Charles Darwin House, 12 Roger Street

Background Noise Survey and Plant Impact Assessment

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1.0 Introduction

1.1 Holtz Acoustics has been commissioned to undertake a background noise survey and plant impact assessment for the proposed rooftop plant installation at Charles Darwin House, 12 Roger Street, London.

1.2 It is proposed that an air handling unit (AHU), external air conditioning condenser units and an extract fan are installed to a rooftop plant area.

1.3 A background noise survey has been undertaken at a location representative of the neighbouring residential properties on John Street.

1.4 A plant noise impact assessment has been undertaken in accordance with National Planning Policies and Camden's Noise Policies. The assessment is in the format of a BS4142:2014 plant noise impact assessment.

1.5 The results of this background noise survey and plant noise assessment are presented in the following sections of this report together with supporting Appendices.

1.6 The author of this report, James Patterson has a Master's Degree in Engineering Acoustics and is a member of the Institute of Acoustics, the professional body for acoustic consultants in the UK.

2.0 Site

2.1 Charles Darwin House is located on the corner of Roger Street and North Mews. Grays Inn Road runs to the east of the building.

2.2 The surrounding area comprises a mix of commercial and residential properties. The noise environment in the surrounding area is dominated distant road traffic noise. The roads immediately around Rogers Street are relatively quiet.

2.3 Charles Darwin House is used as office space spread over five floors and it is understood that existing offices will be refurbished and their use retained.

2.4 It is proposed that the plant items are installed on the roof in a dedicated plant enclosure. This area is currently occupied by existing air handling units which will be removed.

2.5 The nearest residential properties to this plant area appear to be those along John Street. The rear windows of these properties are approximately 17m from the edge of the proposed plant enclosure.

2.6 Figure 1 shows an aerial view of the building and surrounding area.

2.7 Figure 2 shows a site photograph identifying the survey position and the nearest residential windows.

2.8 A technical drawing of the proposed plant layout is shown in Appendix A.

Figure 1. Aerial view of Great Russell Street side of site

Image from Google Maps

Figure 2. Site Photograph

3.0 Planning Guidance

3.1 National Planning Guidance

3.1.1 The National Planning Policy Framework[1] (NPPF) states that planning policies and decisions should aim to:

- Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development.

-Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions,

-Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land use since they were established.

-Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

3.1.2 The NPPF refers to an explanatory note, the Noise Policy Statement for England[2] (NPSE). The NPSE sets out a Noise Policy Vision to

- Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

3.1.3 The NPSE states the long term vision is supported by the following aims.

-Avoid significant adverse impact on health and quality of life

-Mitigate and minimise adverse impacts on health and quality of life

-Where possible, contribute to the improvement of health and quality of life.

3.1.4 The NPSE does not refer to specific noise criteria but sets out the concept of a 'Significant Observed Adverse Effect Level' (SOAEL). This is the level above which significant adverse effects on health and quality of life occur.

[1] Department for Communities and Local Government, National Planning Policy Framework 2012
[2] DEFRA, Noise Policy Statement for England, March 2010

3.1.5 The NPSE states 'It is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptor and at different times. It is acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, not having specific SOAEL values in the NPSE provide the necessary policy flexibility until further evidence and suitable guidance is available.'

3.2 Camden Planning Guidance

3.2.1 Camden's Local Area Requirements for Planning Applications[3] Section 4 states that applications where plant, ventilation, air extraction or conditioning equipment and flues are proposed require an acoustic report.

3.2.2 The policy drivers for this requirement are the NPPF and Camden Local Plan Policies A1 and A4.

3.2.3 The requirements also state that noise and vibration thresholds in Appendix 3 of the Camden Local Plan can provide a starting point for acoustic reports. Further detailed advice on the content of the report can be found in the Camden Planning Guidance on Amenity.

3.2.4 Appendix 3 of the Camden Local Plan[4] states that a relevant standard or guidance document should be reference when determining values for LOAEL and SOAEL for non –anonymous noise. It is expected that British Standard BS4142:2014 'Methods for rating and assessing industrial and commercial sound' will be used.

3.2.5 It goes on to state that for dwellings a 'Rating Level' of 10dB below background (15dB if tonal components are present) should be considered as the design criterion.

3.2.6 A footnote states that 'levels are use specific and different levels will apply dependant on the use of the premises. Commercial premises are usually assessed differently to dwellings and are not strictly considered noise sensitive receivers.

3.2.7 For noise affecting commercial premises, in the past, Camden has required a 'Rating Level' of 5dB below background. It is also common practice to ensure

[3] Camden's Local Area Requirements for Planning Applications

[4] Camden Local Plan 2017

that internal ambient noise levels in commercial premises, as a result of new noise sources, do not exceed the recommended levels in BS:8233:2014.

4.0 Assessment Criteria

4.1 Based on the guidance discussed above the following assessment criterion is proposed.

10dB below representative background level during proposed period of operation – assessed in accordance with BS4142:2014.

4.2 The BS4142:2014 assessment methodology relies on comparing the existing background noise level at the existing receivers with the noise level produced by the new plant. Corrections are also used to account for the characteristic of the new noise source to arrive at the 'Rating Level'.

4.3 BS4142 assesses the impact of a new plant noise source on existing noise sensitive receivers by subtracting the measured background sound level from the rating level and considering the following.

-Typically, the greater this difference, the greater the magnitude of the impact.

-A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.

-A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.

-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 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.

4.4 The rating level must take into account the characteristic of the new noise source including tonality, impulsivity, intermittency and other sound characteristics.

4.5 These corrections are discussed further in Appendix B.

5.0 Background Noise Survey

5.1 A background noise survey has been undertaken at a location representative of the noise environment at the rear windows of the properties on John Street. The survey was unattended and taken over a 24 hour period.

5.2 The sound level meter's microphone was mounted on a tripod and positioned at the edge of the roof of Charles Darwin House. The exact measurement location is shown in the photos and aerial views of the site in preceding sections of this report.

5.3 The survey position can be considered as free field.

5.4 The survey was undertaken between 1231hrs Thursday the 12th September 2019 and 1211hrs Friday the 13th of September 2019.

5.5 Weather monitoring was undertaken during the surveys and the results are shown in Appendix C.

5.6 Details of measurement equipment and calibration procedure are included in Appendix D.

5.7 A summary of the survey results is shown below in Table 1.

Table 1: Summary of survey results

Period	Representative Background Noise Level, $L_{A90,5min}$ (dB)*
Daytime (0700-2300)	52
Night-time (2300-0700)	49

*Representative background level found using the statistical analysis method described in BS4142:2014

5.8 A noise time history is included in Appendix E.

5.9 A table of survey results is included in Appendix F.

5.10 The proposed condenser units will operate at normal capacity during daytime hours (0700-2300hrs) and at reduced capacity 'Low Noise Mode 1' at night (2300-0700hrs) this will be set using a time clock on the units. The remaining plant will have the facility to operate 24 hours a day.

5.11 The cumulative noise level from all items of new plant should therefore not exceed, **42 dBA** during the day and **39 dBA** at night at the nearest residential windows.

6.0 Plant Impact Assessment

6.1 It is proposed that the following plant items are installed within a dedicated plant enclosure on the roof. The plant layout is shown in Appendix A and consists of the following items.

Plant Item	Manufacturer's Published Sound Pressure Level at, dBA	Notes
Daikin RYYQ20T	66 at 1m	6 No
Daikin RYYQ20T set to 'Low Noise Mode 1'	60 at 1m	6 No, time limited low noise mode (2300-0700hrs)
Nuaire DE6-ES Extract Fan	40 at 3m	Toilet Extract breakout
Eco Air ECO 30 HP	Calculated 21 dBA at the residential windows see detail below	Air Handling Unit, 1500mm long attenuators on fresh air and extract sides

All other noise producing items are located internally within the rooftop plant room

Item	63	125	250	500	1k	2k	4k	8k	Notes
Supply Inlet (FA)	68	81	79	75	71	68	67	64	90^o to windows
Extract Outlet (Exhaust)	75	87	84	83	80	75	71	68	180^o to windows
Attenuator insertion loss	8	15	25	40	46	47	43	64	1500mm long attenuator

6.2 Taking into account the attenuator, the directivity of the terminal grilles and the distance propagation over 18m the cumulative level from the AHU terminal has been calculated at 21 dBA.

6.3 The nearest windows to the plant items are those rear windows of the properties on John Street approximately 17m from the edge of the plant enclosure.

6.4 The plant enclosure will be 2.5m high on each side and formed of weather louvres, the side facing the properties on John Street and parts of the sides perpendicular to this will have an internal solid screen. The screen must extend to the floor and have no gaps, an example suitable screen would be formed of a mild steel sandwich panel with an absorbent inner face. The

proposed extent of the solid section of screen is marked up on the roof plan in Appendix A.

6.5 This screen has been designed to provide acoustic screening to the high level windows of the properties on John Street.

6.6 These windows are identified in Figure 2.

6.7 The tables below summarise the plant noise calculations.

Table 2: Summary of plant noise calculations. Daytime (0700-2300hrs)

Step	Notes	Change in Level dBA
Cumulative Plant Noise Level	6 No Daikin condenser and 1 No extract fan	74
Additional Locally Reflective surfaces	No additional reflective surfaces (weather louvre)	-
Distinctive Characteristic Penalty	Intermittency, see notes in Appendix B	+3
Screening losses	Overall screening losses from 2.5m high screen (calculation included in Appendix H)	-8
Distance Losses Over 24m	Spherical spreading	-28
Calculated Level at 1m from receiver	Rear windows of properties on John Street	41
Design Criterion		42

Uncertainties discussed in Appendix A

* The AHU level has been calculated separately (see 6.2) and is more than 10dB below the calculated level therefore has no additional contribution to the cumulative level.

6.8 The calculated level is 1dB below the daytime design criterion.

Table 3: Summary of plant noise calculations. Night-time (2300-0700hrs)

Step	Notes	Change in Level dBA
Cumulative Plant Noise Level	6 No Daikin condenser (low noise mode 1) and 1 No extract fan	68
Additional Locally Reflective surfaces	No additional reflective surfaces (weather louvre)	-
Distinctive Characteristic Penalty	Intermittency, see notes in Appendix B	+3
Screening losses	Overall screening losses from 2.5m high screen (calculation included in Appendix H)	-8
Distance Losses Over 24m	Spherical spreading	-28
Calculated Level at 1m from receiver	Rear windows of properties on John Street	35
Design Criterion		39

* The AHU level has been calculated separately (see 6.2) and is more than 10dB below the calculated level therefore has no additional contribution to the cumulative level.

6.9 The calculated level is 4dB below the daytime design criterion.

6.10 Published unit data is included in Appendix H.

7.0 Vibration

7.1 The condensers, AHU and extract fan will be installed on anti-vibration pads to limit vibration travelling into the Charles Darwin House demise.

7.2 Vibration transmission to the residential properties will not be perceptible.

8.0 Summary

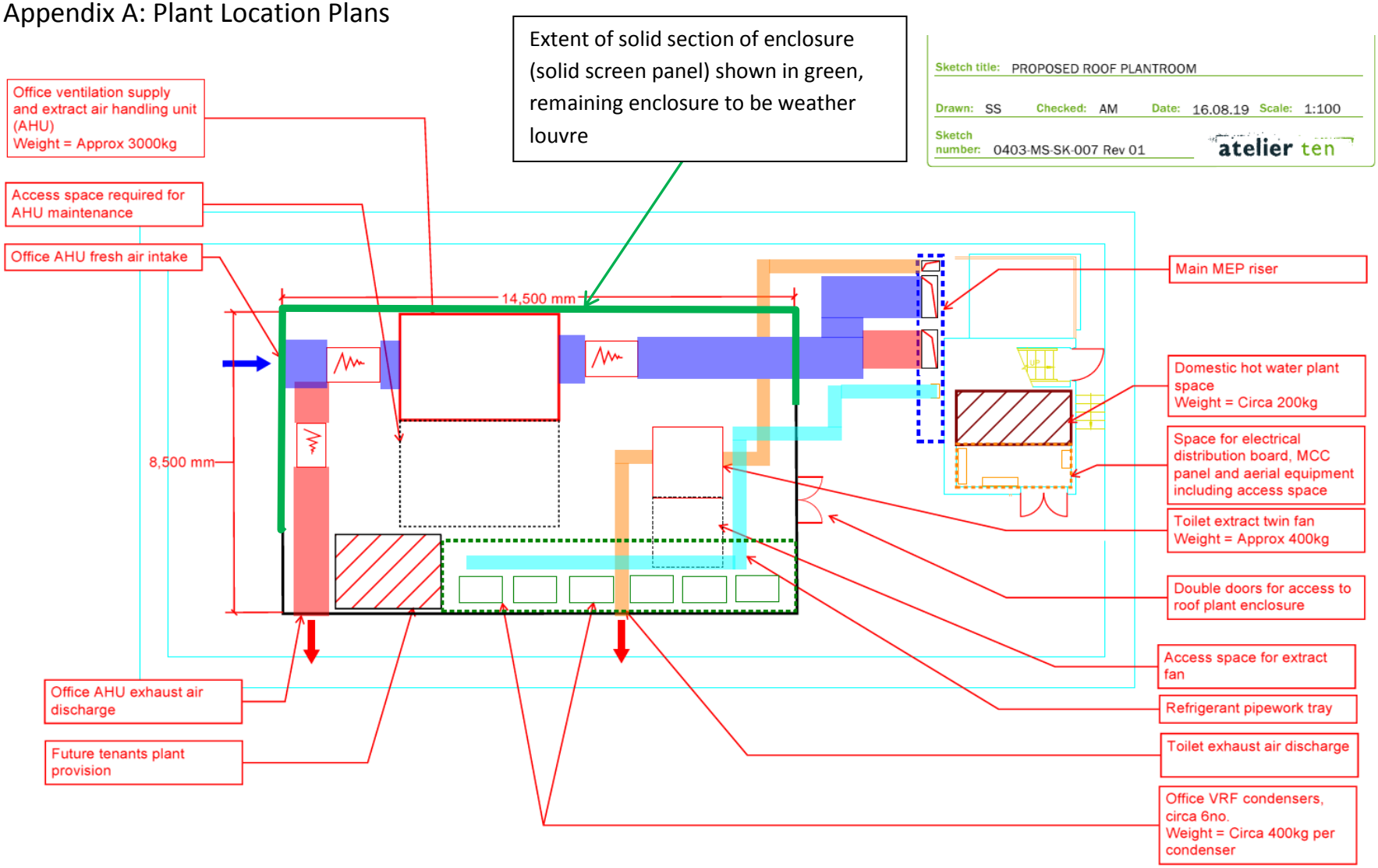
8.1 Background noise surveys have been undertaken at locations representative of the noise environment at the nearest properties in proximity to the proposed external plant.

8.2 Based on the survey results and Camden's noise policies, plant noise limits at the surrounding properties have been set and are included in 5.11 of this report.

8.3 A full plant impact assessment has been undertaken using manufacturer's issued sound levels.

8.4 The calculated noise levels do not exceed the plant noise limits set in this report demonstrating compliance with National and Camden's noise policies.

Appendix A: Plant Location Plans



Appendix B: Acoustic Characteristics and Uncertainties.

Where appropriate a rating penalty should be applied based on the following subjective characteristic of the noise source.

Tonality

The Joint Nordic Method gives a correction of between 0 and +6dB for tonality. Subjectively this can be converted to a penalty of 2dB for a tone which is just perceptible at the noise receptor, 4dB where it is clearly perceptible and 6dB where it is highly perceptible.

Impulsivity

A correction of up to +9dB can be applied for sound that is highly impulsive. Subjectively a penalty of 3dB can be applied for impulsivity that is just perceptible at the noise receptor, 6dB where it is clearly perceptible and 9dB where it is highly perceptible.

Intermittency

When the specific sound has identifiable on/off conditions and the intermittency is readily distinctive against the residual acoustic environment a penalty of 3dB can be applied.

In the case of the proposed condensers the following observations are made.

Tonality

It is not possibly to objectively quantify the tonality of the condensers as they are yet to be installed and detailed data is not available to assess.

Whilst there are tonal elements in our experience condenser are not distinctively tonal and efforts are taken in the blade design to reduce tonality. It is unlikely in this case that any tonality will be just perceptible at the receiver due to the myriad noise sources in the area.

Impulsivity

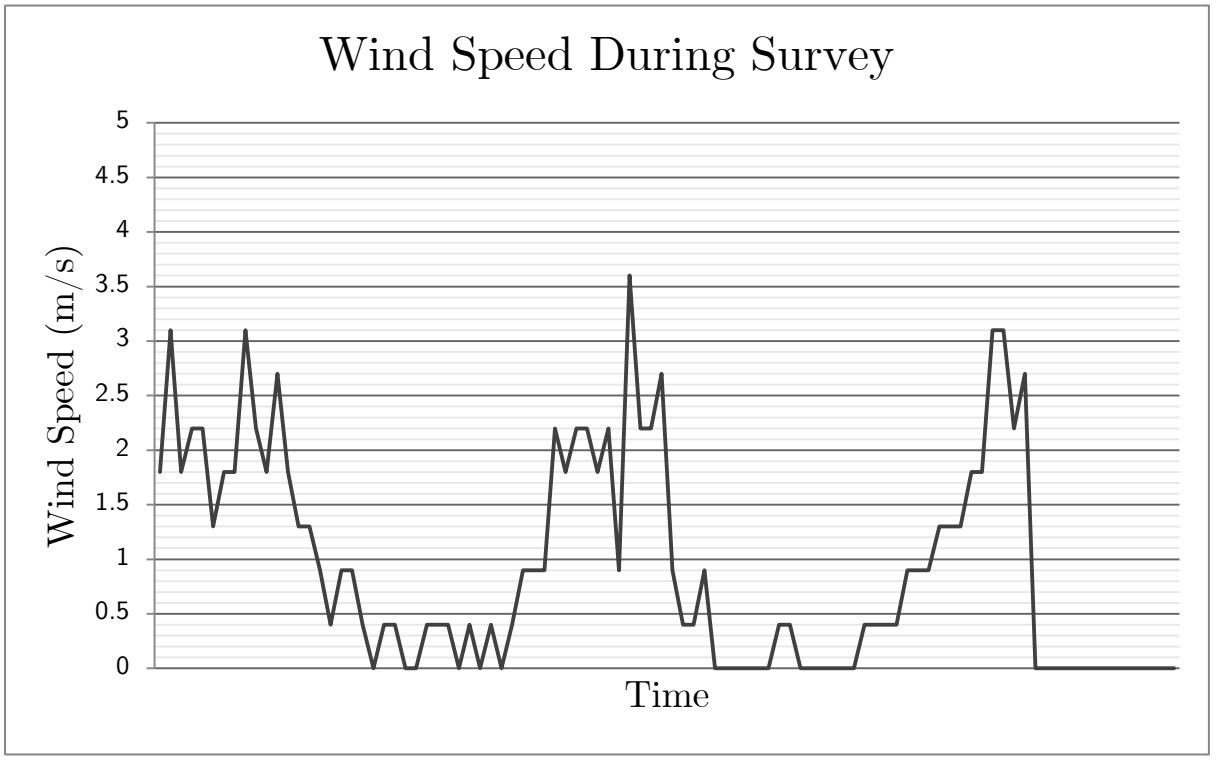
The condensers run on a sot start programme which slowly ramps up the fan speed therefore impulsivity in unlikely.

Intermittency

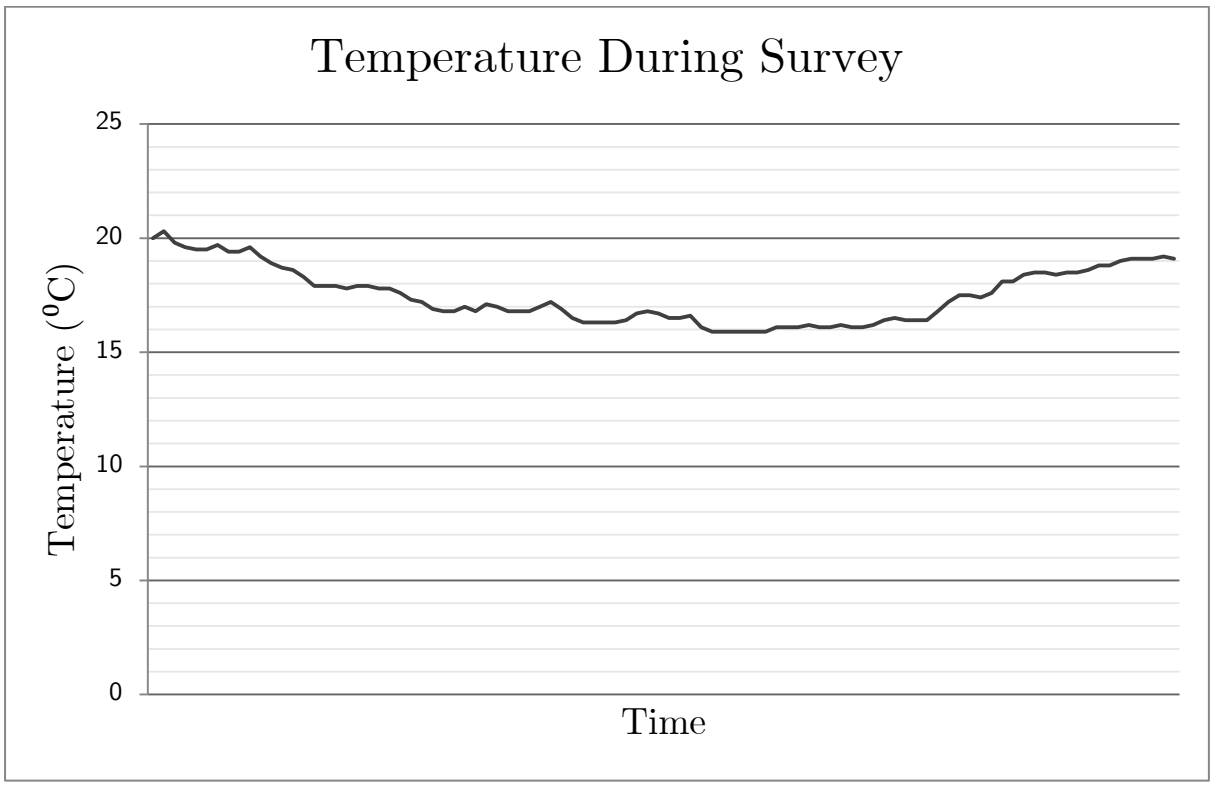
The condensers will switch on and off depending on the cooling load indoors. In order to adopt a cautious approach a 3dB penalty has been applied to the ‘Rating Level’.

The main uncertainty with this assessment is the calculation of the screening losses from the side of the plant enclosure. This is due to the estimation of the John Street window heights, a conservative estimate has been used however it was not possible to measure these directly on site and we have no historic drawings showing the heights. The relative height used is shown in the screening calculation in Appendix H.

Appendix C: Weather Data During Survey



Wind speeds did not exceed 5m/s. A high performance windshield was used on the microphone throughout the survey.



No precipitation was recorded

Appendix D: Survey Methodology

The following equipment was used for the survey

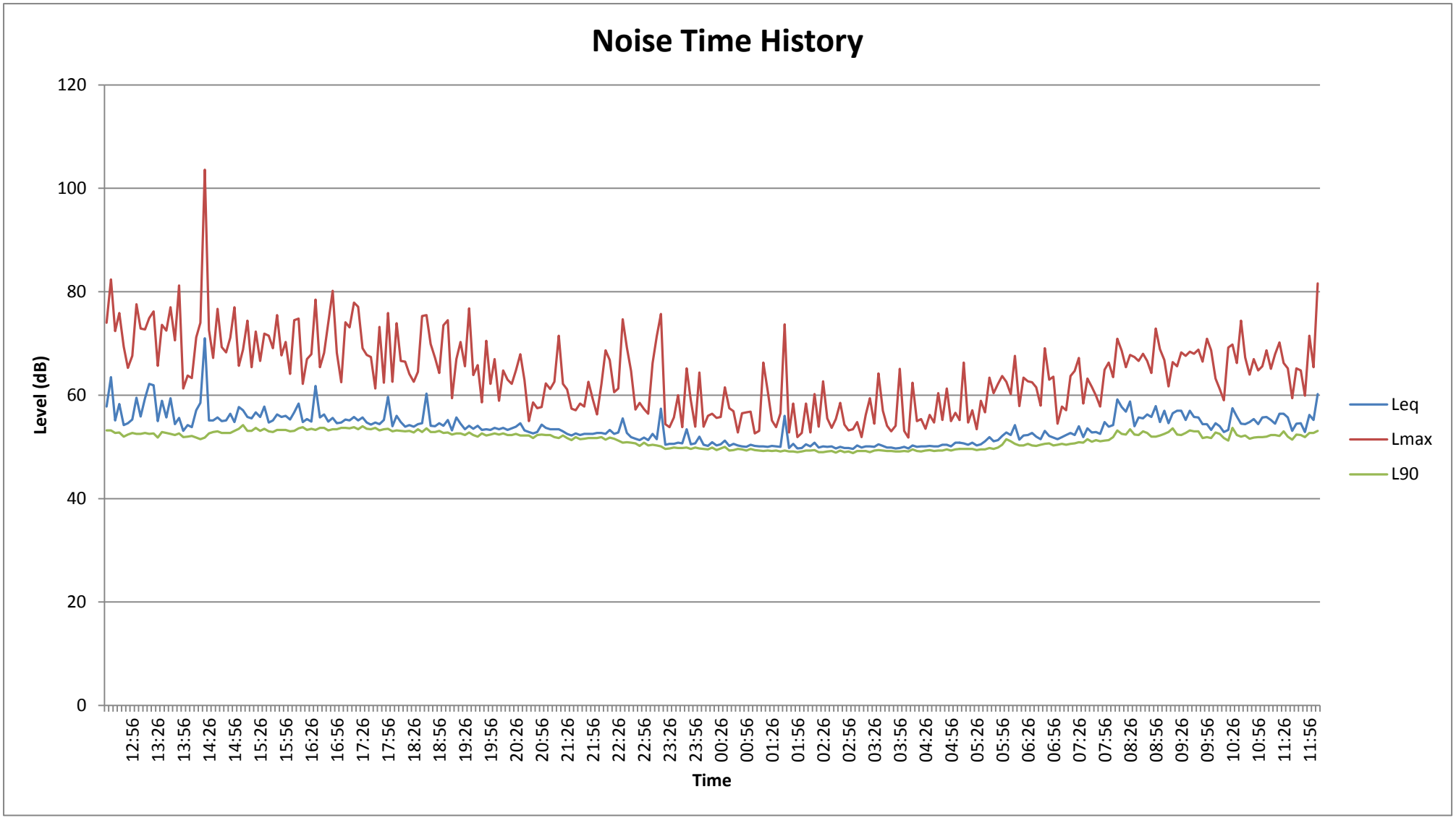
Item	Manufacturer	Type	Serial Number
Sound Level Meter	Rion	NL-52	00643058
Preamplifier	Rion	NH-25	43086
Microphone	Rion	UC-59	06838
Calibrator	Rion	NC-74	34546657
Windshield	Rion	WS-15	NA
Weather Station	Davis	Vantage Vue	NA

Calibration certificates are available.

The sound level meter and associated cabling was calibrated before and after the survey and no significant drift from calibration was noted.

The sound level meter was setup up to integrate measurements over a 5 minute time period and recorded L_{eq}, L_{max}, L_{min} and $_{L90,50,10,1}$ statistics.

Appendix E: Noise Time History



Appendix F: Table of Survey Results

Time	L_{Aeq}	L_{Amax}	L_{A90}	L90							
				63	125	250	500	1k	2k	4k	8k
12/09/2019 12:31:36	58	74	53	61	56	52	50	48	45	38	27
12/09/2019 12:36:36	64	82	53	60	56	52	50	48	45	38	27
12/09/2019 12:41:36	55	72	53	61	56	52	49	48	44	37	27
12/09/2019 12:46:36	58	76	53	61	56	52	50	48	44	37	26
12/09/2019 12:51:36	54	69	52	60	56	52	49	47	43	35	25
12/09/2019 12:56:36	55	65	52	60	56	52	50	47	44	36	25
12/09/2019 13:01:36	55	68	53	61	56	52	50	48	44	36	25
12/09/2019 13:06:36	60	78	53	61	57	52	50	47	44	37	25
12/09/2019 13:11:36	56	73	53	61	56	52	50	47	44	36	25
12/09/2019 13:16:36	59	73	53	61	56	52	50	48	44	37	27
12/09/2019 13:21:36	62	75	53	61	56	51	49	48	44	36	26
12/09/2019 13:26:36	62	76	53	61	56	52	50	48	44	37	26
12/09/2019 13:31:36	55	66	52	61	56	52	49	47	43	36	25
12/09/2019 13:36:36	59	74	53	62	57	52	50	48	44	37	27
12/09/2019 13:41:36	56	73	53	61	56	52	49	47	44	36	25
12/09/2019 13:46:36	59	77	53	62	57	52	50	47	43	36	26
12/09/2019 13:51:36	54	71	52	61	56	52	50	47	43	36	24
12/09/2019 13:56:36	56	81	53	61	57	52	50	47	43	36	25
12/09/2019 14:01:36	53	61	52	61	56	52	49	47	43	35	24
12/09/2019 14:06:36	54	64	52	61	56	52	49	47	43	36	24
12/09/2019 14:11:36	54	63	52	59	56	52	49	47	43	36	24
12/09/2019 14:16:36	57	71	52	59	56	52	49	47	43	35	24
12/09/2019 14:21:36	59	74	52	60	56	51	49	46	42	35	24
12/09/2019 14:26:36	71	104	52	60	56	53	50	46	40	31	19
12/09/2019 14:31:36	55	73	53	59	57	53	50	47	42	33	21
12/09/2019 14:36:36	55	67	53	59	57	54	51	48	42	33	22
12/09/2019 14:41:36	56	77	53	59	57	54	51	48	42	33	21
12/09/2019 14:46:36	55	69	53	59	57	54	51	47	42	32	21
12/09/2019 14:51:36	55	68	53	59	57	53	50	47	42	32	21
12/09/2019 14:56:36	56	71	53	59	57	54	51	47	42	32	21
12/09/2019 15:01:36	55	77	53	60	57	54	51	48	42	33	21
12/09/2019 15:06:36	58	66	54	61	58	54	51	48	43	33	21
12/09/2019 15:11:36	57	69	54	61	59	56	52	49	42	32	21
12/09/2019 15:16:36	56	74	53	60	58	54	51	48	42	32	21
12/09/2019 15:21:36	56	65	53	59	57	54	51	48	42	33	22
12/09/2019 15:26:36	57	72	54	60	58	55	52	48	42	33	22
12/09/2019 15:31:36	56	67	53	60	57	54	51	48	42	33	22
12/09/2019 15:36:36	58	72	54	61	58	55	51	48	42	33	22
12/09/2019 15:41:36	55	72	53	59	57	54	51	48	42	32	21
12/09/2019 15:46:36	55	69	53	59	57	54	51	48	42	33	22
12/09/2019 15:51:36	56	76	53	59	57	54	51	48	42	33	22
12/09/2019 15:56:36	56	68	53	59	57	54	51	48	43	33	23
12/09/2019 16:01:36	56	70	53	60	58	54	51	48	43	33	22
12/09/2019 16:06:36	55	64	53	59	57	54	51	48	42	32	22
12/09/2019 16:11:36	57	75	53	59	58	54	51	48	42	33	22

12/09/2019 16:16:36	58	75	54	59	57	55	52	48	43	33	22
12/09/2019 16:21:36	55	62	54	60	58	55	52	49	43	33	22
12/09/2019 16:26:36	55	67	53	59	57	54	51	48	43	33	22
12/09/2019 16:31:36	55	68	54	59	57	54	52	48	43	33	22
12/09/2019 16:36:36	62	79	53	59	57	54	51	48	42	32	21
12/09/2019 16:41:36	56	65	54	60	58	54	52	48	43	33	22
12/09/2019 16:46:36	56	68	54	60	58	55	52	48	42	32	22
12/09/2019 16:51:36	55	74	53	59	57	54	51	48	42	32	22
12/09/2019 16:56:36	56	80	53	59	57	54	51	48	43	33	22
12/09/2019 17:01:36	55	68	53	59	57	55	51	48	42	32	22
12/09/2019 17:06:36	55	63	54	59	57	54	52	48	43	32	22
12/09/2019 17:11:36	55	74	54	60	58	55	52	48	43	33	22
12/09/2019 17:16:36	55	73	54	60	58	55	52	48	43	33	23
12/09/2019 17:21:36	56	78	54	60	58	55	52	48	43	33	23
12/09/2019 17:26:36	55	77	53	60	57	54	51	48	42	32	22
12/09/2019 17:31:36	56	69	54	60	58	55	52	49	43	33	23
12/09/2019 17:36:36	55	68	54	60	58	55	52	48	43	32	22
12/09/2019 17:41:36	54	67	53	60	58	54	51	48	42	32	22
12/09/2019 17:46:36	55	61	54	60	58	55	52	48	42	33	22
12/09/2019 17:51:36	54	73	53	60	58	54	51	48	42	32	22
12/09/2019 17:56:36	55	62	53	60	58	54	51	48	42	32	22
12/09/2019 18:01:36	60	76	54	60	58	54	51	48	42	32	22
12/09/2019 18:06:36	54	63	53	60	58	54	51	48	42	31	22
12/09/2019 18:11:36	56	74	53	60	58	54	51	48	42	32	21
12/09/2019 18:16:36	55	67	53	59	58	54	51	48	42	31	21
12/09/2019 18:21:36	54	67	53	59	57	54	51	48	42	31	21
12/09/2019 18:26:36	54	64	53	60	58	54	51	48	42	32	21
12/09/2019 18:31:36	54	63	53	59	57	54	51	48	42	31	21
12/09/2019 18:36:36	54	65	53	59	57	54	51	48	42	32	22
12/09/2019 18:41:36	55	75	53	59	57	54	51	48	42	31	21
12/09/2019 18:46:36	60	76	54	60	58	55	52	48	42	31	21
12/09/2019 18:51:36	54	70	53	59	57	54	51	48	42	31	21
12/09/2019 18:56:36	54	67	53	58	57	54	51	48	42	31	21
12/09/2019 19:01:36	55	64	53	60	57	54	51	48	42	32	22
12/09/2019 19:06:36	54	74	53	58	57	54	51	48	42	31	21
12/09/2019 19:11:36	55	75	53	59	57	54	51	48	42	32	21
12/09/2019 19:16:36	53	59	52	58	56	53	50	47	42	31	21
12/09/2019 19:21:36	56	67	53	58	56	53	51	48	42	31	21
12/09/2019 19:26:36	55	70	53	58	57	53	51	48	42	31	21
12/09/2019 19:31:36	53	66	52	58	56	53	50	47	42	31	21
12/09/2019 19:36:36	54	77	53	58	57	54	51	48	42	31	22
12/09/2019 19:41:36	54	64	52	58	56	53	50	47	42	31	21
12/09/2019 19:46:36	54	66	52	58	56	53	50	47	41	30	21
12/09/2019 19:51:36	53	59	53	58	57	53	51	47	41	31	21
12/09/2019 19:56:36	53	71	52	58	56	53	50	47	41	31	21
12/09/2019 20:01:36	53	62	52	57	57	53	50	47	41	31	21
12/09/2019 20:06:36	54	67	53	58	57	53	51	47	42	31	21
12/09/2019 20:11:36	53	59	52	58	57	54	50	47	41	31	21
12/09/2019 20:16:36	54	65	53	58	57	54	51	47	41	31	21
12/09/2019 20:21:36	53	63	52	58	56	53	50	47	41	31	22
12/09/2019 20:26:36	54	62	52	57	56	53	50	47	41	31	22
12/09/2019 20:31:36	54	65	53	58	57	54	50	47	41	31	21

12/09/2019 20:36:36	55	68	52	58	56	53	50	47	42	31	22
12/09/2019 20:41:36	53	63	52	57	57	53	50	47	41	31	21
12/09/2019 20:46:36	53	55	52	57	56	53	50	47	41	31	22
12/09/2019 20:51:36	53	59	52	57	56	53	50	46	41	30	21
12/09/2019 20:56:36	53	58	52	57	57	53	50	47	41	31	22
12/09/2019 21:01:36	54	58	52	58	56	53	50	47	42	31	21
12/09/2019 21:06:36	54	62	52	57	56	53	50	47	42	31	22
12/09/2019 21:11:36	53	61	52	57	57	53	50	47	41	30	21
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12/09/2019 21:36:36	52	57	51	56	55	52	49	46	41	30	21
12/09/2019 21:41:36	53	57	52	56	56	53	50	47	41	30	21
12/09/2019 21:46:36	52	58	52	56	56	52	49	46	41	30	22
12/09/2019 21:51:36	53	58	52	57	55	52	49	47	41	30	21
12/09/2019 21:56:36	53	63	52	57	56	53	50	46	41	30	21
12/09/2019 22:01:36	53	59	52	57	56	53	50	46	41	30	21
12/09/2019 22:06:36	53	56	52	57	56	53	50	47	41	30	22
12/09/2019 22:11:36	53	62	52	57	56	53	50	47	41	30	21
12/09/2019 22:16:36	53	69	51	57	56	52	49	46	41	30	21
12/09/2019 22:21:36	53	67	52	57	56	53	50	47	41	30	21
12/09/2019 22:26:36	53	61	52	57	56	52	49	46	41	30	21
12/09/2019 22:31:36	53	61	51	57	55	52	49	46	41	30	21
12/09/2019 22:36:36	56	75	51	58	55	52	49	46	41	30	21
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12/09/2019 22:46:36	52	65	51	57	55	52	49	46	40	30	21
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12/09/2019 23:11:36	53	66	50	56	54	51	48	46	40	30	21
12/09/2019 23:16:36	52	71	50	56	54	51	48	45	40	30	21
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12/09/2019 23:31:36	51	54	50	55	53	50	47	45	40	30	22
12/09/2019 23:36:36	51	56	50	56	53	50	47	45	40	30	21
12/09/2019 23:41:36	51	60	50	55	54	51	47	45	40	30	22
12/09/2019 23:46:36	51	54	50	56	54	50	47	45	40	30	22
12/09/2019 23:51:36	53	65	50	56	54	50	47	45	40	29	21
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13/09/2019 00:01:36	51	54	50	56	54	51	47	45	40	30	21
13/09/2019 00:06:36	52	64	50	55	53	50	47	45	40	29	22
13/09/2019 00:11:36	50	54	50	55	53	50	47	45	40	29	21
13/09/2019 00:16:36	50	56	50	54	53	50	47	45	40	29	22
13/09/2019 00:21:36	51	56	50	55	54	50	47	45	40	30	22
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13/09/2019 00:31:36	51	56	50	55	53	50	47	45	40	29	21
13/09/2019 00:36:36	51	62	50	55	53	51	47	45	40	30	22
13/09/2019 00:41:36	50	58	49	55	53	50	47	44	39	29	21
13/09/2019 00:46:36	51	57	49	55	53	50	47	45	39	29	21
13/09/2019 00:51:36	50	53	50	55	53	50	47	45	40	29	22

13/09/2019 00:56:36	50	57	50	55	53	50	47	45	40	29	22
13/09/2019 01:01:36	50	57	49	54	53	50	47	44	39	29	21
13/09/2019 01:06:36	50	57	50	55	53	50	47	45	40	29	22
13/09/2019 01:11:36	50	53	49	54	53	50	47	45	40	29	21
13/09/2019 01:16:36	50	53	49	55	53	50	47	44	40	29	22
13/09/2019 01:21:36	50	66	49	54	53	50	47	44	39	29	21
13/09/2019 01:26:36	50	61	49	54	53	50	47	44	39	29	21
13/09/2019 01:31:36	50	55	49	54	53	50	47	44	40	29	21
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13/09/2019 02:01:36	50	52	49	54	53	50	46	44	39	29	21
13/09/2019 02:06:36	50	53	49	54	53	50	47	44	40	29	21
13/09/2019 02:11:36	51	58	49	54	53	50	47	44	40	29	22
13/09/2019 02:16:36	50	53	49	54	53	50	47	45	40	29	22
13/09/2019 02:21:36	51	60	49	54	53	50	47	45	40	29	22
13/09/2019 02:26:36	50	54	49	54	53	50	47	44	39	29	22
13/09/2019 02:31:36	50	63	49	54	53	50	47	44	39	29	21
13/09/2019 02:36:36	50	56	49	54	53	50	47	44	39	29	21
13/09/2019 02:41:36	50	54	49	54	53	50	47	44	39	29	21
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13/09/2019 02:51:36	50	59	49	54	53	50	47	44	40	30	22
13/09/2019 02:56:36	50	54	49	54	53	50	47	44	39	29	21
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13/09/2019 03:06:36	50	53	49	54	53	50	47	44	39	29	22
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13/09/2019 03:36:36	51	64	49	54	53	50	47	44	39	30	23
13/09/2019 03:41:36	50	57	49	54	53	50	47	44	39	29	22
13/09/2019 03:46:36	50	54	49	54	53	50	47	44	39	29	22
13/09/2019 03:51:36	50	53	49	54	53	50	47	44	39	29	22
13/09/2019 03:56:36	50	54	49	54	53	50	47	44	39	29	22
13/09/2019 04:01:36	50	65	49	54	53	50	47	44	39	29	22
13/09/2019 04:06:36	50	53	49	54	53	50	47	44	39	29	22
13/09/2019 04:11:36	50	52	49	54	53	50	47	44	39	29	23
13/09/2019 04:16:36	50	62	50	55	54	50	47	44	40	30	23
13/09/2019 04:21:36	50	55	49	54	53	50	47	44	39	30	23
13/09/2019 04:26:36	50	55	49	54	53	50	47	44	39	29	22
13/09/2019 04:31:36	50	54	49	55	54	50	47	44	40	30	22
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13/09/2019 04:46:36	50	60	49	54	53	50	47	44	39	30	22
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13/09/2019 05:06:36	51	57	50	55	54	50	47	44	40	30	22
13/09/2019 05:11:36	51	55	50	55	54	50	47	44	40	30	22

13/09/2019 05:16:36	51	66	50	55	54	50	47	44	40	30	22
13/09/2019 05:21:36	50	55	50	55	54	50	47	44	40	30	23
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13/09/2019 05:56:36	51	62	50	56	54	51	48	45	40	30	23
13/09/2019 06:01:36	52	64	50	57	55	51	48	45	40	30	22
13/09/2019 06:06:36	53	63	52	56	56	53	49	46	41	30	22
13/09/2019 06:11:36	52	60	51	57	55	52	49	46	41	30	23
13/09/2019 06:16:36	54	68	51	57	55	52	48	45	41	30	23
13/09/2019 06:21:36	51	58	50	57	55	51	48	45	40	30	22
13/09/2019 06:26:36	52	63	50	58	55	51	48	45	40	30	22
13/09/2019 06:31:36	52	63	51	60	55	51	48	45	40	30	23
13/09/2019 06:36:36	53	63	50	57	55	51	48	45	40	30	23
13/09/2019 06:41:36	52	62	50	56	55	51	48	45	40	29	22
13/09/2019 06:46:36	52	58	50	57	55	51	48	45	40	30	22
13/09/2019 06:51:36	53	69	51	56	55	51	48	46	41	30	23
13/09/2019 06:56:36	52	63	51	57	55	52	49	45	40	30	22
13/09/2019 07:01:36	52	64	50	57	55	51	48	45	40	30	22
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13/09/2019 08:01:36	55	65	51	59	56	52	49	46	41	31	22
13/09/2019 08:06:36	54	66	51	58	56	52	49	46	41	31	22
13/09/2019 08:11:36	54	64	52	58	56	53	50	47	41	32	23
13/09/2019 08:16:36	59	71	53	59	56	53	51	48	43	33	24
13/09/2019 08:21:36	58	69	53	59	56	53	50	47	43	33	24
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13/09/2019 08:31:36	59	68	53	59	56	53	51	48	44	34	25
13/09/2019 08:36:36	54	67	52	59	56	53	50	47	43	34	24
13/09/2019 08:41:36	56	67	52	59	56	53	50	47	42	33	22
13/09/2019 08:46:36	56	68	53	60	57	54	51	48	43	33	23
13/09/2019 08:51:36	56	67	53	60	57	54	50	47	42	33	22
13/09/2019 08:56:36	56	64	52	59	56	53	50	47	42	32	22
13/09/2019 09:01:36	58	73	52	59	57	53	50	47	42	32	22
13/09/2019 09:06:36	55	69	52	60	56	53	50	47	42	32	22
13/09/2019 09:11:36	57	67	53	61	57	53	50	47	42	32	22
13/09/2019 09:16:36	55	62	53	60	57	54	51	48	43	33	22
13/09/2019 09:21:36	57	66	54	60	57	54	51	49	43	34	22
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13/09/2019 09:31:36	57	68	52	60	57	53	50	47	42	33	22

13/09/2019 09:36:36	55	68	53	60	56	53	50	48	43	33	22
13/09/2019 09:41:36	57	68	53	60	57	54	51	48	43	34	22
13/09/2019 09:46:36	56	68	53	60	57	54	51	48	42	33	21
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13/09/2019 09:56:36	54	67	52	59	56	53	50	47	42	32	21
13/09/2019 10:01:36	54	71	52	59	56	53	50	46	42	32	21
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13/09/2019 10:21:36	53	59	52	58	56	52	49	46	41	32	21
13/09/2019 10:26:36	53	69	51	58	56	52	49	46	41	32	21
13/09/2019 10:31:36	58	70	54	58	56	52	49	46	48	41	21
13/09/2019 10:36:36	56	66	52	59	56	53	50	47	42	33	22
13/09/2019 10:41:36	55	74	52	58	56	53	50	47	42	32	21
13/09/2019 10:46:36	54	67	52	58	57	53	50	47	41	32	21
13/09/2019 10:51:36	55	64	52	58	56	52	49	46	42	32	21
13/09/2019 10:56:36	55	67	52	58	57	53	50	46	41	32	21
13/09/2019 11:01:36	54	65	52	59	57	52	50	46	42	32	21
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13/09/2019 11:11:36	56	69	52	58	56	53	50	47	42	33	23
13/09/2019 11:16:36	55	65	52	58	57	53	50	47	42	33	21
13/09/2019 11:21:36	55	68	52	58	56	52	50	47	42	33	22
13/09/2019 11:26:36	56	70	52	58	56	53	50	47	42	32	21
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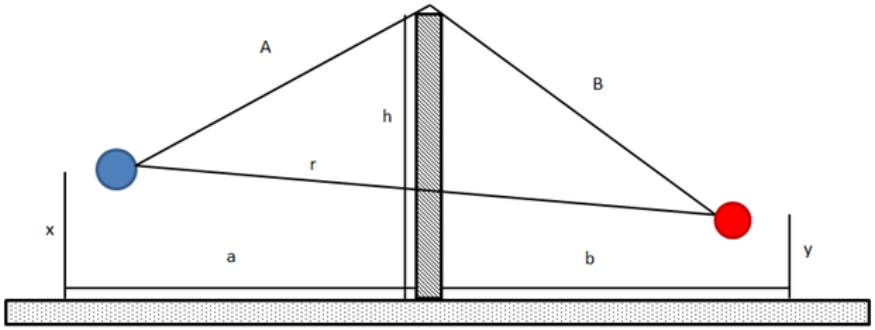
13/09/2019 11:56:36	53	60	52	58	57	52	50	47	41	32	21
13/09/2019 12:01:36	56	72	53	58	57	53	51	47	42	33	22
13/09/2019 12:06:36	55	65	53	59	57	53	51	47	42	33	21
13/09/2019 12:11:36	60	82	53	58	57	53	51	48	43	34	23

Appendix G: Screening Calculation

Barrier Calculation

1	Source height	**1.68 m**	x	A = 5.07 m
	Receiver height	**2.00 m**	y	B = 17.01 m
	Barrier height	**2.50 m**	h	r = 22.00 m
2	Source to barrier	**5.00 m**	a	Line of sight? NO
	Barrier to Receiver	**17.00 m**	b	
3	**Kb = 5**	5 for barrier 8 for berm		PATH DIFF 0.07 m



Octave Band	Hz	63	125	250	500	1000	200	4000	8000
Screen Losses (SRL Book)	dB	7	7	8	9	10	12	13	14
Octave Band	Hz	63	125	250	500	1000	2000	4000	8000
Screen Losses (Maekawa)	dB	5	5	6	7	9	12	15	18
Total Screen Loss	**dB**	**5**	**5**	**6**	**7**	**9**	**12**	**15**	**18**

When calculating using octave bands the overall reduction in dB is 8dB using the Maekawa method.

Appendix H: Manufacturer's Published Noise Levels

RYYQ-T (up to 20 hp)

VRV IV heat pump with continuous heating

Outdoor Units			RYYQ8T	RYYQ10T	RYYQ12T	RYYQ14T	RYYQ16T	RYYQ18T	RYYQ20T
Capacity	Nominal Cooling	kW	22.40	28.00	33.50	40.00	45.00	50.00	56.00
	Nominal Heating	kW	25.00	31.50	37.50	45.00	50.00	56.00	63.00
EER			4.30	3.84	3.73	3.64	3.46	3.40	3.03
ESEER			7.53*	7.2*	6.96*	6.83*	6.5*	6.38*	5.67*
COP			4.54	4.27	4.12	4.02	3.91	3.89	3.71
Dimensions	Height x Width x Depth	mm	1685 x 930 x 765	1685 x 930 x 765	1685 x 930 x 765	1685 x 1240 x 765	1685 x 1240 x 765	1685 x 1240 x 765	1685 x 1240 x 765
Weight		kg	261	268	268	364	364	398	398
Air Flow Rate		m³/sec	2.700	2.917	3.083	3.717	4.333	4.183	4.350
External Static Pressure	High	Pa	78	78	78	78	78	78	78
Electrical Details	Power Supply	Phase / Hz / V	3 / 50 / 380~415						
	Running Current	amps	8.4	11.5	14.2	17.2	20.6	23.4	29.5
	Starting Current	amps	4						
	Fuse Rating	amps	20	25	32	32	40	40	50
Refrigerant Circuit	Refrigerant Type		R410A						
	Refrigerant Charge	kg	5.9	6.0	6.3	10.3	10.4	11.7	11.8
	Additional Charge	kg	data book						
Sound Pressure		dBA	58	58	61	61	64	65	66
Sound Power		dBA	78	79	81	81	86	86	88
Piping Limits	Maximum Length	m	165	165	165	165	165	165	165
	Maximum Vertical Rise	m	data book						
Piping Connections	Liquid	inch (mm)	3/8 (9.5)	3/8 (9.5)	1/2 (12.7)	1/2 (12.7)	1/2 (12.7)	5/8 (15.9)	5/8 (15.9)
	Gas	inch (mm)	3/4 (19)	7/8 (22.2)	1 1/8 (28.6)	1 1/8 (28.6)	1 1/8 (28.6)	1 1/8 (28.6)	1 1/8 (28.6)
Capacity Index Limit			100~260	125~325	150~390	175~455	200~520	225~585	250~650
Maximum Number of Connected Indoor Units			64	64	64	64	64	64	64

Low noise mode data

			8HP	10HP	12HP	14HP	16HP	18HP	20HP
Standard	sound pressure	dBA	58	58	61	61	64	65	66
	Cooling Capacity/Heating Capacity (Norminal)	kW	22.4	28.0	33.5	40.0	45.0	50.0	56.0
	Heating Capacity (Max)	KW	25.0	31.5	37.5	45.0	50.0	56.0	63.0
Low noise level 1	Sound pressure	dBA	56	58	58	58	58	60	60
	Cooling Capacity	kW	20.6	28.0	29.5	35.2	36.9	45.0	47.6
	ratio	-	92%	100%	88%	88%	82%	90%	85%
	Heating Capacity	kW	21.3	28.4	28.9	34.2	35.0	45.9	47.3
	ratio (VS Max)	-	85%	90%	77%	76%	70%	82%	75%
Low noise level 2	Sound pressure issue value	dBA	55	54	54	52	52	52	52
	Cooling Capacity	kW	20.2	23.5	25.1	30.0	31.5	35.0	36.4
	ratio	-	90%	84%	75%	75%	70%	70%	65%
	Heating Capacity	kW	21.3	22.7	23.6	27.9	28.5	33.6	34.7
	ratio (VS Max)	-	85%	72%	63%	62%	57%	60%	55%
Low noise level 3	Sound pressure	dBA	53	52	52	47	47	48	48
	Cooling Capacity	kW	15.7	21.6	23.5	24.0	24.8	27.5	28.0
	ratio	-	70%	77%	70%	60%	55%	55%	50%
	Heating Capacity	kW	16.3	20.5	21.4	21.6	22.0	24.6	25.2
	ratio (VS Max)	-	65%	65%	57%	48%	44%	44%	40%

Ambient condition: Cooling 35 DB./heating 6 WB
Indoor: 100% connection

Used to reduce operation noise level through reduction	Use the "External control adapter."
of the upper limit of the fan using internal input. (Use	Set "Setting mode No. 12"
Step 8 for normal operation.)	to "ON" and select a mode with No. 25.
(1) Level 1: Not higher than Step 7	Set "Setting mode No. 29:
(2) Level 2: Not higher than Step 5	Capacity priority setting" to "ON," as appropriate.
(3) Level 3: Not higher than Step 5	

EXTRACT FAN SIZE DE6 - SOUND DATA

Unit Code		Sound Power Levels dB re 1pW 63	125	250	500	1K	2K	4K	8K	Breakout dBA @ 100% @ 3m	LwA	Breakout dBA @ 75% @ 3m	Breakout dBA @ 50% @ 3m
DE6-ES	Induct Inlet	92	88	76	69	68	63	62	55	40	79	34	25
	Induct Outlet	92	88	76	69	68	63	58	51		76		
	Breakout	76	68	67	54	55	44	39	32		78		
DE6A-ES	Induct Inlet	81	88	81	66	55	56	53	49	39	75	33	24
	Induct Outlet	89	89	71	68	66	62	57	50		75		
	Breakout	69	68	67	52	47	40	34	28		78		