

SANDY BROWN

Consultants in Acoustics, Noise & Vibration

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NatWest, Spinningfields

Noise survey and plant noise egress assessment

London, Manchester, Edinburgh, Birmingham, Belfast, Leeds

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B	3 Mar 22	Updates following comments	Jose M. Gonzalez	Mark Howarth
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H	8 Jun 23	Updated following generator sample measurements	Jose M. Gonzalez	Mark Howarth

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Summary

Sandy Brown has been commissioned by NatWest Group to provide acoustic advice in relation to the proposed development at NatWest Spinningfields, 182 Deansgate, Manchester M3 3LY.

An environmental noise survey has been carried out to determine the existing sound levels in the area. The noise survey was performed between 10:25 on 17 December 2021 and 11:55 on 22 December 2021.

The below condition wording has been suggested by the Local Authority

a) Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location. A report shall be submitted prior to installation to include background noise measurements and a recommended plant noise limit shall be included for agreement by the City Council as local planning authority. Proposals for noise validation testing to address part b) shall be included within the report and to be agreed by the local planning authority.

b) Prior to the use, other than for validation noise testing, a verification report shall be submitted to and approved in writing by the City Council as local planning authority to validate that any plant and equipment installed in association with this application conforms to the recommended plant noise limit in the approved acoustic report. The validation assessment shall undertake post completion testing to confirm that the noise criteria have been met. Any instances of non-conformity with the recommendations in the report shall be detailed along with any measures required to ensure compliance with the agreed noise criteria.

The representative background sound levels measured during the survey were:

- L_{A90} 55 dB during the daytime and L_{A90} 49 dB at night to the north and west
- L_{A90} 56 dB during the daytime and L_{A90} 54 dB at night to the south and east.

Based on the requirements of the Manchester City Council and on the results of the noise survey, noise egress limits have been set. These limits are cumulative, and apply with all plant operating under normal conditions. If plant items contain tonal or attention catching features, a penalty based on the type and impact of those features will be applied, and the limits will be more stringent than those set.

A noise egress assessment has been carried out to determine any additional acoustic mitigation measures required to achieve the noise egress criteria at the nearest noise sensitive premises.

On the basis that the generators are replacing current diesel rotary UPS units, it may be acceptable to relax generator plant noise limits to match those of the existing plant. This is subject to agreement by Manchester City Council.

The generators are proposed to run for planned maintenance, and simultaneously when there is a building mains failure as well as for emergencies. This could be during the day and night-time.

Following installation of the generator, acoustic sample measurements were carried out on 1 June 2023 to determine the actual noise emission from the generator in operation.

An assessment of the proposed plant items associated with the development has been carried out. The predicted levels with normally operating plant in operation only, comply with the day and night-time noise egress limits at the nearest noise sensitive premises.

In the case of a power cut, the predicted cumulative noise levels at the nearest noise sensitive premises with the generator in operation, comply with the daytime noise egress limits at the nearest noise sensitive premises. At night, the predicted cumulative noise levels exceed the night-time limits outside three nearby commercial premises, as follows: by 2 dB at 3 Hardman Street, by 7 dB at 1 The Avenue, and 8 dB at Centurion House.

The proposal includes occasional plant in operation during the night-time, and the worst-case scenario of normally operating plant and generator use from 06:00 hr. In the event of a power cut during the night-time, the limits could be exceeded outside 3 nearby commercial premises. The Local Authority should be consulted to agree a potential relaxation in the event of a power cut during the night-time.

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1 Introduction

Sandy Brown has been commissioned by NatWest Group to provide acoustic advice in relation to the proposed reconfiguration of rooftop plant at NatWest Spinningfields, 182 Deansgate, Manchester M3 3LY

As part of this, an environmental noise survey is required, the purpose of which is to establish the existing background sound levels in the vicinity of nearby noise sensitive premises. These are used to set appropriate limits for noise egress from building services plant in accordance with Manchester City Council requirements.

This report presents the survey method and results, and a discussion of acceptable limits for noise emissions from building services plant.

2 Site description

2.1 The site and its surrounding

The site location in relation to its surroundings is outlined in red in Figure 1.



Figure 1 Aerial view of site (courtesy of Google Earth Pro)

2.2 Adjacent premises

The site is adjacent to the following premises:

- The Old Courthouse (residential, offices and commercial) highlighted in pink in Figure 1
- Yotel Deansgate (hotel), highlighted in dark green in Figure 1.
- Moxy Hotel, highlighted in red in Figure 1.
- DFW (offices) highlighted in blue in Figure 1.
- 3 Hardman Street (offices) highlighted in light green in Figure 1.
- 1 The Avenue (offices and commercial) highlighted in yellow in Figure 1.
- St John's House (offices and commercial) highlighted in cyan in Figure 1.
- Centurion House (offices) highlighted in purple in Figure 1.
- 1 Hardman Street (offices) highlighted in orange in Figure 1.

3 Development proposals

The proposals include changes to the rooftop plant on the NatWest building on Deansgate, Manchester. The proposal includes two generators on level 8, two AHUs and two condenser units on level 7, and three source heat pumps at level 6.

The building has an existing roof plant room in which there is a diesel rotary UPS alongside other electrical equipment. The proposal includes the removal of these plant items and install two generators in the same area within acoustic cabinets.

In addition to this, the proposal is to 'extend' the plant room on Level 6 (which currently contains three chillers and water plant room) such that it encroaches onto the terrace above. The extended area will include new AHUs at level 7.

4 Building services noise egress criteria

4.1 Standard guidance

BS 4142:2014+A1:2019 *Methods for rating and assessing industrial and commercial sound* (BS 4142) provides a method for assessing noise from items such as building services plant against the existing background sound levels at nearby noise sensitive premises.

BS 4142 suggests that if the noise level is 10 dB or more higher than the existing background sound level, it is likely to be an indication of a significant adverse impact. If the level is 5 dB above the existing background sound level, it is likely to be an indication of an adverse impact. If the level does not exceed the background level, it is an indication of having a low impact.

If the noise contains 'attention catching features' such as tones, bangs etc, a penalty, based on the type and impact of those features, is applied.

4.1 Local authority requirements

The below condition wording has been suggested by the Local Authority

a) Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location. A report shall be submitted prior to installation to include background noise measurements and a recommended plant noise limit shall be included for agreement by the City Council as local planning authority. Proposals for noise validation testing to address part b) shall be included within the report and to be agreed by the local planning authority.

b) Prior to the use, other than for validation noise testing, a verification report shall be submitted to and approved in writing by the City Council as local planning authority to validate that any plant and equipment installed in association with this application conforms to the recommended plant noise limit in the approved acoustic report. The validation assessment shall undertake post completion testing to confirm that the noise criteria have been met. Any instances of non-conformity with the recommendations in the report shall be detailed along with any measures required to ensure compliance with the agreed noise criteria.

4.2 Existing plant noise egress

Noise data for the existing rooftop diesel rotary UPS has been provided and summarized in Table 1.

Table 1 Provided data for the existing rooftop diesel rotary UPS

	Sound pressure levels at 1 m, L_{eq} (dB), Octave-band centre frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Discharge louvres	87	97	83	70	62	61	58	60
Inlet louvres	86	82	76	69	62	59	55	57
Enclosure front corner	83	84	77	66	65	62	58	63
Enclosure rear corner	80	84	72	63	57	52	48	46
90 degree exhaust outlet	103	111	101	84	76	76	73	68

Data for the existing AHUs has not been provided.

Based on this data, it is calculated that the existing rooftop diesel rotary UPS contribution at 1 m from the facade of the nearest noise sensitive receptor (St John's House) is L_{Aeq} 56 dB when operational.

5 Noise survey method

The survey included unattended noise measurements.

5.1 Unattended measurements

Unattended noise monitoring was undertaken at the site over 6 days.

Details of the equipment used and the noise indices measured are provided in Appendix A.

The unattended measurements were taken over 15 minute periods between 10:25 on 17 December 2021 and 12:10 on 22 December 2021. The equipment was installed by Jessica Wright and collected by Christian Clark.

The measurement positions used during the survey are indicated in Figure 1, denoted by the numbers '1' and '2'. A photograph showing the measurement locations are provided in Figure 2.

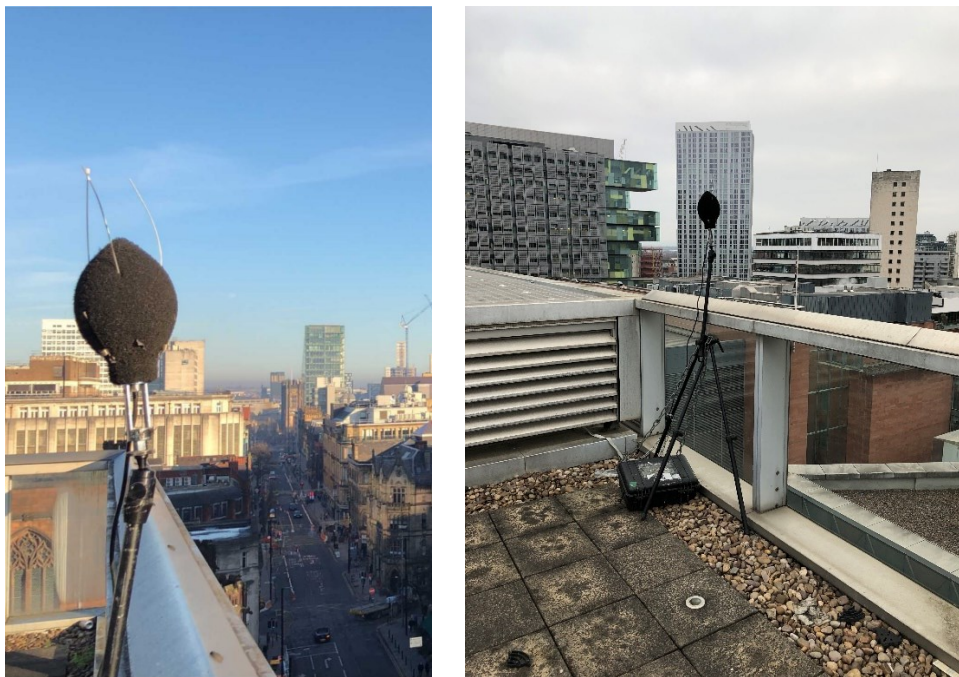


Figure 2 Photographs of measurement positions 1 (left) and 2 (right)

These locations were chosen to be reasonably representative of noise levels at the site and outside the nearest noise sensitive premises. However, the existing plant was not operational during the visit so the levels measured do not include its contribution.

5.2 Attended generator measurements

Attended sample measurements were carried out at 3 locations around the generator on 1 June 2023. These locations are indicated as positions 1 to 3 in Figure 3.

The attended measurements were carried out between 12:37 and 14:46 hrs to determine the noise levels from the generator noise emitting terminations (i.e. intake and exhaust) and break out. The site conditions were considered suitable to carry out the measurements.

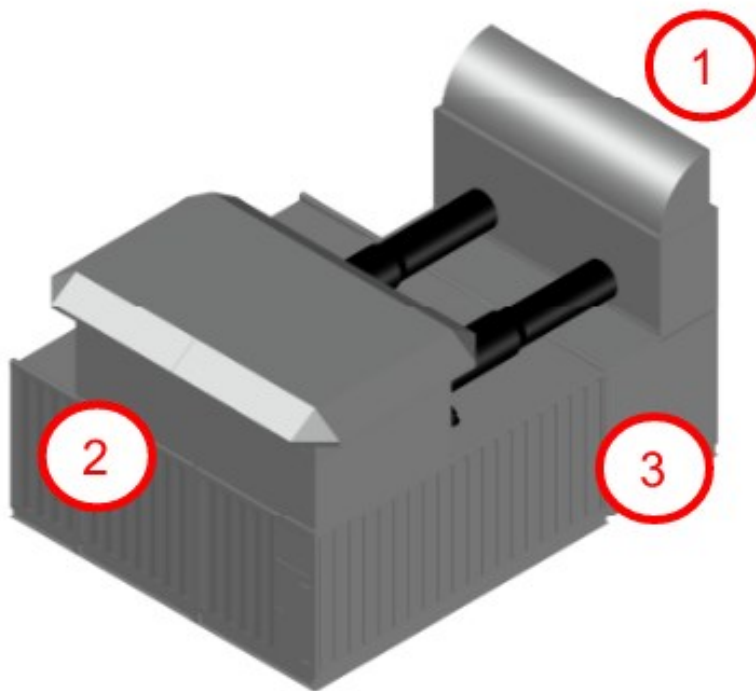


Figure 3 Attended measurement locations

At measurement positions 1 and 2, the microphone was mounted on tripod approximately 1.5 m above the local rooftop level and at least 3 m from any other reflective surface.

For measurement position 3, the microphone was mounted on a tripod approximately 1.5 m above a scaffold tower toe board, approximately 5 m from the rooftop level and approximately 1.5 m from the existing louvre.

All measurements were carried out in third octave band and time interval of 1 minute.

Background measurements were carried out with the generators switched off at each position. Measurements with the generators in operation were carried out with the generators at 50% duty, this is understood to be an N+1 configuration, and how they will operate in case of emergency.

It is understood that the generators were suitably loaded, equivalent to future building loading operation.

Photographs showing the measurement positions are provided in Figure 4.



Figure 4 Photographs of generator measurement positions 1 (left), 2 (centre) and 3 (right)

5.3 Weather conditions

Weather conditions during the unattended and attended surveys are described in Appendix A.

6 Noise survey results

6.1 Unattended noise measurement results

A graph showing the results of the unattended measurements is provided in Appendix B.

Day and night-time ambient noise levels measured during the unattended survey are presented in Table 2 and Table 3.

Table 2 Ambient noise levels measured during the unattended survey at position 1

Date	Daytime (07:00 – 23:00)	Night (23:00 – 07:00)
	$L_{Aeq,16h}$ (dB)	$L_{Aeq,8h}$ (dB)
Friday 17 December 2021	-	62
Saturday 18 December 2021	64	65
Sunday 19 December 2021	65	58
Monday 20 December 2021	62	57
Average	64	61

Table 3 Ambient noise levels measured during the unattended survey at position 2

Date	Daytime (07:00 – 23:00)	Night (23:00 – 07:00)
	$L_{Aeq,16h}$ (dB)	$L_{Aeq,8h}$ (dB)
Tuesday 21 December 2021	64 ^[1]	55
Wednesday 22 December 2021	71 ^[1]	-
Average	-	55

^[1] Measurement not made over full period due to monitoring start and end time (the measurement on 21 December 21 was over 12 hours, and on 22 December 21 over 5 hours); not included in the average.

In line with BS 4142:2014+A1:2019, representative background sound levels have been determined using statistical analysis of the continuous measurements.

Daytime and night-time statistical analysis of representative values for the site are given in Figure 5 and Figure 7 at position 1 and Figure 6 and Figure 8 at position 2.

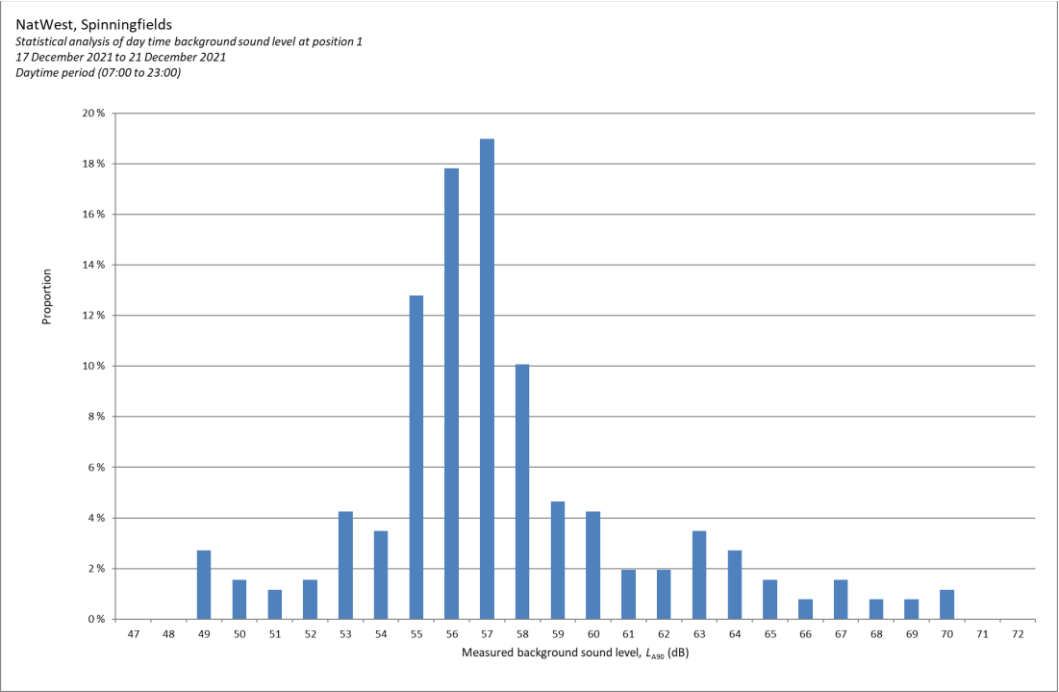


Figure 5 Statistical analysis of daytime background sound levels at position 1

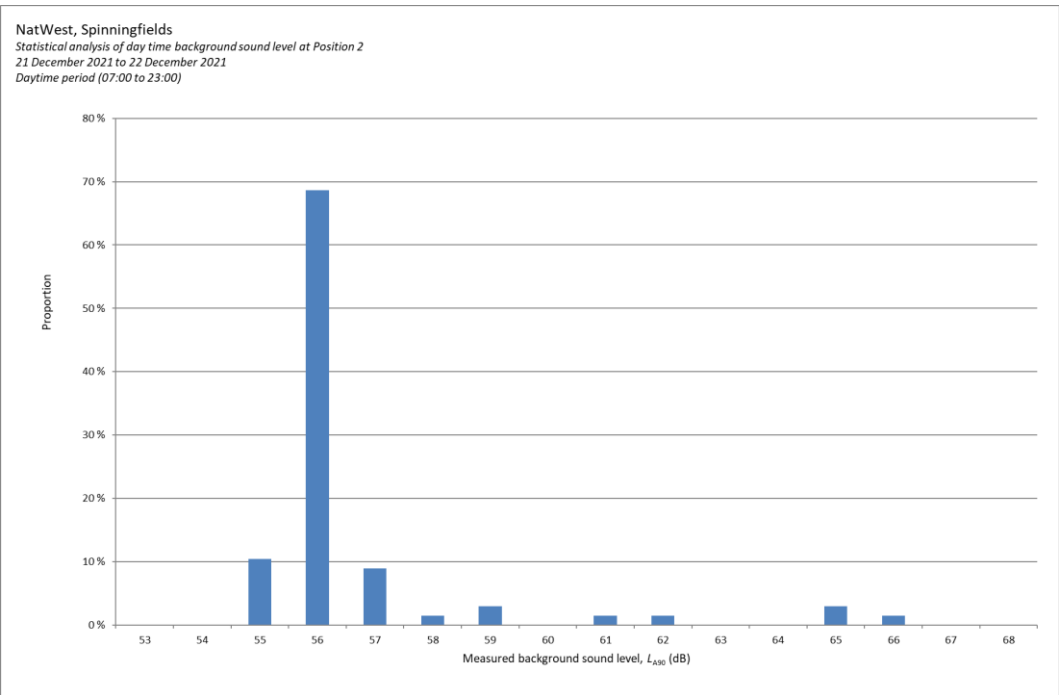


Figure 6 Statistical analysis of daytime background sound levels at position 2

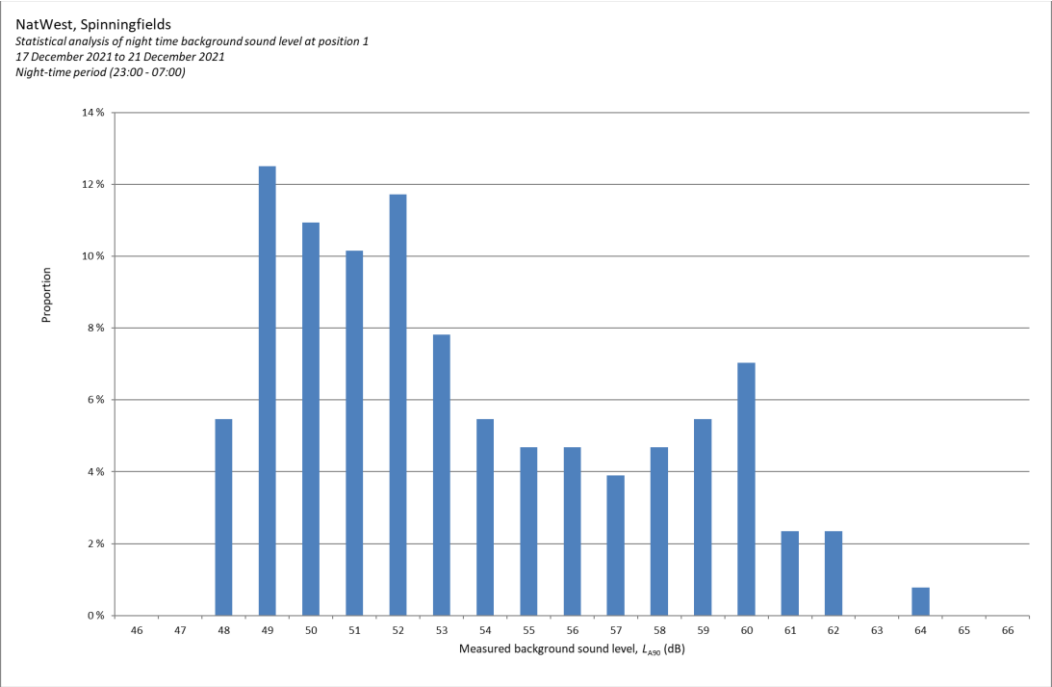


Figure 7 Statistical analysis of night-time background sound levels at position 1

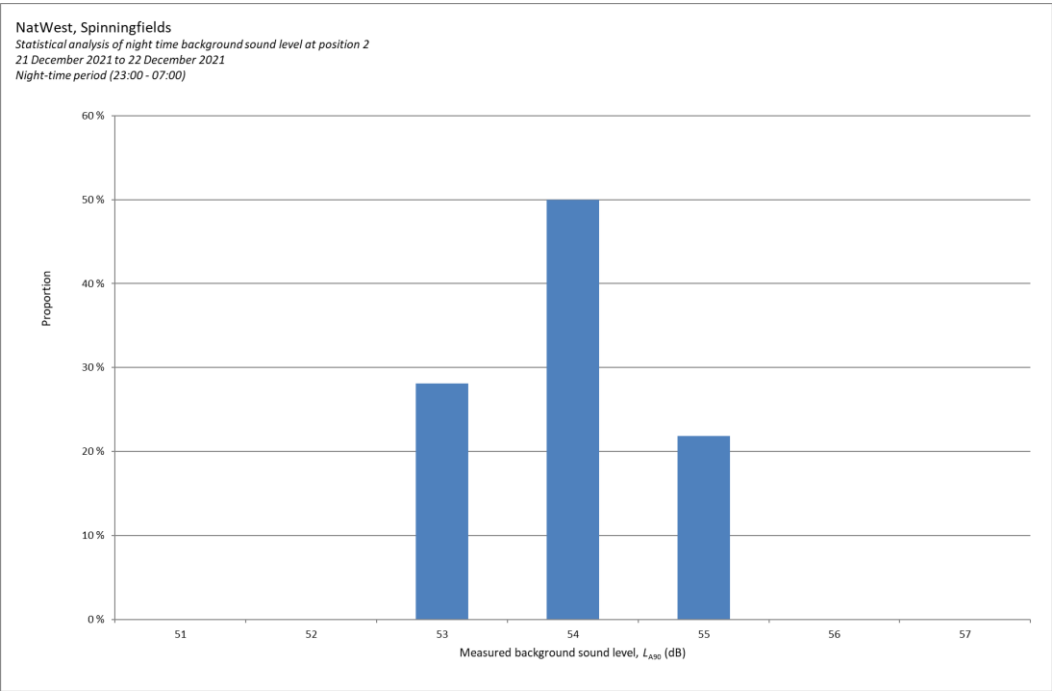


Figure 8 Statistical analysis of night-time background sound levels at position 2

From this analysis, the representative free-field background sound levels measured during the survey were:

- Position 1: L_{A90} 55 dB during the daytime and L_{A90} 49 dB at night
- Position 2: L_{A90} 56 dB during the daytime and L_{A90} 54 dB at night.

6.2 Attended generator measurement results

Noise levels and key sources recorded during the attended measurements are summarised in Table 4.

Table 4 Noise level and key noise sources from attended measurements

Position	Start time	Sound pressure levels (dB)			Description and noise sources
		$L_{Aeq,1min}$	$L_{AFmax,1min}$	$L_{A90,1min}$	
1	12:37	55	63	54	Background measurement with generator switched off, dominated by road traffic and road works on Deansgate (including piling and hammering), distant plant in operation, occasional car horn and reverse beeping
	12:38	55	58	54	
	12:39	56	71	54	
	12:40	56	64	54	
	12:41	58	77	53	
	14:21	71	72	70	Dominated by generator exhaust atmosphere termination
	14:22	71	78	71	
	14:23	71	72	71	
	14:24	71	73	71	
	14:25	71	72	71	
2	12:46	50	56	50	Background measurement with generator switched off, dominated by road traffic and road works on Deansgate (including piling and hammering)
	12:47	53	66	50	
	12:48	53	59	51	
	12:49	54	60	51	
	12:50	53	60	50	

Position	Start time	Sound pressure levels (dB)			Description and noise sources
		$L_{Aeq,1min}$	$L_{AFmax,1min}$	$L_{A90,1min}$	
2	14:27	79	81	79	Dominated by generator intake atmosphere termination
	14:28	79	80	78	
	14:29	79	80	79	
	14:30	79	81	79	
	14:31	79	82	79	
3	13:02	60	66	55	Background measurement with generator switched off, dominated by road works on Deansgate (including piling and hammering), with less contributions from road traffic on Deansgate and reverse beeping
	13:03	57	64	54	
	13:04	57	65	53	
	13:05	58	69	54	
	13:06	61	67	54	
	14:41	74	75	73	Dominated by generator break out with contributions from intake atmosphere termination
	14:42	74	76	73	
	14:43	73	75	73	
	14:44	74	75	73	
	14:45	74	75	73	

The average octave band sound pressure levels measured from the intake and exhaust terminations are summarised in Table 8. The one-third octave band measurement results are presented in Appendix E.

6.3 Plant noise limits

6.3.1 Basic limits

If noise from existing plant is not accounted for, based on the above criteria and the measurement results, the cumulative noise level from the operation of all new plant should not exceed the limits set out in Table 5.

The limits apply at 1 m from the worst affected windows of the nearest noise sensitive premises and are presented as facade levels. These have been corrected relative to the

measured free-field background noise levels by the addition of 3 dB. In this case these limits would apply at the locations shown in Table 5.

Table 5 Plant noise limits at 1 m from the nearest noise sensitive premises

Location	Maximum sound pressure level at 1 m from noise sensitive premises, $L_{Aeq,15min}$ (dB)	
	Daytime (07:00-23:00)	Night-time (23:00-07:00)
The Old Courthouse, Yotel, Moxy Hotel	53	47
Centurion House, St John's House	53	47 ^[1]
1 The Avenue, 3 Hardman Street, DFW, 1 Hardman Street	54	52 ^[1]

^[1] These noise sensitive premises are not for residential purposes, however it is understood that Manchester City Council requires night-time criteria for these buildings 'as the purpose of the condition is also to prevent a general increase of noise in the area and prevent noise creep'

^[2] The limits set out in Table 5 do not include any attention catching features. Penalty corrections for attention catching features may be significant and will need to be considered as the building services design progresses. This is discussed in Appendix D.

6.3.2 Adjusted limits accounting for contributions from existing diesel rotary UPS

On the basis that the generators are replacing current diesel rotary UPS units, it may be acceptable to relax generator plant noise limits to match those of the existing plant. This is subject to agreement by Manchester City Council.

6.4 Proposed plant noise assessment

The proposed development comprises the installation of the following items of plant

Ground level

- 1 x Daikin AHU with supply and extract connection to louvres (highlighted in red in Figure 9)

Level 6

- 3 x Air source heat pumps (AHSP) with AA203S (highlighted in green in Figure 10)

Level 7

- 2 x Daikin AHUs, AHU 7 and AHU 8 (highlighted in orange in Figure 11)
- 2 x FläktGroup condenser units (highlighted in blue in Figure 11)

Level 8

- 2 x MTU Generators highlighted in pink in Figure 12), these units are proposed to operate simultaneously when there is a building main failure and during planned maintenance.

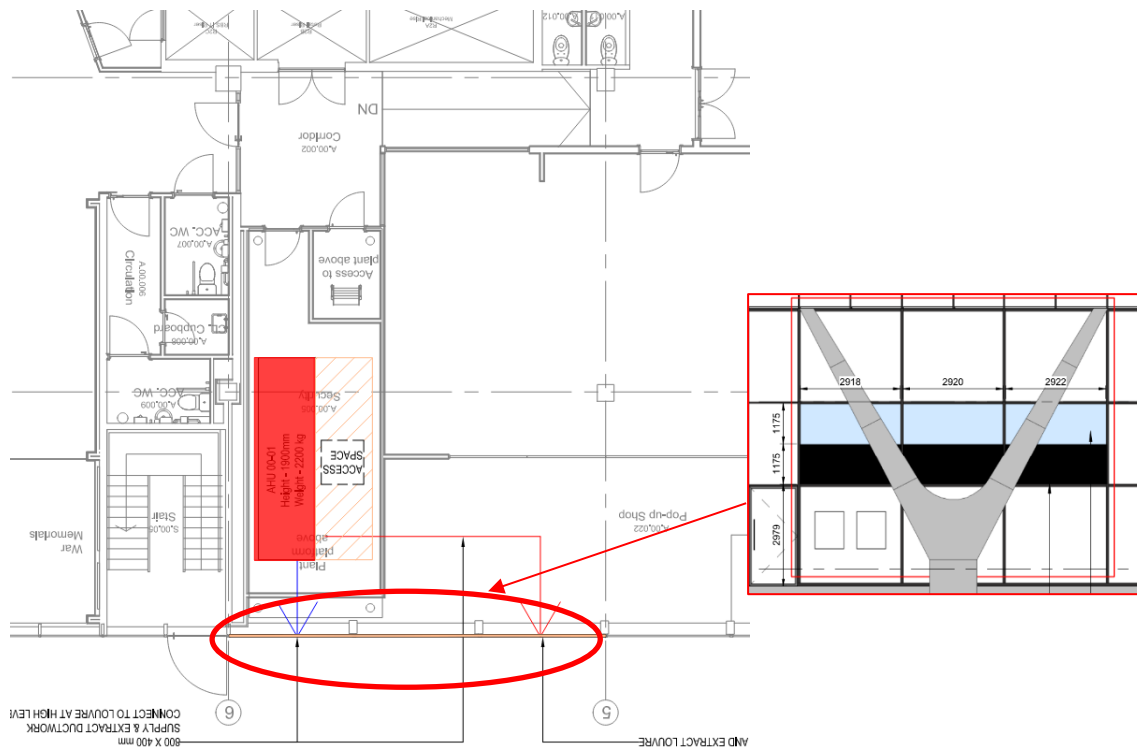


Figure 9 Proposed AHU at ground level with connections to atmosphere side

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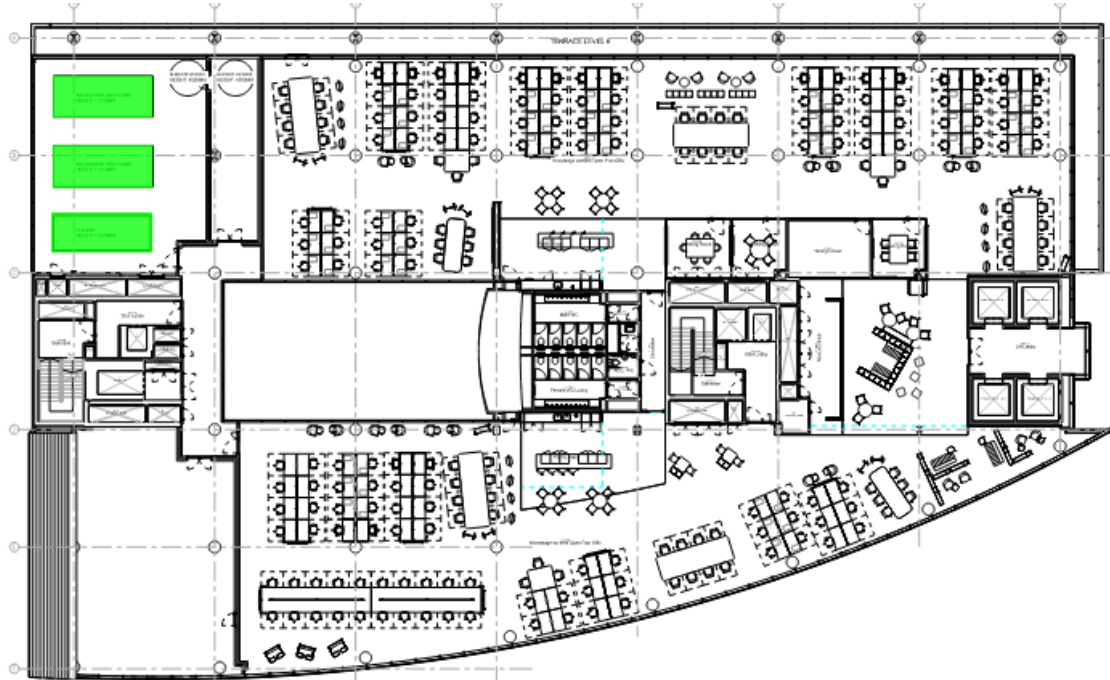


Figure 10 Proposed plant items at level 6

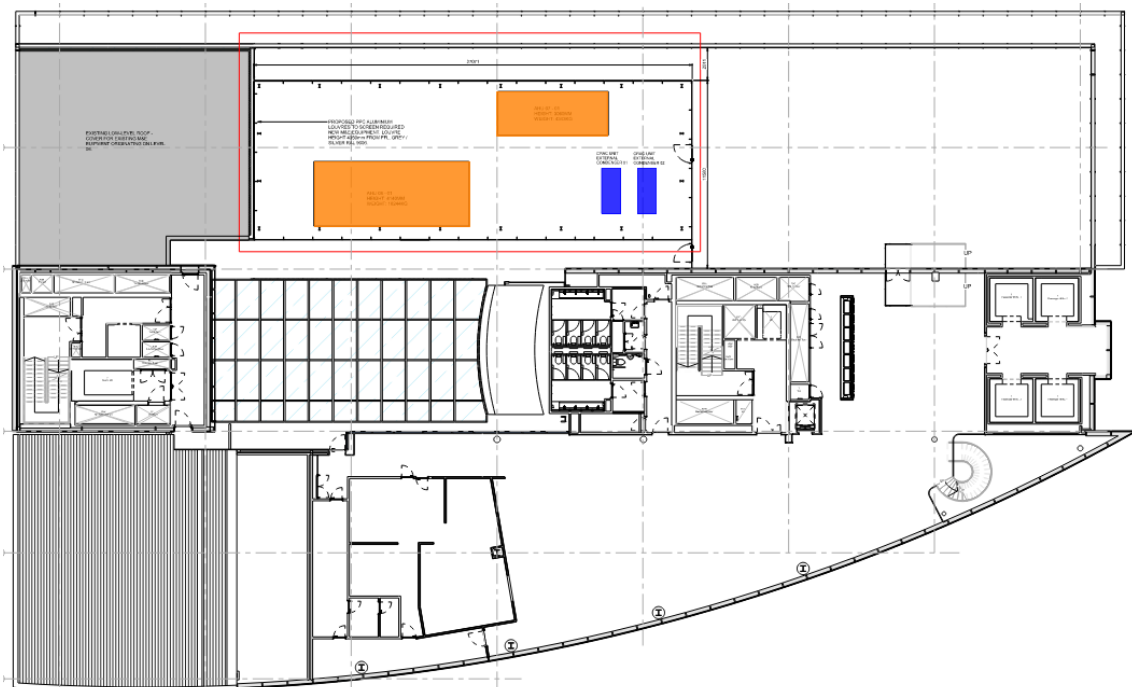


Figure 11 Proposed plant items at level 7

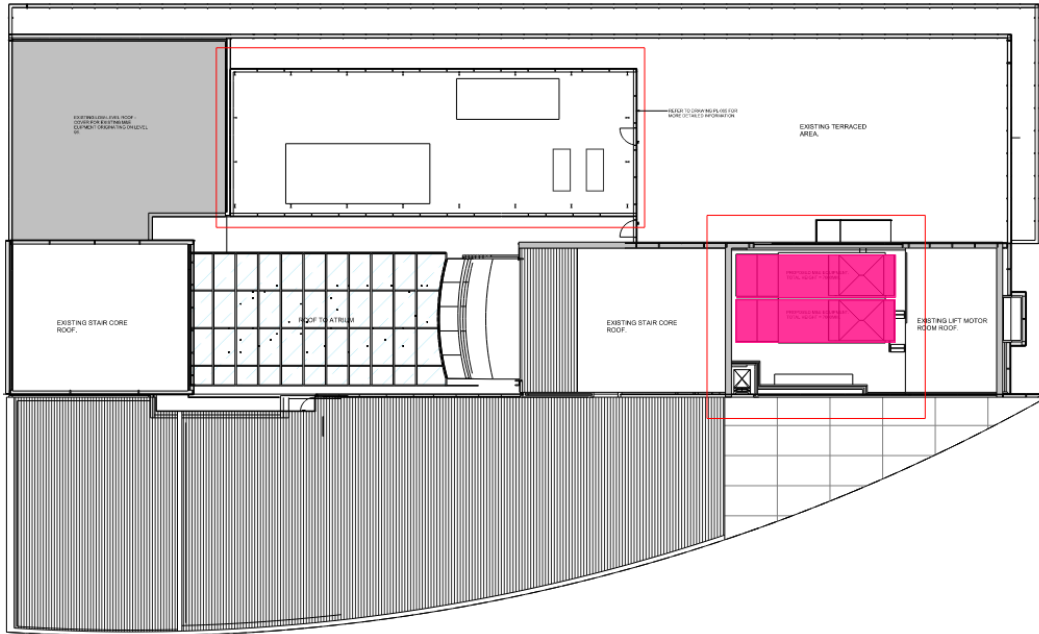


Figure 12 Proposed plant items at level 8

The manufacturer's acoustic data received for the proposed items of plant are summarised in Table 6 to Table 8.

Table 6 Noise data for the proposed AHUs

Plant item	Sound power level, L_w (dB)							
	Octave-band centre frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
<i>AHU Ground floor</i>								
<i>Intake</i>	56	64	51	42	32	31	37	41
<i>Exhaust</i>	63	70	57	56	49	46	50	51
<i>AHU 7</i>								
Supply	62	70	53	43	31	30	37	45
Supply airborne	56	68	53	53	50	45	29	22
Exhaust	70	81	63	60	51	49	56	57.0
Return airborne	55	68	52	53	51	44	29	21

Plant item	Sound power level, L_w (dB)							
	Octave-band centre frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
<i>AHU 8</i>								
Supply	71	73	58	49	37	35	44	52.
Supply airborne	62	70	58	58	55	51	35	28
Exhaust	79	83	69	65	55	53	61	63
Return airborne	64	70	58	58	55	49	34	27

Table 7 Noise data for the proposed ASHPs

Plant item	Sound power level, L_w (dB)							
	Octave-band centre frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Air source heat pump (ASHP)- each	43	52	62	60	59	57	54	36

The average measured octave band sound pressure levels from the intake and exhaust terminations, and break out are summarised in Table 8. In each case the data relates to 2 units in operation (50% duty in N+1 configuration). The levels include attenuation measures included by the generator manufacturer.

The octave band measurement results in Table 8 have been derived from the one-third octave band measurement results, and presented in Appendix E.

Table 8 Generator measurement results (N+1 configuration)

Measurement location	Average sound pressure levels L_{eq} (dB) at 1.5 m from atmosphere terminations and break out							
	Octave-band centre frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
1 exhaust	75	77	72	68	62	63	59	55
2 Intake	83	81	78	75	69	73	70	67
3 Break out	72	80	73	71	68	65	59	53

The generators are proposed to run for planned maintenance, and simultaneously when there is a building mains failure, this could be during the day and night-time.

6.5 Noise egress assessment

The predicted noise rating levels at the nearest noise sensitive premises take into account the following:

- Attenuation due to distance and screening
- AHUs, ASHP, and Condenser units in continuous operation during the daytime
- AHUs, ASHP, and Condenser units proposed to be in operation from 06:00 hrs to provide heating/ cooling prior building use
- Two generators being in continuous operation during power shortage in N+1 configuration
- The location of the plant and directivity due to reflection from nearby surfaces
- 3 dB correction for facade reflection at the nearest noise sensitive premises.

6.5.1 Predicted noise egress levels

The predicted noise levels for operating plant, including the generators, at the nearest noise sensitive premises are summarised in Table 9.

Table 9 Predicted noise egress from rooftop plant at the nearest noise sensitive premises

Location	Predicted sound pressure level at 1 m from noise sensitive premises from normally operating plant only, L_{Aeq} (dB)	Predicted sound pressure level at 1 m from noise sensitive premises from normally operating plant with generator, L_{Aeq} (dB)
The Old Court House	35	46
Yotel Deansgate (Hotel)	38	47
Moxy Hotel	35	46
DFW	44	47
3 Hardman Street	52	54
1 Hardman Street	35	51
1 The Avenue	49	59
Centurion House	42	55

The predicted levels, with normally operating plant in operation only, comply with the day and night-time noise egress limits at the nearest noise sensitive premises without additional mitigation measures.

In the case of a power cut, the predicted cumulative noise levels at the nearest noise sensitive premises with the generator in operation comply with the day and night-time noise egress limits at the nearest noise sensitive premises. However, at night, the predicted cumulative noise levels exceed the night-time limits outside three nearby commercial premises, as follows: by 2 dB at 3 Hardman Street, by 7 dB at 1 The Avenue, and 8 dB at Centurion House.

The proposal includes occasional plant in operation during the night-time, and the use of normally operating plant and potentially generator from 06:00 hr. Based on this as a worst case scenario, the generator and normally operating plant will potentially be in operation 1 hr during the night-time.

In the unlikely event of a power cut during the night-time, the limits are exceeded outside three commercial premises. The Local Authority should be consulted and agree a potential relaxation in the event of a power cut during the night-time.

7 Conclusion

A noise survey has been carried out to determine the representative background sound levels in the vicinity of the site and surrounding noise sensitive premises.

The representative background sound levels measured during the survey were $L_{A90,15min}$ 55 dB during the daytime and $L_{A90,15min}$ 49 dB at night at position 1 and L_{A90} 56 dB during the daytime and L_{A90} 54 dB at night at position 2.

Based on the requirements of the Local Authority, the relevant plant noise limits are:

- The Old Courthouse, Yotel and Moxy Hotel: L_{Aeq} 53 dB during the day and L_{Aeq} 47 dB during the night
- St John's House and Centurion House: L_{Aeq} 53 dB during the day
- 1 The Avenue, 3 Hardman Street, DFW and 1 Hardman Street: L_{Aeq} 54 dB during the day

These limits are cumulative, and apply with all plant operating under normal conditions. If plant items contain tonal or attention catching features, the limits will be more stringent than those set out above. If plant items contain tonal or attention catching features, a penalty based on the type and impact of those features will be applied.

An assessment of the proposed plant items associated with the development has been carried out. The predicted levels with normally operating plant in operation only, comply with the day and night-time noise egress limits at the nearest noise sensitive premises.

In the case of a power cut, the predicted cumulative noise levels at the nearest noise sensitive premises with the generator in operation, comply with the daytime noise egress limits at the nearest noise sensitive premises. At night, the predicted cumulative noise levels exceed the night-time limits by 2 dB at 3 Hardman Street, by 7 dB at 1 The Avenue, and 8 dB at Centurion House.

The proposal includes occasional plant in operation during the night-time, and the worst case scenario of normally operating plant and generator use from 06:00 hr. In the event of a power cut during the night-time, the limits could be exceeded at 3 premises. The Local Authority should be consulted to agree a potential relaxation in the event of a power cut during the night-time.

As detailed in Section 4.1, in line with the Local Authority conditions a verification report is required to discharge the planning condition.

Appendix A

Survey details

Equipment

The unattended noise measurements were taken using a Rion NL-52 sound level meter.

Calibration details for the equipment used during the survey are provided in Table A1.

Table A1 Equipment calibration data

Equipment description	Type/serial number	Manufacturer	Calibration expiry	Calibration certification number
Sound level meter	NL-52/01143564	Rion	15 Dec 22	TCRT20/1738
Microphone	UC-59/10153	Rion	15 Dec 22	TCRT20/1738
Pre-amp	NH-25/43581	Rion	15 Dec 22	TCRT20/1738
Calibrator	NC-74/34257023	Rion	14 Dec 22	TCRT20/1736
Sound level meter	NL-52/00932326	Rion	21 Mar 25	TCRT23/1250
Microphone	UC-59/05549	Rion	21 Mar 25	TCRT23/1250
Pre-amp	NH-25/32354	Rion	21 Mar 25	TCRT23/1250
Calibrator	NC-74/34125432	Rion	21 Mar 25	TCRT23/1248

^[1] Calibration of the meters used for the measurements is traceable to national standards. Calibration certificates for the sound level meter used in this survey are available upon request.

Calibration checks were carried out on the meters and their measurement chains at the beginning and end of the survey. No significant calibration deviation occurred.

Noise indices

Noise indices recorded included the following:

- $L_{Aeq,T}$ The A-weighted equivalent continuous sound pressure level over a period of time, T.
- $L_{AFmax,T}$ The A-weighted maximum sound pressure level that occurred during a given period, T, with a fast time weighting.
- $L_{A90,T}$ The A-weighted sound pressure level exceeded for 90% of the measurement period. Indicative of the background sound level.

Sound pressure level measurements are normally taken with an A-weighting (denoted by a subscript 'A', eg L_{A90}) to approximate the frequency response of the human ear.

A more detailed explanation of these quantities can be found in BS7445: Part 1: 2003 *Description and measurement of environmental noise, Part 1. Guide to quantities and procedures*.

Weather conditions

During the unattended noise measurements in December 2021, weather reports for the area indicated that temperatures varied between -1°C at night and 9°C during the day, and the wind speed was less than 3 m/s.

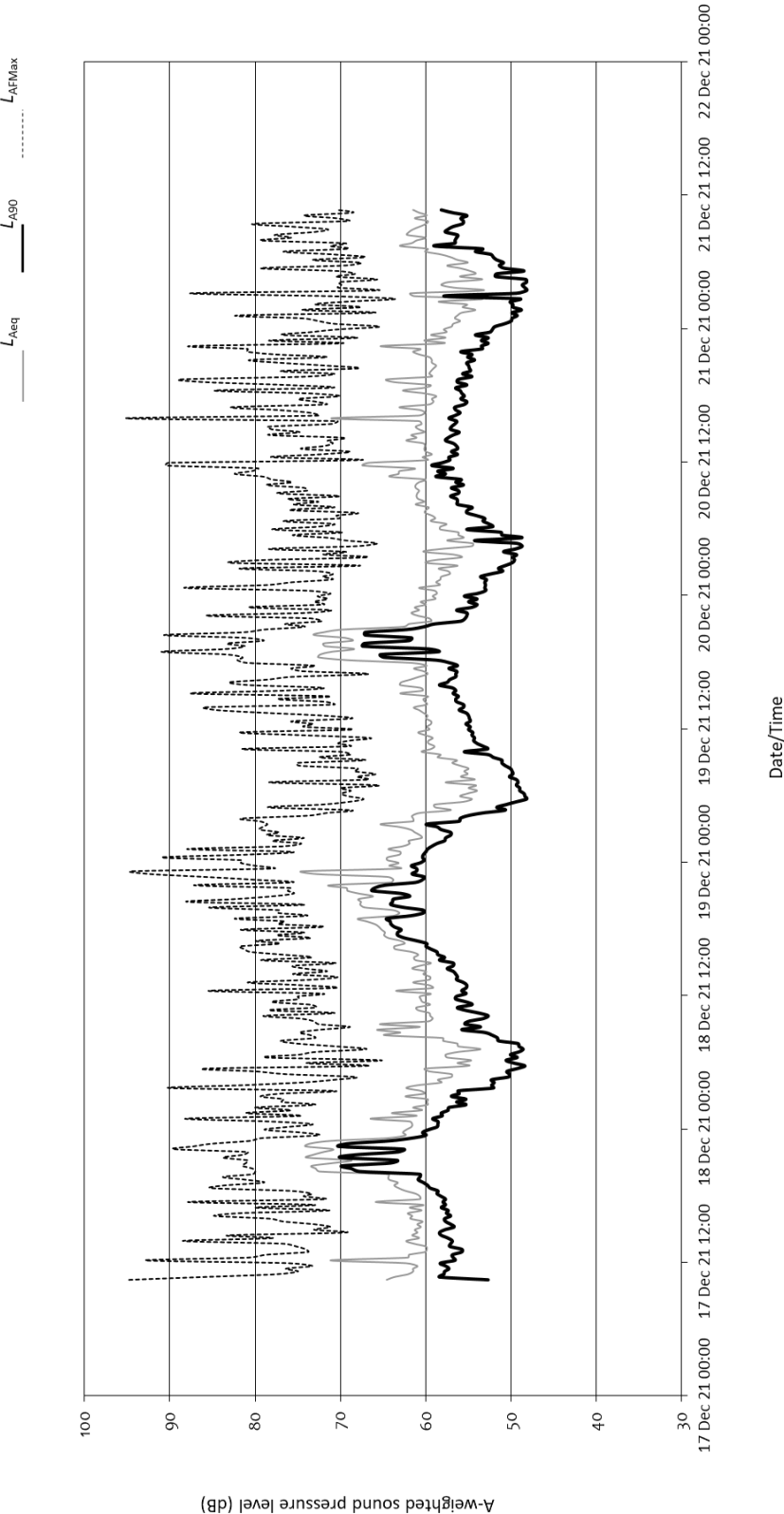
During the attended generator sample measurements on 1 June 2023, the weather was clear and dry and no rain occurred, during the measurements, the measured wind speeds were between 0 m/s and 2.5 m/s.

These weather conditions are considered suitable for obtaining representative measurements.

Appendix B

Results of unattended measurements at position 1

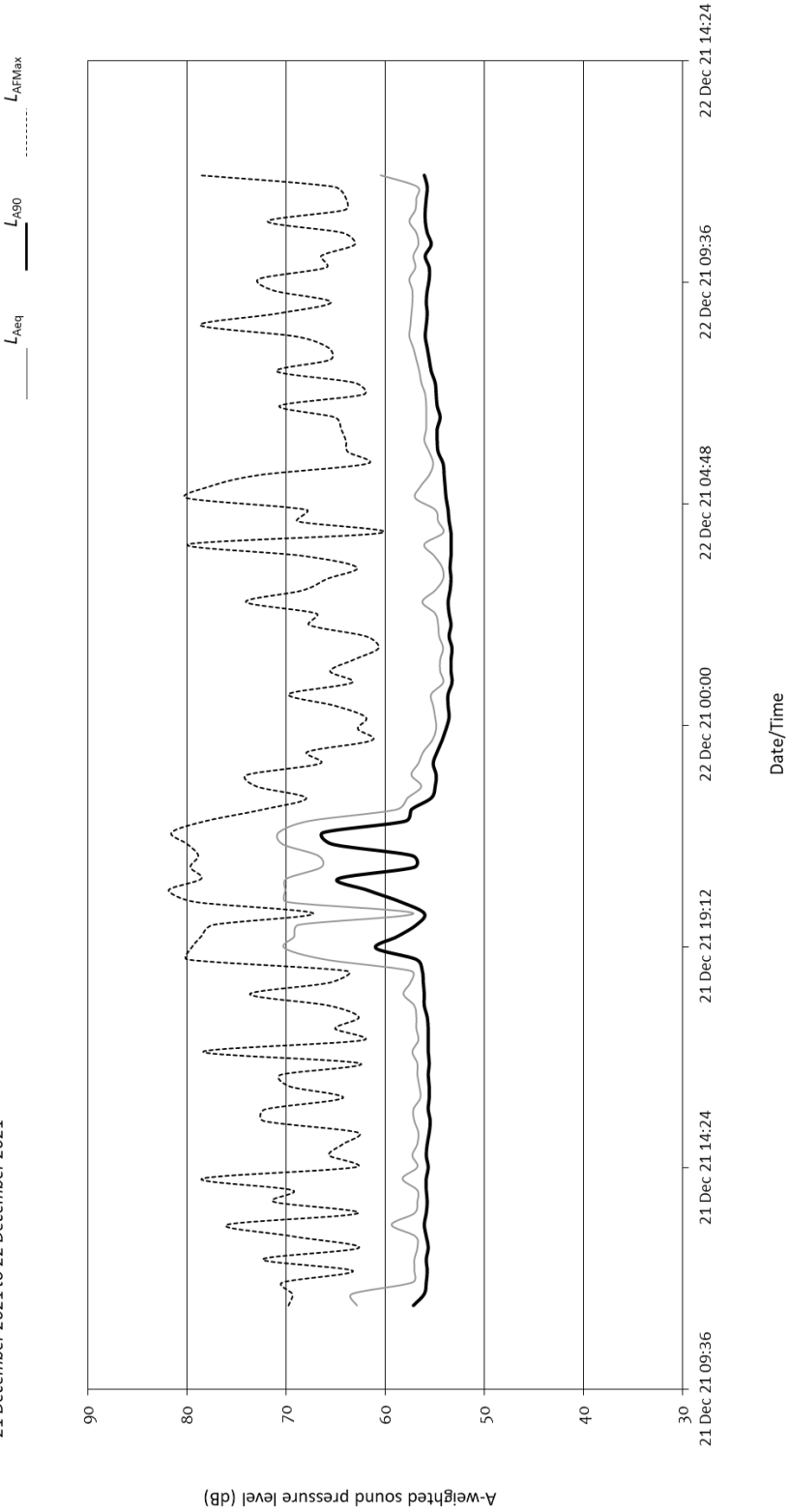
NatWest, Spinningfields
Results of noise logging survey at position 1
17 December 2021 to 21 December 2021



Appendix C

Results of unattended measurements at position 2

NatWest, Spinningfields
Results of noise logging survey at position 2
21 December 2021 to 22 December 2021



Appendix D

BS 4142 corrections for attention catching features

The following applies where plant noise is assessed in accordance with BS 4142:2014+A1:2019.

If the proposed plant noise contains attention catching features (such as tonal elements, whines, whistles, bangs etc), penalty corrections should be applied based on the type and impact of the features.

If appropriate, a subjective assessment of the plant features can be adopted. Where the plant noise contains tonal elements, the following corrections can be made depending on how perceptible the tone is at the noise receptor:

- 0 dB where the tone is not perceptible
- 2 dB where the tone is just perceptible
- 4 dB where the tone is clearly perceptible
- 6 dB where the tone is highly perceptible.

Where the plant noise is impulsive, the following corrections can be made depending on how perceptible the impulsivity is at the noise receptor:

- 0 dB where the impulse is not perceptible
- 3 dB where the impulse is just perceptible
- 6 dB where the impulse is clearly perceptible
- 9 dB where the impulse is highly perceptible.

For noise which is equally both impulsive and tonal, then both features can be accounted for by linearly summing the corrections for both characteristics.

If the plant has other distinctive characteristics, such as intermittency, then a 3 dB correction can be made.

If a subjective assessment of tonality is not appropriate, an objective assessment can be made by analysis of time-averaged, third-octave band sound pressure levels. A noise source is deemed to be tonal if the level in a third-octave band exceeds the level in adjacent third-octave bands by the level differences given below:

- 15 dB in the low frequency third-octave bands (25 Hz to 125 Hz)
- 8 dB in the mid frequency third-octave bands (160 Hz to 400 Hz)
- 5 dB in the high frequency third-octave bands (500 Hz to 10000 Hz).

If an objective assessment identifies the plant noise to be tonal then a 6 dB correction must be made.

Appendix E

Generator average measurement results (1/3 octave band)

Average sound pressure levels L_{eq} (dB) at 1.5 m from atmosphere terminations and break-out																							
Octave-band centre frequency (Hz)																							
Measurement position	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	8k	10k
1	70	68	72	73	72	73	69	64	67	63	65	62	59	55	56	61	57	57	54	56	52	50	52
2	72	76	82	79	75	72	70	73	74	72	69	70	67	62	64	71	65	65	65	66	64	62	64
3	67	67	68	71	78	72	70	65	68	67	66	65	65	62	60	64	57	58	56	55	50	48	50

Appendix F

Environmental noise egress predictions

Comments	Octave band centre frequency (Hz)								Rating 1	Rating 2
	63	125	250	500	1k	2k	4k	8k		
21579										
Natwest, Spinningfields										
JMG										
08/06/2023										
Manchester City Council										
Noise egress assessment										
To 3 Hardman Street										
<u>Ground level</u>										
<i>AHU</i>										
Supply (inlet) Lw (attenuated)	56	64	51	42	32	31	37	41		
800mm Rec UL No TV Elbow (assumed)	-1	-1	-5	-8	-4	-3	-3	-3		
End Ref.Loss 0.3m2 (d=0.62)	-8	-4	-1	0	0	0	0	0		
Lw louvre	48	59	45	34	28	28	34	38		
Screening (worst case)	0	0	0	0	0	0	0	0		
Q	2									
r	53 m	worst case								
Lp	5	17	2	-9	-15	-14	-8	-4	L _A =	3.1
Return (unit outlet) Lw	63	70	57	56	49	46	50	51		
800mm Rec UL No TV Elbow (assumed)	-1	-1	-5	-8	-4	-3	-3	-3		
End Ref.Loss 0.3m2 (d=0.62)	-8	-4	-1	0	0	0	0	0		
Lw louvre	55	65	51	48	45	43	47	48		
Screening (worst case)	0	0	0	0	0	0	0	0		
Q	2									
r	53 m	worst case								
Lp	12	23	8	5	2	1	5	6	L _A =	12.3
<u>Level 7 plant room</u>										
<i>AHU 7</i>										
Supply (inlet) Lw	62	73	59	45	41	41	52	55		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	61	68	51	41	38	38	49	52		
Lp=Lw+10log(Q/(4*PI()*r^2))										
Q	4									
r	43 m									
Lp	23	30	13	3	0	0	11	14	L _A =	18.6
Return (unit outlet) Lw	75	76	66	62	52	52	62	64		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	74	71	58	58	49	49	59	61		
Q	4									
r	43 m									
Lp	36	33	20	20	11	11	21	23	L _A =	27
Supply airborne Lw	57	65	54	56	59	52	38	31		
Return airborne Lw	60	63	55	56	53	50	36	28		
logsum	60	63	55	56	53	50	36	28		
Q	4									
r	43 m									
Lp	22	25	17	18	15	12	-2	-10	L _A =	20

AHU 8

Supply (inlet) Lw	66	78	66	53	47	50	68	65		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	65	73	58	49	44	47	65	62		
$L_p = L_w + 10 \log(Q / (4 * \pi * r^2))$										
Q	4									
r	31	m								
Lp	30	38	23	14	9	12	30	27	L _A =	33

Return (unit outlet) Lw	74	81	70	66	65	63	79	75		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Att. Min IL	0	0	0	0	0	0	0	0		
Lw after attenuator	73	76	62	62	62	60	76	72		
Max. Att. regen. noise	62	65	51	51	51	49	65	61		
Lw after attenuator	73	76	62	62	62	60	76	72		
Q	4									
r	31	m								
Lp	39	42	28	28	28	26	42	38	L _A =	44

Supply airborne Lw	60	69	61	61	67	60	50	39		
Return airborne Lw	59	68	59	60	65	58	52	39		
logsum	59	68	59	60	65	58	52	39		
Q	4									
r	31	m								
Lp	24	33	24	25	30	23	17	4	L _A =	32

Condenser units

Lw (1 unit)	76	71	70	67	71	67	60	53		
Lw (2 units)	79	74	73	70	74	70	63	56		
Q	4									
r	49	m								
Lp	40	35	34	31	35	31	24	17	L _A =	38

Level 6 plant room

ASHP's

Lp at 1m	43	52	62	60	59	57	54	36		
Attenuation	0	0	0	0	0	0	0	0		
$L_2 = L_1 - 20 * \log(r_1 / r_2)$										
r1	1	m								
r2	13	m								
L2	21	30	40	38	37	35	32	14		
add 5 for 3 units	5	5	5	5	5	5	5	5		
Lp	25	34	44	42	41	39	36	18	L _A =	46

Level 8 plant room

Generator

Exhaust measured at 1.5m (2 units)	75	77	72	68	62	63	59	55		
Att. Min IL	0	0	0	0	0	0	0	0		
r1	1.5	m								
r2	61	m								
L2	43	45	40	36	30	31	27	23	L _A =	39
Intake at 1.5m (2 units)	83	81	78	75	69	73	70	67		
Att. Min IL	0	0	0	0	0	0	0	0		
r1	1.5	m								
r2	71	m								
L2	49	47	44	41	35	39	36	33	L _A =	45

Break out at 1.5m (2 units)	72	80	73	71	68	65	59	53		
Attenuation	0	0	0	0	0	0	0	0		
r1	1.5	m								
r2	67	m								
L2	39	47	40	38	35	32	26	20	L _A =	41
Lp contributions (generator)	51	51	47	44	39	41	37	34	L _A =	47
Lp without generators	44	45	45	43	43	40	43	38	L _A =	49
3 dB for facade correction	3	3	3	3	3	3	3	3		Night Criteria
Lp facade	47	48	48	46	46	43	46	41	L _A =	52 52.0
										Night Criteria
Lp with generators	54	55	52	49	47	47	47	43	L _A =	54 52.0

To DFWGround level**AHU**

This NSP is fully screened from the louvre locations.

Level 7 plant room**AHU 7**

Supply (inlet) Lw	62	73	59	45	41	41	52	55		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	61	68	51	41	38	38	49	52		
Screening	5	5	5	6	7	8	10	13		
$L_p = L_w + 10 \log(Q / (4 * \pi * r^2))$										
Q	4									
r	60	m								
Lp	15	22	5	-5	-9	-11	-2	-1	L _A =	8

Return (unit outlet) Lw	75	76	66	62	52	52	62	64		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	74	71	58	58	49	49	59	61		
Screening	5	5	5	6	7	8	10	13		
Q	4									
r	60	m								
Lp	28	25	12	12	2	0	8	8	L _A =	16

Supply airborne Lw	57	65	54	56	59	52	38	31		
Return airborne Lw	60	63	55	56	53	50	36	28		
logsum	62	67	58	59	60	54	40	33		
Screening	5	5	5	6	7	8	10	13		
Q	4									
r	60	m								
Lp	16	21	12	13	13	6	-10	-20	L _A =	16

AHU 8

Supply (inlet) Lw	66	78	66	53	47	50	68	65		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	65	73	58	49	44	47	65	62		
Screening										
$L_p = L_w + 10 \log(Q / (4 * \pi * r^2))$										
Q	4									
r	50	m								
Lp	26	34	19	10	5	8	26	23	L _A =	29

Return (unit outlet) Lw	74	81	70	66	65	63	79	75		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Att. Min IL	0	0	0	0	0	0	0	0		
Lw after attenuator	73	76	62	62	62	60	76	72		
Max. Att. regen. noise	62	65	51	51	51	49	65	61		
Lw after attenuator	73	76	62	62	62	60	76	72		
Screening										
$L_p = L_w + 10 \log(Q / (4 * \pi * r^2))$										
Q	4									
r	50	m								
Lp	34	37	23	23	23	21	37	33	L _A =	39

Supply airborne Lw	60	69	61	61	67	60	50	39		
Return airborne Lw	59	68	59	60	65	58	52	39		
logsum	63	72	63	64	69	62	54	42		
Screening										
$L_p = L_w + 10 \log(Q / (4 * \pi * r^2))$										
Q	4									
r	50	m								
Lp	24	33	24	25	30	23	15	3	L _A =	32

Condenser units

Lw (1 unit)	76	71	70	67	71	67	60	53		
Lw (2 units)	79	74	73	70	74	70	63	56		
Screening (FULL) only 10 dB correctio	5	6	7	9	10	10	10	10		
Q	4									
r	60	m								
Lp	34	28	26	21	24	20	13	6	L _A =	27

Level 6 plant room

ASHP's

Lp at 1m	43	52	62	60	59	57	54	36		
$L_2 = L_1 - 20 * \log(r_1 / r_2)$										
r1	1	m								
r2	50	m								
L2	9	18	28	26	25	23	20	2		
Screen										
add 3 for second unit	3	3	3	3	3	3	3	3		
L2	12	21	31	29	28	26	23	5	L _A =	33

ASHP's

LP at 1m	43	52	62	60	59	57	54	36		
r1	1	m								
r2	50	m								
L2	9	18	28	26	25	23	20	2		
Screening	5	5	5	5	6	6	7	8		
L2	4	13	23	21	19	17	13	-6	L _A =	24

Level 8 plant room

Generators

Exhaust measured at 1.5m (2 units)	75.0	77.0	72.0	68.0	62.0	63.0	59.0	55.0		
Screening	5	5	6	6	7	8	10	13		
r1	1.5	m								
r2	58	m								
L2	38	40	35	30	23	23	17	10	L _A =	32

Intake at 1.5m (2 units)	83.0	81.0	78.0	75.0	69.0	73.0	70.0	67.0		
Screening	5	5	6	6	7	8	10	13		
r1	1.5	m								
r2	67	m								
L2	45	43	39	36	29	32	27	21	L _A =	38

Break out at 1.5m (2 units)	72.0	80.0	73.0	71.0	68.0	65.0	59.0	53.0		
Screening	5	5	6	6	7	8	10	13		
r1	1.5									
r2	63									
L2	34	42	35	33	29	24	16	8	L _A =	35

Lp contributions (generator)	46	47	42	38	32	33	27	21	L _A =	41	
Lp without generators	38	40	34	32	33	29	38	33	L _A =	41	
3dB facade correction	3	3	3	3	3	3	3	3			
Lp facade	41	43	37	35	36	32	41	36	L _A =	44	
Lp with generators	47	48	42	39	36	34	38	34	L _A =	44	
3dB facade correction	3	3	3	3	3	3	3	3			Night time
Lp facade	50	51	45	42	39	37	41	37	L _A =	47	52.0

To Yotel (Hotel)Ground level*AHU*

Supply (inlet) Lw (attenuated)	56	64	51	42	32	31	37	41	
800mm Rec UL No TV Elbow (assumed)	-1	-1	-5	-8	-4	-3	-3	-3	
End Ref.Loss 0.3m2 (d=0.62)	-8	-4	-1	0	0	0	0	0	
Lw louvre	48	59	45	34	28	28	34	38	
Screening (worst case)	0	0	0	0	0	0	0	0	
Q	2								
r	100 m								
Lp	0	11	-3	-14	-20	-20	-14	-10	L _A = -2.4

Return (unit outlet) Lw	63	70	57	56	49	46	50	51	
800mm Rec UL No TV Elbow (assumed)	-1	-1	-5	-8	-4	-3	-3	-3	
End Ref.Loss 0.3m2 (d=0.62)	-8	-4	-1	0	0	0	0	0	
Lw louvre	55	65	51	48	45	43	47	48	
Screening (worst case)	0	0	0	0	0	0	0	0	
Q	2								
r	100 m		worst case						
Lp	7	17	3	0	-3	-5	-1	0	L _A = 6.8

Level 7 plant room*AHU 7*

Supply (inlet) Lw	62	73	59	45	41	41	52	55	
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3	
Lw after elbow	61	68	51	41	38	38	49	52	
Lp=Lw+10log(Q/(4*PI())*(r^2)									
Q	4								
r	107 m								
Lp	15	22	5	-5	-8	-8	3	6	L _A = 11

Return (unit outlet) Lw	75	76	66	62	52	52	62	64	
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3	
Lw after elbow	74	71	58	58	49	49	59	61	
Q	4								
r	107 m								
Lp	28	25	12	12	3	3	13	15	L _A = 19

Supply airborne Lw	57	65	54	56	59	52	38	31	
Return airborne Lw	60	63	55	56	53	50	36	28	
logsum	62	67	58	59	60	54	40	33	
Q	4								
r	107 m								
Lp	16	22	12	13	14	9	-5	-13	L _A = 17

AHU 8

Supply (inlet) Lw	66	78	66	53	47	50	68	65	
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3	
Lw after elbow	65	73	58	49	44	47	65	62	
Lp=Lw+10log(Q/(4*PI())*(r^2)									
Q	4								
r	115 m								
Lp	19	27	12	3	-2	1	19	16	

Return (unit outlet) Lw	74	81	70	66	65	63	79	75		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Att. Min IL	0	0	0	0	0	0	0	0		
Lw after attenuator	73	76	62	62	62	60	76	72		
Max. Att. regen. noise	62	65	51	51	51	49	65	61		
Lw after attenuator	73	76	62	62	62	60	76	72		
Q	4									
r	115	m								
Lp	27	30	16	16	16	14	30	26	L _A =	32
Supply airborne Lw	60	69	61	61	67	60	50	39		
Return airborne Lw	59	68	59	60	65	58	52	39		
logsum	63	72	63	64	69	62	54	42		
Q	4									
r	115	m								
Lp	16	25	17	17	23	16	8	-4	L _A =	25
<i>Condenser units</i>										
Lw (1 unit)	76	71	70	67	71	67	60	53		
Lw (2 units)	79	74	73	70	74	70	63	56		
Screening-fully, only 10 dB correction	5	6	7	9	10	10	10	10		
Q	4									
r	109	m								
Lp	28	22	20	15	18	14	7	0	L _A =	22
<u>Level 6 plant room</u>										
<i>ASHP's</i>										
Lp at 1m	43	52	62	60	59	57	54	36		
L2=L1-20*log(r1/r2)										
r1	1	m								
r2	121	m								
L2	1	10	20	18	17	15	12	-6		
add 3 B for second unit	3	3	3	3	3	3	3	3		
L2	4	13	23	21	20	18	15	-3	L _A =	25
<i>ASHP's</i>										
Lp at 1m	43	52	62	60	59	57	54	36		
r1	1	m								
r2	129	m								
L2	1	10	20	18	17	15	12	-6	L _A =	22
<u>Level 8 plant room</u>										
<i>Generators</i>										
Level 8										
Exhaust measured at 1.5m (2 units)	75.0	77.0	72.0	68.0	62.0	63.0	59.0	55.0	L _A =	71
r1	1.5	m								
r2	110	m								
L2	38	40	35	31	25	26	22	18	L _A =	33
Intake at 1.5m (2 units)	83.0	81.0	78.0	75.0	69.0	73.0	70.0	67.0		
r1	1.5									
r2	105	m								
L2	46	44	41	38	32	36	33	30		
Lp	47	45	42	39	33	36	33	30	L _A =	43

Break out at 1.5m (2 units)	72.0	80.0	73.0	71.0	68.0	65.0	59.0	53.0			
r1	1.5										
r2	105 m										
L2	35	43	36	34	31	28	22	16	L _A =	37	
Lp contributions (generator)	47	48	44	41	35	37	34	31	L _A =	44	
Lp without genarators	33	34	28	26	27	23	31	27	L _A =	35	
3 dB facade correction	3	3	3	3	3	3	3	3			Night time
Lp facade	36	37	31	29	30	26	34	30	L _A =	38	47.0
Lp with generators	48	48	44	41	36	38	36	32	L _A =	44	
3 dB facade correction	3	3	3	3	3	3	3	3			Night time
Lp facade	51	51	47	44	39	41	39	35	L _A =	47	47.0

To Centurion House

Ground level

AHU

Supply (inlet) Lw (attenuated)	56	64	51	42	32	31	37	41	
800mm Rec UL No TV Elbow (assumed)	-1	-1	-5	-8	-4	-3	-3	-3	
End Ref.Loss 0.3m2 (d=0.62)	-8	-4	-1	0	0	0	0	0	
Lw louvre	48	59	45	34	28	28	34	38	
Screening (worst case)	0	0	0	0	0	0	0	0	
Q	2								
r	55 m								
Lp	5	17	2	-9	-15	-15	-9	-5	L _A = 2.8

Return (unit outlet) Lw	63	70	57	56	49	46	50	51	
800mm Rec UL No TV Elbow (assumed)	-1	-1	-5	-8	-4	-3	-3	-3	
End Ref.Loss 0.3m2 (d=0.62)	-8	-4	-1	0	0	0	0	0	
Lw louvre	55	65	51	48	45	43	47	48	
Screening (worst case)	0	0	0	0	0	0	0	0	
Q	2								
r	55 m		worst case						
Lp	12	23	8	5	2	0	4	5	L _A = 12.0

Level 7 plant room

AHU 7

Supply (inlet) Lw	62	73	59	45	41	41	52	55	
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3	
Lw after elbow	61	68	51	41	38	38	49	52	
Screening worst case	0	0	0	0	0	0	0	0	
Supply	61	68	51	41	38	38	49	55	
Lp=Lw+10log(Q/(4*PI())*(r^2)									
Q	4								
r	71 m								
Lp	19	26	9	-1	-4	-4	7	13	L _A = 15

Return (unit outlet) Lw	75	76	66	62	52	52	62	64	
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3	
Lw after elbow	74	71	58	58	49	49	59	61	
Screening worst case	0	0	0	0	0	0	0	0	
Return	74	71	58	58	49	49	59	61	
Q	4								
r	71 m								
Lp	32	29	16	16	7	7	17	19	L _A = 23

Supply airborne Lw	57	65	54	56	59	52	38	31	
Return airborne Lw	60	63	55	56	53	50	36	28	
logsum	62	67	58	59	60	54	40	33	
Screening worst case	0	0	0	0	0	0	0	0	
Lw	62	67	58	59	60	54	40	33	
Q	4								
r	71 m								
Lp	20	25	16	17	18	12	-2	-9	L _A = 21

AHU 8

Supply (inlet) Lw	66	78	66	53	47	50	68	65		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	65	73	58	49	44	47	65	62		
Screening worst case	0	0	0	0	0	0	0	0		
Lw	65	73	58	49	44	47	65	62		
$L_p = L_w + 10 \log(Q / (4 * \pi r^2))$										
Q	4									
r	81	m								
Lp	22	30	15	6	1	4	22	19	L _A =	25

Return (unit outlet) Lw	74	81	70	66	65	63	79	75		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Att. Min IL	0	0	0	0	0	0	0	0		
Lw after attenuator	73	76	62	62	62	60	76	72		
Max. Att. regen. noise	62	65	51	51	51	49	65	61		
Lw after attenuator	73	76	62	62	62	60	76	72		
Screening worst case	0	0	0	0	0	0	0	0		
Lw	73	76	62	62	62	60	76	72		
Q	4									
r	81	m								
Lp	30	33	19	19	19	17	33	29	L _A =	35

Supply airborne Lw	60	69	61	61	67	60	50	39		
Return airborne Lw	59	68	59	60	65	58	52	39		
logsum	63	72	63	64	69	62	54	42		
Screening	0	0	0	0	0	0	0	0		
Lw	63	72	63	64	69	62	54	42		
Q	4									
r	81	m								
Lp	19	28	20	20	26	19	11	-1	L _A =	28

Condenser units

Lw (1 unit)	76	71	70	67	71	67	60	53		
Lw (2 units)	79	74	73	70	74	70	63	56		
Screening worst case	0	0	0	0	0	0	0	0		
Q	4									
r	69	m								
Lp	37	32	31	28	32	28	21	14	L _A =	35

Level 6 plant room*ASHP's*

Lp at 1m	43	52	62	60	59	57	54	36		
Screening-fully (take only half)	7	8	10	11	12	12	12	12		
Lp at 1m	37	44	53	49	47	45	42	24		
$L_2 = L_1 - 20 * \log(r_1 / r_2)$										
r1	1	m								
r2	97	m								
L2	-3	4	13	9	7	5	2	-16	L _A =	13
add 3 B for second unit	3	3	3	3	3	3	3	3		
L2	0	7	16	12	10	8	5	-13	L _A =	16

ASHP's

LP at 1m	43	52	62	60	59	57	54	36		
Screening- fully (take only half)	7	8	10	11	12	12	12	12		
LP	37	44	53	49	47	45	42	24		
r1	1	m								
r2	98	m								
L2	-3	4	13	9	7	5	2	-16	L _A =	13

Level 8 plant room*Generators*

Exhaust measured at 1.5m (2 units)	75.0	77.0	72.0	68.0	62.0	63.0	59.0	55.0		
Screening	0	0	0	0	0	0	0	0		
r1	1.5	m								
r2	63	m								
L2	43	45	40	36	30	31	27	23	L _A =	38
Intake at 1.5m (2 units)	83.0	81.0	78.0	75.0	69.0	73.0	70.0	67.0		
Screening	0	0	0	0	0	0	0	0		
r1	1.5	m								
r2	53	m								
L2	52.0	50.0	47.0	44.0	38.0	42.0	39.0	36.0	L _A =	48
Break out at 1.5m (2 units)	72.0	80.0	73.0	71.0	68.0	65.0	59.0	53.0		
Screening	0	0	0	0	0	0	0	0		
r1	1.5									
r2	55									
L2	41	49	42	40	37	34	28	22		
Contribution from generator	53	53	49	46	41	43	40	36	L _A =	49
Lp without generators	39	39	32	30	34	29	34	30	L _A =	39
3 dB facade	3	3	3	3	3	3	3	3		Night time
Lp facade	42	42	35	33	37	32	37	33	L _A =	42 47.0
Lp with generators	56	55	51	48	43	46	43	40	L _A =	52
3 dB façade correction	3	3	3	3	3	3	3	3		Night time
Lp facade	59	58	54	51	46	49	46	43	L _A =	55 47.0

1 The Avenue

Ground level

AHU

Supply (inlet) Lw (attenuated)	56	64	51	42	32	31	37	41	
800mm Rec UL No TV Elbow (assumed)	-1	-1	-5	-8	-4	-3	-3	-3	
End Ref.Loss 0.3m2 (d=0.62)	-8	-4	-1	0	0	0	0	0	
Lw louvre	48	59	45	34	28	28	34	38	
Screening (worst case)	0	0	0	0	0	0	0	0	
Q	2								
r	9 m								
Lp	20	32	18	7	1	1	7	11	L _A = 18.5

Return (unit outlet) Lw	63	70	57	56	49	46	50	51	
800mm Rec UL No TV Elbow (assumed)	-1	-1	-5	-8	-4	-3	-3	-3	
End Ref.Loss 0.3m2 (d=0.62)	-8	-4	-1	0	0	0	0	0	
Lw louvre	55	65	51	48	45	43	47	48	
Screening (worst case)	0	0	0	0	0	0	0	0	
Q	2								
r	9 m								
Lp	27	38	24	21	18	16	20	21	L _A = 27.7

Level 7 plant room

AHU 7

Supply (inlet) Lw	62	73	59	45	41	41	52	55	
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3	
Lw after elbow	61	68	51	41	38	38	49	52	
Lp=Lw+10log(Q/(4*PI())*(r^2)									
Screening worst case	0	0	0	0	0	0	0	0	
Q	4								
r (Horizontal)	19 m								
Lp	30	37	20	10	7	7	18	21	L _A = 26

Return (unit outlet) Lw	75	76	66	62	52	52	62	64	
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3	
Lw after elbow	74	71	58	58	49	49	59	61	
Screening worst case	0	0	0	0	0	0	0	0	
Q	4								
r	19 m								
Lp	43	40	27	27	18	18	28	30	L _A = 34

Supply airborne Lw	57	65	54	56	59	52	38	31	
Return airborne Lw	60	63	55	56	53	50	36	28	
logsum	62	67	58	59	60	54	40	33	
Screening (worst case)	0	0	0	0	0	0	0	0	
Q	4								
r	19 m								
Lp	31	37	27	28	29	24	10	2	L _A = 32

AHU 8

Supply (inlet) Lw	66	78	66	53	47	50	68	65	
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3	
Lw after elbow	65	73	58	49	44	47	65	62	
Screening (worst case 1/2)	6	8	9	11	12	12	12	12	
Lp=Lw+10log(Q/(4*PI())*(r^2)									
Q	4								
r	22 m								
Lp	27	33	17	6	0	3	21	18	L _A = 25

Return (unit outlet) Lw	74	81	70	66	65	63	79	75		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Att. Min IL	0	0	0	0	0	0	0	0		
Lw after attenuator	73	76	62	62	62	60	76	72		
Max. Att. regen. noise	62	65	51	51	51	49	65	61		
Lw after attenuator	73	76	62	62	62	60	76	72		
Screening	6	8	9	11	12	12	12	12		
Q	4									
r	22	m								
Lp	35	37	21	20	19	17	33	29	L _A =	35

Supply airborne Lw	60	69	61	61	67	60	50	39		
Return airborne Lw	59	68	59	60	65	58	52	39		
logsum	63	72	63	64	69	62	54	42		
Screening	6	8	9	11	12	12	12	12		
Q	4									
r	22	m								
Lp	24	32	22	21	25	18	10	-2	L _A =	28

Condenser units

Lw (1 unit)	76	71	70	67	71	67	60	53		
Lw (2 units)	79	74	73	70	74	70	63	56		
Screening fully (worst case 1/2)	6	8	9	11	12	12	12	12		
Q	4									
r	20	m								
Lp	42	35	33	28	31	27	20	13	L _A =	34

Level 6 plant room

ASHP's

Lp at 1m	43	52	62	60	59	57	54	36		
Screening	0	0	0	0	0	0	0	0		
L2=L1-20*log(r1/r2)										
r1	1	m								
r2	14	m								
L2	20	29	39	37	36	34	31	13		
add 3 B for second unit	3	3	3	3	3	3	3	3		
L2	23	32	42	40	39	37	34	16	L _A =	44

ASHP's

LP at 1m	43	52	62	60	59	57	54	36		
screening	5	5	6	7	8	10	13	16		
r1	1	m								
r2	19	m								
L2	12	21	30	28	25		16	-5	L _A =	29

Level 8 plant room

Generators

Exhaust measured at 1.5m (2 units)	75.0	77.0	72.0	68.0	62.0	63.0	59.0	55.0		
screening	0	0	0	0	0	0	0	0		
r1	1.5	m								
r2	26	m								
L2	50	52	47	43	37	38	34	30	L _A =	46

Intake at 1.5m (2 units)	83.0	81.0	78.0	75.0	69.0	73.0	70.0	67.0		
screening	0	0	0	0	0	0	0	0		
r1	1.5	m								
r2	26	m								
L2	58	56	53	50	44	48	45	42	L _A =	54

Break out at 1.5m (2 units)	72.0	80.0	73.0	71.0	68.0	65.0	59.0	53.0			
screening	5	5	5	5	5	5	7	8			
r1	1.5	m									
r2	26	m									
L2	42	50	43	41	38	35	27	20	L _A =	44	
Lp generator contributions	59	58	55	51	46	49	46	43	L _A =	55	
Lp without genarators	46	46	43	41	41	38	38	33	L _A =	46	
3 dB facade correction	3	3	3	3	3	3	3	3			Night time
Lp facade	49	49	46	44	44	41	41	36	L _A =	49	52.0
Lp with genarators	59	59	55	52	47	49	46	43	L _A =	56	
3 dB facade correction	3	3	3	3	3	3	3	3			Night time
Lp facade	62	62	58	55	50	52	49	46	L _A =	59	52.0

The Old Courthouse/ Moxy hotel (worst case)

Ground level

AHU

This NSP is fully screened from the louvre locations.

Level 7 plant room

AHU 7

Supply (inlet) Lw	62	73	59	45	41	41	52	55		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	61	68	51	41	38	38	49	52		
$L_p = L_w + 10 \log(Q / (4 * \pi r^2))$										
Screening- fully	13	16	18	22	24	24	24	24		
Q	4									
r	48	m								
Lp	10	14	-6	-19	-25	-25	-14	-11	L _A =	-1

Return (unit outlet) Lw	75	76	66	62	52	52	62	64		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	74	71	58	58	49	49	59	61		
Screening- fully	13	16	18	22	24	24	24	24		
Q	4									
r	48	m								
Lp	23	17	1	-2	-14	-14	-4	-2	L _A =	5

Supply airborne Lw	57	65	54	56	59	52	38	31		
Return airborne Lw	60	63	55	56	53	50	36	28		
logsum	62	67	58	59	60	54	40	33		
Screening- fully	13	16	18	22	24	24	24	24		
Q	4									
r	48	m								
Lp	11	13	0	-1	-3	-8	-22	-30	L _A =	3

AHU 8

Supply (inlet) Lw	66	78	66	53	47	50	68	65		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	65	73	58	49	44	47	65	62		
Screening (fully)	13	16	18	22	24	24	24	24		
$L_p = L_w + 10 \log(Q / (4 * \pi r^2))$										
Q	4									
r	46	m								
Lp	14	19	1	-11	-18	-15	3	0	L _A =	7

Return (unit outlet) Lw	74	81	70	66	65	63	79	75		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Att. Min IL	0	0	0	0	0	0	0	0		
Lw after attenuator	73	76	62	62	62	60	76	72		
Max. Att. regen. noise	62	65	51	51	51	49	65	61		
Lw after attenuator	73	76	62	62	62	60	76	72		
Screening	13	16	18	22	24	24	24	24		
Q	4									
r	46	m								
Lp	22	23	6	3	0	-2	14	10	L _A =	17

Supply airborne Lw	60	69	61	61	67	60	50	39		
Return airborne Lw	59	68	59	60	65	58	52	39		
logsum	63	72	63	64	69	62	54	42		
Screening	13	16	18	22	24	24	24	24		
Q	4									
r	46	m								
Lp	12	18	6	4	7	0	-8	-20	L _A =	10

Condenser units

Lw (1 unit)	76	71	70	67	71	67	60	53		
Lw (2 units)	79	74	73	70	74	70	63	56		
Screening (fully)	13	16	18	22	24	24	24	24		
Q	4									
r	46	m								
Lp	25	17	13	7	8	4	-3	-10	L _A =	12

Level 6 plant room

ASHP's

Lp at 1m	43	52	62	60	59	57	54	36		
Screening	24	24	24	24	24	24	24	24		
L2=L1-20*log(r1/r2)										
r1	1	m								
r2	56	m								
L2	8	17	27	25	24	22	19	1		
add 3 B for second unit	3	3	3	3	3	3	3	3		
L2	11	20	30	28	27	25	22	4	L _A =	32

ASHP's

LP at 1m	43	52	62	60	59	57	54	36		
Screening	24	24	24	24	24	24	24	24		
r1	1	m								
r2	58	m								
L2	-16	-7	3	1	0	-2	-5	-23	L _A =	5

Level 8 plant room

Generators

Exhaust measured at 1.5m (2 units)	75.0	77.0	72.0	68.0	62.0	63.0	59.0	55.0		
Screening- fully (take 1/2)	6	8	9	11	12	12	12	12		
r1	1.5	m								
r2	38	m								
L2	41	41	35	29	22	23	19	15	L _A =	32

Intake at 1.5m (2 units)	83.0	81.0	78.0	75.0	69.0	73.0	70.0	67.0		
Screening- fully (take 1/2)	6	8	9	11	12	12	12	12		
r1	1.5	m								
r2	38	m								
L2	49	45	41	36	29	33	30	27		
Lp (2 x generator)	49	47	42	37	30	33	30	27	L _A =	41

Break out at 1.5m (2 units)	72.0	80.0	73.0	71.0	68.0	65.0	59.0	53.0		
Screening- fully (take 1/2)	6	8	9	11	12	12	12	12		
r1	1.5	m								
r2	38	m								
Lp (2 x generator)	38	44	36	32	28	25	19	13	L _A =	35
Lp generator contributions	50	50	43	39	32	34	31	28	L _A =	42

Lp without genarators	29	28	30	28	27	25	23	12	L _A =	32	
3dB facade correction	3	3	3	3	3	3	3	3			Night time
Lp facade	32	31	33	31	30	28	26	15	L _A =	35	47.0
Lp with generators	50	50	44	39	33	35	31	28	L _A =	43	
3dB facade correction	3	3	3	3	3	3	3	3			Night time
Lp facade	53	53	47	42	36	38	34	31	L _A =	46	47.0

1 Hardman Street

Ground level

AHU

This NSP is fully screened from the louvre locations.

Level 7 plant room

AHU 7

Supply (inlet) Lw	62	73	59	45	41	41	52	55		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	61	68	51	41	38	38	49	52		
$L_p = L_w + 10 \log(Q / (4 * \pi r^2))$										
Screening- fully	13	16	18	22	24	24	24	24		
Q	4									
r	48	m								
Lp	10	14	-6	-19	-25	-25	-14	-11	L _A =	-1

Return (unit outlet) Lw	75	76	66	62	52	52	62	64		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	74	71	58	58	49	49	59	61		
Screening- fully	13	16	18	22	24	24	24	24		
Q	4									
r	48	m								
Lp	23	17	1	-2	-14	-14	-4	-2	L _A =	5

Supply airborne Lw	57	65	54	56	59	52	38	31		
Return airborne Lw	60	63	55	56	53	50	36	28		
logsum	60	63	55	56	53	50	36	28		
Screening- fully	13	16	18	22	24	24	24	24		
Q	0									
r	48	m								
Lp	9	9	-2	-4	-10	-13	-27	-35	L _A =	-2

AHU 8

Supply (inlet) Lw	66	78	66	53	47	50	68	65		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Lw after elbow	65	73	58	49	44	47	65	62		
Screening (fully)	13	16	18	22	24	24	24	24		
$L_p = L_w + 10 \log(Q / (4 * \pi r^2))$										
Q	4									
r	46	m								
Lp	14	19	1	-11	-18	-15	3	0	L _A =	7

Return (unit outlet) Lw	74	81	70	66	65	63	79	75		
1400mm Rec UL No TV Elbow	-1	-5	-8	-4	-3	-3	-3	-3		
Att. Min IL	0	0	0	0	0	0	0	0		
Lw after attenuator	73	76	62	62	62	60	76	72		
Max. Att. regen. noise	62	65	51	51	51	49	65	61		
Lw after attenuator	73	76	62	62	62	60	76	72		
Screening	13	16	18	22	24	24	24	24		
Q	4									
r	46	m								
Lp	22	23	6	3	0	-2	14	10	L _A =	17

Supply airborne Lw	60	69	61	61	67	60	50	39		
Return airborne Lw	59	68	59	60	65	58	52	39		
logsum	59	68	59	60	65	58	52	39		
Screening	13	16	18	22	24	24	24	24		
Q	4									
r	46	m								
Lp	8	14	2	0	3	-4	-10	-23	L _A =	6

Condenser units

Lw (1 unit)	76	71	70	67	71	67	60	53		
Lw (2 units)	79	74	73	70	74	70	63	56		
Screening (fully)	13	16	18	22	24	24	24	24		
Q	4									
r	46	m								
Lp	25	17	13	7	8	4	-3	-10	L _A =	12

Level 6 plant room

ASHP's

Lp at 1m	43	52	62	60	59	57	54	36		
Screening	24	24	24	24	24	24	24	24		
L2=L1-20*log(r1/r2)										
r1	1	m								
r2	56	m								
L2	8	17	27	25	24	22	19	1		
add 3 B for second unit	3	3	3	3	3	3	3	3		
L2	11	20	30	28	27	25	22	4	L _A =	32

ASHP's

LP at 1m	43	52	62	60	59	57	54	36		
Screening	24	24	24	24	24	24	24	24		
r1	1	m								
r2	58	m								
L2	-16	-7	3	1	0	-2	-5	-23	L _A =	5

Level 8 plant room

Generators

Air outlet at 1m (2 units)										
Exhaust measured at 1.5m (2 units)	75.0	77.0	72.0	68.0	62.0	63.0	59.0	55.0		
Screening	0	0	0	0	0	0	0	0		
r1	1.5	m								
r2	61	m								
L2	43	45	40	36	30	31	27	23	L _A =	39

Intake at 1.5m (2 units)	83.0	81.0	78.0	75.0	69.0	73.0	70.0	67.0		
Screening	0	0	0	0	0	0	0	0		
r1	1.5	m								
r2	73	m								
L2	49	47	44	41	35	39	36	33		
Lp (2 x generator)	50	49	46	42	36	40	37	34	L _A =	46

Break out at 1.5m (2 units)	72.0	80.0	73.0	71.0	68.0	65.0	59.0	53.0		
Screening	0	0	0	0	0	0	0	0		
r1	1.5	m								
r2	65	m								
Lp (2 x generator)	39	47	40	38	35	32	26	20	L _A =	41
Lp generator contributions	51	52	48	44	39	41	37	34	L _A =	48

Lp without genarators	29	27	30	28	27	25	23	12	L _A =	32	
3dB facade correction	3	3	3	3	3	3	3	3			Night time
Lp facade	32	30	33	31	30	28	26	15	L _A =	35	52.0
Lp with generators	51	52	48	45	40	41	38	34	L _A =	48	
3dB facade correction	3	3	3	3	3	3	3	3			Night time
Lp facade	54	55	51	48	43	44	41	37	L _A =	51	52.0