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Consultants in Acoustics, Noise & Vibration

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2 June 2017

40-46 Princess Street, Manchester

Environmental noise survey and plant assessment report

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Version	Date	Comments	Author	Reviewer
A	17 May 17		Jose Maria Gonzalez	James Atha
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Summary

Sandy Brown has been commissioned by Wittington Investments (Properties) Ltd to provide acoustic advice in relation to the proposed development at 40 -46 Princess Street, Manchester.

An environmental noise survey has been carried out to determine the existing background sound levels in the area and to set appropriate plant noise limits in line with the requirements of the Manchester City Council. The noise survey was performed between 13:28 on 2 May 2017 and 01:36 on 3 May 2017.

To the north-east, the representative background sound levels measured during the survey were $L_{A90,15min}$ 60 dB during the daytime and $L_{A90,15min}$ 59 dB at night. To the south, the representative background sound levels measured during the survey were $L_{A90,15min}$ 56 dB during the daytime and $L_{A90,15min}$ 57 dB at night. To the north (courtyard), the representative background sound levels measured during the survey were $L_{A90,15min}$ 62 dB during the daytime and $L_{A90,15min}$ 47 dB at night.

Based on the requirements of Manchester City Council and on the results of the noise survey, all plant must be designed such that the cumulative noise level at 1 m from the worst affected windows of the nearby noise sensitive premises is to be at least 5 dB below the typical background noise levels measured. These limits are cumulative, and apply with all plant operation 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.

Based on the proposed plant items and location, 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. These are discussed herein.

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1 Introduction

Sandy Brown has been commissioned by Wittington Investments (Properties) Ltd to provide acoustic advice in relation to the proposed development at 40-46 Princess Street, Manchester.

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. The results of the survey measurements have been used to set appropriated limits for noise egress from building services plant associated with the development and to set appropriate limits for noise egress from building services plant in line with the requirements of Manchester City Council.

This report presents the survey method, results of the environmental noise survey, and determines limits for noise emission from new building services plant to be installed. An assessment of the noise levels from the proposed items of plant has also been carried out and the required mitigation measures determined.

2 Site description

2.1 The site and its surrounding

The site location in relation to its surroundings is outlined in yellow in Figure 1. The site is bounded by Princess Street north to east, a courtyard and office building to the north-west, 2 Harper Street to the southwest and Harter Street to the south.



Figure 1 Site map (courtesy of Google Earth Pro)

2.2 Adjacent premises

The site is located in a mixed use area, with the immediate surrounding comprising of residential accommodation, hotel, office, retail units (including restaurants) and 'The Spot' night club which is located in the basement of 40 Princess Street. The nearest existing residential accommodation is located approximately 8 m to the south-west. This is highlighted in red in Figure 1.

The 2 Harter Street building which is adjacent to the site to the south-west is currently being converted into apartments. Additionally, there is a conversion of first floor offices into apartments at 103 Portland Street which approximately 5 m to the north-west, these future apartments are also considered to be noise sensitive premises. These are highlighted in blue and green respectively in Figure 1 There is hotel accommodation (Townhouse Hotel) located approximately 15 m to the north-east, this is also considered a noise sensitive premise and highlighted in light blue in Figure 1.

The nearest existing daytime noise sensitive premises are the rear facade of 109 and 113 Portland Street to the north and west respectively. These are highlighted in purple and brown respectively in Figure 1. Other day time noise sensitive premises include 101 and 103 Princess Street approximately 15 m and 25 m respectively to the east. These are highlighted in pink and orange respectively in Figure 1.

3 Method

Details of the equipment used, the noise indices and the weather conditions during the survey are provided in Appendix A. Further information on the specific survey method is provided in this section.

3.1 Attended measurements

3.1.1 Daytime attended measurements

Attended sample measurements were performed by Jose M. Gonzalez at 4 locations around the proposed site. These are indicated in Figure 1 as positions 1 to 3. The attended measurements were carried out on 2 May 2017, over 15 minute periods, with the purpose of determining the existing noise levels from road traffic, pedestrians and other significant noise sources in the area.

The locations of the measurements are indicated in Figure 1. In each case the microphone was mounted on a tripod at approximately 1 m from a reflective and approximately 1.5 m above the ground level.

3.1.2 Night time attended measurements

Attended sample measurements were performed by Jose M. Gonzalez at 3 of locations around the proposed site. These are indicated in Figure 1 as positions 1 to 3. The attended measurements were carried out between 23:51 on 2 May 2017 and 01:36 on 6 May 2017, over 15 minute periods, with the purpose of determining the existing noise levels from road traffic, pedestrians and other significant noise sources in the area.

The locations of the measurements are indicated in Figure 1. In each case the microphone was mounted on a tripod at approximately 1 m from a reflective and approximately 1.5 m above the ground level.

4 Measurement results

4.1 Observations

The dominant noise sources observed at the site during the survey consisted of road traffic on Princess Street and Harter Street.

Less significant noise sources included road traffic on Portland Street, distant plant and pedestrians passing by.

4.2 Attended measurement results

4.2.1 Daytime attended measurements results

The sound pressure levels recorded during the attended measurements are summarised in Table 1, along with the dominant noise sources noted during the measurements All the attended measurements were performed over 15 minute periods.

Table 1 Sound pressure levels from attended measurements (Daytime)

Position	Start time	Sound pressure levels (dB)			Noise sources
		$L_{Aeq,15min}$	$L_{AFmax,15min}$	$L_{A90,15min}$	
1	13:28	63	78	58	Distant road traffic on Princess Street, pedestrians passing by talking, constant distant plant, truck reverse beeping and slamming door.
	14:17	68	91	59	Distant road traffic on Princess Street, cars passing by pedestrians passing by talking, constant distant plant, distant scaffolding and building works.
	19:00	62	84	56	Distant road traffic on Princess Street, pedestrians passing by talking, distant constant plant.
	19:48	62	76	57	
2	13:44	68	83	60	Road traffic on Princess Street, distant road traffic along Portland Street, pedestrians passing by talking.
	14:32	67	83	60	
	19:16	70	89	62	Road traffic on Princess Street, distant road traffic along Portland Street, pedestrians passing by talking, roller shutter, distant car slamming door.
	20:04	68	85	60	
3	14:01	67	77	66	Distant road traffic along Princess Street, constant plant along courtyard (condenser, extract units), building works, drops in rubbish bin
	14:48	67	80	66	
	19:32	63	74	63	Distant road traffic along Princess Street, constant plant along courtyard (as above).
	20:22	63	75	62	

4.2.2 Night-time attended measurements

The sound pressure levels recorded during the attended measurements are summarised in Table 2, along with the dominant noise sources noted during the measurements All the attended measurements were performed over 15 minute periods.

Table 2 Sound pressure levels from attended measurements (Night-time)

Position	Start time	Sound pressure levels (dB)			Noise sources
		$L_{Aeq,15min}$	$L_{AFmax,15min}$	$L_{A90,15min}$	
1	23:51	61	76	58	Distant road traffic on Princess Street, cars passing by, constant distant plant, distant siren
	00:48	61	76	57	
2	00:16	68	91	59	Road traffic on Princess Street, distant road traffic along Portland Street, pedestrians passing by talking, siren (L_{AFmax} 91 dB).
	01:04	65	79	59	
3	00:31	51	66	47	Distant road traffic on Princess Street, distant constant plant
	01:21	52	66	47	

As attended measurements have been carried out rather than unattended noise logging over a period of a number of days there are a limited number of background sound measurements.

As such it would not be appropriate to carry out statistical analysis to determine the representative background noise level. The minimum background sound levels measured has been therefore been used as the representative background sound level.

The representative background noise levels measured during the survey are given in Table 3

Table 3 Representative measured background levels measured

Location	Time of day	Representative background noise level ($L_{A90,15min}$ dB)
South	Daytime (07:00-23:00)	56
	Night-time (23:00-07:00)	57
North-east	Daytime (07:00-23:00)	60
	Night-time (23:00-07:00)	59
North (Courtyard)	Daytime (07:00-23:00)	62
	Night-time (23:00-07:00)	47

5 Building services noise egress

5.1 Standard guidance

Guidance for noise emission from proposed new items of building services plant is given in BS 4142: 2014 '*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 the nearest noise sensitive.

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.

5.2 Local Authority criteria

5.2.1 Plant noise egress

Manchester City Council (MCC) provides guidance in relation to plant noise emissions in *Planning and Noise Technical Guidance* document dated December 2015 states the following in relation to plant noise egress:

'The development should be designed so as to achieve a rating level of 5 dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location.'

Corrections for tonal or attention catching characteristics would need to be applied to the rating level in accordance with BS4142: 2014.

5.3 Limits

5.3.1 Basic limits

Based on the above criteria and the measurement results, the cumulative noise level resulting from the operation of all new plant at 1 m from the worst affected windows of the nearest noise sensitive premises should not exceed the limits set out in Table 4.

Table 4 Plant noise limits at 1 m from the nearest noise sensitive premises

Location	Time of day	Maximum sound pressure level at 1 m from noise sensitive premises ($L_{Aeq,15min}$ dB)
South	Daytime (07:00-23:00)	51
	Night-time (23:00-07:00)	52
North-east	Daytime (07:00-23:00)	55
	Night-time (23:00-07:00)	54
North (Courtyard)	Daytime (07:00-23:00)	57
	Night-time (23:00-07:00)	42

The limits set out in Table 4 do not include any attention catching features. The penalties for attention catching features may be significant, and will need to be considered as the building services design progresses. This is discussed further in Section 5.3.2.

The corresponding octave band levels are provided in Table 5.

Table 5 Representative measured background sound levels in octave bands

		Representative measured background noise levels (dB) at each octave band centre frequency (Hz)						
Location	Time of day	63	125	250	500	1k	2k	4k
South	Daytime (07:00-23:00)	65	63	59	54	53	48	39
	Night-time (23:00-07:00)	64	65	59	54	51	47	38
North-east	Daytime (07:00-23:00)	69	67	60	56	54	49	42
	Night-time (23:00-07:00)	66	67	58	56	54	48	39
North Courtyard	Daytime (07:00-23:00)	67	67	60	60	57	52	42
	Night-time (23:00-07:00	55	52	46	44	41	37	29

5.3.2 Attention catching features

If the proposed plant noise contains attention catching features (such as tonal elements, whines, whistles, bangs etc), the plant should be designed to achieve a limit below those set out above, 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 taken into account 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 is not appropriate then an objective assessment can be made. A noise source is deemed to be tonal if the time averaged sound pressure level in a one-third octave band exceeds the level in adjacent one-third octave bands by the level differences given below:

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

6 Plant noise assessment

6.1 Proposed plant

The proposed development consists of a mixed use building with a ground floor café/restaurant, basement gym and office accommodation on all other floors. As part of the works, new building services plant is proposed to be installed at roof level and in the rear courtyard of the building.

Indicative plant selections have been provided by Crookes Walker Consulting for the major items of plant. The main items of plant to be installed at ground level are understood to consist of the following:

- Three Mitsubishi PURY-EP200YLM-A
- One Mitsubishi PURY-EP250YLM-A
- Five Mitsubishi PURY-EP300YLM-A
- Two Mitsubishi PURY-EP350YLM-A
- Two Mitsubishi PURY-EP450YLM-A
- Three Mitsubishi PURY-EP800YLM-A
- One TEMPAir 9000EXT air handling unit

The main items of plant to be installed on the rooftop level are understood to consist of the following:

- Two Mitsubishi PURY-EP200YLM-A
- Two Mitsubishi PURY-EP300YLM-A
- Four Mitsubishi PURY-EP350YLM-A
- Two Mitsubishi PURY-EP450YLM-A
- One Mitsubishi PURY-EP600YLM-A
- One FlaktWoods eQ Prime

The proposed plant items to be installed at ground level are understood to consist of 16 outdoor condenser units serving the gym and offices and a single air handling unit (AHU) serving the gym. These are highlighted in blue and pink respectively in Figure 2.

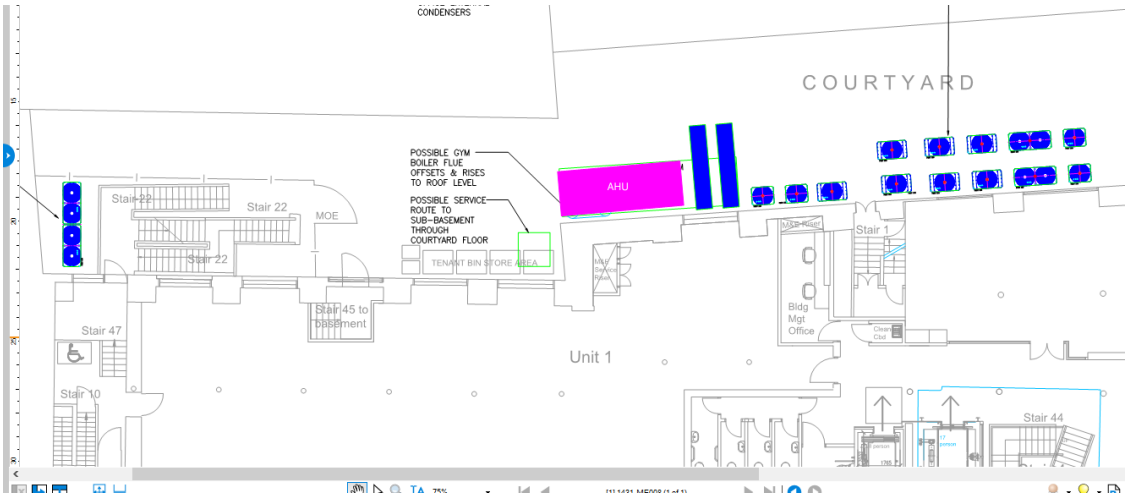


Figure 2 Proposed ground level plant item locations

The proposed plant items to be installed at roof top level are understood to consist of 12 outdoor condenser units serving the offices on level 2 to 5 and a new air handling unit (AHU) serving the offices. These are highlighted in blue and pink respectively in Figure 3.

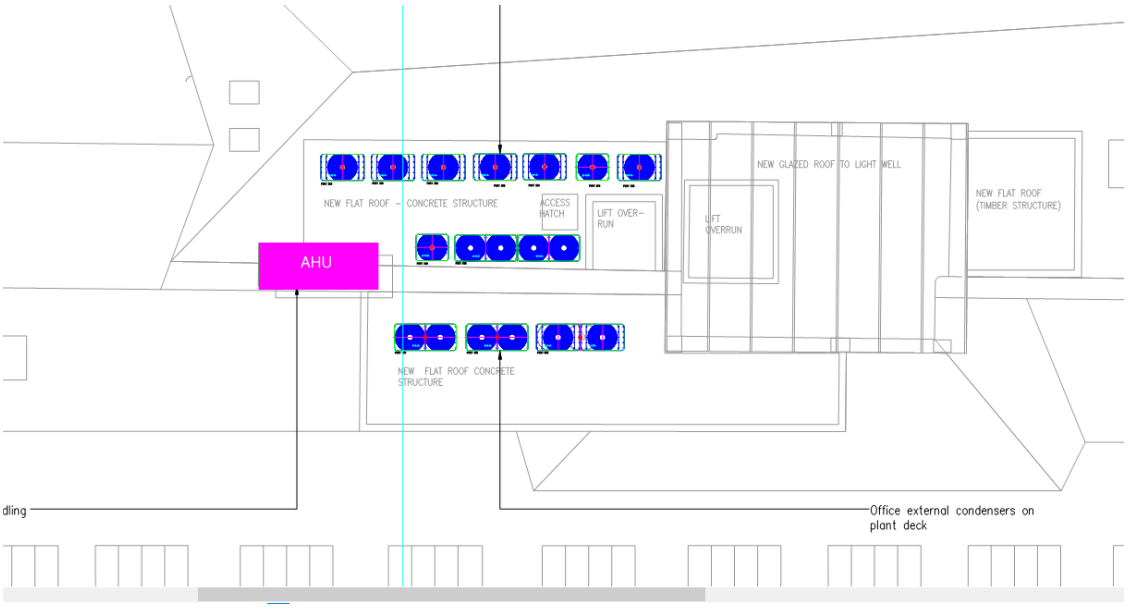


Figure 3 Proposed rooftop plant item locations

Table 6 and Table 7 present the noise data received for the condenser units listed above.

Table 6 Manufacturer sound power levels for the proposed outdoor condenser units

	Sound pressure levels, at 1m (dB) Octave band centre frequency (Hz)						
Plant item	63	125	250	500	1k	2k	4k
Mitsubishi PURY-EP200YLM-A	75	65	62	58	51	45	39
Mitsubishi PURY-EP250YLM-A	76	66	63	59	52	46	42
Mitsubishi PURY-EP300YLM-A	74	69	65	62	56	48	41
Mitsubishi PURY-EP350YLM-A	74	69	65	62	56	48	43
Mitsubishi PURY-EP450YLM-A	73	70	65	61	56	51	47
Mitsubishi PURY-EP600YLM-A	77	72	68	65	59	51	45
Mitsubishi PURY-EP800YLM-A	75	72	68	64	59	54	49

The noise data received for the proposed AHU units are provided Table 7.

Table 7 Manufacturer sound power levels for the proposed AHU plant units

	Sound power levels, L_w(dB) Octave band centre frequency (Hz)						
Plant item	63	125	250	500	1k	2k	4k
TEMPAir 9000EXT							
Supply	69	69	76	73	71	67	64
Exhaust	73	72	81	80	83	73	70
FlaktWoods eQ Prime							
Supply	71	67	75	74	74	75	73
Exhaust	72	68	76	75	75	76	74
Case radiation	63	64	68	59	60	59	56

External louvres are also proposed to the ground floor level of the building along the courtyard and Harter Street. No details of these or the equipment that terminates to these louvres has been received. The following assessment is based on the overall noise contributions from these louvres being at least 10 dB below the criteria given in Table 4. This will need to be assessed as the design progresses and further details become available.

The following terminations are also potentially proposed for future tenants:

- 2 kitchen extract flues discharging at rooftop level at the location where condenser units are proposed
- Gym boiler flues discharging at rooftop level.

The assessment has been carried out based on these being limited to meet a maximum combined sound power level of L_w 68 dB.

6.2 Predicted plant noise rating levels

Calculations have been carried out to determine the noise rating levels from the proposed plant items outside the nearby noise sensitive premises, taking into account the following:

- Attenuation due to distance and screening
- Assumes that the plant units operate continuously and that the noise generated does not contain tonal elements or is impulsive
- Direct and reverberant sound pressure levels in the courtyard
- The location of the plant items and directivity due to reflections from nearby surfaces.
- Where spectral noise data has not been provided, data for a similar condenser unit has been used in the predictions
- Noise contributions from any plant terminations to the potential external louvres being at least 10 dB below the criteria given in Table 4.

The noise egress levels resulting from the operation of the proposed items of plant have been predicted at the nearest noise sensitive premises, the results are given in Table 8.

Table 8 Predicted noise level from the operation of the proposed items of plant at nearest noise sensitive premises

Location	Predicted sound pressure level, L_{Aeq} (dB)
109 to 113 Portland Street (courtyard)	60
103 Portland Street (courtyard)	70
48 Princess Street	63
2 Harter Street	61

The predictions indicate that the levels at the nearest noise sensitive premises exceed the limits set out in Table 4.

7 Acoustic mitigation measures

The assessment above indicates that acoustic mitigation measures will require to achieve the noise criteria set out in Section 5.3.1. To ensure the Manchester City Council requirements for plant noise egress is achieved at all times, the acoustic mitigation measures outlined in the following sections shall be considered. This assessment is based on the initial indicative plant selections, and a further review of attenuation measures will need to be undertaken once plant design has been finalised.

7.1 Courtyard plant

It is recommended that low noise condenser equipment be selected or acoustic enclosures be provided to reduce the noise levels. Taking into account the proposed locations of the condenser units, the maximum sound power levels are given in Table 9. These are based on all of the units operating simultaneously.

Table 9 Maximum sound power levels per plant item location at ground floor level

Proposed item of plant/ location of plant	Currently proposed sound pressure levels at 1m (dBA)	Maximum recommended sound pressure level, at 1m (dBA) from each unit	
		Day time (23:00-07:00)	Night time (23:00-07:00)
Mitsubishi PURY-EP200YLM-A	59	53	36[1]
Mitsubishi PURY-EP250YLM-A	60	54	37[1]
Mitsubishi PURY-EP300YLM-A	63	55	39[1]
Mitsubishi PURY-EP350YLM-A	63	55	40[1]
Mitsubishi PURY-EP450YLM-A	63	55	39[1]
Mitsubishi PURY-EP800YLM-A	66	54	40[1]

[1]The maximum sound power level limits per item of plant are very low for night time operations, and may not be practical to achieve. Therefore, it is recommended that the condenser units in this area be switched off at night.

If the condensers can be relocated to the rooftop, this would reduce the extent of mitigation measures that are required.

The AHU at ground floor level should be reselected/attenuated to meet the maximum sound power levels from plant items given in Table 10.

Table 10 Maximum sound power levels for AHU

	Octave band centre frequency (Hz)						
	63	125	250	500	1k	2k	4k
Day time (07:00 – 23:00)							
Supply	69	63	64	60	58	54	51
Exhaust	71	65	63	58	61	51	48
Case radiated	63	60	58	53	49	46	46
Night time (23:00 – 07:00)							
Supply	64	53	49	42	40	36	33
Exhaust	67	56	51	44	47	37	34
Case radiated	50	50	47	41	36	35	34

The above supply and exhaust levels can be achieved by providing attenuators to the AHU supply and exhaust connections to control noise egress to the atmosphere. The recommended performances for the attenuators are provided in Table 11.

Table 11 Recommended attenuator performances for the AHU (ground floor level)

	Octave band centre frequency (Hz)						
	63	125	250	500	1k	2k	4k
Day time (07:00 – 23:00)							
Minimum IL (dB) Supply	0	6	12	13	13	13	13
Maximum regen noise L_w (dB) Supply	59	53	54	50	48	44	41
Minimum IL (dB) Exhaust	2	7	18	22	22	22	22
Maximum regen noise L_w (dB) Exhaust	61	55	53	48	51	41	38
Night time (23:00 – 07:00)							
Minimum IL (dB) Supply	5	16	27	31	31	31	31
Maximum regen noise L_w (dB) Supply	54	43	39	32	30	26	23
Minimum IL (dB) Exhaust	6	16	30	36	36	36	35
Maximum regen noise L_w (dB) Exhaust	57	46	41	34	37	27	24

For daytime, 1500 mm long attenuators would typically be capable of achieving the recommended attenuator performances. 2100 mm long attenuator would typically be capable of achieving the recommended attenuator performances at night time.

7.2 Rooftop plant

It is recommended that low noise condenser equipment be selected or acoustic enclosures be provided to reduce the noise levels from the condensers. Taking into account the proposed location of the condenser units, the maximum sound power levels are given in Table 12

Table 12 Maximum sound power levels per plant item location at roof top level

Proposed item of plant/ location of plant	Currently proposed sound pressure levels at 1m (dBA)	Maximum recommended sound pressure level, at 1m (dBA) from each unit	
		Day time (23:00-07:00)	Night time (23:00-07:00)
Mitsubishi PURY-EP200YLM-A	59	49	49
Mitsubishi PURY-EP300YLM-A	63	53	53
Mitsubishi PURY-EP350YLM-A	63	53	53
Mitsubishi PURY-EP450YLM-A	63	53	53
Mitsubishi PURY-EP600YLM-A	66	56	56
Mitsubishi PURY-EP800YLM-A	66	56	56

Another option would be to provide solid screening around the rooftop units to block the line of sight to the nearby noise sensitive premises.

It is recommended that the AHU be re-selected or provided with attenuators/enhanced casing to meet the maximum sound power levels given in Table 13.

Table 13 Maximum sound power levels for rooftop AHU supply and exhaust

	Maximum sound power levels, L_w(dB) Octave band centre frequency (Hz)						
	63	125	250	500	1k	2k	4k
Supply	79	65	67	64	64	63	61
Exhaust	80	68	71	69	67	66	64
Case radiated	71	70	74	65	66	63	60

This could be achieved for the supply and exhaust connections with attenuators connections with the performances provided in Table 14.

Table 14 Recommended attenuator performances for AHU (gym) at rooftop level

	Octave band centre frequency (Hz)						
	63	125	250	500	1k	2k	4k
Minimum IL (dB) Supply	-	8	14	16	16	16	16
Maximum regen noise L_w (dB) Supply	69	56	58	55	55	54	52
Minimum IL (dB) Exhaust	-	7	12	13	15	15	15
Maximum regen noise L_w (dB) Exhaust	70	58	61	59	57	56	54

900 mm long attenuator would typically be capable of achieving the performance given above.

8 Conclusion

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

To the north-east, the representative background sound levels measured during the survey were $L_{A90,15min}$ 60 dB during the daytime and $L_{A90,15min}$ 59 dB at night. To the north-west, the representative background sound levels measured during the survey were $L_{A90,15min}$ 56 dB during the daytime and $L_{A90,15min}$ 57 dB at night. To the south, the representative background sound levels measured during the survey were $L_{A90,15min}$ 62 dB during the daytime and $L_{A90,15min}$ 47 dB at night.

Based on the requirements of Manchester City Council and on the results of the noise survey, all plant must be designed such that the cumulative noise level at 1 m from the worst affected windows of the nearby noise sensitive premises is to be at least 5 dB below the typical background noise levels measured.

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 indicated in Section 5.3.2 will be applied, and the limits will be more stringent than those set out above.

An assessment of the proposed plant items associated with the development has been carried out. Predictions indicate that providing that the recommended mitigation measures are incorporated within the design, the proposed plant items are expected to comply with the relevant noise limits at the nearest noise sensitive premises.

Appendix A

Survey details

Equipment

A Rion NL-52 sound level meter was used to undertake the attended measurements. The 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	21 Dec 18	1612654
Microphone	UC-59/10153	Rion	21 Dec 18	1612654
Pre-amp	NH-25/43581	Rion	21 Dec 18	1612654
Calibrator	NC-74/34257023	Rion	19 Dec 18	1612649

Calibration of the sound level meters used for the tests is traceable to national standards. The calibration certificates for the sound level meter used in this survey are available upon request.

The sound level meters and microphones were calibrated at the beginning and end of the measurements using their respective sound level calibrators. No significant deviation in calibration occurred.

Noise indices

The equipment was set to record a continuous series of broadband sound pressure levels. 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 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.

The L_{A90} is considered most representative of the background sound level for the purposes of complying with any local authority requirements.

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 attended measurements carried out between 2 May 2017 and 3 May 2017, the weather was clear and dry and no rain occurred. Wind speeds varied between approximately 0 m/s and 3 m/s.

These weather conditions are considered suitable for obtaining representative measurements.