product	Insertion Loss (dB) at octave band centre frequencies (Hz)							
		63	125	250	500	1K	2k	4k	8k
Current insertion loss from the proposed acoustic silencer	900mm Diameter Type D Cylindrical Silencer	4	5	9	17	19	15	14	13
Acoustic Louvre / additional insertion losses required	Allaway acoustics L60E (See Appendix D)	4	4	5	8	12	16	15	13

Note, the additional insertion loss requirement could also be attained from specifying a silencer product (rather than incorporating the L60E acoustic louvre). The additional silencer would require insertion performance values equal to or greater than those attained by the L60E louvre, as specified in Table 4—6.



Figure 4—8 Highest calculated LAr,T noise levels 1m from the Middle Block Kenavon Drive NSR façades (left) and podium vents (right) – implemented acoustic attenuation elements detailed in Table 4—6.

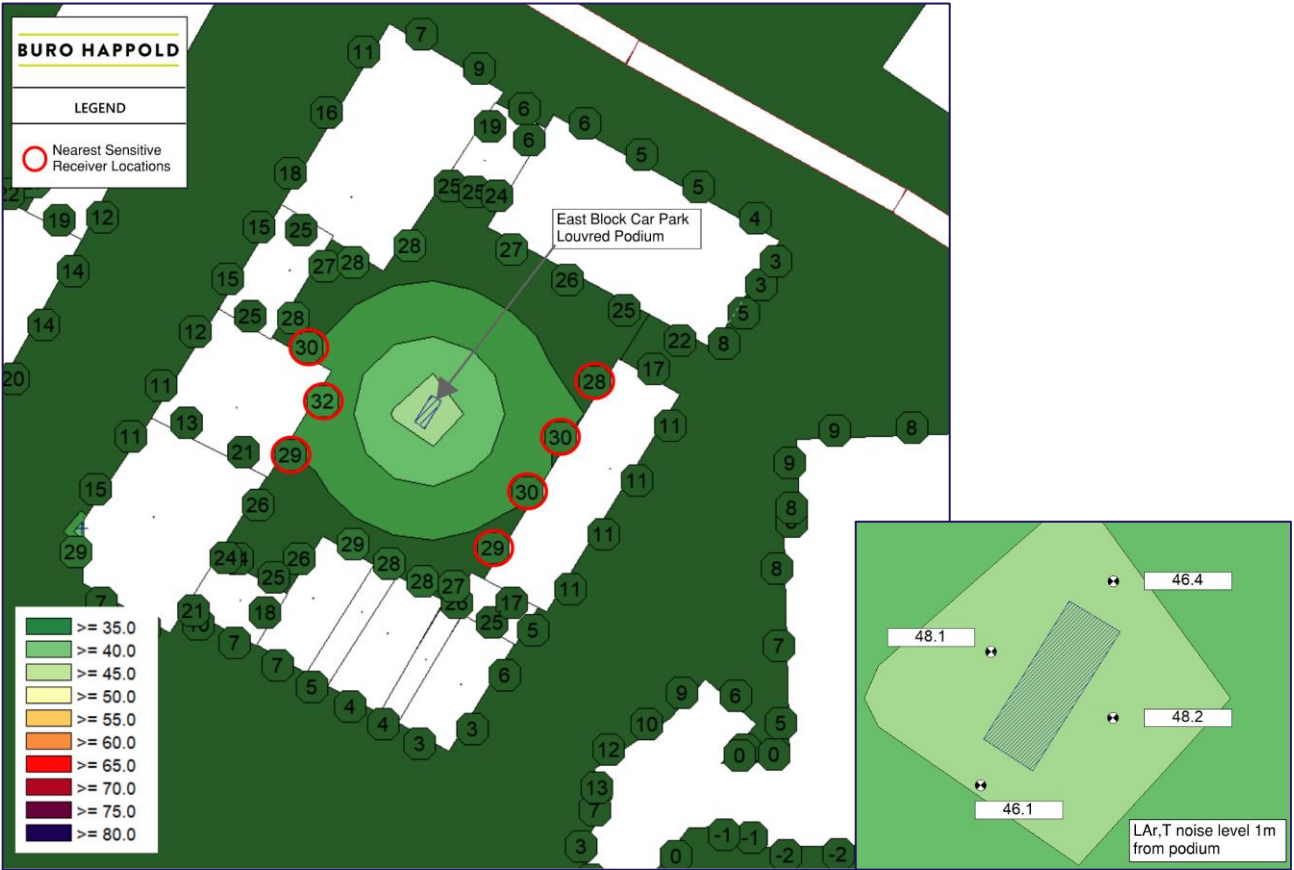


Figure 4—9 Highest calculated LAr,T noise levels 1m from the East Block Kenavon Drive NSR façades (left) and podium vents (right) – implemented acoustic attenuation elements detailed in Table 4—6.

4.5 Commercial Unit Noise Breakout

Kenavon Drive commercial units are proposed as future fit-out spaces. Due to the potential for the premises to require air-handling units (AHUs) with efflux terminations on the façade of the development, plant noise limits must be set on future plant installations.

Figure 4—10 and Figure 4—11 demonstrate the potential for the AHUs of proposed commercial restaurant and nursery spaces to be located near to noise sensitive façades (potentially as close as 3m from the AHU units). It is recommended that all future AHU plant is designed to meet the following daytime and night-time criteria at a 1m distance from the external plant unit termination point:

- Daytime period (07:00-23:00): 44 dB $L_{A,r,T}$ at 1m from the external termination of the AHU (to achieve 35 dB $L_{A,r,T}$ at 3m).
- Night-time period (23:00-07:00): 38 dB $L_{A,r,T}$ at 1m from the external termination of the AHU (to achieve 29 dB $L_{A,r,T}$ at 3m). It is not expected that AHU plant will run during night-time periods, this level has been provided for completeness.

In addition to the AHU's, a noise limit is required for the restaurant extract fan (marked on Figure 4—10). It is understood that the location for the extract efflux termination is not set, therefore the following limits assume a worst-case scenario with the extract fan located towards a periphery of the roof.

- Daytime plant limit (07:00-23:00): 50 dB $L_{A,r,T}$ at 1m from the external termination of the extract fan
- Night-time plant limits (23:00-07:00): 44 dB $L_{A,r,T}$ at 1m from the external termination of the extract fan

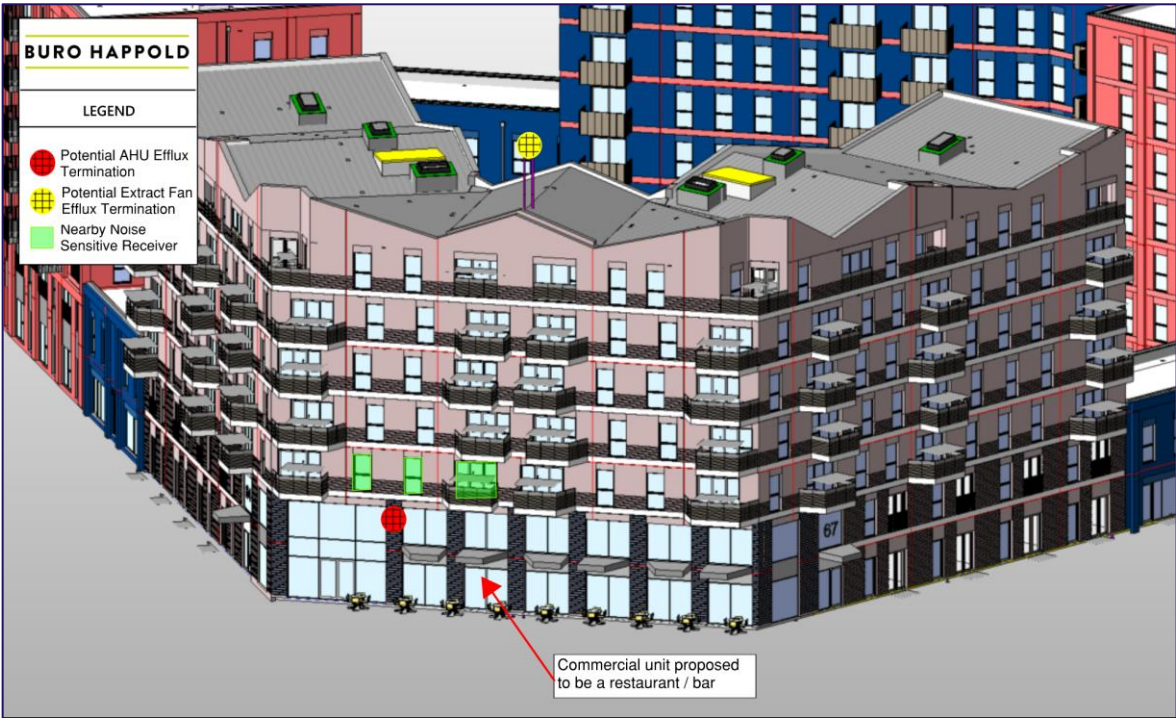


Figure 4—10 3D screenshot of Revit commercial restaurant unit and the potential location of AHU plant near sensitive Kenavon Drive receivers (Source Project Revit Model: O446-AA5990C-M-ZZ-A-MIDDLE.rvt, Issued 20/08/2020)



Figure 4—11 3D screenshot of Revit commercial nursery unit and the potential location of AHU plant near sensitive Kenavon Drive receivers (Source Project Revit Model: O446-AA5990C-M-ZZ-A-MIDDLE.rvt, Issued 20/08/2020)

4.6 Cumulative Noise Breakout Assessment



Figure 4—12 Highest calculated LAr,T noise levels 1m from the Kenavon Drive and existing NSR façades under a cumulative impact assessment scenario with all plant items / compounds operational

5 Conclusion

A desktop noise model assessment was conducted on CadnaA 2019 software to evaluate the noise impact of the Kenavon Drive plant.

Limiting plant noise levels and insertion loss noise mitigation requirements have been set based on achieving $L_{A,r,T}$ sound pressure levels that are 10dB below the representative background noise level (at a 1m distance from sensitive façades), as required by Planning Condition 33.

Section 4 shows the design level targets can be achieved with all plant operational, on implementation of the noise mitigation actions proposed within the report. A summary of the identified attenuation requirements, are provided below:

Middle block energy centre compound:

- Minimum R_w 45 dB sound insulation performance on entrance door and solid façade backing
- Additional energy centre intake duct silencer with the following insertion loss performance targets

Attenuator Description	Frequency Band (Hz) Insertion Loss – dB							
	63	125	250	500	1k	2k	4k	8k
Energy Centre Intake Duct, Additional Silencer Section	7	13	19	31	48	41	35	25

Middle block energy centre flue exhausts:

- In-duct acoustic silencers for the Boiler and CHP flue exhausts. Limiting the boilers flues to 43dB(A) and the CHP flues to 45dB(A) $L_{A,r,T}$ sound pressure levels at one metre from the termination points.
- The modelled insertion loss targets are shown below.

Attenuator Description	Frequency Band (Hz) Insertion Loss – dB							
	63	125	250	500	1k	2k	4k	8k
Boiler Flue Silencer	11	22	21	20	27	24	29	10
CHP Flue Silencer	10	21	31	39	51	48	42	31

Middle and east block substation compounds:

- The following insertion loss requirements are needed on the façade louvres for each of the substations.
- This can be achieved with the 300m deep allaway acoustics louvre (referenced in Appendix C).

Kenavon Drive Substation Location	Required Insertion Loss (dB) at octave band centre frequencies (Hz)							
	63	125	250	500	1K	2k	4k	8k
Middle Block	0	0	3	7	8	14	16	0
East Block	0	0	6	10	11	17	19	0

Car park intake noise breakout to car parking areas:

- The NR 55 CIBSE rating should be achieved through specifying a new silencer product capable of attaining the following insertion loss requirements (in place of the existing silencer proposal).

Scenario	Insertion Loss (dB) at octave band centre frequencies (Hz)							
	63	125	250	500	1K	2k	4k	8k
Required insertion loss performance of a new silencer proposal (in place of the existing silencer)	0	9	16	22	25	24	22	21

Car park exhaust noise through podium top vents:

- Additional insertion loss performances are required for the exhaust fan noise to the atmosphere. This can be attained through incorporating an acoustic silencer or a 150mm L60E allaway acoustics louvre into the podium top vent design.
- The required insertion loss values are shown below

Attenuation Description	Suitable Proposed / Potential Product	Insertion Loss (dB) at octave band centre frequencies (Hz)							
		63	125	250	500	1K	2k	4k	8k
Acoustic Louvre / addition insertion losses required	allaway acoustics L60E (See Appendix D)	4	4	5	8	12	16	15	13

Future fitout commercial space plant limits:

Future fit-out air handling unit plant noise limits

- Daytime period (07:00-23:00): 44 dB $L_{A,r,T}$ at 1m from the external termination of the AHU
- Night-time period (23:00-07:00): 38 dB $L_{A,r,T}$ at 1m from the external termination of the AHU

Future fit-out restaurant extract fan plant noise limits

- Daytime plant limit (07:00-23:00): 50 dB $L_{A,r,T}$ at 1m from the external termination of the extract fan
- Night-time plant limits (23:00-07:00): 44 dB $L_{A,r,T}$ at 1m from the external termination of the extract fan

If the noise mitigation requirements set out above are met in full, the noise assessment report here demonstrates that Planning Condition 33 can be discharged.

Appendix A Noise Survey Data

The following section details the results from a noise survey conducted by MLM between Monday 27th and Tuesday 28th June 2016.

The results outlined within this section were extracted from the ‘Kenavon Drive Stage 4 Acoustics Report’ (issued 8th June 2020), which was based on a noise survey provided in the following report:

MLM
L&Q
Kenavon Drive, Reading
Stage 3 Acoustics Report
Document Ref: MS/101307/MS/R2

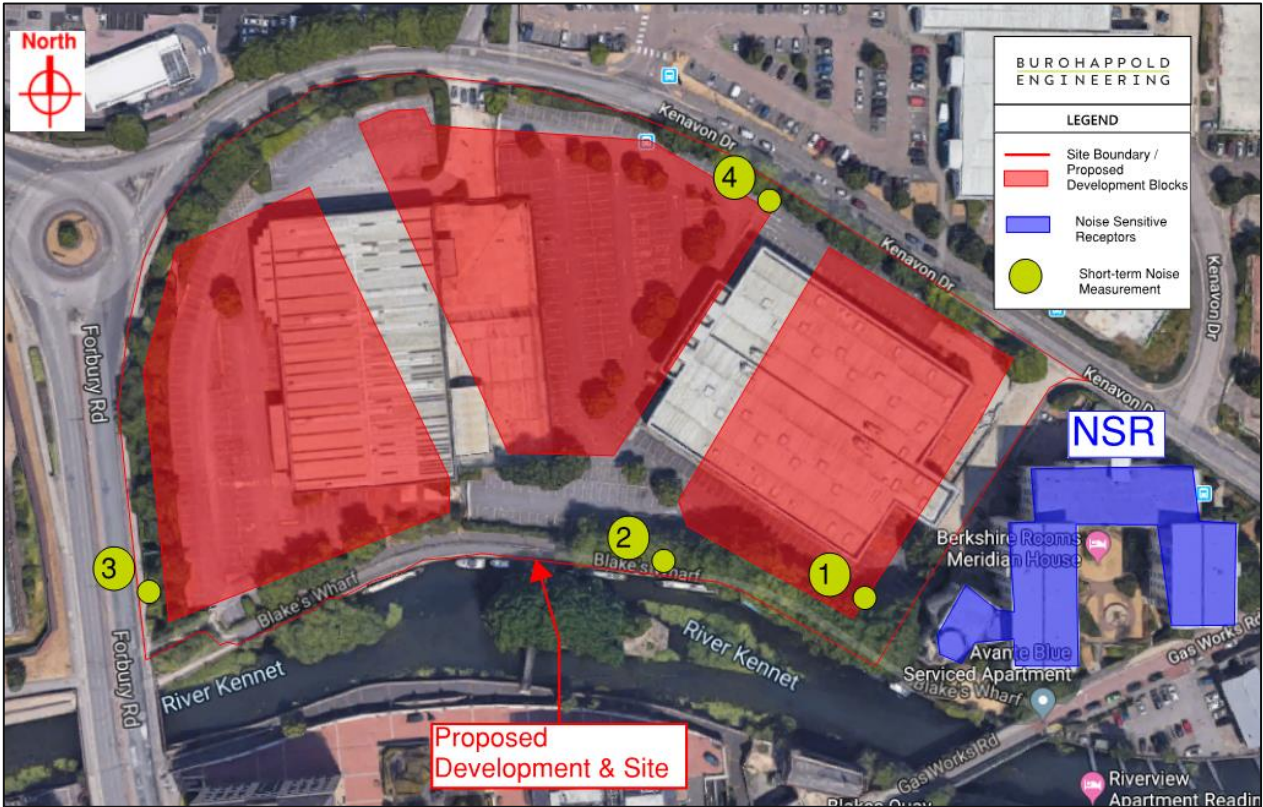


Figure 5—1 Image showing the Kenavon Drive site boundary, NSRs and noise survey monitoring locations (Source: Google Maps)

The measurement locations shown in Figure 5—1 are described as follows:

Location 1

The location is representative of the background noise levels at the adjacent residential building (NSR). Noise was predominantly dominated by road traffic movements along the local road network, being continuous during the daytime period and intermittent during the night-time period.

Location 2

This position is considered to be representative of the background sound conditions in the centre of the site. These are dominated by road traffic movements along the local road network, being continuous during the daytime and intermittent during the night-time period.

Location 3

This position is representative of the sound conditions at the location of the western façade of the proposed building. The noise climate was dominated by road traffic along the adjacent Forbury Road.

Location 4

This position is considered representative of the noise climate to the north of the site. At this position, road traffic movements along Kenavon Drive dominated the noise climate.

A.1 Survey Results

The dominant noise sources in the vicinity of the site were reported to be associated with road traffic on local and more distant roads, in particular from Forbury Road to the west.

The results of the noise survey reproduced in Table 5—1 are considered representative of the noise environment around the Kenavon Drive Site. The included descriptors are as follows:

- L_{Aeq,15min}** – the continuous equivalent A-weighted sound pressure level over a 15-minute period. The steady state noise level, which over the period under consideration contains the same amount of sound energy as the time-varying noise;
- L_{AF,max}** – the maximum instantaneous A-weighted sound pressure level measured during a 15-minute period. Typically corresponding to a short-duration event with a very high sound pressure level; and
- L_{A90,15min}** – the A-weighted sound pressure level exceeded for 90% of the measurement period. A level, which would be perceived as a constant, background noise level. Typically, largely unaffected by local traffic pass-by or by transient events. More usually attributable to constantly running building services plant or distant road traffic. What one would hear when there is no local traffic present (or other readily identifiable noise source).

The “design level” values outlined in Table 5—1 were derived from the short-term noise survey measurements at locations 1, 2, 3 and 4. The values for each descriptor were selected using the following rationale:

- Existing Ambient L_{Aeq,T} Noise Climate** – a logarithmic average of L_{Aeq,15minute} values measured during the **worst-case (highest level)** day and night-time measurement periods;
- Maximum L_{AF,max} Noise Exposures** – **Typical** representative L_{AF,max} values. The dataset was sampled to 15-minute periods within each measurement and maximum noise levels excluding those caused by events such as blue light emergency vehicle passes were selected.

Background L_{A90,15min} Noise Climate – an arithmetic average of L_{A90,15minute} values measured during representative, **worst-case (lowest level)** day and night-time periods. It is acknowledged that averaging statistical quantities interferes with their statistical basis, however, it is proposed that this practice has merit in representing a typical value for use in assessment.

Table 5—1 Noise survey results and design levels

Position	Time Period of the 15 min Period Measurements (HH:MM- HH:MM)	Average L _{Aeq15 min} - dB(A))	Typical L _{AF,max} - dB(A))	L _{A90,15min} - dB(A))
1	13:00-14:00	56	71	50
	14:00-15:00	53	60	51
	15:00-16:00	53	64	50
	22:00-23:00	48	57	45
1	Daytime design level - dB(A)	56	71	45

Position	Time Period of the 15 min Period Measurements (HH:MM- HH:MM)	Average L _{Aeq15 min} - dB(A))	Typical L _{AF,max} - dB(A))	L _{A90,15min} - dB(A))
	23:00-00:00	45	53	41
	00:00-01:00	43	48	40
	01:00-02:00	42	51	39
	Night-time design level - dB(A)	45	53	39
2	13:00-14:00	52	62	46
	14:00-15:00	54	67	50
	15:00-16:00	52	60	48
	22:00-23:00	47	56	43
	Daytime design level - dB(A)	54	67	43
	23:00-00:00	45	53	41
	00:00-01:00	48	62	40
	01:00-02:00	42	51	38
	Night-time design level - dB(A)	48	62	38
3	13:00-14:00	69	84	62
	14:00-15:00	68	77	60
	15:00-16:00	67	76	61
	22:00-23:00	67	76	53
	Daytime design level - dB(A)	69	84	53
	23:00-00:00	63	73	42
	00:00-01:00	63	78	41
	01:00-02:00	62	77	39
	Night-time design level - dB(A)	63	78	39
4	13:00-14:00	58	71	51
	14:00-15:00	60	74	52
	15:00-16:00	60	71	51
	22:00-23:00	53	70	41
	Daytime design level - dB(A)	60	74	41
	23:00-00:00	55	78	40
	00:00-01:00	52	73	38
	01:00-02:00	48	70	34
	Night-time design level - dB(A)	55	78	34

Appendix B Substation Tonality Assessment

Table 5—2 Substation Tonality Assessment

Frequency (Hz)	A-Weight Sound Power Levels (dBA)	Un-weight Sound Power Levels (dB)	Difference to Upper 1/3 Octave Band (dB)	Difference to Lower 1/3 Octave Band (dB)	Tonal?
50	25	55.2	3	-	no
63	26	52.2	17.7	-3	no
80	12	34.5	-11.6	-17.7	no
100	27	46.1	0	11.6	no
125	30	46.1	5.7	0	no
160	27	40.4	-11.5	-5.7	no
200	41	51.9	9.3	11.5	yes
250	34	42.6	-4	-9.3	no
315	40	46.6	0.8	4	no
400	41	45.8	7.6	-0.8	no
500	35	38.2	0.3	-7.6	no
630	36	37.9	1.1	-0.3	no
800	36	36.8	1.8	-1.1	no
1000	35	35	-2.4	-1.8	no
1250	38	37.4	-0.6	2.4	no
1600	39	38	0.2	0.6	no
2000	39	37.8	-3.9	-0.2	no
2500	43	41.7	-2.1	3.9	no
3150	45	43.8	1.8	2.1	no
4000	43	42	0.5	-1.8	no
5000	42	41.5	29.4	-0.5	no
6300	12	12.1	-1	-29.4	no
8000	12	13.1	-1.4	1	no
10000	12	14.5	14.5	1.4	no

Table 5—2 shows tonality is present at the 200Hz 1/3 Octave Band. A +3dB penalty has been applied to the substation plant item rating level, in line with the BS 4142 assessment criteria.

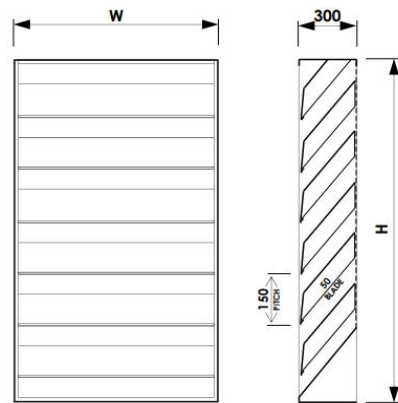
Appendix C Allaway L70E acoustic louvre

**DATA SHEET L70E
ACOUSTIC LOUVRE
MODEL AL3015**

THIS IS NOT A STAND ALONE DOCUMENT AND UNLESS REFERRED TO IN A DATED EQUIPMENT SCHEDULE IS SUBJECT TO REVISION WITHOUT NOTICE.



DIMENSIONS



SPECIFICATION

LOUVRES ARE CONSTRUCTED FROM FOLDED SHEET METAL AND HAVE A SERIES OF HORIZONTAL BLADES CONTAINED WITHIN A FOUR SIDED EXTERNAL FRAME.

THE MATERIAL OF CONSTRUCTION MAY BE PRE-GALVANISED STEEL (SUFFIX G) OR ALUMINIUM (SUFFIX A).

GALVANISED BIRD SCREENS ARE FITTED AS STANDARD.

CASING SIDES ARE PROVIDED WITH 10mm DIA HOLES FOR FIXING ADJACENT SECTIONS TOGETHER, OR FIXING THE LOUVRE INTO THE BUILDERSWORK OPENING.

LOUVRES ARE SUPPLIED SELF FINISH AS STANDARD OR WITH AN OPTIONAL POLYESTER POWDER FINISH (SUFFIX P).

NOTES

THIS DATA SHEET IS TO BE READ IN CONJUNCTION WITH THE EQUIPMENT SCHEDULE.

WIDTH (W) AND HEIGHT (H) DIMENSIONS GIVEN ON THE EQUIPMENT SCHEDULE ARE AS MANUFACTURED. ADEQUATE CLEARANCE MUST BE ALLOWED WHEN CONSTRUCTING THE BUILDERSWORK OPENING, A MINIMUM OF 10 mm IS RECOMMENDED.

LOUVRES WILL BE SUPPLIED WITHOUT SUPPORT STEELWORK, CLEATS, BRACKETS, FIXINGS, FLASHING, MASTIC, OR OTHER SUCH ITEMS, UNLESS OTHERWISE STATED.

EXCESSIVELY LARGE OR HEAVY LOUVRES MAY BE MANUFACTURED IN MATING SECTIONS FOR EASE OF HANDLING.

LOUVRES ARE MANUFACTURED TO STANDARD SHEET METAL TOLERANCES OF +/- 3 mm.

SUFFIX

THE SUFFIX DEFINES ADDITIONAL FEATURES OR SPECIAL CONSTRUCTIONAL DETAILS

G GALVANISED STEEL CONSTRUCTION.

A ALUMINIUM CONSTRUCTION.

P POLYESTER POWDER COAT.

X SPECIAL CONSTRUCTION - REFER TO EQUIPMENT SCHEDULE FOR DETAILS.

WEIGHT

LOUVRE WEIGHTS ARE GIVEN ON THE EQUIPMENT SCHEDULE, APPROXIMATELY:

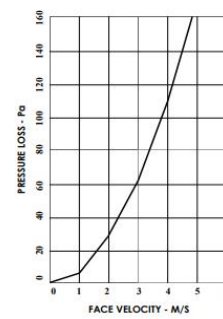
52kg/M² GALVANISED CONSTRUCTION
37kg/M² ALUMINIUM CONSTRUCTION

ACOUSTIC PERFORMANCE

SOUND REDUCTION INDEX: BS EN ISO 10140 - 2

63	125	250	500	1000	2000	4000	8000	Hz
5	6	8	11	18	25	20	16	dB

PRESSURE LOSS



STANDARD SIZES

THERE ARE NO STANDARD SIZES. ALL LOUVRES ARE MADE TO ORDER.

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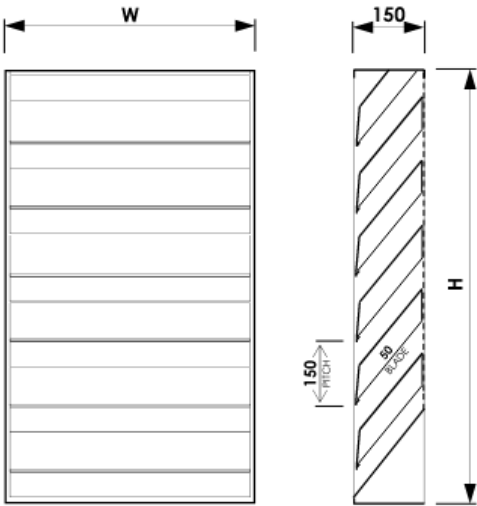
Appendix D Allaway L60E acoustic louvre

DATA SHEET **L60E**
ACOUSTIC LOUVRE
MODEL **AL1515**

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DIMENSIONS



SUFFIX

THE SUFFIX DEFINES ADDITIONAL FEATURES OR SPECIAL CONSTRUCTIONAL DETAILS

G GALVANISED STEEL CONSTRUCTION.

A ALUMINIUM CONSTRUCTION.

P POLYESTER POWDER COAT.

X SPECIAL CONSTRUCTION - REFER TO EQUIPMENT SCHEDULE FOR DETAILS.

WEIGHT

LOUVRE WEIGHTS ARE GIVEN ON THE EQUIPMENT SCHEDULE. APPROXIMATELY:

28kg/M² GALVANISED CONSTRUCTION

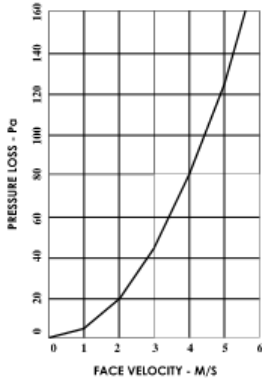
20kg/M² ALUMINIUM CONSTRUCTION

ACOUSTIC PERFORMANCE

SOUND REDUCTION INDEX: BS EN ISO 10140 - 2

63	125	250	500	1000	2000	4000	8000	Hz
4	4	5	8	12	16	15	13	dB

PRESSURE LOSS



STANDARD SIZES

THERE ARE NO STANDARD SIZES. ALL LOUVRES ARE MADE TO ORDER.

SPECIFICATION

LOUVRES ARE CONSTRUCTED FROM FOLDED SHEET METAL AND HAVE A SERIES OF HORIZONTAL BLADES CONTAINED WITHIN A FOUR SIDED EXTERNAL FRAME.

THE MATERIAL OF CONSTRUCTION MAY BE PRE-GALVANISED STEEL (SUFFIX G) OR ALUMINIUM (SUFFIX A).

GALVANISED BIRD SCREENS ARE FITTED AS STANDARD.

CASING SIDES ARE PROVIDED WITH 10mm DIA HOLES FOR FIXING ADJACENT SECTIONS TOGETHER, OR FIXING THE LOUVRE INTO THE BUILDERSWORK OPENING.

LOUVRES ARE SUPPLIED SELF FINISH AS STANDARD OR WITH AN OPTIONAL POLYESTER POWDER FINISH (SUFFIX P).

NOTES

THIS DATA SHEET IS TO BE READ IN CONJUNCTION WITH THE EQUIPMENT SCHEDULE.

WIDTH (**W**) AND HEIGHT (**H**) DIMENSIONS GIVEN ON THE EQUIPMENT SCHEDULE ARE AS MANUFACTURED. ADEQUATE CLEARANCE MUST BE ALLOWED WHEN CONSTRUCTING THE BUILDERSWORK OPENING. A MINIMUM OF 10 mm IS RECOMMENDED.

LOUVRES WILL BE SUPPLIED WITHOUT SUPPORT STEELWORK, CLEATS, BRACKETS, FIXINGS, FLASHING, MASTIC, OR OTHER SUCH ITEMS, UNLESS OTHERWISE STATED.

EXCESSIVELY LARGE OR HEAVY LOUVRES MAY BE MANUFACTURED IN MATING SECTIONS FOR EASE OF HANDLING.

LOUVRES ARE MANUFACTURED TO STANDARD SHEET METAL TOLERANCES OF +/- 3 mm.

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Noise Breakout Assessment
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10 November 2020

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