

Plant Noise Impact Assessment

Hough End Leisure Centre

Manchester

M20 1NA

Stroma Built Environment Ltd.

SBE Ref: 079040 – AC - 2v1

I. Revision History

Revision	Date	Description	
1v1	06/02/2024	First Issue	
		Compiled By	Authorised By
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1. Introduction

- 1.1 Stroma Built Environment (SBE) have been appointed by ISG Construction Limited (The Client) to undertake acoustic consultancy services for an external plant noise assessment to satisfy the requirements of Planning Condition 20 for the proposed extension of Hough End Leisure Centre, 480 Princess Road, Manchester, M20 1NA (The Site).
- 1.2 The purpose of this report is to assess the acoustic impact of fixed mechanical building services plant associated with the proposed development in line with the requirements of Condition 20. The assessment is based on the results of the baseline noise survey undertaken by third party consultant, Waterman Infrastructure & Environment Limited, hereafter referred to as Waterman.
- 1.3 This document has been prepared for the sole use, benefit, and information of ISG Construction Limited for the purposes set out in the document or instructions commissioning the works. The liability of SBE in respect of the information contained herein will not extend to any third party.
- 1.4 The standards and guidance documents that have been used to complete this assessment have been included in Section 2, these include BS 4142 “*Methods for rating and assessing industrial and commercial sound*” and Planning Condition 20.
- 1.5 This report is limited to addressing the specific acoustic issues contained herein and is based on information and drawings provided by the client.
- 1.6 Whilst every effort has been made to ensure that this report is easy to understand, it is technical in nature. A glossary of terminology has been included in Appendix III.

2. Standards and Guidance Documents

BS 4142:2014 *Methods for rating and assessing industrial and commercial sound*

- 2.1 BS 4142 describes a method for assessing the impact from noise sources that are of an industrial nature (e.g. fans, pumps, chillers, air handling units etc.). The assessment methodology is based upon determining a 'rating level' for the equipment being assessed, which is the level of noise from the item or items of plant being assessed (measured as an L_{Aeq}).
- 2.2 The rating level is then compared with the underlying background noise level (measured as an L_{A90}) in the absence of noise from the item or items of plant being assessed. The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact.
- 2.3 BS 4142 states that a penalty should be added for any plant which gives rise to noise features that may increase disturbance such as tonal, impulsive, or intermittent characteristics. A rating penalty for a sound may be applied based on a subjective assessment of its characteristics.

Planning Condition 20

- 2.4 The development is understood to have been granted planning permission by Manchester City Council (MCC) ref: 132513/VO/2021 subject to conditions of which Planning Condition 20 is pertinent to noise from fixed plant and is repeated below:

“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 5 dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location. Prior to commencement of the use hereby approved scheme shall be submitted to and approved in writing by the City Council as local planning authority in order to secure a reduction in the level of noise emanating from the site.

Prior to occupation of the development a verification report shall be submitted to and approved in writing by the City Council as local planning authority to validate that the work undertaken throughout the development conforms to the recommendations and requirements in the approved Noise Impact Assessment. The report shall also 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.”

3. Site Baseline Conditions

Site Description

- 3.1 The proposed development is situated along Princess Road, Manchester, M20 1NA; to the north is located Manchester Rovers Football Club, to the west is located football pitches and beyond that sports facilities such as The Greater Manchester Police Sports and Social Club and YSG Football Academy.
- 3.2 Residential dwellings are located east from the site on the opposite side of Princess Road. The proposed development comprises of a new two-storey extension to Hough End Leisure Centre, this contains a café, changing spaces with WCs on the ground floor and fitness suite, club room and training room on the first floor.

Identified Nearest Noise Sensitive Receptors

- 3.3 The nearest identified Noise Sensitive Receptors (NSRs) are set out in Table 1 and labelled NSR A.

Table 1: Identified NSRs

NSR	Description	Approximate Distance from Site Boundary
A	Residential Dwellings (Princess Road)	70m

- 3.4 Figure 1 below displays the location of the nearest Noise Sensitive Receptor (NSR A) highlighted with a blue box. The NSR marked below has been chosen due to this position having the least amount of screening from the proposed development, specifically the externally located ASHP's, therefore this location presents a worse-case assessment.



Figure 1: Nearest Noise Sensitive Receptor

Noise Survey

- 3.5 SBE have not been appointed to undertake a noise survey, therefore assessment has been based on data contained within the Waterman noise assessment report ref: *132513_VO_2021-NOISE_IMPACT_ASSESSMENT-1842718*. It is understood that the Waterman report was produced during the COVID-19 pandemic, as such baseline noise conditions were based on historic noise survey data obtained at another site in the vicinity of the development site in September 2017 and publicly available road traffic noise mapping (extrium.co.uk/noiseviewer).
- 3.6 Figure 2 shows the baseline noise levels used to inform the Waterman report.

Period	dB LAeq,T	dB LA90,T	L _{Amax}
Daytime	75 ¹	54 ¹	92
Night-time	66 ¹	45 ¹	84

Figure 2: Waterman adopted baseline noise levels

- 3.7 The above data displayed in Figure 2 has been used to inform the rating level limits for fixed plant items, this has been set at 5 dB below the adopted background sound level in line with the requirements of Condition 20.

4. External Plant Noise Impact Assessment

Plant Noise Limits

- 4.1 The Waterman report sets out plant noise limits based on the baseline data as per section 3 above. Limits are set at 5 dB below the background noise level (L_{A90}) in line with MCC guidance. These rating level limits are set out in Table 2 as an $L_{Ar,Ti}$ for daytime and night-time periods.

Table 2: BS 4142 Maximum Plant Noise Limits

Location	Period	Representative Background Noise Level (dB $L_{A90,T}$)	Rating Noise Level limit (dB $L_{Ar,Ti}$)
All NSRs	Daytime (07:00 – 23:00)	54	≤ 49
	Night-time (23:00 – 07:00)	45	≤ 40

Assessed Building Services Plant

- 4.2 Sources of externally located, or externally terminating, noise generating plant associated with the development that have been considered in this assessment are set out in Table 3. Ventilation drawings that have been used for this assessment have been included in Appendix I.

Table 3: Plant Noise Sources Considered in the Assessment

Reference	Manufacturer	Model	Location	Quantity	Unit Type
KEF/01/01	Vent-Axia	Bifurcated Case Axial Fans	Kitchen Extract Canopy	1	Bifurcated Extract Fan
SF/01/01	Vent-Axia	Sentinel D-Box Twin Fan	Ground and First WC's	1	External Twin Fan
HRU 01/01	Nuaire	XBC 65	01-01-14 Training Room	1	HRU
HRU 01/02	Nuaire	XBC 65	01-01-15 Club Room	1	HRU
AHU/01	Komfovent	VERSO-RHP-20-L	First Floor Plant Room	1	AHU
AHU/02	Komfovent	VERSO-RHP-20-ML	First Floor Plant Room	1	AHU
AHU/03	Komfovent	VERSO-RHP-30-L	First Floor Plant Room	1	AHU
AHU/04	Komfovent	VERSO-RHP-30-L	First Floor Plantroom	1	AHU
-	CIAT	Aquaciat Power ILD 0800R	External Plant	2	ASHP

Reference	Manufacturer	Model	Location	Quantity	Unit Type
-	CIAT	Aquaciat Caleo TD 0300B	External Plant Compound	2	ASHP
-	Mitsubishi	PURY-EP350YNW-A	Roof	1	VRF Condenser
-	Mitsubishi	PUHY-P400YNW-A	Roof	1	DX Condenser
-	Mitsubishi	PUZ-ZM35VKA2	Roof	1	Dx Condenser

Noise Impact Assessment

- 4.3 Noise levels have been calculated with propagation according to ISO-9613-2.
- 4.4 It has been assumed that all plant included within the assessment will potentially operate concurrently at any point during the day or night-time period and at design duty. Where multiple fan speeds are displayed within the data, the highest fan speed has been used to present a worst-case scenario.
- 4.5 The assessment has been carried out using:
- Single figure Sound Power Levels (SWL) for ASHP unit Aquaciat Caleo TD 0300B and condenser units PURY-EP350YNW-A, PUHY-P400YNW-A, PUZ-ZM35VKA2;
 - Octave band SWLs for all other units displayed within Table 3; and
 - Attenuator insertion losses as per data supplied by the client.
- 4.6 Plant layouts are displayed in Appendix I. Appendix II presents the noise data and attenuator insertion loss data used to inform the assessment.
- 4.7 No corrections have been made for the acoustic character as the noise is anticipated to be broadband in character. Plant is understood to operate continuously and shall not be intermittent or impulsive, therefore no corrections have been made.
- 4.8 Drawing *HEV-VES-01-00-DR-M-56202 Dated 26/10/23* shows details of the ASHP enclosure, it can be seen that a brick wall is shown for illustrative purposes and that the free area of the wall should be at least 50%. Given this is illustrative only, SBE have not included any associated screening or attenuation for the ASHPs from this enclosure.
- 4.9 Table 4 presents the cumulative plant noise levels at the nearest identified NSRs, along with a comparison against the rating noise level limits set out in Table 2.

Table 4: Calculated Plant Noise Levels at NSR

Location	Calculated Cumulative Noise Level at NSR (dB L _{Ar,Tr})	Rating Level Limit (dB L _{Ar,Tr})	Level Above Rating Level Limit (dB)	Compliant
NSRA Daytime (07:00 – 23:00)	39	49	-10	YES
NSR A Night-time (23:00 – 07:00)	39	40	-1	YES

- 4.10 Table 4 above shows that the calculated cumulative noise level at the NSR is below the rating level limit and is therefore compliant with the rating level criteria set out in Table 2.

Planning Condition 20

- 4.11 Section 2 of this report details the requirements for the proposed plant items to comply with Planning Condition 20. Table 4 displays the results of the cumulative plant noise levels at the NSRs, it can be seen within Table 4 that the cumulative noise level from all plant falls below the rating level limit as per Table 2 and therefore satisfies the requirements of Condition 20.

Estimate of Calculation Uncertainty

- 4.12 An assessment of uncertainty in measurement and calculation is undertaken following guidance in University of Salford document '*A good practice guide on the sources and magnitude of uncertainty arising in the practical measurement of environmental noise*' (2007).
- 4.13 Assessment is undertaken against measured site background sound level measurements. The uncertainty of noise survey measurements is expected to be ± 1 dB based on the allowable uncertainty for a calibrated Class 1 precision integrating sound level meter, quoted by BS 61672-11:2003 as ± 1 dB at 1 kHz.
- 4.14 Sound data for plant equipment has been taken from manufacturer quoted noise. In accordance with BS EN ISO 3740:2001 the uncertainty of source measurement is expected to be ± 1 dB in each octave band.
- 4.15 The uncertainty in a distance attenuation calculation is quoted by ISO 9613-2:1996 as ± 3 dB for sources < 5m from ground level.

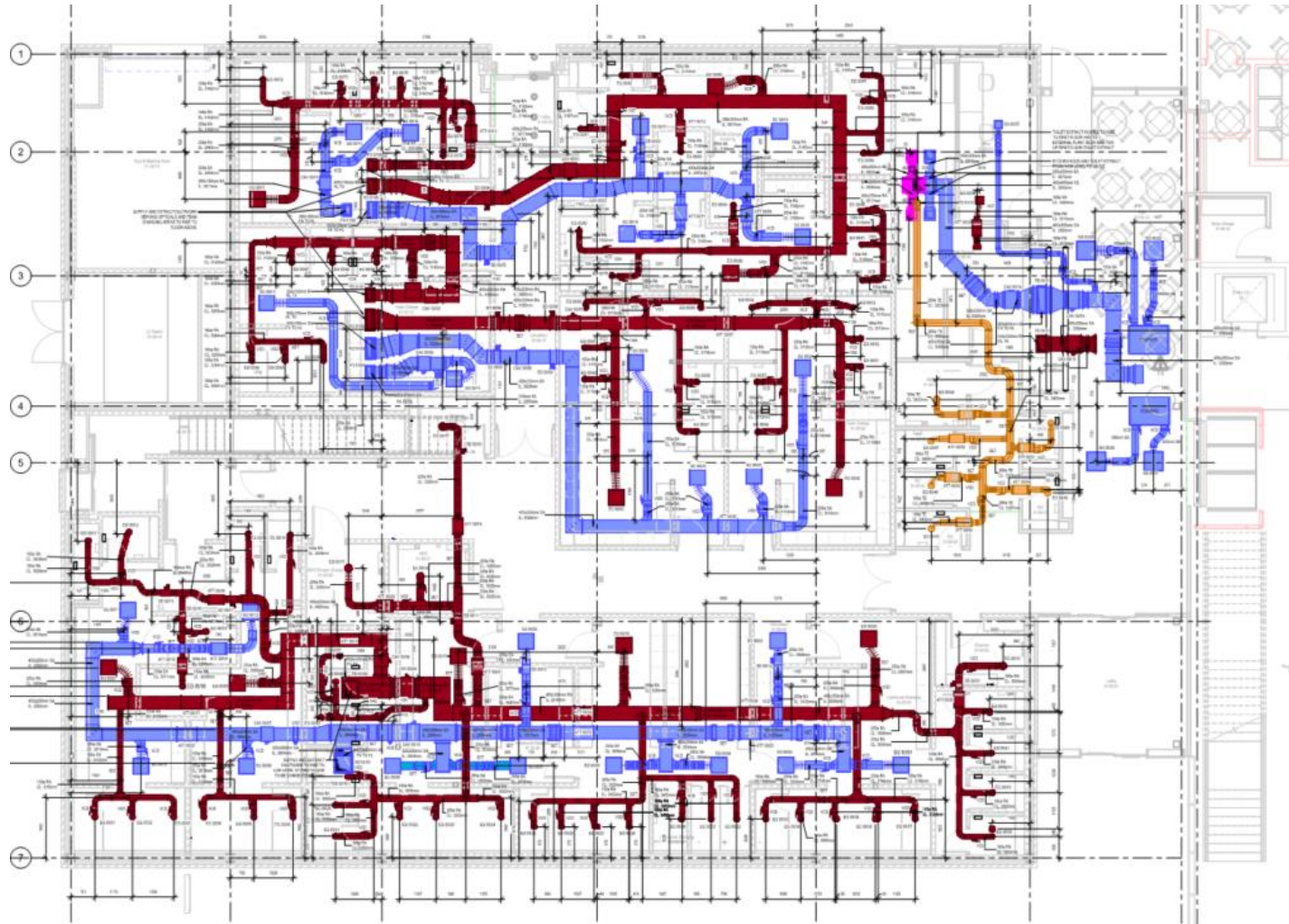
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- 4.16 It is therefore considered that the maximum uncertainty in measurement and calculation is ± 3 dB. This level of uncertainty could mean that plant noise levels during the night-time could exceed the rating level limit by 2 dB during the night-time, however this would still fall 3 dB below the background sound level and would still result in a 'low noise impact' as per BS 4142. Additionally, the assessment is noted to be based on the worst-case assumption that all plant operate at design duty for 24 hours, which is unlikely to be the case in reality.

5. Summary and Conclusion

- 5.1 ISG Construction Limited (The Client) have commissioned Stroma Built Environment (SBE) to carry out a plant noise impact assessment at the proposed extension located at Hough End Leisure Centre, 480 Princess Road, Manchester, M20 1NA.
- 5.2 This report has considered the acoustic impact of the operation of mechanical building services plant associated with the proposed development at the nearest identified Noise Sensitive Receptors (NSRs) in relation to satisfying the requirements of Planning Condition 20.
- 5.3 Assessment has been based on the baseline noise condition information detailed in the Waterman report (ref: *WIE17320-100-R-1.1.2(001)*).
- 5.4 Planning Condition 20 requires the cumulative plant noise level of all operational plant to be designed to be 5 dB below the prevailing background noise level (L_{A90}) during the daytime and night-time periods.
- 5.5 The results of the assessment (displayed within Table 4) indicates that noise from mechanical building services plant associated with the development meet the requirements of Planning Condition 20 during the daytime and night-time periods.

Appendix I. Mechanical Plant Layout

Ground Floor



Nov 17

1
2
3
4
5
6
7

SUPPLY AND EXTRACT DUCTWORK IS TO BE LEVEL WITH APPROPRIATE AT THE MECHANICAL TO BE FITTED SUITE EXTENSION

AIR INTAKE TO BE PROVIDED OR ADJUSTED TO BE FITTED SUITE EXTENSION

EXTRACT BELLOWS FOR RETURN AIR TRANSFER

Appendix II. Mechanical Plant Data

Heat Recovery Units – HRU 01/01 & HRU 01/02

Frequency	[Hz]	63	125	250	500	1000	2000	4000	8000	dB(A)
Outdoor Lw	[dB]	59	49	56	47	47	44	43	40	53
Supply Lw	[dB]	64	56	68	61	62	61	60	54	68
Extract Lw	[dB]	58	48	55	47	46	44	43	41	52
Exhaust Lw	[dB]	63	55	67	60	61	61	60	55	67
Casing Lw	[dB]	56	48	53	36	35	32	23	17	45

Heat Pump 1 – AW-HT-/LN-CA-E/0524

SOUND DATA OUTDOOR HOT

Frequencies	Hz	63	125	250	500	1000	2000	4000	8000
Sound power (spectrum)	dB	88	89	88	86	83	78	71	65
Sound power level in heating	dB(A)	88							
Sound pressure level (spectrum)	dB	56	57	56	54	51	46	39	33

Heat Pump 2 & 3 – NX-N-G06/SL-CA/0904T

SOUND DATA COLD

Frequencies	Hz	63	125	250	500	1000	2000	4000	8000
Sound power (spectrum)	dB	87	86	85	83	80	75	68	62
Sound power level in cooling	dB(A)	85							
Sound pressure level (spectrum)	dB	55	54	53	51	48	43	36	30
Sound Pressure	dB(A)	53							

Air Source Heat Pump

Acoustic Sound Power Level Radiated										
Sound Power at Chiller Acoustic Center (dB)										
Load (%)	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	Global sound power (dB)	A-Weighted Global sound power (dB(A))
Max	80.0	81.5	85.0	82.5	79.5	74.0	68.5	75.5	89.5	84.5

Extract Fan - SF/01/01

	63	125	250	500	1k	2k	4k	8k	Total	dbA @ 3m
Inlet	62	65	60	66	56	46	46	42	70	47
Outlet	60	66	60	72	63	62	57	52	74	50

Bifurcated Extract Fan - KEF/01/01

	63	125	250	500	1k	2k	4k	8k	Total	dbA @ 3m
Inlet	75	75	80	81	81	77	74	64	87	64
Outlet	78	76	80	80	79	77	74	65	87	63

Air Handling Unit – AHU/01

Sound power level L _w	to the air ducts				to surrounding
	Supply air flow [dB]		Exhaust air flow [dB]		[dB]
F[Hz]	Inlet	Outlet	Inlet	Outlet	
63	56.0	67.0	57.1	64.7	59.8
125	53.2	65.5	55.2	62.0	57.5
250	59.4	75.8	63.5	69.6	65.7
500	55.3	72.8	58.8	68.4	54.6
1000	50.4	76.0	52.3	72.8	55.6
2000	46.0	72.4	47.6	69.4	49.2
4000	40.7	68.9	44.3	65.3	40.2
8000	33.8	63.9	36.8	60.1	34.1
dB(A)	57	79	60	76	61

Air Handling Unit – AHU/02

Sound power level L _w	to the air ducts				to surrounding
	Supply air flow [dB]		Exhaust air flow [dB]		[dB]
F[Hz]	Inlet	Outlet	Inlet	Outlet	
63	57.1	68.5	61.5	65.6	61.7
125	53.6	65.9	58.1	62.1	58.3
250	58.5	73.4	59.4	64.1	63.3
500	54.5	71.0	57.4	65.8	53.4
1000	50.0	73.0	49.6	68.2	53.8
2000	45.7	69.7	44.5	67.8	48.5
4000	40.4	66.0	42.3	65.2	39.9
8000	33.2	60.5	36.4	59.2	33.6
dB(A)	56	77	57	73	59

Air Handling Unit – AHU/03

Sound power level L _w	to the air ducts				to surrounding
	Supply air flow [dB]		Exhaust air flow [dB]		[dB]
F[Hz]	Inlet	Outlet	Inlet	Outlet	
63	55.5	65.3	57.3	65.0	59.5
125	52.0	64.2	55.1	62.3	57.2
250	57.8	72.7	62.8	68.7	64.4
500	52.6	69.1	56.6	66.0	52.6
1000	45.8	69.2	48.0	68.6	52.3
2000	42.7	65.8	44.6	65.8	46.6
4000	38.3	62.8	41.7	62.3	38.2
8000	33.1	59.8	35.8	58.9	33.3
dB(A)	54	74	58	73	59

Air Handling Unit – AHU/04

Sound power level L _w	to the air ducts		to surrounding	
	Supply air flow [dB]		Exhaust air flow [dB]	
F[Hz]	Inlet	Outlet	Inlet	Outlet
63	59.0	69.8	55.2	64.0
125	54.9	68.2	54.5	62.1
250	60.6	76.6	61.3	67.5
500	54.1	73.0	56.2	66.3
1000	50.7	75.8	48.4	68.5
2000	45.6	69.6	44.0	64.0
4000	40.4	66.2	41.1	61.0
8000	35.3	63.7	35.8	57.6
dB(A)	57	79	57	72
				60

OUTDOOR UNITS		PUHY-P200YNW-A2	PUHY-P250YNW-A2	PUHY-P300YNW-A2	PUHY-P350YNW-A2	PUHY-P400YNW-A2	PUHY-P400YSNW-A2
CAPACITY (kW)	Heating (nominal)	25.0	31.5	37.5	45.0	50.0	50.0
	Cooling (nominal)	22.4	28.0	33.5	40.0	45.0	44.8
	High Performance Heating (UK)	25.0	31.5	35.6	42.8	45.0	50.0
	COP Priority Heating (UK)	22.8	28.7	34.1	41.0	43.0	45.5
	Cooling (UK)	20.0	25.1	30.0	35.8	40.3	40.1
POWER INPUT (kW)	Heating (nominal)	6.08	8.49	10.30	12.32	14.20	12.16
	Cooling (nominal)	6.03	9.62	11.31	13.98	17.57	12.47
	High Performance Heating (UK)	7.66	10.70	13.70	16.39	16.05	15.56
	COP Priority Heating (UK)	6.08	8.49	10.30	12.32	13.77	12.16
	Cooling (UK)	3.50	5.58	6.56	8.11	11.24	7.23
COP / EER (nominal)		4.11 / 3.71	3.71 / 2.91	3.64 / 2.96	3.65 / 2.86	3.52 / 2.56	4.11 / 3.59
MAX NO. OF CONNECTABLE INDOOR UNITS		20	25	30	35	40	40
MAX CONNECTABLE CAPACITY		50-130% OU Capacity	50-130% OU Capacity	50-130% OU Capacity	50-130% OU Capacity	50-130% OU Capacity	50-130% OU Capacity
AIRFLOW (m³/min)	High	170	185	240	270	300	170 / 170
	Low	170	185	240	270	300	170 / 170
PIPE SIZE mm (in)	Gas	22.2 (7/8")	22.2 (7/8")	22.2 (7/8")	28.58 (1-1/8")	28.58 (1-1/8")	28.58 (1-1/8")
	Liquid	9.52 (3/8")	9.52 (3/8")	9.52 (3/8")	12.7 (1/2")	12.7 (1/2")	12.7 (1/2")
SOUND PRESSURE LEVEL (dBA)		59.0 / 58.0	61.0 / 60.0	64.5 / 61.0	64.5 / 62.0	67.0 / 65.0	62.0 / 61.0
SOUND POWER LEVEL (dBA)		77.0 / 75.0	80.0 / 78.0	84.0 / 80.0	84.0 / 80.0	86.0 / 82.0	80.0 / 78.0
WEIGHT (kg)	Heating / Cooling	213	213	226	277	277	213 + 213
	Heating / Cooling	213	213	226	277	277	213 + 213
DIMENSIONS (mm)	Width	920	920	920	1240	1240	920 + 920
	Depth	740	740	740	740	740	740
(1798mm without legs)	Height	1858	1858	1858	1858	1858	1858
	Height	1858	1858	1858	1858	1858	1858
ELECTRICAL SUPPLY ²		380-415v, 50Hz	380-415v, 50Hz	380-415v, 50Hz	380-415v, 50Hz	380-415v, 50Hz	380-415v, 50Hz
PHASE ²		Three	Three	Three	Three	Three	Three
STARTING CURRENT (A) ²		8	8	8	8	8	8
NOMINAL SYSTEM RUNNING CURRENT (A) ²		9.7 / 9.6 [16.1]	13.6 / 15.4 [17.8]	16.5 / 18.1 [22.7]	19.7 / 22.4 [26.4]	22.7 / 28.1 [31.9]	19.5 / 19.9 [16.1 + 16.1]
GUARANTEED OPERATING RANGE (°C)		-20-15.5 / -5-52	-20-15.5 / -5-52	-20-15.5 / -5-52	-20-15.5 / -5-52	-20-15.5 / -5-52	-20-15.5 / -5-52
FUSE RATING (MCB sizes BS EN 60947-2) - (A) ²		1 x 20	1 x 20	1 x 25	1 x 32	1 x 32	1 x 20 / 1 x 20
MAINS CABLE No. Cores ²		4 + earth	4 + earth	4 + earth	4 + earth	4 + earth	4 + earth / 4 + earth
CHARGE REFRIGERANT (kg) / CO ₂ EQUIVALENT (T) R410A (GWP 2088)		6.5 / 13.6	6.5 / 13.6	6.5 / 13.6	9.8 / 24.0	9.8 / 20.5	13 / 27.1
MAX ADDITIONAL REFRIGERANT (kg) / CO ₂ EQUIVALENT (T) R410A (GWP 2088)		15.9 / 33.2	22.9 / 47.8	23.4 / 48.9	24 / 50.1	24.4 / 51.0	32 / 66.8

OUTDOOR UNITS		PURY-EP200YNW-A2	PURY-EP250YNW-A2	PURY-EP300YNW-A2	PURY-EP350YNW-A2	PURY-EP400YNW-A2	PURY-EP400YSNW-A2
CAPACITY (kW)	Heating (nominal)	25.0	31.5	37.5	45.0	50.0	50.0
	Cooling (nominal)	22.4	28.0	33.5	40.0	45.0	44.8
	High Performance Heating (UK)	25.0	31.5	35.6	42.8	45.0	50.0
	COP Priority Heating (UK)	22.8	28.7	34.1	41.0	43.0	45.5
	Cooling (UK)	20.0	25.1	30.0	35.8	40.3	40.1
POWER INPUT (kW)	Heating (nominal)	6.72	9.51	10.90	13.39	16.33	13.85
	Cooling (nominal)	6.38	9.75	11.20	14.23	18.75	13.17
	High Performance Heating (UK)	8.47	11.98	14.50	17.81	18.45	17.73
	COP Priority Heating (UK)	6.72	9.51	10.90	13.39	16.33	13.85
	Cooling (UK)	3.70	5.66	6.50	8.25	12.00	7.64
COP / EER (nominal)		3.72 / 3.51	3.31 / 2.87	3.44 / 2.99	3.36 / 2.81	3.06 / 2.40	3.61 / 3.40
MAX NO. OF CONNECTABLE INDOOR UNITS		20	25	30	35	40	40
MAX CONNECTABLE CAPACITY		50-150% OU Capacity	50-150% OU Capacity	50-150% OU Capacity	50-150% OU Capacity	50-150% OU Capacity	50-150% OU Capacity
AIRFLOW (m³/min)	High	170	185	240	250	315	170 / 170
	Low	170	185	240	250	315	170 / 170
PIPE SIZE mm (in)	Gas	19.05 (3/4")	22.2 (7/8")	22.2 (7/8")	28.58 (1-1/8")	28.58 (1-1/8")	28.58 (1-1/8")
	Liquid	15.88 (5/8")	19.05 (3/4")	19.05 (3/4")	19.05 (3/4")	22.2 (7/8")	22.2 (7/8")
SOUND PRESSURE LEVEL (dBA) @ 1m		59.0 / 59.0	64.0 / 61.0	67.0 / 61.0	64.0 / 62.5	69.0 / 65.0	62.0 / 62.0
SOUND POWER LEVEL (dBA) @ 100% CAPACITY		76.0 / 76.0	83.0 / 78.0	86.0 / 80.0	83.0 / 81.0	88.0 / 83.0	79.0 / 79.0
SOUND POWER LEVEL (dBA) @ 90% CAPACITY		74.5 / 71.0	76.0 / 73.5	82.0 / 74.5	81.0 / 76.0	83.5 / 77.0	77.5 / 74.0
SOUND POWER LEVEL (dBA) @ 75% CAPACITY		71.5 / 66.5	74.5 / 69.5	77.5 / 70.5	77.0 / 73.0	78.0 / 73.0	74.5 / 69.5
WEIGHT (kg)	Heating / Cooling	219	228	230	275	275	219 + 219
	Heating / Cooling	219	228	230	275	275	219 + 219
DIMENSIONS (mm)	Width	920	920	920	1240	1240	920 + 920
	Depth	740	740	740	740	740	740
(1798mm without legs)	Height	1858	1858	1858	1858	1858	1858
	Height	1858	1858	1858	1858	1858	1858
ELECTRICAL SUPPLY ¹		380-415v, 50Hz	380-415v, 50Hz	380-415v, 50Hz	380-415v, 50Hz	380-415v, 50Hz	380-415v, 50Hz
PHASE ¹		Three	Three	Three	Three	Three	Three
STARTING CURRENT (A) ¹		8	8	8	8	8	8 / 8
NOMINAL SYSTEM RUNNING CURRENT (A) ¹		10.7 / 10.2 [16.1]	15.2 / 15.6 [20.3]	17.4 / 17.9 [22.3]	21.4 / 22.8 [24.8]	26.1 / 30.0 [33.3]	22.2 / 21.1 [16.1 + 16.1]
GUARANTEED OPERATING RANGE (°C)		-20-15.5 / -5-52	-20-15.5 / -5-52	-20-15.5 / -5-52	-20-15.5 / -5-52	-20-15.5 / -5-52	-20-15.5 / -5-52
FUSE RATING (MCB sizes BS EN 60947-2) - (A) ¹		1 x 20	1 x 25	1 x 25	1 x 25	1 x 40	1 x 20 / 1 x 20
MAINS CABLE No. Cores ¹		4 + earth	4 + earth	4 + earth	4 + earth	4 + earth	4 + earth / 4 + earth
CHARGE REFRIGERANT (kg) / CO ₂ EQUIVALENT (T) R410A (GWP 2088)		5.2 / 10.9	5.2 / 10.9	5.2 / 10.9	8 / 16.7	8 / 16.7	10.4 / 21.7
MAX ADDITIONAL REFRIGERANT (kg) / CO ₂ EQUIVALENT (T) R410A (GWP 2088)		28.3 / 59.1	34.3 / 71.6	34.3 / 71.6	39 / 81.4	39 / 81.4	48.6 / 101.5

PUZ-ZM OUTDOOR UNITS		PUZ-ZM35VKA2	PUZ-ZM50VKA2	PUZ-ZM60VHA2	PUZ-ZM71VHA2	PUZ-ZM100VKAR2	PUZ-ZM100YKAR2 ③
SOUND PRESSURE LEVEL (dBA)	Heating/Cooling	46 / 44	46 / 44	49 / 47	49 / 47	51 / 49	51 / 49
SOUND POWER LEVEL (dBA)	Cooling	65	65	67	67	69	69
WEIGHT (kg)		46	46	67	67	105	111
DIMENSIONS (mm)	Width x Depth x Height	809 x 300 x 630	809 x 300 x 630	950 x 330 + 25 x 943	950 x 330 + 25 x 943	1050 x 330 + 40 x 1338	1050 x 330 + 40 x 1338
ELECTRICAL SUPPLY		220-240v, 50Hz	220-240v, 50Hz	220-240v, 50Hz	220-240v, 50Hz	220-240v, 50Hz	380-415v, 50Hz
PHASE		Single	Single	Single	Single	Single	Three
SYSTEM POWER INPUT (kW)	Heating/Cooling (nominal)	1.040 / 0.869	1.347 / 1.239	1.732 / 1.560	2.116 / 1.863	3.102 / 2.405	3.102 / 2.405
	Heating/Cooling (UK)	0.81 / 0.84	1.12 / 1.12	1.25 / 1.65	1.54 / 1.92	2.47 / 2.06	2.47 / 2.06
STARTING CURRENT (A)		4.3	4.3	5.3	5.3	10.7	2.6
SYSTEM RUNNING CURRENT (A)	Heating/Cooling [MAX]	4.97 / 4.31 [13.4]	5.98 / 5.57 [13.4]	7.41 / 6.65 [19.4]	9.10 / 7.96 [19.4]	13.46 / 10.45 [27.1]	4.49 / 5.45 [8.6]
FUSE RATING (BS88) - HRC (A)		16	16	25	25	32	16
MAINS CABLE No. CORES		3	3	3	3	3	5
MAX PIPE LENGTH (m)		50	50	55	55	100	100
MAX HEIGHT DIFFERENCE (m)		30	30	30	30	30	30
CHARGE REFRIGERANT (kg) / CO ₂ EQUIVALENT (t) - R32 (GWP 675) - 30m		2.00 / 1.35 (30m)	2.00 / 1.35 (30m)	2.80 / 1.89 (30m)	2.80 / 1.89 (30m)	3.60 / 2.43 (40m)	3.60 / 2.43 (40m)
MAX ADDITIONAL REFRIGERANT (kg) / CO ₂ EQUIVALENT (t) - R32 (GWP 675)		0.30 / 0.20	0.30 / 0.20	0.80 / 0.54	0.80 / 0.54	2.40 / 1.62	2.40 / 1.62

Item	System Reference	Code	Suffix	DWG	L1	L2/ID	W	H	Vol	PD	Wt	No.	Performance, dB								
					mm	mm	mm	mm	m ³ /s	Pa	kg	Off.	63	125	250	500	1k	2k	4k	8k	
1	ATT 00/01 - SF 01/01 XTALK	PL	G	A13G	600	160			0.018	5	6	1	IL	1	2	6	16	23	19	17	12
2	ATT 00/02 - SF 01/01 XTALK	PL	G	A13G	600	160			0.018	5	6	1	IL	1	2	6	16	23	19	17	12
3	ATT 00/03 - SF 01/01 XTALK	PL	G	A13G	600	160			0.018	5	6	1	IL	1	2	6	16	23	19	17	12
4	ATT 00/04 - SF 01/01 XTALK	PL	G	A13G	600	160			0.018	5	6	1	IL	1	2	6	16	23	19	17	12
5	ATT 00/05 - SF 01/01 XTALK	PL	G	A13G	600	160			0.018	5	6	1	IL	1	2	6	16	23	19	17	12
6	ATT 00/06 - TEAM CHANGE 01-00-22 SUP	SL	GJ	A02G	600		400	250	0.174	5	19	1	IL	3	7	11	19	33	29	26	15
7	ATT 00/07 - TEAM CHANGE 01-00-22 EXT	SL	GJ	A02G	600		400	250	0.174	5	19	1	IL	3	7	11	19	33	29	26	15
8	ATT 00/08 - OFFICIALS CHANGE 01-00-19 EXT	SL	GJ	A02G	600		400	250	0.146	5	19	1	IL	3	7	11	19	33	29	26	15
9	ATT 00/09 - OFFICIALS CHANGE 01-00-19 SUP	PL	G	A13G	600	250			0.073	5	8	1	IL	1	2	6	15	20	15	14	10
10	ATT 00/10 - OFFICIALS CHANGE 01-00-20 EXT	PL	G	A13G	600	160			0.018	5	6	1	IL	1	2	6	16	23	19	17	12
11	ATT 00/11 - OFFICIALS CHANGE 01-00-20 SUP	PL	G	A13G	600	250			0.073	5	8	1	IL	1	2	6	15	20	15	14	10
12	ATT 00/12 - OFFICIALS CHANGE 01-00-19 EXT	PL	G	A13G	600	160			0.018	5	6	1	IL	1	2	6	16	23	19	17	12
13	ATT 00/13 - TEAM CHANGE 01-00-16 EXT	PL	G	A13G	600	250			0.173	5	8	1	IL	1	2	6	15	20	15	14	10
14	ATT 00/14 - TEAM CHANGE 01-00-13 EXT	SL	GJ	A02G	600		400	250	0.173	5	19	1	IL	3	7	11	19	33	29	26	15
15	ATT 00/15 - CIRCULATION 2 01-00-06-2 EXT	PL	G	A13G	600	200			0.042	5	7	1	IL	1	2	6	16	23	19	17	12
16	ATT 00/16 - TEAM CHANGE 01-00-09-2 EXT	PL	G	A13G	600	160			0.018	5	6	1	IL	1	2	6	16	23	19	17	12
17	ATT 00/17 - TEAM CHANGE 01-00-09 EXT	SL	GJ	A02G	600		400	250	0.09	5	19	1	IL	3	7	11	19	33	29	26	15
18	ATT 00/18 - TEAM CHANGE 01-00-09 SUP	PL	G	A13G	600	250			0.074	5	8	1	IL	1	2	6	15	20	15	14	10
19	ATT 00/19 - COMMUNAL CHANGE 01-00-05 EXT	SL	GJ	A02G	600		400	250	0.292	5	18	1	IL	1	3	6	15	25	21	19	11
20	ATT 00/20 - AWC/SHOWER CHANGE 01-00-08 EXT	PL	G	A13G	600	250			0.042	5	8	1	IL	1	2	6	15	20	15	14	10
21	ATT 00/21 - COMMUNAL CHANGE 01-00-05 EXT	PL	G	A13G	600	250			0.126	5	8	1	IL	1	2	6	15	20	15	14	10
22	ATT 00/22 - COMMUNAL CHANGE 01-00-04 EXT	SL	GJ	A02G	600		450	300	0.443	5	22	1	IL	2	5	9	18	26	21	18	11
23	ATT 00/23 - COMMUNAL CHANGE 01-00-04 SUP	SL	GJ	A02G	600		450	300	0.465	5	22	1	IL	2	5	9	18	26	21	18	11
24	ATT 00/24 - COMMUNAL CHANGE 01-00-03 EXT	SL	GJ	A02G	600		450	300	0.26	5	22	1	IL	2	5	9	18	26	21	18	11
25	ATT 00/25 - COMMUNAL CHANGE 01-00-03 SUP	SL	GJ	A02G	600		450	250	0.281	5	20	1	IL	1	3	6	15	25	21	19	11
26	ATT 00/26 - CLEANERS 01-00-02 EXT	PL	G	A13G	600	200			0.042	5	7	1	IL	1	2	6	16	23	19	17	12
27	ATT 00/27 - TEAM CHANGE 01-00-09 SUP	SL	GJ	A02G	600		400	250	0.218	5	19	1	IL	3	7	11	19	33	29	26	15
28	ATT 00/28 - TEAM CHANGE 01-00-09 2 EXT	PL	G	A13G	600	200			0.072	5	7	1	IL	1	2	6	16	23	19	17	12
29	ATT 00/29 - CAFE 01-00-33 EXT	PL	G	A13G	600	160			0.02	5	6	1	IL	1	2	6	16	23	19	17	12
30	ATT 00/30 - CAFE 01-00-33 SUP	PL	G	A13G	600	160			0.02	5	6	1	IL	1	2	6	16	23	19	17	12
31																					
32	ATT 01/01 - HRU01/01 INT	PL	G	A13G	900	300			0.36	5	14	1	IL	2	3	7	18	25	19	17	13
33	ATT 01/02 - HRU01/01 EXH	PL	G	A13G	900	300			0.36	5	14	1	IL	2	3	7	18	25	19	17	13
34		PLP	GM	A13G	900	400			0.7	15	27	1	IL	4	12	14	22	24	22	24	21
35	ATT 01/04 - HRU01/01 SUP	PLP	G	A13G	900	300			0.36	15	21	1	IL	4	12	19	29	34	34	32	28
36	ATT 01/05 - HRU01/02 EXH	PL	G	A13G	900	300			0.36	5	14	1	IL	2	3	7	18	25	19	17	13

Item	System Reference	Code	Suffix	DWG	L1	L2/ID	W	H	Vol	PD	Wt	No.	Performance, dB									
37	ATT 01/06 - HRU01/02 INT	PL	G	A13G	900	300			0.36	5	14	1	IL	2	3	7	18	25	19	17	13	
38	ATT 01/07 - HRU01/02 SUP	PLP	G	A13G	900	300			0.36	15	21	1	IL	4	12	19	29	34	34	32	28	
39	ATT 01/08 - HRU01/01 EXT	PLP	G	A13G	900	300			0.36	15	21	1	IL	4	12	19	29	34	34	32	28	
40	ATT 01/09 - AWC 2 01-01-02-2 EXT	PL	G	A13G	600	160			0.028	5	6	1	IL	1	2	6	16	23	19	17	12	
41	ATT 01/10 - WC 01-01-03 EXT	PL	G	A13G	600	160			0.014	5	6	1	IL	1	2	6	16	23	19	17	12	
42	ATT 01/11 - WC 01-01-04 EXT	PL	G	A13G	600	160			0.014	5	6	1	IL	1	2	6	16	23	19	17	12	
43	ATT 01/12 - WC 01-01-05 EXT	PL	G	A13G	600	160			0.014	5	6	1	IL	1	2	6	16	23	19	17	12	
44	ATT 01/13 - WC 01-01-06 EXT	PL	G	A13G	600	160			0.014	5	6	1	IL	1	2	6	16	23	19	17	12	
45	ATT 01/14 - WC 01-01-07 EXT	PL	G	A13G	600	160			0.016	5	6	1	IL	1	2	6	16	23	19	17	12	
46	ATT 01/15 - SF01/01 EXT*	PL	G	A13G	900	250			0.207	5	12	1	IL	2	3	7	18	25	19	17	13	
47	ATT 01/16 - SF01/01 EXH*	PL	G	A13G	900	250			0.207	5	12	1	IL	2	3	7	18	25	19	17	13	
48	ATT 01/17 - AHU4 SUP	SP	G	A02G	1200		600	600	1.44	20	67	1	IL	5	10	18	28	36	28	24	14	
49	ATT 01/18 - AHU4 EXT	SP	G	A02G	1200		600	600	1.26	20	67	1	IL	5	10	18	28	36	28	24	14	
50	ATT 01/19 - AHU2 INT	SL	GJ	A02G	1200		500	500	1.07	20	46	1	IL	6	11	18	25	30	22	18	10	
51	ATT 01/20 - AHU2 EXH OMITTED																					
52	ATT 01/21 - AHU2 SUP	SL	GJ	A02G	1200		500	500	1.07	20	46	1	IL	6	11	18	25	30	22	18	10	
53	ATT 01/22 - AHU2 EXT OMITTED																					
54	ATT 01/23 - AHU3 SUP	SL	G	A02G	1200		600	600	1.046	10	57	1	IL	7	12	18	22	24	17	12	6	
55	ATT 01/24 - AHU3 EXT	SL	G	A02G	1200		600	600	1.086	10	57	1	IL	7	12	18	22	24	17	12	6	
56	ATT 01/25 - AHU3 EXH	SL	G	A02G	1200		600	600	1.086	10	57	1	IL	7	12	18	22	24	17	12	6	
57	ATT 01/26 - AHU3 INT	SL	G	A02G	1200		600	600	1.046	10	57	1	IL	7	12	18	22	24	17	12	6	
58	ATT 01/27 - AHU4 INT	SP	G	A02G	1200		600	600	1.44	20	67	1	IL	5	10	18	28	36	28	24	14	
59	ATT 01/28 - AHU4 EXH	SP	G	A02G	1200		600	600	1.26	20	67	1	IL	5	10	18	28	36	28	24	14	
60	ATT 01/29 - AHU1 SUP	SL	G	A02G	1200		400	600	0.988	20	46	1	IL	5	10	18	28	36	28	24	14	
61	ATT 01/30 - AHU1 EXT	SL	G	A02G	1200		400	600	0.988	20	46	1	IL	5	10	18	28	36	28	24	14	
62	ATT 01/31 - AHU1 EXH	SP	G	A02G	1200		600	600	0.988	10	67	1	IL	5	10	18	28	36	28	24	14	
63	ATT 01/32 - AHU1 INT	SP	G	A02G	1200		600	600	0.988	10	67	1	IL	5	10	18	28	36	28	24	14	
64	ATT 01/33 - KEF1 EXTRACT*	PLP	GM	A13G	900	400			0.7	15	27	1	IL	4	12	14	22	24	22	24	21	
65	ATT 01/34 - KEF1 EXHAUST*	PLP	GM	A13G	900	400			0.7	15	27	1	IL	4	12	14	22	24	22	24	21	

Appendix III. Acoustic Glossary

Sound pressure level and the decibel, dB

A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the values into manageable numbers. The decibel is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (threshold of hearing) to 120 dB (threshold of pain).

Frequency and hertz, Hz

Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or hertz (Hz). Sometimes large frequency values are written as kilohertz (kHz), where 1 kHz = 1000 Hz. The human range of hearing is commonly accepted to be 20 Hz to 20,000 Hz. Additionally, an octave can be used to describe the interval between a frequency in Hz and either half or double that frequency.

Frequency weighting

Different weighting networks can be applied to a given sound level in each stated octave band by a specified amount, in order to better represent the response of the human ear. The most commonly used weighting network is the 'A' weighting, and the letter 'A' will be included within a descriptor to indicate that the value has been 'A' weighted, e.g. $L_{Aeq,T}$ or L_{A90} . An 'A' weighted noise level may also be written as dB(A). Other weightings less commonly used are 'C' and 'D' weighting.

Noise indices

When a noise level varies with time, the measured 'A' weighted dB level will vary as well. In this case it is therefore not possible to represent the noise climate with a simple 'A' weighted dB value. In order to describe noise where the level is continuously varying, a number of other indices, including statistical parameters, are used. The various indices used are described as below:

$L_{Aeq,T}$	The 'A' weighted 'equivalent continuous noise level' which is an average of the total sound energy measured over a specified time period, T
L_{Amax}	The maximum 'A' weighted noise level that was recorded during the monitoring period.
L_{A10}	The 'A' weighted noise level that was recorded for at least 10% of the monitoring period.
L_{A90}	The 'A' weighted noise level that was recorded for at least 90% of the monitoring period, usually taken as the underlying 'background' noise level.

Sound level difference, D

The sound level difference between two internal spaces, or between internal and external spaces. The ' D ' value is used to denote the differences at each third octave or octave band, with a single figure 'weighted' value to describe an overall performance. Note that the ' D ' value will always describe an in-situ or on-site acoustic performance. All values are described using the decibel.

D_w	Single figure weighted sound level difference, simply the measured source noise level minus receiver noise level, not adjusted to reference conditions
$D_{nT,w}$	Weighted normalised sound level difference – a single, weighted sound insulation value, normalised to a reference reverberation time using the measured reverberation time in the receive room
$D_{nT,w} + C_{tr}$	As above, with a spectral adaptation term applied to account for the effects of low frequency noise, and based on urban traffic noise
$D_{nf,w}$	Overall flanking normalised level difference - A parameter that defines the flanking transmission of sound from room to room where a dividing partition or floor construction abuts a flanking building element common to both rooms, such as the building façade or ceiling
$D_{n,e,w}$	Element normalised level difference. A level difference level derived transmission through the small technical element only, irrespective of area. This value is used to represent the sound insulation of façade ventilators.
$D_{n,e,w} + C_{tr}$	As above, with a spectral adaptation term applied to account for the effects of low frequency noise, and based on urban traffic noise

Sound reduction index, R

This describes the sound transmitted through a material or building element, such as a wall, door or window. It is measured in a laboratory with suppressed flanking transmission. The ' R ' value is used to denote the differences at each third octave or octave band, with a single figure 'weighted' value to describe an overall performance. All values are described using the decibel.

R_w	Weighted single figure sound reduction index
$R_w + C_{tr}$	As above, with a spectral adaptation term applied to account for the effects of low frequency noise, and based on urban traffic noise
R'_w	The 'apparent sound reduction index', a field measurement to obtain the sound reduction index of a material or element, with all effects of site installation accepted.

Standardised impact sound pressure level, $L'_{nT,w}$

$L'_{nT,w}$ is the single figure used to characterise the impact sound pressure level in a receiving room, normalised to a reference reverberation time. Impact noise can be classified as (but is not limited to) the result of footfall impact on a separating floor to a habitable space below. All values are described using the decibel.

Reverberation time, T and T_{mf}

The reverberation time of a space is a measure of the rate at which sound decays, measured in seconds. It is defined as the time taken for the sound pressure level to reduce by 60 dB from its original impulse level. Reverberation time is commonly quoted in terms of the mid-frequency reverberation time, T_{mf} , the arithmetic average of the reverberation times in the 500 Hz, 1 kHz and 2 kHz octave bands.

Absorption Coefficient

The acoustic absorption provided by a surface is defined as the sound absorption coefficient α , which denotes the fraction of sound energy absorbed between 0 (no absorption) and 1 (no reflection). The absorption coefficient of a material varies with the frequency of incident sound waves, therefore is considered for different frequencies.

Absorption Class

Based on the absorption coefficients, the overall sound absorption of a material is classified from Class A to Class E as defined in BS EN ISO 11654:1997, with Class A providing the highest level of acoustic absorption.

Noise rating, NR

The noise rating or NR system is commonly used in the design of noise emitted by internal building services systems. The system is frequency dependent, and was empirically derived to prevent disturbance to occupants in habitable or working areas from building services noise that exhibits 'tonal' elements, e.g. rumbles, whines, whistles etc. There is no direct relationship between the average 'A' weighted noise level in dB and the NR. However, as a guide, and assuming the absence of strong low frequency content in a given noise, the NR could generally be said to be 6 dB less than the average 'A' weighted dB value.

Privacy

Privacy is the addition of the level of sound insulation between two rooms and the background noise within a receiving room. It can be used to assess the level of privacy afforded in the 'receiving room' for speech from the 'source room'. The 'privacy factor' is a unit-less value that is the combination of the average 'A' weighted background noise level in dB and the weighted sound level difference (D_w) in dB.

Appendix IV. SBE Acoustic Credentials

SBE have specialised in providing the UK Construction Industry with a range of acoustics services since 2006. Specialising in Building Acoustics, all SBE acousticians are members of the Institute of Acoustics.

SBE is accredited for on-site acoustic testing by United Kingdom Accreditation Service (UKAS) (Testing Laboratory Number 2731).

SBE meet the relevant acoustic requirements typically required in the UK, including for sound insulation testing as defined in Approved Document E for the purposes of testing for Part E to the Building Regulations 2010.

Appendix V. Report Conditions

This document has been prepared for the sole use, benefit and information of the Client. The liability of Stroma Built Environment Ltd. in respect of the information contained herein will not extend to any third party unless prior agreement is obtained in writing from Stroma Built Environment Ltd.

This report is limited to addressing the specific acoustic issues contained herein. Advice has been provided for acoustic reasons only and it is recommended that appropriate expert advice be sought on all the ramifications, e.g. safety, fire, structural, CDM etc., associated with any proposals contained herein.

The in-situ performance of acoustic measures is influenced to a large extent by the quality of workmanship and compliance with the specifications on-site during construction, as such, Stroma Built Environment Ltd. accepts no liability for issues with acoustic performance arising from such factors.

Acoustic survey and testing work carried out for the project is representative of the prevailing conditions at the time of the work. Conditions can vary and no warranty is given as to the possibility of changes in the environment of the site and surrounding area at differing times.

In particular, it should be noted that where calculations are carried out that are based on assumptions regarding certain aspects where information has not been supplied, these are provided for indicative purposes only and should be treated as such.