

Acoustic Consultancy Report

01745/3/1/2

External Plant Assessment

Report Prepared For

Vital Energi
Octagon Energy Centre
30 October 2020

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Contents

i)	Executive Summary	3
ii)	Document History	3
1	Introduction	4
2	Survey	4
2.1	Site Description	4
2.2	Receiver Location	4
2.3	Local Noise Climate	4
2.4	Measurements	4
2.5	Measurement Results	5
3	Evaluation of Design Criteria	5
3.1	Residential Design Criterion	5
3.1.1	BS4142:2014	5
3.1.2	World Health Organisation Night Noise Guidelines for Europe (2009)	6
3.1.3	World Health Organisation (WHO) Guidelines for Community Noise (1999)	6
3.1.4	BS8233:2014	6
3.1.5	Local Authority Requirements	7
3.1.6	Recommended Residential Design Rating Level	7
3.2	Commercial Design Criterion (BS8233:2014)	7
3.2.1	Recommended Commercial Design Rating Level	8
3.3	Design Rating Levels	8
4	Review of Current Design	8
4.1	Current Design	8
4.2	Calculated Results	9
5	Noise Mitigation	9
5.1	Noise Mitigation Scheme	9
5.2	Mitigated Results	10
6	Conclusion	10
	Appendix A: Site Plan	11
	Appendix B: Measurement Data	12
	Appendix C: Plant Data	14
	Appendix D: Calculations	15
	Appendix E: Glossary	21

i) Executive Summary

New mechanical plant is to be installed at the Octagon Energy Centre, Manchester, M13 0FN.

LCP has been commissioned by Vital Energi to carry out an acoustic environment survey and to use the obtained data to assess the potential noise impact of the plant installation on surrounding noise sensitive receptors.

The design criterion is as follows:

Day:	45 dB $L_{Aeq, T}$ at 68m, Manchester Campus student accommodation;
Day:	42 dB $L_{Aeq, T}$ at 47m, Residential properties along Carmoor Road;
Evening:	43 dB $L_{Aeq, T}$ at 68m, Manchester Campus student accommodation;
Evening:	42 dB $L_{Aeq, T}$ at 47m, Residential properties along Carmoor Road;
Night:	36 dB $L_{Aeq, T}$ at 68m, Manchester Campus student accommodation;
Night:	35 dB $L_{Aeq, T}$ at 47m, Residential properties along Carmoor Road;
Commercial Day:	55 dB $L_{Aeq, T}$ at 30m, Carmoor Road Garage.

The design as proposed and assessed will achieve the required criteria provided the mitigation detailed in section 5 of this report is implemented; the calculated rating levels are as follows:

Day:	33 dB $L_{Aeq, T}$ at 68m, Manchester Campus student accommodation;
Day:	35 dB $L_{Aeq, T}$ at 47m, Residential properties along Carmoor Road;
Evening:	33 dB $L_{Aeq, T}$ at 68m, Manchester Campus student accommodation;
Evening:	35 dB $L_{Aeq, T}$ at 47m, Residential properties along Carmoor Road;
Night:	33 dB $L_{Aeq, T}$ at 68m, Manchester Campus student accommodation;
Night:	35 dB $L_{Aeq, T}$ at 47m, Residential properties along Carmoor Road;
Commercial Day:	42 dB $L_{Aeq, T}$ at 30m, Carmoor Road Garage.

This report concludes that the design criteria can be achieved.

ii) Document History

Issue	Date	Issue Details	Issued By	Checked By
1	30 th October 2020	Initial Issue	RM	VB

1 Introduction

New mechanical plant is to be installed at Octagon Energy Centre, Manchester, M13 0FN.

LCP has been commissioned by Vital Energi to carry out an acoustic environment survey and to use the obtained data to assess the potential noise impact of the plant installation on surrounding noise sensitive receptors.

The report details recommendations for necessary noise mitigation where necessary.

2 Survey

2.1 Site Description

The site layout together with the measurement position is shown in the drawing contained within Appendix A.

2.2 Receiver Location

The site was surveyed to determine the location of the most affected receiver.

The nearest residential receivers with direct line of sight to the plant area are Manchester Campus student accommodation which is 68m away, towards the east of site and the residential properties along Carmoor Road which are 47m away towards the south of the site. The nearest commercial property is 30m away towards the west of site. This is shown in the site plan in Appendix A.

2.3 Local Noise Climate

The predominant local noise sources were existing plant and construction in the vicinity, in addition to road traffic along Heathersage Road.

2.4 Measurements

The noise monitoring took place between the 13/10/2020 and 15/10/2020. The measurement period was considered sufficient to establish the representative background sound levels corresponding to the operational period of the plant.

The weather conditions monitored during the survey are shown in the following table.

Table 1: Weather Conditions at Measurement Location

Weather	13/10/2020	14/10/2020	15/10/2020
Average Wind Speed	4m/s	4m/s	2m/s
Wind Direction	SE	SW	S
Cloud Cover	70%	20%	40%
Max. Temperature	11°C	14°C	11°C
Min. Temperature	9°C	6°C	3°C
Precipitation	11:30 to 15:00 – Light rain.	None	None

2.5 Measurement Results

The measured statistical broad-band sound pressure levels are shown within Appendix B. The representative background sound level(s) obtained being as follows:

Table 2: Representative background sound levels, dB re 2×10^{-5} Pa

Measurement Position	L _{A90} , 15 mins Day*	L _{A90} , 15 mins Evening*	L _{A90} , 15 mins Night*
MP1	50	48	41
MP2	47	47	40

* Day, Evening and Night periods are defined as between 07:00 - 19.00, 19.00 - 23.00 and 23:00 - 07:00 respectively.

3 Evaluation of Design Criteria

3.1 Residential Design Criterion

3.1.1 BS4142:2014

BS4142:2014 states that the significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs.

Table 3: BS4142 assessment based upon rating level

Difference between background noise and rating levels	Assessment
+ 10 dB	Indication of a significant adverse impact
+ 5 dB	Indication of an adverse impact
0 dB	Indication of low impact

Certain acoustic features can increase the significance of impact. The specific sound level should be corrected if a tone, impulse or other acoustic feature is expected to be present.

Table 4: Corrections for acoustic features, subjective method

Acoustic Feature	Correction, dB		
	Just Perceptible	Clearly Perceptible	Highly Perceptible
Tonality	2	4	6
Impulsivity	3	6	9
Other Characteristics	3		
Intermittency	3		

Typically the acoustic feature correction would not be expected to exceed 10dB.

Where the level of uncertainty could affect the conclusion, take reasonably practicable steps to reduce the level of uncertainty.

3.1.2 World Health Organisation Night Noise Guidelines for Europe (2009)

The WHO's document 'Night Noise Guidelines for Europe (NNG)' states the following:

"...it is recommended that the population should not be exposed to night noise levels greater than 40 dB of $L_{night, outside}$ during the part of the night when most people are in bed."

It then goes on to say:

"An interim target (IT) of 55 dB $L_{night, outside}$ is recommended in the situations where the achievement of NNG is not feasible in the short run for various reasons."

3.1.3 World Health Organisation (WHO) Guidelines for Community Noise (1999)

The WHO's 'Guidelines for Community Noise' gives the following relevant noise criteria:

Table 5: Guideline values for community noise, from Guidelines for Community Noise (WHO, 1999)

Specific Environment	$L_{Aeq, T}$ dB	Time Base (hours)	$L_{Amax, fast}$ dB
Outdoor living area (serious annoyance, daytime and evening)	55	16	-
Outdoor living area (moderate annoyance, daytime and evening)	50	16	-
Dwelling, indoors	35	16	-
Inside bedrooms	30	8	45
Outside bedrooms	45	8	60
Outdoors in parkland and conservation areas*	-	-	-

* Existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low

The WHO's 'Guidelines for Community Noise' also gives the following general guidance on the expected sound insulation performance of a façade with a partly open window, it states that:

"At night, sound pressure levels at the outside facades of the living spaces should not exceed 45 dB L_{Aeq} and 60 dB L_{Amax} , so that people may sleep with bedroom windows open. These values have been obtained by assuming that the noise reduction from outside to inside with the window partly open is 15 dB."

3.1.4 BS8233:2014

The criteria offered in BS8233 for residential buildings are largely based on the recommendations made in the Guidelines for Community Noise.

Using the general guidance from above, on the expected sound insulation performance of a façade with a partly open window, the criteria shown in the table below have been adapted from the criteria offered in table 4 of BS8233 in order to obtain acceptable external noise levels.

The noise levels shown should be treated as overall noise levels, i.e., the combination of all existing noise levels at the site, and noise levels from any proposed plant or activity.

Table 6: External ambient noise levels for dwellings, based on BS8233, dB re 2×10^{-5} Pa

Activity	Location	Time period	
		07:00 to 23:00	23:00 to 07:00
Resting	Living Room	50 $L_{Aeq, 16 \text{ hour}}$	-
Dining	Dining Room/area	55 $L_{Aeq, 16 \text{ hour}}$	-
Sleeping (daytime resting)	Bedroom	50 $L_{Aeq, 16 \text{ hour}}$	45 $L_{Aeq, 8 \text{ hour}}$

In addition to the above criteria, BS8233 goes on to say:

“For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 $L_{Aeq, T}$, with an upper guideline value of 55 dB $L_{Aeq, T}$ which would be acceptable in noisier environments.”

The above criteria are in line with the recommendations made in WHO’s ‘Guidelines for Community Noise’.

3.1.5 Local Authority Requirements

Manchester City Council Local Authority Conditions state that:

‘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’

3.1.6 Recommended Residential Design Rating Level

On the basis of the above the recommended residential design rating level should therefore be:

Residential Design Rating Level
Representative $L_{A90, 15 \text{ mins}}$ - 5 dB

3.2 Commercial Design Criterion (BS8233:2014)

External design criteria for non-residential buildings have been derived from BS8233:2014.

Using the general guidance from WHO, on the expected sound insulation performance of a façade with a partly open window, the criteria shown in the table below have been adapted from the criteria offered in tables 2 and 6 of BS8233 in order to obtain acceptable external noise levels.

The noise levels shown should be treated as overall noise levels, i.e., the combination of all existing noise levels at the site, and noise levels from any proposed plant or activity.

Table 7: External ambient noise levels for non-domestic buildings, based on BS8233, dB re 2×10^{-5} Pa

Activity	Location	Design Level $L_{Aeq, 16 \text{ hr}}$
Speech or telephone communications	Department store, cafeteria, canteen, kitchen	70
	Concourse, corridor, circulation space	70

Study and work requiring concentration	Library, gallery, museum	65
	Staff/meeting room, training room	60
	Executive office	55
	Open plan office	65
Listening	Place of worship, counselling, meditation, relaxation	50

3.2.1 Recommended Commercial Design Rating Level

On the basis of the above the recommended commercial design rating level should therefore be:

Commercial Design Rating level

$L_{Aeq, T}$ 55 dB

3.3 Design Rating Levels

The design levels to be adopted for this project are set out in the table below.

Table 8: Design rating levels, dB re 2×10^{-5} Pa

Receiver Premises	Approximate Distance (m)	Design Level (Day) $L_{Aeq, 12 \text{ hr}}$	Design Level (Evening) $L_{Aeq, 4 \text{ hr}}$	Design Level (Night) $L_{Aeq, 8 \text{ hr}}$
Manchester Campus student accommodation	68	45	43	36
Residential properties along Carmoor Road	47	42	42	35
Carmoor Road Garage	30	55	-	-

4 Review of Current Design

4.1 Current Design

The proposed plant shall be located within a plantroom and on the roof of the proposed energy centre. The plant within the plantroom will consist of 2 x JMS620 CHP's, 1 x JMS624 CHP, 3 x 8MWe Unimat Bosch Boilers and 3 x 30kW LTHW pumps. The CHP's air extract ducts will be positioned above the CHP's facing east and the inlet air ducts will be positioned above the CHP's facing west. The gas exhaust duct for the CHP's will be exhausted through a new chimney. Attenuators will be installed to the inlet, extract and exhaust ducts. All attenuators and the enclosures for the CHP's will be supplied by the manufacturer. The boilers will be fitted with shrouds around the burners and exhaust through the new chimney.

In addition, 3 x Dry Air Coolers will be installed externally on the roof of the proposed energy centre.

All proposed mechanical plant will have the capability to operate continuously over a 24 hour period.

Limiting noise levels have been selected for the proposed boiler exhausts and are shown in Appendix C.

4.2 Calculated Results

Calculations of the predicted noise levels have been carried out with the appropriate corrections for geometric attenuation, barrier effect, reflective surfaces and multiple source addition.

The design rating levels to be adopted for this project, together with the predicted noise levels, are set out in the table below.

Table 9: Design and predicted rating levels, dB re 2×10^{-5} Pa

Receiver Premises	Approximate Distance (m)	Design Level (Day) $L_{Aeq, 12 \text{ hr}}$	Design Level (Evening) $L_{Aeq, 4 \text{ hr}}$	Design Level (Night) $L_{Aeq, 8 \text{ hr}}$	Predicted Level $L_{Aeq,T}$
Manchester Campus student accommodation	68	45	43	36	37
Residential properties along Carmoor Road	47	42	42	35	39
Carmoor Road Garage	30	55	-	-	43

Plant noise level data used in this assessment are contained within Appendix C.

Calculations are shown within Appendix D.

5 Noise Mitigation

As the plant installation has been assessed to be over the required criteria at the surrounding noise sensitive receptors, the following option shall be applied in order that noise emissions are reduced to acceptable levels.

Should the plant installation be redesigned after consideration of the mitigation option, the installation shall be re-assessed to ensure compliance to the specification has been achieved.

5.1 Noise Mitigation Scheme

The suggested mitigation measure is the introduction of an acoustic louvre which will surround the three dry air coolers on the roof. The acoustic louvre will be a minimum of 500mm taller than the dry air cooler's it is surrounding. The typical performance of the acoustic louvre is shown in the table below.

Table 10: typical acoustic louvre performance, dB

	Octave Band Centre Frequency (Hz)								R_w
	63	125	250	500	1k	2k	4k	8k	
SH300*	7	7	10	17	29	30	27	21	22

* data taken from Caice.

It is important to note that as the criteria is a single figure dB(A) value, the performance of any enclosure, screen or attenuator at each individual frequency can vary from those shown above and still meet the single figure dB(A) value.

5.2 Mitigated Results

The design rating levels to be adopted for this project, together with the predicted noise levels inclusive of the mitigation detailed in Section 5, are set out in the table below.

Table 11: Design and predicted mitigated rating levels, dB re 2×10^{-5} Pa

Receiver Premises	Approximate Distance (m)	Design Level (Day) $L_{Aeq, 12 \text{ hr}}$	Design Level (Evening) $L_{Aeq, 4 \text{ hr}}$	Design Level (Night) $L_{Aeq, 8 \text{ hr}}$	Predicted Level $L_{Aeq,T}$
Manchester Campus student accommodation	68	45	43	36	33
Residential properties along Carmoor Road	47	42	42	35	35
Carmoor Road Garage	30	55	-	-	42

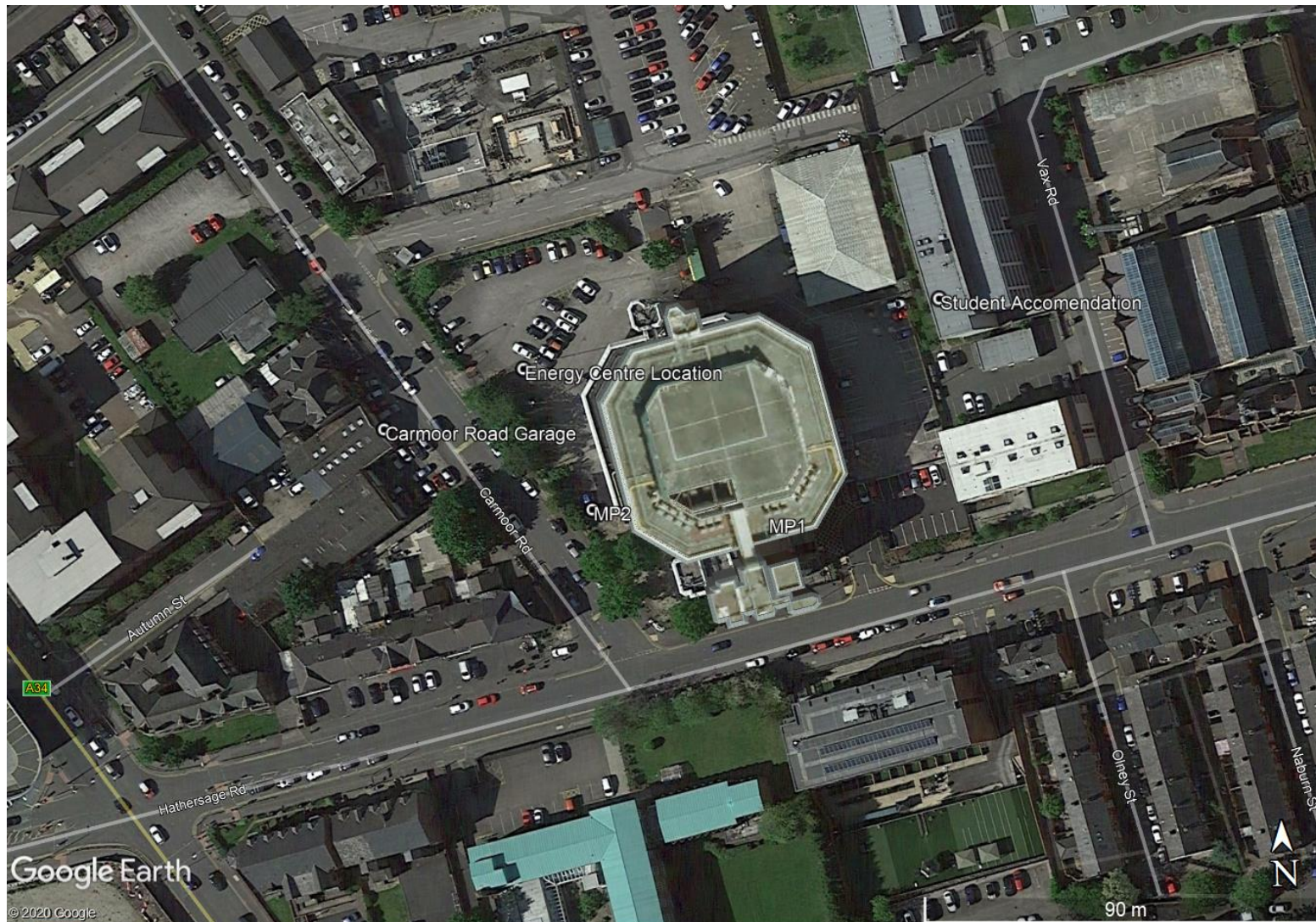
Calculations are shown within Appendix D.

6 Conclusion

An environmental noise survey has been undertaken in order to establish the representative background sound levels local to the site generally in accordance with the method contained within BS4142: 2014.

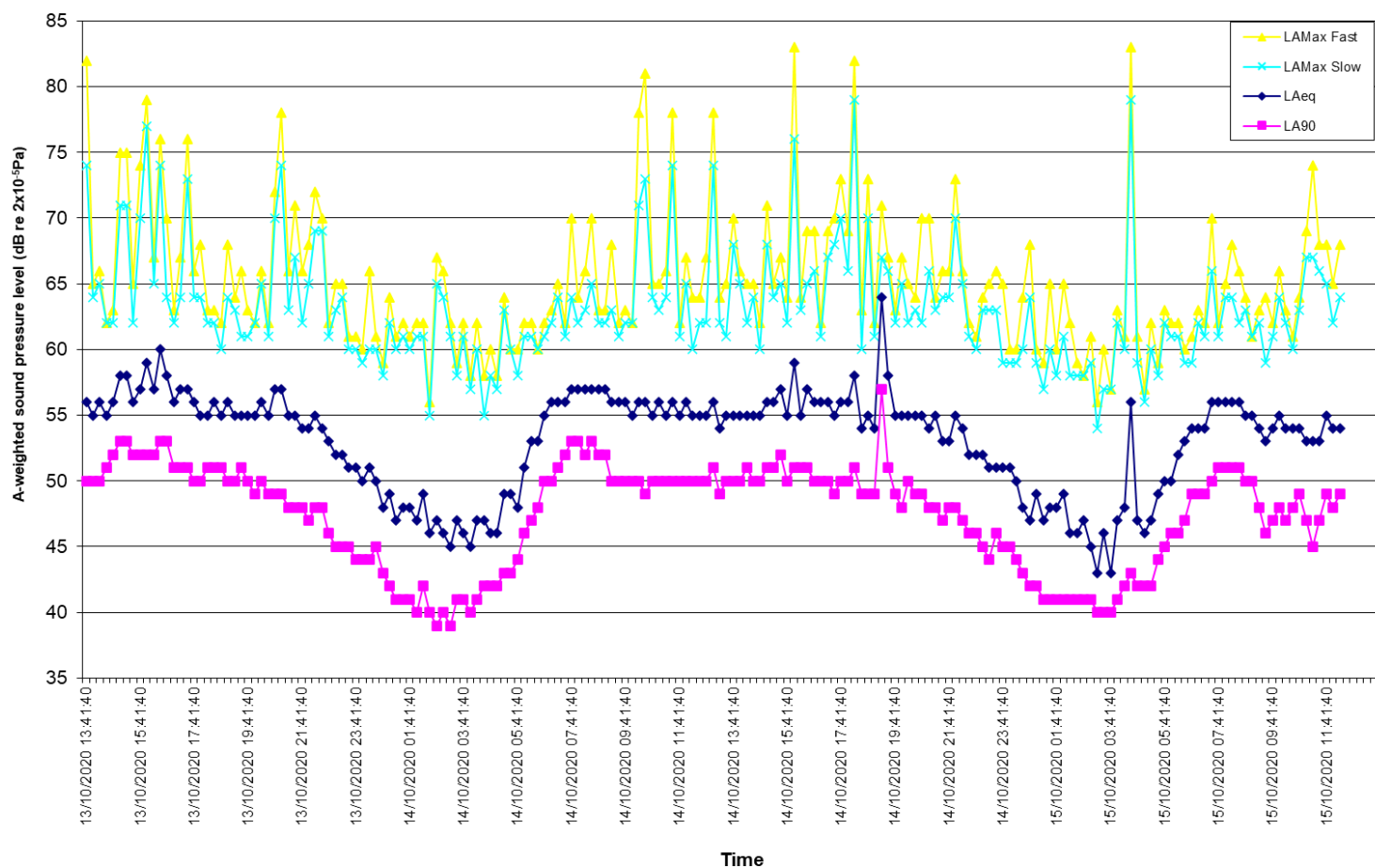
Calculations have been carried out to determine the noise levels at the nearest receiver premises. The calculations show that with the implementation the noise mitigation measures detailed in section 5 of this report the design criteria will be met.

Appendix A: Site Plan



Appendix B: Measurement Data

MP1:

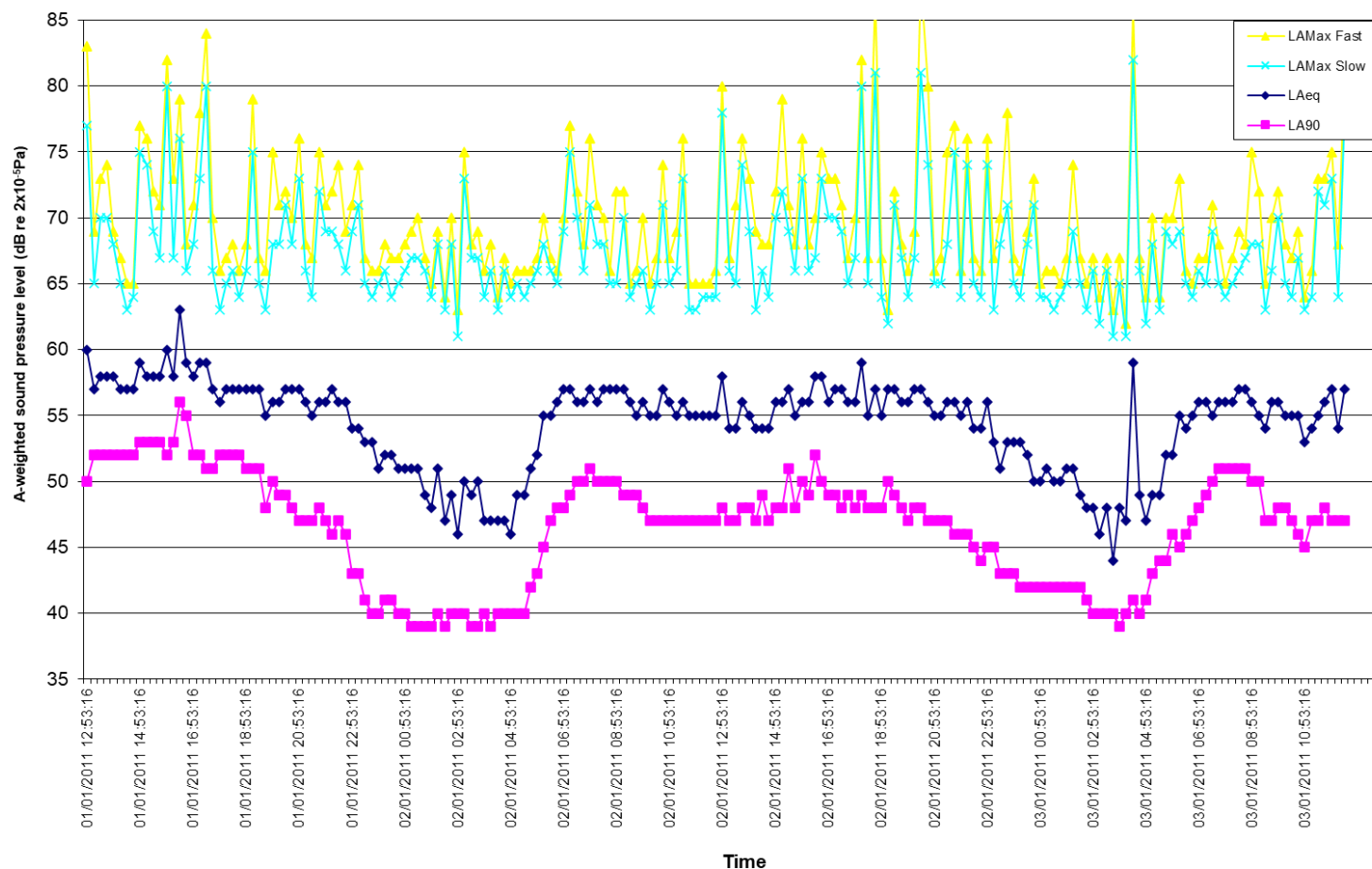


Sound pressure level measurements were obtained using the following instrumentation complying with the Class 1 specification of BS EN 61672:2003

- Svantek 959 Sound Level Meter S/N: 11258
- Svantek pre-amplifier SV12L S/N: 13111 with GRAS microphone capsule 40AE S/N: 86548

Calibration checks were made prior to and after completion of measurements using a Svantek SV30A calibrator, S/N: 43066 complying with Class 1 specification of BS EN 60942:2003, calibration level 114.0 dB @ 1.0 kHz. All acoustic instrumentation carried current manufacturer's certificates of conformance.

MP2:



Sound pressure level measurements were obtained using the following instrumentation complying with the Class 1 specification of BS EN 61672:2003

- Svantek 959 Sound Level Meter S/N: 11207
- Svantek pre-amplifier SV12L S/N: 49860 with GRAS microphone capsule 40AE S/N: 215511

Calibration checks were made prior to and after completion of measurements using a Svantek SV33 calibrator, S/N: 43066 complying with Class 1 specification of BS EN 60942:2003, calibration level 114.0 dB @ 1.0 kHz. All acoustic instrumentation carried current manufacturer's certificates of conformance.

Appendix C: Plant Data

Plant noise data used in the preceding assessment follow.

Table 12: Manufacturer's plant sound pressure data, dB re 2×10^{-5} Pa

Plant	Distance (m)	Octave Band Centre Frequency (Hz)								L _{PA}
		63	125	250	500	1k	2k	4k	8k	
CHP (JMS620 Inlet)	1	85	72	63	36	24	23	43	62	64
CHP (JMS620 Outlet)	1	85	72	63	36	24	23	43	62	64
CHP (JMS620 Exhaust)	1	80	62	61	48	48	57	51	47	61
CHP (JMS624 Enclosure)	1	85	72	63	36	24	23	43	62	64
CHP (JMS624 Inlet)	1	86	71	48	38	35	35	35	43	61
CHP (JMS624 Outlet)	1	83	72	56	42	41	40	45	57	62
CHP (JMS624 Exhaust)	1	84	66	65	52	52	61	55	51	65
CHP (JMS624 Enclosure)	1	77	76	66	55	49	43	39	41	63
DAC (JMS620)	1	42	42	49	55	58	57	52	45	62
DAC (JSM624)	1	50	50	56	58	60	58	55	49	64
30kW LTHW Pump*	1	60	61	63	63	66	63	59	53	70
8MWe Unimat Bosch Boilers*	1	78	77	75	72	69	66	63	60	75

* The sound pressure spectrum for this unit has been estimated based upon the manufacturer's single figure broadband value.

Limiting noise levels have been selected for the proposed boiler exhaust ducts and are shown in the table below.

Table 13: Limiting sound pressure data, dB re 2×10^{-5} Pa

Plant	Distance (m)	L _{PA}
8MWe Unimat Bosch Boilers Exhaust duct*	1	54

Appendix D: Calculations

Manchester Campus student accommodation no mitigation:

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw)								Lw		Receiver Distance (m)	dB(A)	Lp	No. off	dB	Angular Directivity		63	125	250	500	1k	2k	4k	8k	Façade correction		dB	Duct Losses (input negative values)								Additional Attenuation											
			63	125	250	500	1k	2k	4k	8k	dB(A)	Lw								63	125	250	500	1k	2k	4k	8k				63	125	250	500	1k	2k	4k	8k	63	125	250	500	1k	2k	4k	8k				
1	CHP 1 (JMS620 Inlet)	1.00	85	72	63	36	24	23	43	62	64	72	105.0	-48	24	1	0	180(-dB)	-9	-9	-9	-9	-9	-9	-9	-9	-9	Yes	3	-10	-5	-3	-2	-4	-4	-4	-4	1	2	2	2	3	3	4	7	7				
2	CHP 1 (JMS620 Outlet)	1.00	85	72	63	36	24	23	43	62	64	72	90.0	-47	25	1	0	45(-3dB)	-3	-3	-3	-3	-3	-3	-3	-3	-3	Yes	3									1	2	2	2	3	3	4	7	7				
3	CHP 2 (JMS620 Inlet)	1.00	85	72	63	36	24	23	43	62	64	72	105.0	-48	24	1	0	180(-dB)	-9	-9	-9	-9	-9	-9	-9	-9	-9	Yes	3	-10	-5	-3	-2	-4	-4	-4	-4	1	2	2	2	3	3	4	7	7				
4	CHP 2 (JMS620 Outlet)	1.00	85	72	63	36	24	23	43	62	64	72	105.0	-48	24	1	0	180(-dB)	-9	-9	-9	-9	-9	-9	-9	-9	-9	Yes	3									1	2	2	2	3	3	4	7	7				
5	CHP 2 (JMS620 Exhaust)	1.00	80	62	61	48	35	36	57	51	47	61	69	60.0	-45	25	1	0	180(-dB)	-9	-9	-9	-9	-9	-9	-9	-9	-9	Yes	3	-10	-5	-3	-2	-4	-4	-4	-4	1	2	2	2	3	3	4	7	7			
6	CHP 3 (JMS624 Inlet)	1.00	86	74	66	38	35	36	58	43	61	69	98.0	-47	22	1	0	180(-dB)	-9	-9	-9	-9	-9	-9	-9	-9	-9	Yes	3									1	2	2	2	3	3	4	7	7				
7	CHP 3 (JMS624 Outlet)	1.00	86	74	66	38	35	36	58	43	61	69	98.0	-47	22	1	0	45(-3dB)	-3	-3	-3	-3	-3	-3	-3	-3	-3	Yes	3									1	2	2	2	3	3	4	7	7				
8	CHP 3 (JMS624 Exhaust)	1.00	84	66	65	52	52	61	65	51	65	73	68.0	-45	29	1	0	180(-dB)	-9	-9	-9	-9	-9	-9	-9	-9	-9	Yes	3	-10	-5	-3	-2	-4	-4	-4	-4	1	2	2	2	3	3	4	7	7				
9	DAC 1	1.00	42	42	49	55	58	57	52	45	62	70	72.0	-45	25	1	0	None	0	0	0	0	0	0	0	0	0	Yes	3																					
11	DAC 2	1.00	42	42	49	55	58	57	52	45	62	70	76.0	-46	25	1	0	None	0	0	0	0	0	0	0	0	0	Yes	3																					
12	DAC 3	1.00	50	50	58	58	58	55	49	64	64	72	79.0	-46	26	1	0	None	0	0	0	0	0	0	0	0	0	Yes	3																					
13	Plantroom break out	1.00	70	60	55	51	49	45	40	40	55	63	68.0	-45	18	1	0	None	0	0	0	0	0	0	0	0	0	Yes	3																					
14	Boiler 1 exhaust flume	1.00	47	47	47	47	47	47	47	47	54	62	68.0	-45	17	1	0	180(-dB)	-9	-9	-9	-9	-9	-9	-9	-9	-9	Yes	3	-10	-5	-3	-2	-4	-4	-4	-4													
15	Boiler 2 exhaust flume	1.00	47	47	47	47	47	47	47	47	54	62	68.0	-45	17	1	0	180(-9dB)	-9	-9	-9	-9	-9	-9	-9	-9	-9	Yes	3	-10	-5	-3	-2	-4	-4	-4	-4													
16	Boiler 3 exhaust flume	1.00	47	47	47	47	47	47	47	47	54	62	68.0	-45	17	1	0	180(-9dB)	-9	-9	-9	-9	-9	-9	-9	-9	-9	Yes	3	-10	-5	-3	-2	-4	-4	-4	-4													

[illegible]

Criteria									
NR	63	125	250	500	1k	2k	4k	8k	dB(A)
27	57	45	37	31	27	24	22	20	36

Ref.	Plant	Excess								
		63	125	250	500	1k	2k	4k	8k	dB(A)
1	CHP 1 (JMS620 Inlet)	-19	-20	-21	-42	-50	-48	-25	-5	-19
2	CHP 1 (JMS620 Outlet)	-11	-13	-14	-34	-43	-41	-18	3	-12
3	CHP 1 (JMS620 Exhaust)	-20	-27	-20	-26	-22	-10	-14	-16	-18
4	CHP 2 (JMS620 Inlet)	-19	-20	-21	-42	-50	-48	-25	-5	-19
5	CHP 2 (JMS620 Outlet)	-11	-13	-14	-34	-43	-41	-18	3	-12
6	CHP 2 (JMS620 Exhaust)	-20	-27	-20	-26	-22	-10	-14	-16	-18
7	CHP 3 (JMS624 Inlet)	-16	-20	-35	-38	-38	-35	-32	-22	-21
8	CHP 3 (JMS624 Outlet)	-15	-14	-22	-30	-27	-25	-17	4	-16
9	CHP 3 (JMS624 Exhaust)	-16	-23	-15	-22	-18	-6	-10	-12	-14
10	DAC 1	-49	-39	-33	-11	-4	-2	-5	0	-8
11	DAC 2	-50	-39	-33	-11	-4	-2	-5	0	-8
12	DAC 3	-42	-31	-17	-9	-2	-1	-2	-6	-8
13	Plantroom break out	-21	-19	-16	-14	-12	-13	-15	-14	-16
14	Boiler 1 exhaust fume	-53	-42	-33	-27	-23	-20	-18	-16	-26
15	Boiler 2 exhaust fume	-53	-42	-33	-27	-23	-20	-18	-16	-26
16	Boiler 3 exhaust fume	-53	-42	-33	-27	-23	-20	-18	-16	-26
	Totall	-2	-4	-1	-5	-7	-5	-10	2	-2

Ref.	Plant	Mitigated Receiver LV								
		63	125	250	500	1k	2k	4k	8k	dB(A)
1	CHP 1 (JMS620 Inlet)	37	23	14	-13	-26	-27	-8	8	14
2	CHP 1 (JMS620 Outlet)	45	31	21	-5	-19	-20	-1	16	22
3	CHP 1 (JMS620 Exhaust)	28	14	15	3	1	10	4	0	14
4	CHP 2 (JMS620 Inlet)	37	23	14	-13	-26	-27	-8	8	14
5	CHP 2 (JMS620 Outlet)	45	31	21	-5	-19	-20	-1	16	22
6	CHP 2 (JMS620 Exhaust)	28	14	15	3	1	10	4	0	14
7	CHP 3 (JMS624 Inlet)	40	24	0	-9	-14	-14	-15	-9	14
8	CHP 3 (JMS624 Outlet)	41	29	13	-1	-3	-4	0	9	18
9	CHP 3 (JMS624 Exhaust)	31	19	19	7	5	14	8	4	18
10	DAC 1	7	7	14	20	23	22	17	10	28
11	DAC 2	7	7	14	20	23	22	17	10	28
12	DAC 3	15	15	21	23	23	23	20	14	29
13	Pintroom break out	36	26	21	17	15	11	6	6	21
14	Boiler 1 exhaust fume	-6	-1	1	2	0	0	0	0	7
15	Boiler 2 exhaust fume	-6	-1	1	2	0	0	0	0	7
16	Boiler 3 exhaust fume	-6	-1	1	2	0	0	0	0	7
	Totals	53	38	32	30	37	31	26	25	37

Barrier Path Difference Loss:													
Source height	Receiver height	Barrier height	Source to barrier distance	Barrier to receiver distance	Calculated path difference	63	125	250	500	1000	2000	4000	8000
1.0			105.0	-1.00	0	0	0	0	0	0	0	0	0
1.0			90.0	-0.99	0	0	0	0	0	0	0	0	0
1.0			68.0	-0.99	0	0	0	0	0	0	0	0	0
1.0			100.0	-1.00	0	0	0	0	0	0	0	0	0
1.0			90.0	-0.99	0	0	0	0	0	0	0	0	0
1.0			68.0	-0.99	0	0	0	0	0	0	0	0	0
1.0			90.0	-0.99	0	0	0	0	0	0	0	0	0
1.0			105.0	-1.00	0	0	0	0	0	0	0	0	0
1.0			68.0	-0.99	0	0	0	0	0	0	0	0	0
10.0			72.0	-9.31	0	0	0	0	0	0	0	0	0
10.0			76.0	-9.34	0	0	0	0	0	0	0	0	0
10.0			79.0	-9.37	0	0	0	0	0	0	0	0	0
1.0			68.0	-0.99	0	0	0	0	0	0	0	0	0
1.0			68.0	-0.99	0	0	0	0	0	0	0	0	0
1.0			68.0	-0.99	0	0	0	0	0	0	0	0	0
1.0			68.0	-0.99	0	0	0	0	0	0	0	0	0

[illegible][illegible][illegible]



Carmoor Road Garage with mitigation:

Ref.	plant	Ref.dist.	Sound Level (Lp/Lw)								Lw	Receiver Distance (m)	dB(A)	Lp	No. off	dB	Angular Directionality	63	125	250	500	1k	2k	4k	8k	Façade correction	dB	Duct Losses (input negative values)								Additional Attenuation																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
			63	125	250	500	1k	2k	4k	8k																		dB(A)	63	125	250	500	1k	2k	4k	8k	63	125	250	500	1k	2k	4k	8k																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
1	CHP 1 (JMS620 Inlet)	1.00	85	72	63	36	24	23	43	62	64	72	30.0	-38	35	1	0	None	0	0	0	0	0	0	0	0	Yes	3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												

Appendix E: Glossary

The list below details the major acoustical terms and descriptors, with brief definitions:

'A' Weighting

Weighting applied to the level in each stated octave band by a specified amount, in order to better represent the response of the human ear. The letter 'A' will follow a descriptor, indicating the value has been 'A' weighted. An 'A' weighted noise level may also be written as dB(A).

Airborne Noise

Noise transmitted through air.

Ambient Noise

The total noise level including all 'normally experienced' noise sources.

dB or Decibel

Literally meaning 'a tenth of a bel', the bel being a unit devised by the Bell Laboratory and named after Alexander Graham Bell. A logarithmically based descriptor to compare a level to a reference level. Decibel arithmetic is not linear, due to the logarithmic base. For example:

30 dB + 30 dB $\neq$ 60 dB

30 dB + 30 dB = 33 dB

$D_{nTw} + C_{tr}$

The weighted, normalised difference in airborne noise levels measured in a source room (L1) and a receive room (L2) due to a separating partition.

D Is simply $L1 - L2$.

D_{nT} Is the normalisation of the measured level difference to the expected (in comparison to the measured) reverberation time in the receiving room.

D_{nTw} Is the weighted and normalised level difference. This value is the result of applying a known octave band weighting curve to the measured result.

C_{tr} Is a correction factor applied to the D_{nTw} to account for the known effects of particular types of noise, such as loud stereo music or traffic noise.

Frequency (Hz)

Measured in Hertz (after Heinrich Hertz), and represents the number of cycles per second of a sound or tone.

Insertion Loss, dB

The amount of sound reduction offered by an attenuator or louvre once placed in the path of a noise level.

LA90, T

The 'A' weighted noise level exceeded for 90% of the time period T, described or measured. The '90' can be substituted for any value between 1 and 99 to indicate the noise level exceeded for the corresponding percentage of time described or measured.

LAeq, T

The 'A' weighted 'equivalent' noise level, or the average noise level over the time period T, described or measured.

LAmax

The 'A' weighted maximum measured noise level. Can be measured with a 'slow' (1 sec) or 'fast' (0.125 sec) time weighting.

LAmin

The 'A' weighted minimum measured noise level.

NR

Noise Rating (NR) level. A frequency dependent system of noise level curves developed by the International Organisation for Standardisation (ISO). NR is used to categorise and determine the acceptable indoor environment in terms of hearing preservation, speech communication and annoyance in any given application as a single figure level. The US predominantly uses the Noise Criterion (NC) system.

Octave

The interval between a frequency in Hz (f) and either half or double that frequency (0.5f or 2f).

Pa

Pascals, the SI unit to describe pressure, after physicist Blaise Pascal.

Reverberation Time, T_{mf}, RT60, RT30 or RT20

The time taken in seconds for a sound to diminish within a room by 1,000 times its original level, corresponding to a drop in sound pressure of 60 dB. When taking field measurements and where background noise levels are high, the units RT20 or RT30 are used (measuring drops of 20 or 30 dB respectively). Sometimes given as a mid-frequency reverberation time, T_{mf} which is the average of reverberation time values at 500Hz, 1kHz and 2kHz.

R_w

The sound reduction value(s) of a constructional element such as a door, as measured in a laboratory, with a known octave band weighting curve applied to the result.

Sound Power Level

A noise level obtained by calculation from measurement data, given at the face of an item of plant or machinery. Referenced to 10^{-12} W or 1pW.

Sound Pressure Level

A noise level measured or given at a distance from a source or a number of sources. Referenced to 2×10^{-5} Pa.

Subjective Effect of Changes in Sound Pressure Level

The table below details the subjective effects of variations in sound pressures (adapted from Bies and Hansen).

Difference between background noise and rating levels	Increase in ambient noise level in 'real terms'	Change in apparent loudness
+ 10 dB	+ 10 dB	Twice as loud
+ 5 dB	+ 6 dB	Clearly noticeable
0 dB	+ 3 dB	Just perceptible
-10 dB	0 dB	No change

W

Watts, the SI unit to describe power, after engineer James Watt.