Building Services Noise Assessment
8–16 Newton Street, Manchester

December 2017

Project: Building Services Noise Assessment, Newton Street, Manchester

Client: Eastern Green Ltd, 2nd Floor, 1 Ashley Road, Altrincham, Cheshire

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Authorised by	Ryan Swales, BSc, MIOA Director & Principal Consultant
Signature	

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1. Introduction

1.1 RS Acoustic Engineering has been appointed by Eastern Green Ltd to undertake a noise assessment with regard to a refurbishment at No. 8 – 16 Newton Street, Manchester, M1 2AN.

1.2 As part of the proposed office refurbishment, a new air-conditioning system is to be installed and will comprise roof-top mounted condensing units and an internal plant room at 2nd floor level.

1.3 The manufacturer's octave band sound pressure level data has been used to determine the cumulative condenser sound level at adjacent noise sensitive receptors.

1.4 An environmental noise survey has been conducted in order to quantify the typical background sound level during the daytime and night-time period.

1.5 Where appropriate, reference has been made to the guidance given within BS 4142:2014 *Methods for rating and assessing industrial and commercial sound*.

1.6 The survey and assessment was conducted by Mr Ryan Swales ($BSc_{(Hons)}$, MIOA), Principal Acoustic Consultant and Corporate Member of the Institute of Acoustics.

1.7 This assessment is based on scheme drawings provided by Atelier MB Architects.

1.8 This report provides the survey results, details of the proposed condenser units, the calculated sound levels at adjacent receptors and recommendations regarding appropriate noise control.

2. Assessment Criteria & Guidance

Manchester City Council, Planning & Noise (Technical Guidance)

2.1 With regard to noise from fixed plant and equipment, Manchester City Council's guidance document states the following:

'Any noise assessment needs to consider not only the overall level of noise emitted but also its particular characteristics. The noise assessment should be based on BS 4142:2014 and any application for fixed plant, equipment or machinery must demonstrate 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'.

British Standard 4142:2014: Methods for rating and assessing industrial and commercial sound

2.2 The current standard describes methods for rating and assessing sound of an industrial and/or commercial nature, such as sound from manufacturing processes and fixed mechanical plant.

2.3 The methods described in the standard use outdoor sound levels to assess the likely effect of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

2.4 BS 4142 is not intended to be applied to the derivation of indoor sound levels arising from sound levels outside, or the assessment of indoor sound levels.

2.5 The standard has three different methods (subjective, objective and reference) of applying a penalty to tonal, impulsive and intermittent noises, as separate entities.

2.6 For example, the subjective method applies tonality corrections on a sliding scale between 0 dB and +6 dB, depending on whether a prominent tone is just perceptible at the receptor (+2 dB), clearly perceptible (+4 dB) or highly perceptible (+6 dB).

2.7 An additional correction of up to +9 dB may then be applied for 'impulsivity', depending on whether the impulsive sound is just perceptible at the receptor (+3 dB), clearly perceptible (+6 dB) or highly perceptible (+9 dB).

2.8 The objective and reference methods also apply a penalty on a sliding scale from 0 dB to +6 dB for a prominent discrete tone, which is identified via direct sound measurement (e.g. one-third octave band measurements).

2.9 The new standard now no longer indicates significance of noise impacts as giving rise to a '*likelihood of complaint*' but rather as an '*indication*' of varying degrees of '*adverse impact'*.

2.10 BS 4142:2014 states that a difference of around +10 dB or more (excess of rating level above the background sound level) is likely to be an indication of a significant adverse impact, depending on the context. A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.

2.11 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. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context.

3. Environmental Noise Survey

Survey methodology

3.1 An environmental noise survey has been conducted by RS Acoustic Engineering in order to establish the prevailing background sound levels at the site.

3.2 Continuous sound level monitoring was conducted over a 42-hour period on the north east facing elevation. The microphone was positioned above the roof-top parapet wall and was directly opposite office accommodation on Dale Street.

3.3 Measurements were performed from 12:57 hours on Monday 25th through to 06:57 hours on Wednesday 27th September 2017.

3.4 Several time-synchronised sample measurements were also conducted during the daytime period to the south west of the building on Back Piccadilly.

3.5 A measurement interval of 15 minutes was used throughout the survey and measurements were considered to be subject to reflections from the building facade (as opposed to free-field conditions).

3.6 The background noise monitoring positions used during the survey are shown in Figure 3.1.

3.7 The dominant source of noise at the site is road traffic flow on the local road network. Dale Street and Newton Street are particularly busy during the daytime period and consequently background sound levels are relatively high and also of a steady-state.

Figure 3.1 – Site location and survey measurement positions (Source: Google Earth)

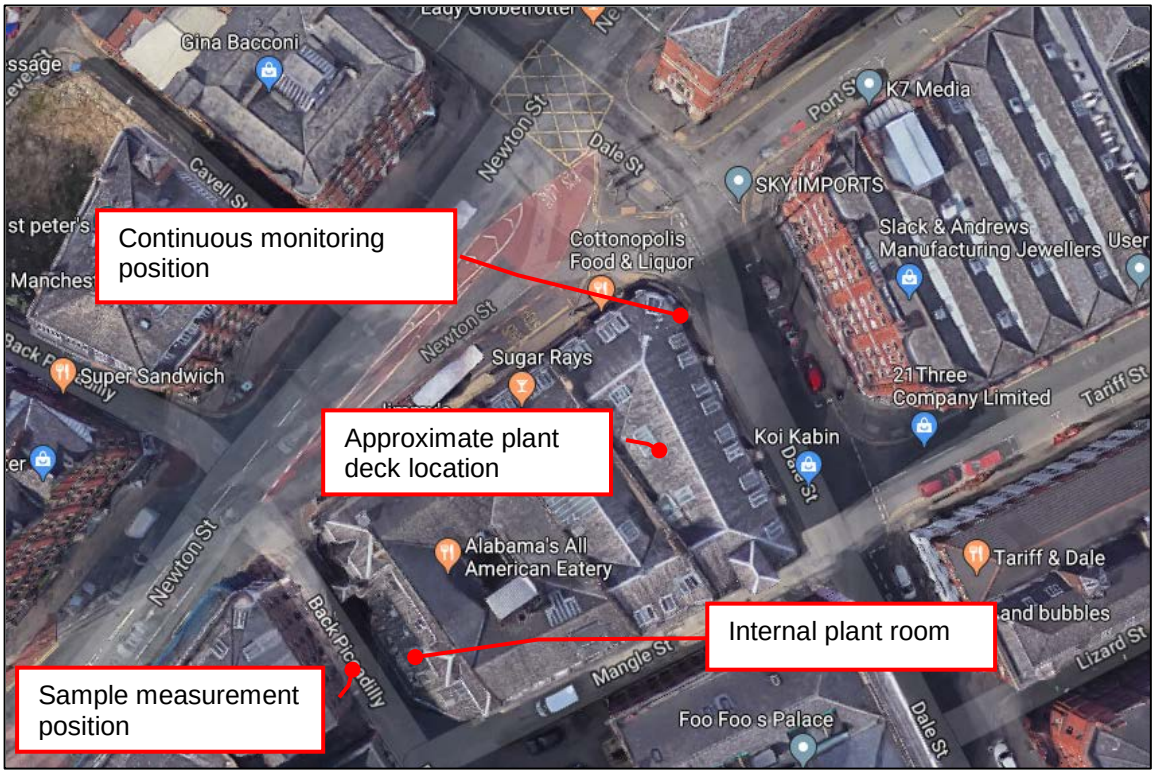


Figure 3.2 – Photographs showing continuous monitoring position



Survey equipment

3.8 The survey was carried out using the following Class 1 specification equipment:

- Brüel & Kjaer 2250-Light data logging sound level meter, with microphone type 4189 and pre-amplifier type ZC0032.
- Brüel & Kjaer 2260 sound level meter, with microphone type 4189 and pre-amplifier type ZC0026.
- Brüel & Kjaer 4231 acoustic calibrator.

3.9 Calibration of the sound level meter and microphone used for the measurements are traceable to UKAS accredited laboratories. Calibration certificates are provided in Appendix A.

3.10 The calibration of both sound level meter and microphone was checked using a 1 kHz tone at 94 dB prior to and following the measurements performed. The drift in calibration was less than 0.1 dB.

Weather conditions

3.11 The weather conditions during the survey were generally dry and fine with intermittent sunny spells. On-site wind speed measurements were less than 2 m/s^{-1}.

3.12 Temperatures during the survey ranged between 14°C and 18°C. The overall weather conditions were considered suitable to obtain representative measurements.

Results summary

3.13 Table 3.1 presents a summary of the measured background L_{A90} sound pressure levels at the continuous monitoring position. Measured values have been rounded to the nearest whole number.

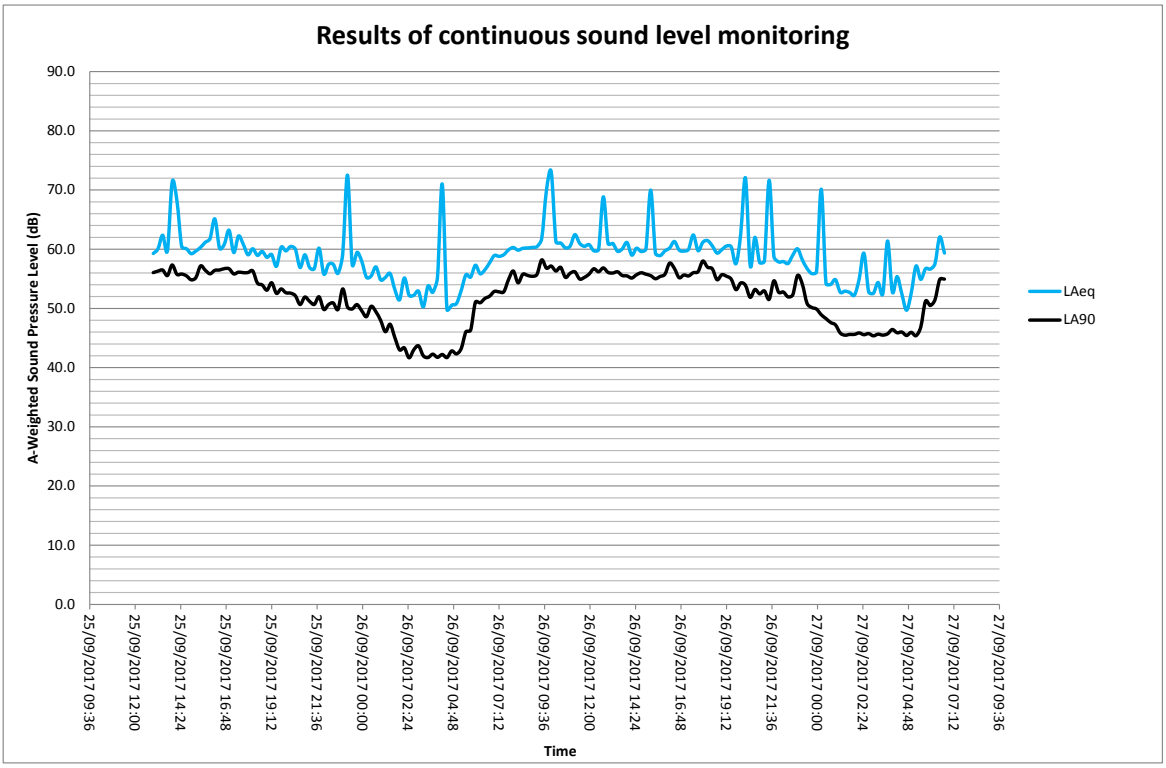
Table 3.1 – Summary of measured background L_{A90} sound pressure levels

Date	Period, Hours	Typical[1] $L_{A90,15min}$ dB	Lowest $L_{A90,15min}$ dB	Highest $L_{A90,15min}$ dB
Monday 25/09/2017 - Tuesday 26/09/2017	Daytime (13:00-23:00)	56	50	57
	Night-time (23:00-07:00)	42	42	53
Tuesday 26/09/2017 - Wednesday 27/09/2017	Daytime (07:00-23:00)	56	52	58
	Night-time (23:00-07:00)	46	45	56

[1]Considered to be the representative background sound level (from a statistical analysis)

3.14 The results of the continuous monitoring are presented graphically in Figure 3.3. Additional survey data can be made available upon request.

Figure 3.3 – Graph showing results of continuous sound level monitoring



3.15 The results of the sample measurements indicate that background sound levels are typically of a similar magnitude (+/- 1.5 dB) to those measured at the continuous monitoring position.

Sound level targets for new building services plant

3.16 Taking into account MCC's requirements, the sound rating level (L_{Aeq}) from all new building services plant should be at least 5 dB below the typical background sound level ($L_{A90,T}$).

3.17 Table 3.2 presents the applicable sound rating level targets for new building services plant.

Table 3.2 – Sound level targets for new building services plant

Period, Hours	Typical Background Sound Level $L_{A90,15min}$ dB	Target Rating Level $L_{Aeq,T}$ dB
Daytime (07:00-23:00)	56	51
Night-time (23:00-07:00)	42	37

3.18 It is anticipated that the proposed condenser units serving the building will operate during the daytime hours only. On this basis, the appropriate target rating level at adjacent noise sensitive receptors is 51 dB $L_{Aeq,T}$.

3.19 Should plant operation be necessary during the night-time period, the corresponding target level is 37 dB $L_{Aeq,T}$.

4. Noise Assessment & Discussion

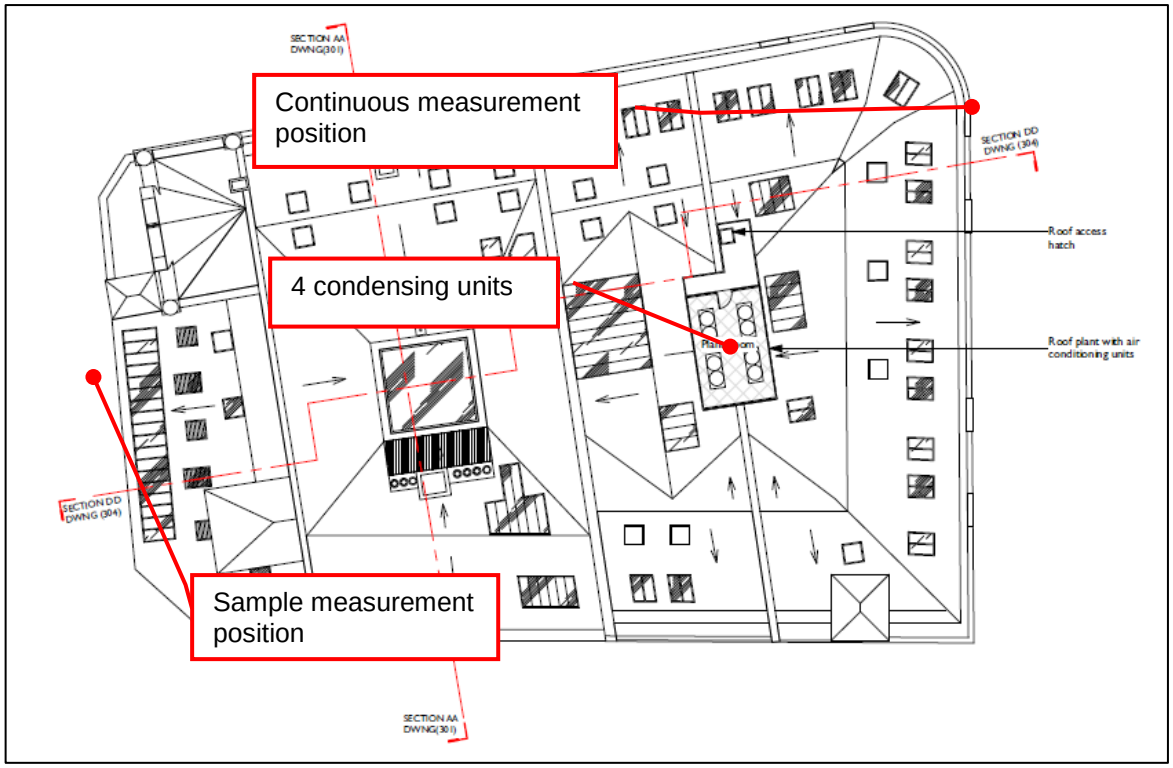
Nearest noise sensitive receptors & proposed plant location

4.1 The nearest noise sensitive receptors to the external roof-top condensing units are office accommodation on the opposite side of Dale Street (to the north east). The distance from the plant deck to the adjacent façade is approximately 25 metres.

4.2 There is also office accommodation and retail units on the opposite side of Newton Street to the north west. The distance from the plant deck to the adjacent façade is approximately 40 metres.

4.3 Figure 4.1 shows the location of the roof-top plant deck and associated condensing units.

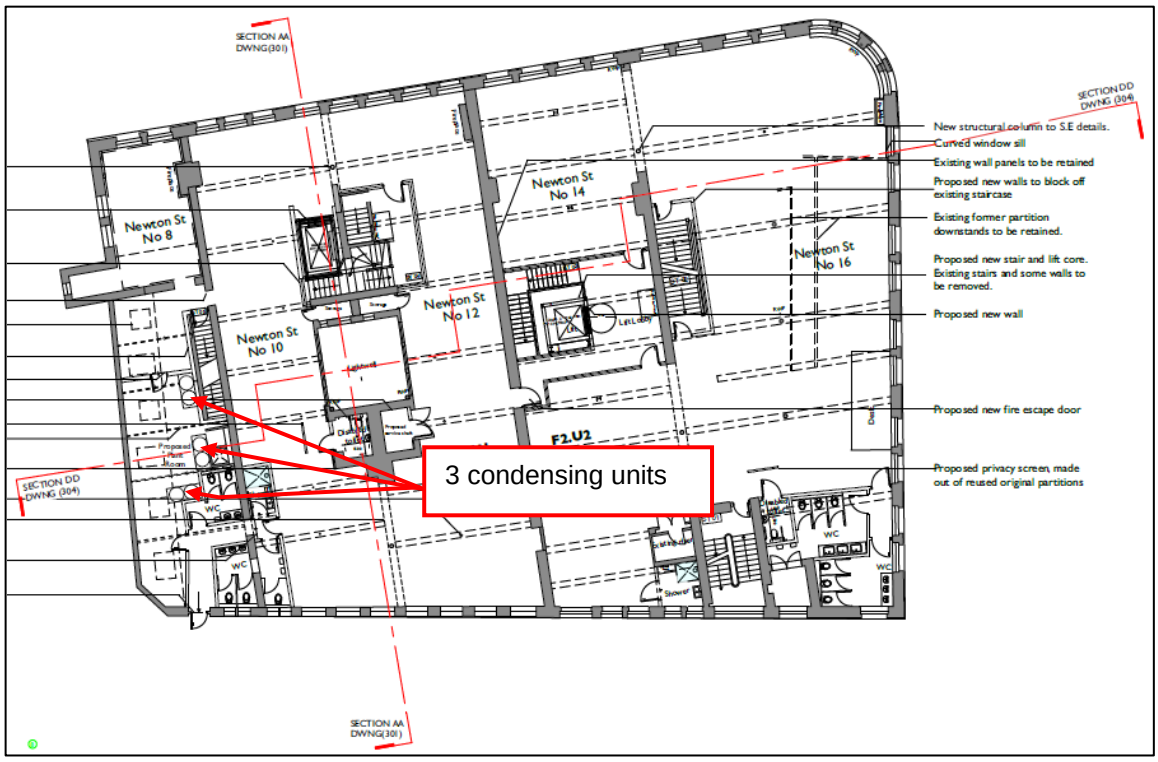
Figure 4.1 – Proposed roof-top condensing units



4.4 Figure 4.2 overleaf shows the location of the 2nd floor internal plant room and associated condensing units.

4.5 The nearest noise sensitive receptor to the internal plant room is office accommodation on the opposite side of Back Piccadilly. The distance from the roof openings to the adjacent façade is approximately 8 metres.

Figure 4.2 – Proposed 2nd floor plant room condensing units



New building services plant

4.6 It is understood that there will be no air supply and extract system serving the building (i.e. no air handling units).

4.7 There will be four outdoor condensing units installed on a steel deck at roof level. The units will provide air-conditioning to No's 14 and 16 Newton Street.

4.8 The model type is understood to be:

- Mitsubishi PURY-P450YLM-A1, sound pressure level 62.5 dBA at 1 metre.

4.9 There will be three outdoor condensing units installed within an internal 2nd floor plant room. The units will provide air-conditioning to No's 08, 10 and 12 Newton Street.

4.10 The model type is understood to be:

- Mitsubishi PURY-P350/400YLM-A1, sound pressure level 62.5 dBA at 1 metre

4.11 The manufacturer's octave-band sound pressure levels for the Mitsubishi condenser units are presented in Table 4.1 and 4.2. The sound level data corresponds to a distance of 1 metre from the unit. The condenser sound level data is also presented graphically in Appendix B.

4.12 Stated sound pressure levels are for the unit running at standard/normal speed (as opposed to the quieter low noise mode).

Table 4.1 – Condenser PURY-P450YLM-A1 octave band sound pressure levels (dB)

Octave Band Centre Frequency (Hz)								Overall L_{Aeq} dB
63	125	250	500	1000	2000	4000	8000	
72.5	69.5	64.5	60.5	55.5	50.5	47.0	41.0	62.5

Table 4.2 – Condenser PURY-P350/400YLM-A1 octave band sound pressure levels (dB)

Octave Band Centre Frequency (Hz)								Overall L_{Aeq} dB
63	125	250	500	1000	2000	4000	8000	
73.5	68.5	64.5	61.5	55.5	48.0	43.0	37.5	62.5

Predicted condenser sound levels at adjacent receptors

Sound levels from roof-top condensing units

4.13 It is assumed that all four units will operate simultaneously and at normal operating duty. Where units run at lower operating speeds (low noise mode) and where units shut-down for an extended period, the cumulative sound level will be reduced.

4.14 To determine the level of sound attenuation due to distance separation, standard acoustic principals for a point source have been assumed (6 dB of attenuation per doubling of distance).

4.15 Table 4.3 presents a calculation summary for the roof-top condenser units taking into consideration the sound pressure spectrum, surface directivity factor and distance separation. Tabulated values have been rounded to the nearest whole number.

Table 4.3 – Roof-top condenser sound pressure levels at adjacent receptors

	Octave Band Centre Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
PURY-P450YLM-A1 L_{eq} dB	73	70	65	61	56	51	47	41
PURY-P450YLM-A1 L_{eq} dB	73	70	65	61	56	51	47	41
PURY-P450YLM-A1 L_{eq} dB	73	70	65	61	56	51	47	41
PURY-P450YLM-A1 L_{eq} dB	73	70	65	61	56	51	47	41
Cumulative sound pressure L_{eq} dB	**79**	**76**	**71**	**67**	**62**	**57**	**53**	**47**
Directivity factor dB	+3	+3	+3	+3	+3	+3	+3	+3
Distance attenuation dB	-28	-28	-28	-28	-28	-28	-28	-28
A-weighting correction dB	-26	-16	-9	-3	0	+1	+1	-1
Resulting level dB	**28**	**35**	**37**	**39**	**37**	**33**	**29**	**21**
A-weighted specific sound level L_{Aeq} = 44 dB								

4.16 The calculation results indicate that the cumulative sound pressure level from the roof-top condensing units will be approximately 12 dB below the typical background sound level during the daytime period (07:00 – 23:00 hours).

4.17 Since the specific sound level is 12 dB below the background sound level, noise emissions from the roof-top condensing units will be inaudible during the daytime period.

4.18 Taking into consideration the typical operating characteristics of the proposed condenser units and the resulting specific sound level, it is anticipated that that there will be no discernible tonal characteristics at adjacent receptors.

4.19 On this basis, the specific sound level is considered equal to the sound rating level (i.e. no further acoustic corrections/penalties are necessary).

4.20 With regard to an assessment of the likely impacts, BS 4142 states:

'*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...'*

'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. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context'.

4.21 On this basis, the proposed roof-top condensing units are expected to have a low impact at adjacent receptors.

4.22 Assuming daytime operation only, noise control measures such as acoustic enclosures or acoustic screens around the roof-top plant area are considered unnecessary.

4.23 It is assumed that non-acoustic louvred screens will be installed around the plant deck in order to provide visual screening. In practice, such screening will provide a small degree of sound attenuation, however, for this assessment attenuation due to screening is assumed to be negligible.

Night-time operation and associated sound rating level

4.24 Should it be necessary to operate the air-conditioning system and associated condenser units during the night-time period (23:00 – 07:00 hours), noise control/attenuation measures will be required to adequately reduce noise emissions from the roof-top plant area.

4.25 The predicted specific sound level is approximately 2 dB above the night-time typical background sound level. However, if it is assumed that a tonal noise is just perceptible during the night-time period, a correction of +2 dB to the specific sound level is considered appropriate (i.e. in order to obtain the rating level).

4.26 On this basis, the sound rating level for the roof-top condenser units is 46 dB $L_{Ar,T}$.

- Specific sound level of 44 dB $L_{Aeq,T}$ + 2 dB tonal penalty = 46 dB $L_{Ar,T}$.

4.27 The rating level is therefore 4 dB above the 'lower' typical background sound level (i.e. 42 dB $L_{A90,15min}$) and equal to the higher typical level during the night-time period.

4.28 BS 4142 states that a difference of around +5 dB (excess of rating level above the background sound level) is likely to be an indication of an adverse impact, depending on the context.

4.29 On this basis, acoustic screens should be installed around the plant deck in order to reduce noise emissions during the night-time period. Noise attenuation of the order 10 to 15 dB can be achieved with an effective barrier and therefore there should be no difficulty in satisfying the night-time sound level targets.

4.30 To work effectively, the height of the acoustic screen should be such that there is no direct line-of-sight between the condensing units and the adjacent receptors. Since the condensing units are circa 1.7 metres high, it is estimated that the screening would need to be at least 2.5 metres in height (the screen manufacturer will confirm the dimensions and roof loading).

Sound levels from 2nd floor internal plant room

4.31 The plant room construction comprises traditional brickwork external walls, pitched tiled roof and a lath/plaster ceiling. There will be several new weather louvres installed within the existing roof-light openings. The louvres will be the weakest element acoustically with regard to plant room sound insulation.

4.32 It is assumed that all three units will operate simultaneously and at normal operating duty.

4.33 Table 4.4 presents a calculation summary for the internal condenser units taking into consideration the sound pressure spectrum, plant room sound insulation and distance separation.

4.34 The specific sound level at the adjacent building facade has been determined using the following equation:

- $SPL_2 = SPL_1 - R + 10\ Log\ S - 20\ Log\ r - 14\ dB$

4.35 Where SPL_2 is the sound pressure level at the receptor, SPL_1 is the sound pressure level on the inside of the building, R is the composite sound reduction, S is the surface area of the building envelope and r is the distance from the source to the receptor.

Table 4.4 – Plant room sound pressure levels at adjacent receptors

	Octave Band Centre Frequency (Hz)							
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
PURY-P350/400YLM-A1 L_{eq} dB	74	69	65	62	56	48	43	38
PURY-P350/400YLM-A1 L_{eq} dB	74	69	65	62	56	48	43	38
PURY-P350/400YLM-A1 L_{eq} dB	74	69	65	62	56	48	43	38
Cumulative sound pressure L_{eq} dB	**79**	**74**	**70**	**67**	**61**	**53**	**48**	**43**
Composite sound insulation of plant room R_w dB	-12	-13	-13	-15	-15	-15	-15	-16
10log S dB	+19	+19	+19	+19	+19	+19	+19	+19
Distance attenuation dB	-18	-18	-18	-18	-18	-18	-18	-18
Correction dB	-14	-14	-14	-14	-14	-14	-14	-14
A-weighting correction dB	-26	-16	-9	-3	0	+1	+1	-1
Resulting level dB	**28**	**32**	**35**	**36**	**33**	**26**	**21**	**13**
A-weighted specific sound level L_{Aeq} = 41 dB								

4.36 The calculation results indicate that the cumulative sound pressure level from the plant room will be approximately 15 dB below the typical background sound level during the daytime period (07:00 – 23:00 hours).

4.37 Since the specific sound level is approximately 15 dB below the background sound level, noise emissions from the plant room condensing units will be inaudible during the daytime period.

4.38 Taking into consideration the typical operating characteristics of the proposed condenser units and the resulting specific sound level, it is anticipated that that there will be no discernible tonal characteristics at adjacent receptors.

4.39 On this basis, the specific sound level is considered equal to the sound rating level (i.e. no further acoustic corrections/penalties are necessary). The proposed plant room condensing units are therefore expected to have a low impact at adjacent receptors.

4.40 Assuming daytime operation only, acoustically rated louvres are considered unnecessary for the plant room.

Night-time operation and associated sound rating level

4.41 Should it be necessary to operate the air-conditioning system and associated condenser units during the night-time period (23:00 – 07:00 hours), acoustically rated louvres will be required to adequately reduce noise emissions from the internal plant room.

4.42 The predicted specific sound level is approximately 1 dB below the night-time typical background sound level. However, if it is assumed that a tonal noise is just perceptible during the night-time period, a correction of +2 dB to the specific sound level is considered appropriate (i.e. in order to obtain the rating level).

4.43 On this basis, the sound rating level for plant room noise emissions is 43 dB $L_{Ar,T}$.

- Specific sound level of 41 dB $L_{Aeq,T}$ + 2 dB tonal penalty = 43 dB $L_{Ar,T}$.

4.44 The rating level is therefore 1 dB above the 'lower' typical background sound level (i.e. 42 dB $L_{A90,15min}$) during the night-time period.

4.45 As an example of appropriate noise control, a single bank 150mm deep acoustic louvre will provide sufficient sound attenuation. With non-acoustic weather louvres, the plant room composite sound insulation is expected to be approximately 15 dB R_w. However, with 150mm deep acoustic louvres, the plant room sound insulation is expected to increase to approximately 23 dB R_w.

4.46 Assuming 150mm deep acoustic louvres are installed, the plant room sound level will be reduced to approximately 35 dB $L_{Aeq,T}$ and will therefore be notably below the background sound level.

4.47 It is recommended that the minimum sound insulation values given in Table 4.5 are achieved by the acoustic louvre.

Table 4.5 – Acoustic louvre sound reduction index

Sound Reduction Index (dB)	Octave Band Centre Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Single bank, 150mm deep, standard profile	4	4	6	8	11	11	11	10

Vibration control & structure-borne noise

4.48 It is recommended that suitable anti-vibration (resilient) mounts are fitted to the condenser units in order to eliminate the potential for structure-borne noise. Without appropriate anti-vibration mounts, vibration levels from the condenser units could potentially become audible as structure-borne noise within the internal office space.

4.49 For guidance, the following suppliers provide suitable anti-vibration mounts for building services plant.

- http://www.eurovib.co.uk/www.eurovib.co.uk/mounts.html
- http://www.farrat.com/products/vibration-acoustic-and-shock-isolation

5. Conclusion

5.1 During the daytime period, the predicted rating level for the roof-top condensing units is approximately 12 dB below the typical background sound level at adjacent receptors on Dale Street.

5.2 The predicted rating level for the plant room condensing units is approximately 15 dB below the typical background sound level at adjacent receptors on Back Piccadilly.

5.3 BS 4142 states '*Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context*'.

5.4 Manchester City Council's target rating level of 5 dB below the typical background sound level will therefore be achieved during daytime hours (07:00 – 23:00).

5.5 During the night-time period, the predicted rating level for the roof-top condensing units is approximately 4 dB above the typical background sound level.

5.6 The predicted rating level for the plant room condensing units is approximately 1 dB above the typical background sound level during the night-time period.

5.7 Manchester City Council's target rating level will therefore not be achieved during the night-time hours (23:00 – 07:00).

5.8 Since the building is to be used as office accommodation, it is considered unlikely that the air-conditioning system and associated condenser units will need to operate during the night-time period.

5.9 Should night-time operation be necessary, acoustic screens will be required for the roof-top plant deck and acoustic louvres will be required for the 2nd floor plant room.

Appendix A
Equipment calibration certificates

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Page 1 of 3

APPROVED SIGNATORIES
Claire Lomax [x] Andy Moorhouse [ ]
Gary Phillips [ ] Danny McCaul [ ]

acoustic calibration laboratory
The University of Salford, Salford, Greater Manchester, M5 4WT, UK
http://www.acoustics.salford.ac.uk
t 0161 295 3030/0161 295 3319 f 0161 295 4456 e c.lomax1@salford.ac.uk

UKAS CALIBRATION 0801

University of Salford MANCHESTER

Certificate Number: 02766/1 Date of Issue: 26 July 2016

PERIODIC TEST OF A SOUND LEVEL METER to IEC 61672-3:2006

FOR:	RS Acoustic Engineering Ltd 156 Tuncroft Lane Stockport SK1 4AR
FOR THE ATTENTION OF:	Ryan Swales
PERIODIC TEST DATE:	25th and 26th July 2016
TEST PROCEDURE:	CTP12 (Laboratory Manual)

Sound Level Meter Details

Manufacturer	Bruel & Kjaer	
Model	2250 Light	
Serial number	2638934	
Class	1	
Hardware version	2.0	Software version: BZ7130 Version 3.1

Associated Items	Microphone	Preamplifier
Manufacturer	Bruel & Kjaer	Bruel & Kjaer
Model	4189	ZC 0032
Serial Number	2143254	8938

Test Engineer (initial): GP Name: Gary Phillips

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to the units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Certificate Number: 02766/1 Date of Issue: 26 July 2016

Procedures from IEC 61672-3: 2006 and TPS 49 Edition 2 June 2009 were used to perform the periodic tests.

The manufacturer's instruction manual was marked as follows: B&K 2250-L with mic 4950 BE 1774-11 June 2007 From hardware version 2.0.

Adjustment data used to adjust the sound levels indicated in response to the application of an electrostatic actuator to sound levels equivalent to those that would be indicated in response to plane, progressive sound waves were obtained from the manufacturer.

The sound level meter calibration check frequency is 1000 Hz, the reference sound pressure level is 94 dB. As this instrument only has a single range, this range is the reference level range.

The environmental conditions in the laboratory at the start of the test were:
Static pressure 101.356 kPa ± 0.015 kPa, air temperature 23.9 °C ± 0.3 °C, relative humidity 51.5 % ± 1.7%.

The initial response of the instrument to application of the suitable laboratory sound calibrator was 93.8 dB (C). The instrument was then adjusted to indicate 93.9 dB (C). This indication was obtained from the calibration certificate of the calibrator, and information in the manufacturer's instruction manual specified in this certificate, when the instrument is configured as follows; Transd. Used: 4189, Sound Field Correction: Free-field, Windscreen Correction: None. The instrument was calibrated without a windshield. Consult manufacturer's instructions if using a windshield.

With the microphone installed the level of self-generated noise was:

A: 17.2 dB

With the microphone replaced by an electrical input device with a similar capacitance to that of the supplied microphone, the levels of self-generated noise were:

A: 13.3 dB
B: 12.7 dB
C: 14.3 dB
Z: 19.0 dB

The environmental conditions in the laboratory at the end of the test were:
Static pressure 101.459 kPa ± 0.015 kPa, air temperature 22.8 °C ± 0.3 °C, relative humidity 43.6 % ± 1.7%.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to the units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Certificate Number: 02766/1 Date of Issue: 26 July 2016

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organization responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.*

No information on the uncertainty of measurement, required by 11.7 of IEC 61672-3:2006, of the adjustment data obtained from the manufacturer of the microphone, was published in the instruction manual or made available by the manufacturer or supplier. The uncertainty of measurement of the adjustment data has therefore been assumed to be numerically zero for the purpose of this periodic test. If these uncertainties are not actually zero, there is a possibility that the frequency response of the sound level meter may not meet the requirements of IEC 61672-1:2002.

The microphone corrections applied as specified in 12.6 of IEC 61672-3:2006 were obtained from a frequency response measured by this Laboratory using the electrostatic actuator method. This response in isolation is not covered by our UKAS accreditation.

*NOTE
The instrument was submitted with a B&K 4189 microphone whereas the microphone specified in the instruction manual is a B&K 4950.

Instruments used in the verification procedure were traceable to *National Standards*. The electrostatic actuator method was employed in the acoustical tests of a frequency weighting.

The uncertainty evaluation has been carried out in accordance with UKAS requirements. All measurement results are retained at the acoustic calibration laboratory for at least four years.

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UKAS CALIBRATION 0801

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APPROVED SIGNATORIES
Claire Lomax [ ] Andy Moorhouse [ ]
Gary Phillips [x] Danny McCaul [ ]

G. Phillips

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http://www.acoustics.salford.ac.uk
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University of Salford MANCHESTER

Certificate Number: 03263/1 Date of Issue: 27 June 2017

CALIBRATION OF A SOUND CALIBRATOR

FOR:	RS Acoustic Engineering Ltd 76 Marple Road Stockport Cheshire SK2 5QH
FOR THE ATTENTION OF:	Ryan Swales
DESCRIPTION:	Calibrator with housing for one-inch microphones and adaptor type UC 0210 for half-inch microphones.
MANUFACTURER:	Bruel & Kjaer
TYPE:	4231
SERIAL NUMBER:	2153318
DATE OF CALIBRATION:	23/06/2017
TEST PROCEDURE:	CTP06 (Laboratory Manual)

Test Engineer (initial): CL Name: Claire Lomax

Calibrations marked 'Not UKAS Accredited' in this certificate have been included for completeness.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to the units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

Certificate of Calibration

Issued by University of Salford (Acoustics Calibration Laboratory)
UKAS ACCREDITED CALIBRATION LABORATORY NO. 0801

Certificate Number: 03263/1 Date of Issue: 27 June 2017

MEASUREMENTS

The sound pressure level generated by the calibrator was measured using a calibrated, WS2P condenser microphone as specified in the certificate. The calibration was carried out with the calibrator in the half-inch configuration.

Five determinations of the sound pressure level, frequency and total distortion were made.

The results have been corrected to the reference pressure of 101.325 kPa using manufacturer's data.

RESULTS

Coupler configuration:	Half-inch
Microphone type:	GRAS 40AG
Output level (dB re 20μPa):	94.04 dB ± 0.10 dB
Frequency (Hz):	999.84 Hz ± 0.12 Hz
Total Distortion (%):	0.34 % ± 0.25 % (Not UKAS Accredited)

Average environmental conditions at the time of measurement were:

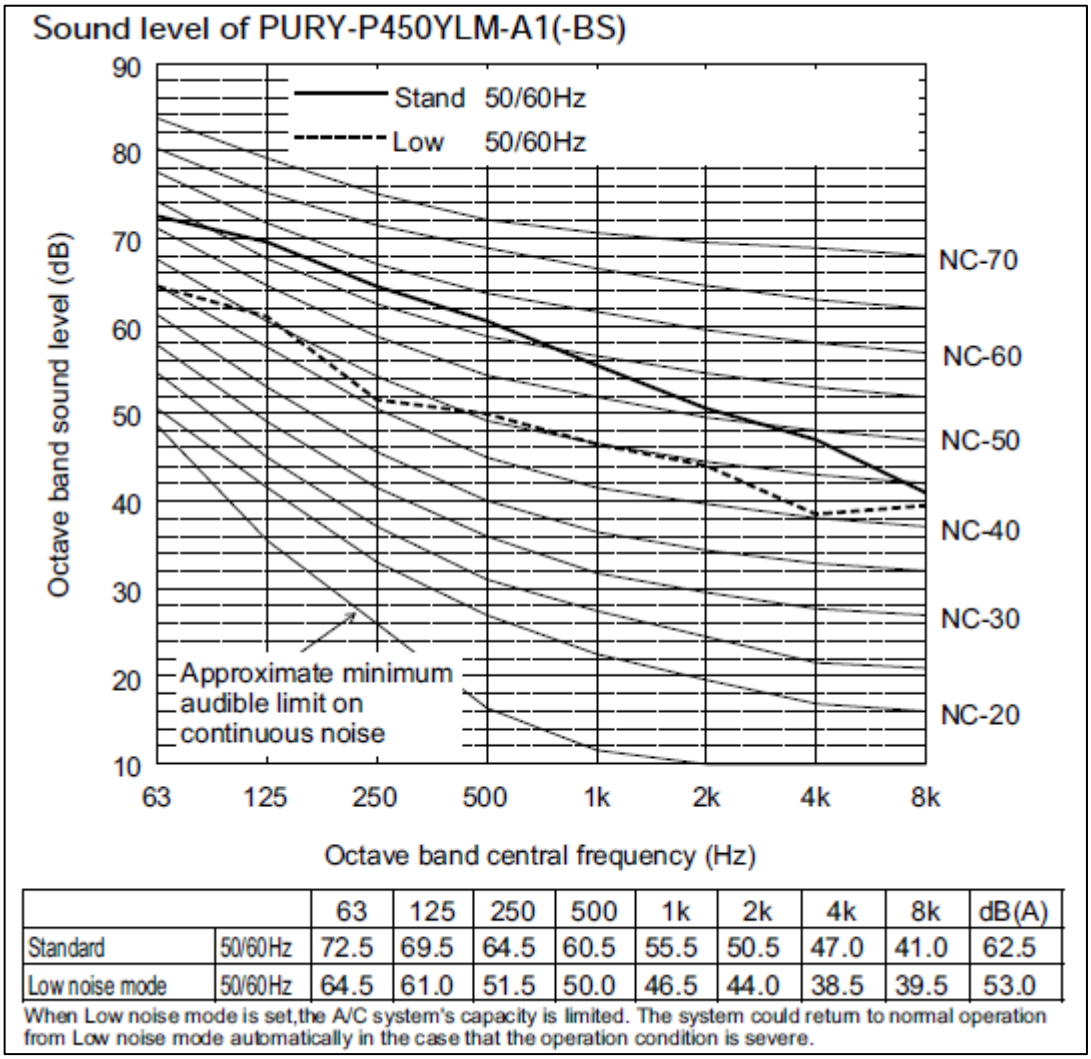
Pressure:	100.732 kPa ± 0.018 kPa
Temperature:	24.0 °C ± 0.4 °C
Relative humidity:	48.7 % ± 2.0 %

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

All measurement results are retained at the acoustic calibration laboratory for at least four years.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to the units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full except with the prior written approval of the issuing laboratory.

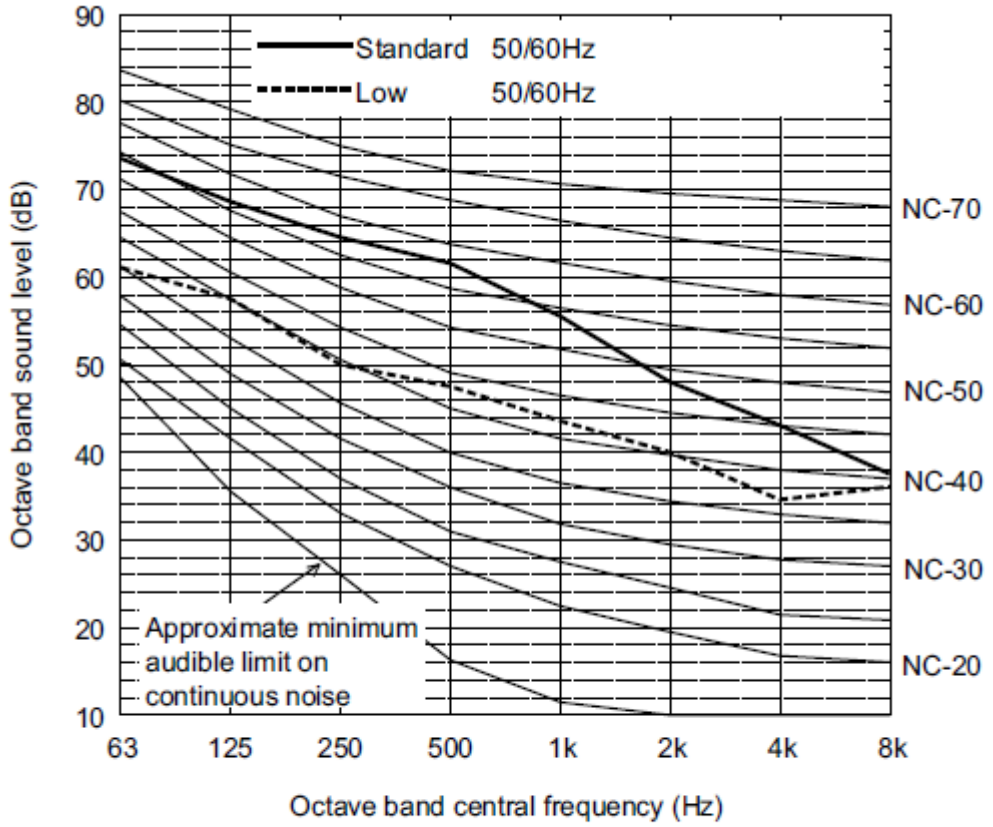
Appendix B
Condenser sound level data



		63	125	250	500	1k	2k	4k	8k	dB(A)
Standard	50/60Hz	72.5	69.5	64.5	60.5	55.5	50.5	47.0	41.0	62.5
Low noise mode	50/60Hz	64.5	61.0	51.5	50.0	46.5	44.0	38.5	39.5	53.0

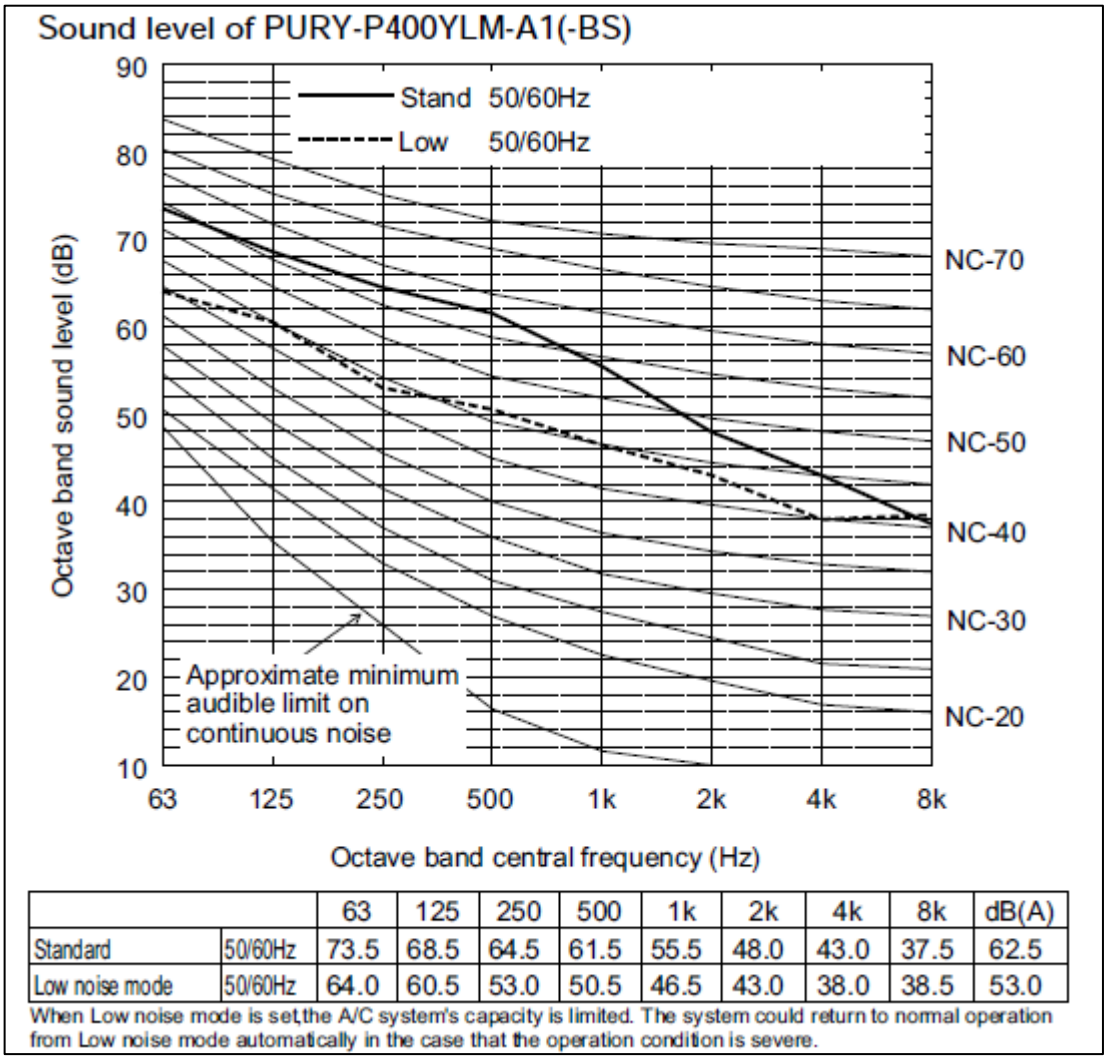
When Low noise mode is set,the A/C system's capacity is limited. The system could return to normal operation from Low noise mode automatically in the case that the operation condition is severe.

Sound level of PURY-P350YLM-A1(-BS)



		63	125	250	500	1k	2k	4k	8k	dB(A)
Standard	50/60Hz	73.5	68.5	64.5	61.5	55.5	48.0	43.0	37.5	62.5
Low noise mode	50/60Hz	61.0	57.5	50.0	47.5	43.5	40.0	34.5	36.0	50.0

When Low noise mode is set,the A/C system's capacity is limited. The system could return to normal operation from Low noise mode automatically in the case that the operation condition is severe.



		63	125	250	500	1k	2k	4k	8k	dB(A)
Standard	50/60Hz	73.5	68.5	64.5	61.5	55.5	48.0	43.0	37.5	62.5
Low noise mode	50/60Hz	64.0	60.5	53.0	50.5	46.5	43.0	38.0	38.5	53.0

When Low noise mode is set,the A/C system's capacity is limited. The system could return to normal operation from Low noise mode automatically in the case that the operation condition is severe.

Appendix C
Glossary of acoustic terminology

Acoustic terminology

Term	Description
dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure ($2x10^{-5}$Pa).
dB(A)	The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90} etc, according to the parameter being measured.
Acoustic environment	Sound from all sources as modified by the environment.
Ambient sound level	The totally encompassing sound in a given situation at a given time; it is usually composed of sound from many sources, near and far.
Background sound level	The sound level in the absence of a specific noise source under consideration (e.g. plant/machinery), measured as $L_{A90,T}$.
Residual sound	Ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound.
Specific sound source	Sound source being assessed.
Specific sound level	Equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T.
Rating level $L_{Ar,T}$	Specific sound level plus any adjustment for the characteristic features of the sound.