Bishop Auckland Bus Station and Car Park

PLANNING NOISE REPORT

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Project Manager:	Dominic Brown
Author:	P. BUSHELL
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Jacobs
2nd Floor Cottons Centre
Cottons Lane
London SE1 2QG
England
Phone: +44 (0)203 980 2000
www.jacobs.com

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Executive Summary

A noise impact assessment has been undertaken to support the planning application for a proposed new bus station and car park in Bishop Auckland, County Durham. The assessment has been formed from a combination of site survey work and a desk-based indicative noise impact assessment.

The proposed development site is the current existing bus station site and ground level car park in Bishop Auckland, between Clayton Street and Saddler Street. The proposals for the development include a reconfigured car parking area to include more car parking bays, and a reconfigured bus station with a new bus station hub and passenger concourse building, hereafter referred to as the Proposed Scheme.

Following a consultation with the Environmental Health Department at Durham County Council an ambient noise survey was completed at the site and sensitive receptor locations in March 2022. The intention of the survey was to establish the representative background and ambient sound levels at the proposed development site and sensitive receptor locations. The measured data from the survey has been used to inform a qualitative construction noise assessment and an indicative assessment of sound levels generated by the operation of fixed plant items associated with the Proposed Scheme.

The results of the qualitative construction noise assessment for the Proposed Scheme anticipate that the noise and vibration impact of the construction phase would be not significant. It is noted that a quantitative construction noise and vibration assessment will need to be undertaken as part of the construction noise environmental management plan (CEMP) when the principal contractor is appointed. The CEMP, prepared by the principal contractor, will need to be submitted to and agreed with Durham County Council prior to the commencement of any works on-site.

An initial indicative assessment has been completed to BS4142:2019 to predict the potential impact of sound levels generated by the operation of fixed plant items associated with the Proposed Scheme. Following the application of mitigation measures, as advised in this report, the results of the indicative assessment for both daytime and night-time identify that no noise impact is likely to occur at sensitive receptors.

It is noted that the BS4142 assessment has been based on the preliminary plant specification available at RIBA Stage 3, which may be subject to change as the design of the Proposed Scheme progresses. It is therefore recommended that the predicted rating levels identified in this report be secured by the implementation of a suitable noise planning condition.

1. Introduction

A new bus station and car park is proposed at the existing bus station site in Bishop Auckland, County Durham. Jacobs were commissioned to undertake a noise impact assessment of the new bus station and car park, to support the planning application. The assessment has been formed from a combination of site survey work and a desk-based assessment.

A consultation was undertaken with Durham County Council (DCC) in March 2022 to agree a suitable approach and methodology for the ambient sound survey, and corresponding noise assessment of the new bus station and car park, hereafter referred to as the Proposed Scheme. The results of the ambient noise survey, also undertaken in March 2022 have been used to inform the assessment.

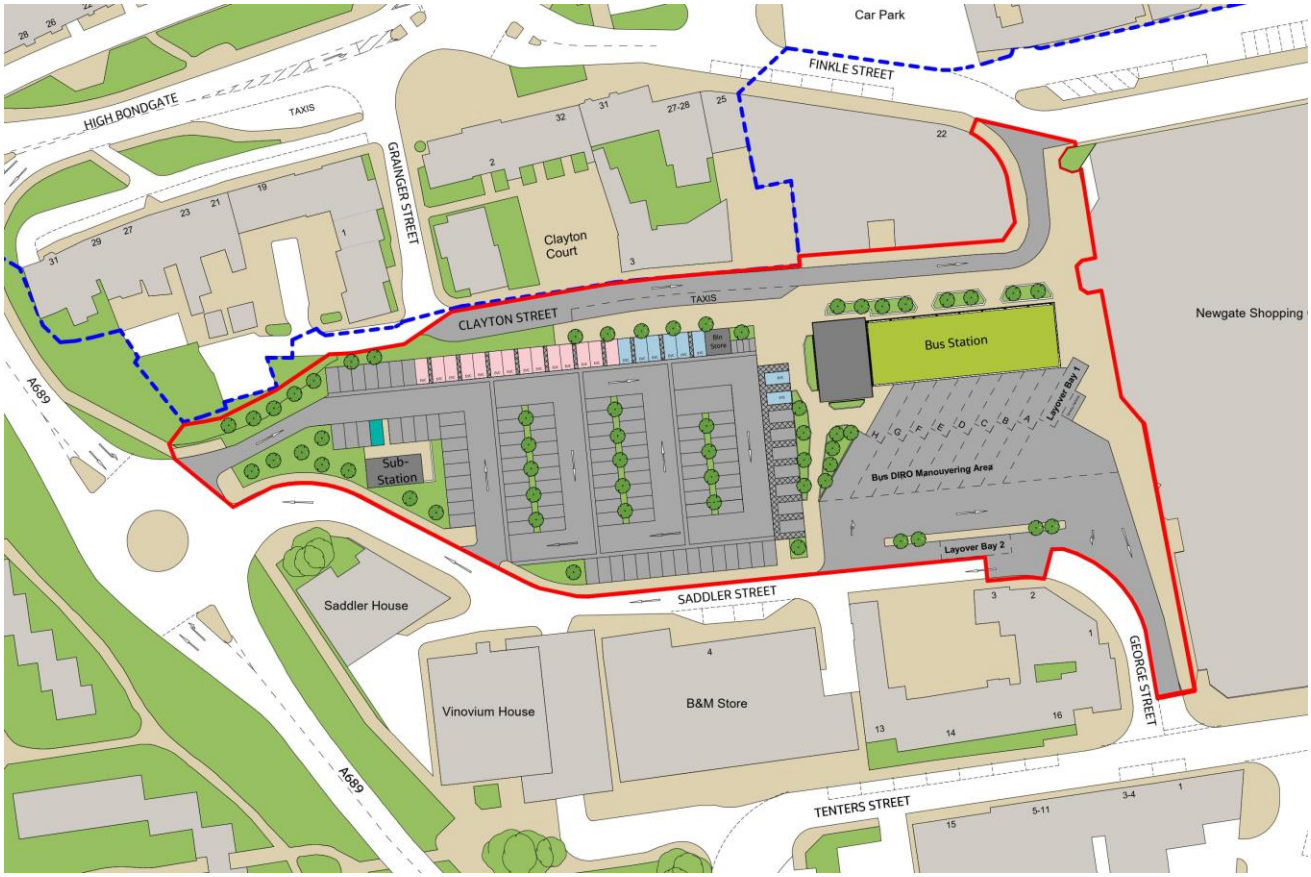
1.1 Scope

The scope of this assessment includes an ambient noise survey to establish the existing baseline sound conditions at the development site and noise sensitive receptors (NSR). The results of the survey have been used to inform a qualitative construction noise assessment with reference to BS5228 (discussed in Section 2), and an initial indicative assessment of sound levels from the operation of fixed plant to BS4142 (also discussed in Section 2) to determine the significance of the potential impact as a result of operational activity at the site. This report documents the methodology and results of the assessment. A glossary of acoustics terminology is provided in Appendix A.

1.2 Site Description

The proposed development site is located on the existing bus station site in Bishop Auckland, between Clayton Street and Saddler Street. A plan of the proposed development site to show the layout of the car park, bus station and development red line boundary is shown in Figure 1.1.

Figure 1.1: Proposed Scheme layout



2. Legislation, Guidance, and Methodology

This section provides a summary of the relevant National noise legislation, British Standards and guidance documents used to guide and inform the assessment.

2.1 Noise Policy Statement for England (NPSE)

Any new development or works must take into consideration the Government's policy on noise. This is set out in the Noise Policy Statement for England (NPSE) which was published in March 2010 (Department for Environment Food and Rural Affairs, 2010). It contains the high-level vision of promoting good health and good quality of life (well-being) through the effective management of noise. It is supported by three aims which are to be achieved through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development. These aims are:

- avoid significant adverse impacts on health and quality of life;
- mitigate and minimise adverse impacts on health and quality of life; and
- where possible, contribute to the improvement of health and quality of life.

The aims would need to be considered when undertaking the impact assessment, especially the treatment of any adverse impacts, but also the possibility for enhancement.

2.2 Control of Pollution Act 1974 (CoPA)

The Control of Pollution Act (CoPA) grants powers to deal with noise nuisances and places a duty on local authorities to inspect their areas from time to time to detect anything which should be dealt with under the Act. It also defines and empowers local authorities to create noise abatement zones within their areas. However, few local authorities have chosen to do this.

Much of CoPA has now been replaced and extended by the Environmental Protection Act 1990. However, Sections 60 and 61 which relate to noise and vibration from construction sites remain relevant.

Section 60 of CoPA allows a local authority to serve a notice of its requirements for the control of site noise to the individual or entity carrying out or controlling the works. The notice may stipulate noise limits for work, plant or machinery that should be avoided, hours during which construction activities may be carried out and provide for any change in circumstances.

Section 61 (S61) of CoPA concerns the procedures adopted when a contractor or developer approaches the local authority prior to any construction activities taking place, with the intention of agreeing noise and vibration limits in advance of works.

If consent is granted under S61, then this would be considered a valid defence by the Magistrate's court if the local authority was to later reverse its position and pursue an action under Section 60.

2.3 BS5228-1:2009 + A1:2014: 'Code of practice for noise and vibration control on construction and open sites Part 1: Noise'

The British Standard 5228-1 provides suitable methods for the calculation of noise from construction activities, including basic information regarding noise levels from a range of construction equipment.

2.4 BS 7445 Parts 1-3 (BSI, 1991-2003)

British Standard 7445-2:1991 "Description and measurement of environmental noise - Part 2: Guide to the acquisition of data pertinent to land use" describes methods to be used for measuring and describing environmental noise levels at a site in a consistent manner. This standard describes procedures for determining the long term average noise level and provides recommendations on:

- Measurement equipment;
- Locations and numbers of measurement positions;
- Measurement time intervals;
- Acceptable metrological conditions; and
- Information to be recorded and reported.

The surveys described in Section 4 below have been carried out with reference to the guidance and requirements contained in BS 7445-2:1991 (BSI, 1991).

2.5 BS 4142:2014+A1:2019

BS 4142:2014+A1:2019 – Methods for rating and assessing industrial and commercial sound (hereafter referred to as BS4142) details procedures for rating and assessing sound from commercial or industrial facilities to determine the likelihood of disturbance the sound emitted from such facilities has (or might have) upon persons using nearby premises for residential purposes.

Using BS 4142 the likelihood of disturbance is determined through comparison of the sound attributable to the existing or future source, defined as the 'specific sound level' (expressed as L_{Aeq}), against the typical and representative background sound level (expressed as L_{A90}). Where applicable, the specific sound level is adjusted to take into account characteristic features such as tonality, discrete impulses and intermittency. The resulting 'corrected' specific sound level (the correction is 0 dB where no features are present) is defined as the 'rating level' (expressed as $L_{Ar,Tr}$). In respect of the comparison between the rating level and the background sound level, BS 4142 states the following:

- Typically, the greater this difference, the greater the magnitude of the impact.
- A difference of around +10 dB or more 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.
- 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. Sensitive Receptors

The site for the Proposed Scheme is the existing bus station and carpark site, situated a in mixed commercial and residential area in Bishop Auckland. The residential NSR locations used in the assessment were agreed with DCC in the consultation in March 2022 and are shown Table 3.1 and on Figure 3.1. The NSR locations used in the assessment are considered to adequately represent all key residential receptors affected by noise from the Proposed Scheme.

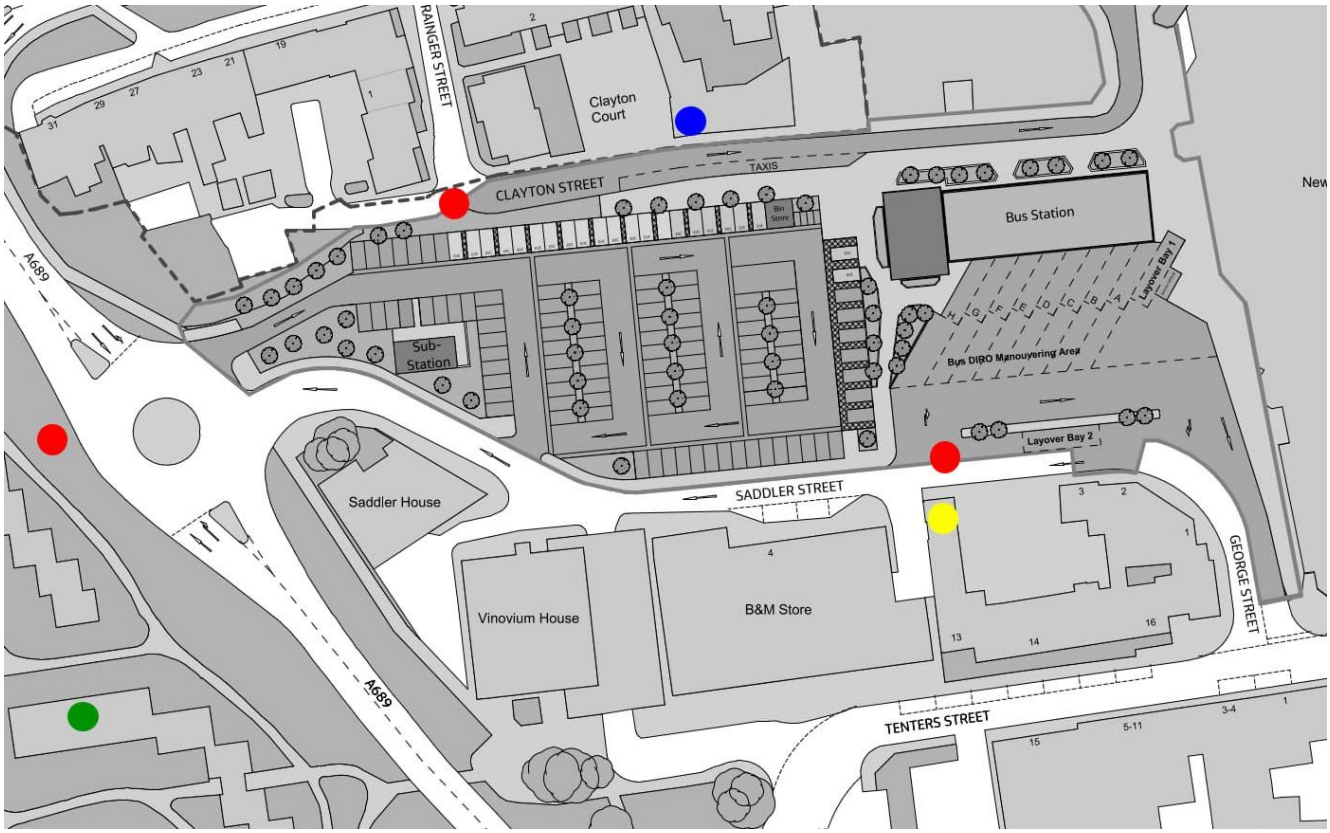
Table 3.1: Representative sensitive receptors included in the assessment

NSR Address	Receptor Type	Distance from proposed new bus station building, m
13 Tenters Street (rear of property)	Residential	48
3 Clayton Court	Residential	40
14 Edgar Grove	Residential	170

The NSR are shown in Figure 3.1 and represented by coloured circles at Tenters Street (yellow circle), Clayton Court (blue circle) and Edgar Grove (green circle).

The red circles identify the measurement locations used in the ambient noise survey (discussed in Section 4) undertaken in March 2022.

Figure 3.1: Representative residential receptors included in the assessment



4. Ambient Noise Survey, Methodology and Results

4.1 Survey Methodology

The general methodology employed for the survey is described in this section.

Environmental sound levels were measured as an attended exercise at three representative locations. The survey took place during the daytime of Monday 14th and the night-time of Tuesday 15th March 2022. There was no rainfall during the survey, temperature was between 8 degrees during the daytime, dropping to 4 degrees during the night-time. Wind speeds were below 2m/s for the duration of the survey. The sound level meter was set up using a propriety windshield and mounted on a 1.5 m high tripod. All measurements were undertaken with due regard to the Standards described in Section 2.

The sound level meter used during survey one was a RION NL-32 (serial number: 00976222) Class 1 precision grade sound level meter, with a RION NC-74 calibrator (serial number: 34494274). The equipment used for the survey was laboratory calibrated within 12 months prior to the survey. The sound level meter was calibrated before and after the survey measurements, no significant drift was found to occur in the calibration values during the survey.

The sound level indices recorded during the measurements include broadband L_{Aeq}, L_{A90}, L_{Amax} and L_{Amin}.

4.2 Results Summary

As a precautionary measure the lowest measured L_{A90} data, rounded to the nearest whole integer value, have been used to establish the representative background sound level for both the day and night-time periods. A summary of the results is provided in Table 4.1. Appendix B shows the full results of survey.

Table 4.1: Representative background sound level at receptors

Survey period	**Representative background sound level, L_{A90} dB**
Daytime 0700hrs to 2300hrs	46
Night-time 2300hrs to 0700hrs	26

5. Outline Construction Assessment

Any construction activity has the potential to adversely impact nearby noise sensitive receptors. Noise impact has the potential to be significant where works take place within approximately 300m of sensitive receptors, such as residential properties, particularly where these already experience high levels from dominant sources such as road traffic.

It is understood that at the time of writing this report the construction plant list, works phasing and programme are still under development, these will be finalised when the principal contractor is appointed. When appointed, the principal contractor will develop a construction noise environmental management plan to minimise noise and vibration throughout the construction phase. In order to set out the main principles for consideration a qualitative assessment approach is provided in this report, which focusses on good practice measures for noise control and approved hours for noisy construction activities.

During the survey undertaken in March 2022, daytime ambient noise levels were measured at the development site in the range of 52 to 69 L_{Aeq} dB. This ambient noise level range should be taken into consideration during the preparation of the Construction Environmental Management Plan (CEMP), with due consideration to establishing construction noise threshold levels as set out in Table E1, Page 119, BS5228-1:2009.

Construction activities included in the Proposed Scheme that are likely to generate noise are, but not limited to:

- Ground works and site clearance
- Road laying
- Construction of pavements and walkways
- Concrete cutting
- Use of power tools and heavy plant
- Construction of bus station concourse building
- Erection of fences and barriers

The following standard construction working hours are likely to be suitable, however these should be agreed between the appointed contractor and DCC as part of the CEMP:

- Weekdays 07:00 to 19:00 hours
- Saturday 07:00 to 13:00 hours
- Sunday/Bank Holidays No noisy activities (noisy activities include the use of plant or equipment which are audible at the site boundary)

Section 60 of the CoPA 1974 enables local authorities in whose area work is going to be carried out to serve a notice of its requirements for the control of site noise on the person/entity who appears to the local authority to be responsible for carrying out the works. As such, there is the potential for the local authority to serve a notice requiring details of the proposed plant or machinery and construction methods to be used.

The potential impacts of the construction activities can be minimised by implementation of the CEMP, the use of best practicable means (BPM) under Section 72 of CoPA 1974 and good practice under BS 5228 Part 1: Noise and BS 5228 Part 2: vibration. These are general principles for the control of noise and vibration during the construction works which include, but are not limited to:

- Selecting quieter plant and equipment;
- Turning equipment off when they are not in use;
- Providing enclosures around fixed plant like power generators or using mains power;
- Ensuring that all plant and equipment are well maintained;
- Public liaison;
- Use rubber linings in chutes and dumpers to reduce impact noise;
- Minimise drop heights of materials;
- Start plant up sequentially rather than simultaneously;
- Move fixed plant away from identified noise sensitive locations;
- Modify existing plant with noise attenuation packages such as acoustic enclosures and attenuators;
- Avoid using diesel power generators and use local electricity grid wherever possible;
- For impact driven piling, a non-metallic dolly between the hammer and the driving helmet should be used;
- Introducing an acoustic shroud for impact driven piles;
- Choose quieter piling methods, and;
- Avoiding unnecessary revving of engines.

With the identified measures in place it is anticipated that significant noise and vibration effects should be avoided in line with the NPSE.

6. Indicative Noise Assessment

This section of the report considers the potential noise impact as a result of the operation of the Proposed Scheme.

A BS4142 assessment has been completed, which considers sound levels from the operation of fixed plant associated with the bus station passenger concourse building and sub-station. The assessment provides an indicative estimate of noise impact associated with the operation of the Proposed Scheme.

6.1 Fixed Plant

There will be fixed plant associated with the new bus station building and sub-station, through discussions with the design team the main fixed plant items are understood to include:

- 2No. variable refrigerant flow (VRF) units located on the roof of the new bus station building;
- Air handing units (AHU) located internally within the first-floor plant room of the new bus station building;
- 1No. condenser unit at ground level against the west facing façade of the bus station building, and;
- Sub-station transformer located in car park.

With the exception of the sub-station transformer, the assessment has used the manufacturers warranted sound power level data from the preliminary plant equipment specification, which are included in Appendix C for reference. It is noted that at this stage (RIBA Stage 3) these are considered as representative plant only, changes to the equipment specification may be required as the Proposed Scheme design is refined and progresses through the subsequent design stages. Table 6.1 provides sound power levels for the preliminary plant equipment proposed at RIBA Stage 3.

Table 6.1: Sound power levels for the preliminary plant equipment specification

Plant item	**Unit details**	**Manufacturer's specifications sound power level, dB(A)**
VRF	Mitsubishi R2 series PURY-P200YNW-A1	71
AHU supply louvre	Air handling systems Ltd AHU 10ACH & AHU 6ACH	75
AHU discharge louvre		80
Condenser unit	Daikin EWAT016CZN-A1	76
Sub station	Transformer*	75

*At this stage a manufacturers specification is not available for the substation transformer. To inform the assessment sound power level data for an indicative 6000 kVA transformer has been sourced from Table 11.28, page 602, Bies and Hansen, Engineering Noise Control Theory and Practice, Fourth Edition, 2009.

The substation building will house a transformer, at this stage it is assumed the sub-station building will include standard weather louvres to provide ventilation and cooling.

The VRF units will be located on the rooftop of the bus station hub building and will benefit from the screening provided by the rooftop parapet.

The AHUs will be located internally in the first floor plant room, the supply and discharge air connections will be ducted to louvres located on the east and west facing elevations of the bus station hub building at first floor level.

The cumulative sound level produced by all plant items operating simultaneously at base load have been predicted at the NSR locations. A summary of the results is shown in Table 6.2. The full calculations are shown in Appendix D.

Table 6.2: Predicted sound levels at NSR locations from fixed plant

NSR	NSR location	Predicted specific sound level, Ls dB(A)
NSR 1	13 Tenters Street	34
NSR 2	3 Clayton Court	34
NSR 3	14 Edgar Grove	24

The predicted specific sound levels from Table 6.2 have been used to inform the BS4142 assessment.

6.2 Acoustic Feature Correction

A BS4142 assessment requires that an 'acoustic feature correction' is considered and added to the specific noise level (L_s) in order to obtain the rating noise level at the NSR location.

The subjective method in BS4142 recommends a penalty correction of 2 dB where the specific level contains a tonal component which is just perceptible and a 4 dB correction where it is clearly perceptible. The building services plant proposed for installation is not considered to have intermittent or impulsive characteristics, however, there may be a tonal characteristic due to low level fan noise. Therefore, a tonal correction of 2dB has been duly applied to the assessment.

6.3 Assessment Summary

Tables 6.3 and 6.4 present a summary of the BS 4142 assessment for daytime and night-time respectively.

Table 6.3: BS4142 assessment summary – Daytime

Results	Levels			Relevant BS4142 Clause	Commentary
	NSR 1	NSR 1	NSR 3		
Background sound level Daytime L_{A90} dB	46	46	46	8	Obtained via measurement considered representative of each NSR location.
On time corrections	0	0	0	7.3.14	Plant has the potential to operate continuously, no correction applied.
Specific sound level (L_s)	34	34	24	7.3.1	Ls calculated as per Table 6.2
Acoustic feature correction	2	2	2	9.2	Acoustic feature correction applied for just perceptible tonal contribution
Rating level (L_r) (Specific Level + Acoustic feature correction)	36	36	26	9.1	Specific noise + feature penalty.
Difference in Rating Level relative to Background Sound Level	-10	-10	-20	9.1	Assessment indicates no impact.

The results of the BS4142 assessment for the daytime identify that no noise impact is likely to occur as a result of the Proposed Scheme.

Table 6.4: BS4142 assessment summary – Night time

Results	Levels			Relevant BS4142 Clause	Commentary
	NSR 1	NSR 1	NSR 3		
Background sound level Daytime L_{A90} dB	26	26	26	8	Obtained via measurement considered representative of each NSR location.
On time corrections	0	0	0	7.3.14	Plant has the potential to operate continuously, no correction applied.
Specific sound level (L_s)	34	34	24	7.3.1	Ls calculated as per Table 6.2
Acoustic feature correction	2	2	2	9.2	Acoustic feature correction applied for just perceptible tonal contribution
Rating level (L_r) (Specific Level + Acoustic feature correction)	36	36	26	9.1	Specific noise + feature penalty.
Difference in Rating Level relative to Background Sound Level	10	10	0	9.1	Assessment indicates adverse impact at NSR 1 (Tenters Street) and NSR 2 (Clayton Court)

The results of the BS4142 assessment for the night-time identify an indication of an adverse impact at NSR 1 and NSR 2 as a result of the Proposed Scheme.

A review of the plant sound power levels has identified that the dominant sources are the AHU supply and discharge louvres at the first-floor level of the bus station building and the external condenser unit at ground level. To reduce operational sound levels the following mitigation items are recommended:

- Acoustic louvres are recommended for the AHUs with a minimum acoustic insertion loss of 15 dB
- A sound reducing acoustic pack should be fitted to the ground level condenser unit with a minimum insertion loss of 10dB

The BS4142 night time assessment is repeated in Table 6.5 with the recommended mitigation applied.

Table 6.5: BS4142 assessment summary with mitigation – Night time

Results	Levels			Relevant BS4142 Clause	Commentary
	NSR 1	NSR 1	NSR 3		
Background sound level Daytime L_{A90} dB	26	26	26	8	Obtained via measurement considered representative of each NSR location.
On time corrections	0	0	0	7.3.14	Plant has the potential to operate continuously, no correction applied.
Specific sound level (L_s)	22	23	18	7.3.1	Ls calculated with recommended mitigation applied to AHU louvres and ground level condenser.
Acoustic feature correction	2	2	2	9.2	Acoustic feature correction applied for just perceptible tonal contribution
Rating level (L_r) (Specific Level + Acoustic feature correction)	24	25	20	9.1	Specific noise + feature penalty.
Difference in Rating Level relative to Background Sound Level	-2	-1	-6	9.1	Assessment indicates no impact.

The results of the BS4142 assessment for the night-time with the recommended mitigation applied identify that no noise impact is likely to occur as a result of the Proposed Scheme.

6.4 Noise from vehicle movements

The development site is currently divided between an operating bus station and ground level car park with a capacity of approximately 70 car parking bays. The Proposed Scheme is a reconfiguration of the existing bus station and car parking layout with the addition of a new bus station hub and passenger concourse building.

The capacity of the new car parking area will be increased from the existing 70 bays to approximately 100 bays and will be relocated to the north-west of the site, as illustrated in Figure 1.1.

The character of the noise produced by the operation of the Proposed Scheme will be the same as produced currently at the site and will include slow moving buses and cars entering the site, manoeuvring, and leaving the site. The Proposed Scheme is therefore considered unlikely to result in significant noise effects from vehicle movements at NSR locations.

7. Summary and Conclusions

A noise impact assessment has been undertaken to support the planning application for a proposed new bus station and car park in Bishop Auckland, County Durham. The assessment has been formed from a combination of site survey work and a desk-based assessment.

An ambient noise survey was completed at sensitive receptor locations in March 2022 to establish the representative background and ambient sound levels. These data have been used to inform the qualitative construction noise assessment and the initial BS4142 assessment for fixed plant items.

During the construction phase it is anticipated that the noise and vibration impact of the Proposed Scheme would be not significant. With respect to the NPSE construction noise and vibration levels are anticipated to be between LOAEL and SOAEL. A quantitative construction noise and vibration assessment will be undertaken as part of the CEMP when the principal contractor is appointed. The CEMP will be submitted to Durham County Council and agreed prior to the commencement of any works on-site.

The character of the noise produced by the operation of the Proposed Scheme will be the same as produced currently at the site and will include slow moving buses and cars entering the site, manoeuvring, and leaving the site. The Proposed Scheme is therefore considered unlikely to result in significant noise effects from vehicle movements at NSR locations.

An initial assessment has been completed to BS4142 to predict the noise impact of the operation of fixed plant items during the operation of the Proposed Scheme. With the acoustic mitigation recommended for AHU louvres and the ground level condenser applied, the results of the assessment for both daytime and night-time identify that no noise impact is likely to occur.

It is noted that the BS4142 assessment has been based on the preliminary plant specification available at RIBA Stage 3, which may be subject to change as the design of the Proposed Scheme progresses. It is therefore recommended that the predicted rating levels identified in the report are secured by the implementation of a suitable noise planning condition.

Appendix A. Glossary of Acoustics Terminology

A sound wave travelling through the air is a regular disturbance in ambient atmospheric pressure. These pressure fluctuations, when of frequencies within the audible range, are detected by the human ear which passes nerve responses to the brain, producing the sensation of hearing. The audible range is generally quoted as 20 Hz to 20 kHz frequency range.

Noise has been defined in a variety of ways and is very much dependent on factors such as the listener's attitude to the source of the sound and their environment but is essentially any sound that is unwanted by the recipient.

It is impossible to measure the degree of nuisance caused by noise directly, as this is essentially a subjective response of the listener, but it is possible to measure the "loudness" of that noise. Loudness is related to both the sound pressure (the magnitude of the maximum excursion of the pressure wave around the ambient atmospheric pressure) and the frequency, both of which can be measured.

The human ear is sensitive to a wide range of sound levels; the sound pressure level of the threshold of pain is over a million times that of the quietest audible sound. In order to reduce the relative magnitude of the numbers involved, a logarithmic scale of decibels (dB) based on a reference level of the lowest audible sound is used.

The response of the human ear is not constant over all frequencies. It is therefore usual to weight the measured sound level per frequency to approximate human response. This is achieved by using filters to vary the sound contribution at different frequencies of a measured signal. The "A-weighting" network is the most commonly used and has been shown to correlate closely to the non-linear and subjective response of humans to sound. The use of this weighting is denoted by a capital A in the unit abbreviation (i.e. LAmax, LAeq, LA90 etc.) or a capital A in brackets after a dB level (i.e. 3 dB(A)).

Sound Pressure Level: The sound pressure level (Lp or SPL) is the instantaneous acoustic pressure and is measured in decibels (dB). Since the ear is sensitive to variations in pressure, rather than source power or intensity, the measurement of this parameter gives an indication of the impact on people. The SPL is defined as:

$$SPL = 10\log_{10}\left(\frac{p^2}{p_{ref}^2}\right) \quad \text{or} \quad SPL = 20\log_{10}\left(\frac{p}{p_{ref}}\right)$$

where:

p is the rms pressure of the sound in question (in pascals)

p_{ref} is the reference sound pressure, defined as the limit of human audibility (2 x 10-5 Pa)

Sound Power Level: The sound power level (LW or PWL) is a measure of the acoustic energy output of a source and is a property of the source itself. The PWL is also measured in dB and is given by:

$$PWL = 10\log_{10}\left(\frac{W}{W_0}\right)$$

where:

W is the sound power of the source (in watts)

W_0 is the reference sound power (10-12 watts)

Broadband: When the broadband term is used in conjunction with an acoustic measure (i.e. broadband sound pressure level) it reflects that the value of this measure is representative of the entire audible range.

Octave and third octave bands: A third octave band is defined as range of frequencies of a sound where the upper limit of the range is defined as 21/3 times the lower limit. Third octave bands are often used to divide a sound into frequency components in order to describe or quantify the spectral makeup of the sound.

L_{eq}: The L_{eq} is defined as the equivalent continuous sound level and is the most widely used parameter for assessing environmental noise. Since this descriptor is a type of average level, it must by definition have an associated time period over which the measurement is referring to. This is often included in the abbreviation in the form $L_{eq, T}$, where T is the time period (i.e. $L_{Aeq, 5\ min}$). The formula for calculating the L_{eq} is:

$$L_{eq} = 10\log_{10}\left(\frac{1}{t_2 - t_1}\int_{t_1}^{t_2}\frac{p^2}{p_{ref}^2}.dt\right)$$

In practice, since most modern sound level meters are digital and hence take periodic samples of the sound pressure level, the L_{eq} will be the logarithmic average of all the SPL samples taken in the measurement period.

Ln: The Ln is a statistical descriptor and refers to the level that is exceeded for n% of the time during a particular measurement period. Again, the measurement period that the descriptor refers to is often included in the abbreviation in the format Ln, T. Two of the most commonly used statistical descriptors used for environmental noise assessments are the L90 and the L10. These are described in more detail below.

L_{90}: The L_{90} refers to the level exceeded for 90% of the measurement period and is widely considered to represent background sound, or the underlying noise in an area between noisy events (such as cars passing etc.).

Free-Field: The term "free-field" refers to sound levels that have been measured or predicted in the absence of any influence of reflections from nearby surfaces. In practice, a measurement is considered to be free-field if it was taken at a distance of over 3.5 m from reflecting surfaces to the side of the source. Where a reflecting surface is perpendicular to the line between sound source and receptor/measurement position, a greater distance to the reflecting surface is required (around 10 m) for truly free-field conditions.

Insertion Loss: Is a term to describe the reduction or difference in sound pressure level, for example, with an attenuator and with no attenuator in place.

Appendix B. Bishop Auckland - Ambient Noise Survey Results

Location/Period	Address	Start Time	Measurement Time	Leq	LE	Lmax	Lmin	L1	L10	L50	L90	L99
A – DT1	1	14/03/2022 13:47	00d 00:15:00.0	57.1	86.7	75.1	46.5	69.8	59	52.2	49	47.5
B – DT1	2	14/03/2022 14:15	00d 00:15:00.0	58.2	87.8	72	48.4	67.1	62	56.1	52.2	49.5
C – DT1	3	14/03/2022 14:35	00d 00:15:00.0	68.7	98.3	84.7	54.5	77.4	73	65	59.1	55.7
A – DT2	4	14/03/2022 14:58	00d 00:15:00.0	55.8	85.4	75.9	44.8	66.5	57	51.6	49	47.3
B – DT2	5	14/03/2022 18:08	00d 00:15:00.0	56	85.6	75.9	43	65.8	58	53.9	49.2	45.2
C – DT2	6	14/03/2022 18:26	00d 00:15:00.0	68	97.6	84.7	51	76.6	73	63.8	57.2	53.3
A – DT3	7	14/03/2022 18:46	00d 00:15:00.0	52	81.6	72.4	43.1	62.6	54	48.3	45.8	44.2
B – DT3	8	14/03/2022 19:04	00d 00:15:00.0	57.9	87.5	74.7	43.5	68.2	60	54.4	49.1	44.9
C – DT3	9	14/03/2022 19:22	00d 00:15:00.0	66.8	96.4	81.6	38.6	77.2	72	60.7	50.3	40.4
A – NT1	10	15/03/2022 00:35	00d 00:15:00.0	34	63.6	60.9	25.5	44	36	29.9	27.7	26.5
B – NT1	11	15/03/2022 00:57	00d 00:15:00.0	39.1	68.7	57.5	26.3	51.3	41	33.4	29.5	27.5
C – NT1	12	15/03/2022 01:17	00d 00:15:00.0	45.5	75.1	63.8	24.6	59.4	45	29.8	26.4	25.5
A – NT2	13	15/03/2022 01:37	00d 00:15:00.0	31.6	61.2	63.2	24.4	39.5	30	27.3	25.9	25.3
B – NT2	14	15/03/2022 01:57	00d 00:15:00.0	31.6	61.2	51.1	24.3	40.4	33	29	26.7	25.5
C – NT2	15	15/03/2022 02:15	00d 00:15:00.0	50.4	80	72.3	24.8	62.6	54	31.7	27.2	25.8

Appendix C. Preliminary Plant Specifications

TECHNICAL SPECIFICATION

EWAT~CZN

MODEL		EWAT016CZN-A1	EWAT021CZN-A1	EWAT025CZN-A1	EWAT032CZN-A1	EWAT040CZN-A1	EWAT040CZN-A2
COOLING PERFORMANCE							
Capacity - Cooling	kW	15.9	20.9	25.6	32.4	39.6	41.4
Capacity control - Type		Inverter Controlled	Inverter Controlled	Inverter Controlled	Inverter Controlled	Inverter Controlled	Inverter Controlled
Capacity control - Minimum capacity	%	18	14	12	19	15	14
Unit power input - Cooling	kW	5.5	6.6	8.5	10.3	13.4	13.2
EER		2.9	3.16	3	3.13	2.95	3.12
SEER		5	5	5.06	5.21	5.09	5.41
IPLV		5.83	6.29	6.05	6.25	5.87	6.37
CASING							
Colour *		IW	IW	IW	IW	IW	IW
Material *		GPSS	GPSS	GPSS	GPSS	GPSS	GPSS
DIMENSIONS							
Height	mm	1878	1878	1878	1878	1878	1878
Width	mm	1152	1152	1152	1752	1752	2306
Length	mm	802	802	802	802	802	814
WEIGHT							
Unit Weight	kg	222	245	245	340	339	480
Operating Weight	kg	223	247	247	343	342	486
WATER HEAT EXCHANGER							
Type *		Brazed plate	Brazed plate	Brazed plate	Brazed plate	Brazed plate	Brazed plate
Fluid		Water	Water	Water	Water	Water	Water
Fouling Factor	m2°C/W	0	0	0	0	0	0
Water Volume	l	1	2	2	2	2	5
Water temperature in	°C	12	12	12	12	12	12
Water temperature out	°C	7	7	7	7	7	7
Water flow rate	l/s	0.8	1	1.2	1.6	1.9	2
Water pressure drop	kPa	19.8	11.3	16.3	19.2	27.6	9.91
Insulation material *		Black closed-cell flexible elastomeric foam	Black closed-cell flexible elastomeric foam	Black closed-cell flexible elastomeric foam	Black closed-cell flexible elastomeric foam	Black closed-cell flexible elastomeric foam	Black closed-cell flexible elastomeric foam
AIR HEAT EXCHANGER							
Type *		Al Fins&Cu Tubes	Al Fins&Cu Tubes	Al Fins&Cu Tubes	Al Fins&Cu Tubes	Al Fins&Cu Tubes	Al Fins&Cu Tubes
FAN							
Type *		Axial	Axial	Axial	Axial	Axial	Axial
Drive *		VFD	VFD	VFD	VFD	VFD	VFD
Nominal air flow	l/s	3228	3122	3524	5080	6701	5444
Air Temperature	°C	35	35	35	35	35	35
Quantity	No.	1	1	1	2	2	2
Speed	rpm	800	800	900	700	900	700
Motor input	kW	0.4	0.4	0.5	0.5	1.1	0.5
COMPRESSOR							
Type		Scroll	Scroll	Scroll	Scroll	Scroll	Scroll
Oil charge	l	2.2	2.2	2.2	3.2	3.2	4.4
Quantity	No.	1	1	1	1	1	2
SOUND LEVEL**							
Sound Power - Cooling	dB(A)	76	76	78	79	80	80
Sound Pressure level @1m distance - Cooling	dB(A)	59.7	59.7	61.7	62.2	63.2	62.8
REFRIGERANT CIRCUIT							
Refrigerant type		R32	R32	R32	R32	R32	R32
Refrigerant charge	kg	3	5	5	6.5	6.7	10.2
N. of circuits	No.	1	1	1	1	1	2
PIPING CONNECTIONS							
Evaporator water inlet/outlet	mm	1"1/4 (female)	1"1/4 (female)	1"1/4 (female)	1"1/4 (female)	1"1/4 (female)	2" (female)

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TECHNICAL SPECIFICATION

PROJECT DETAILS

Project Name	Bus Station	**Quote No.**	22994
Unit Reference	Wcs	**Revision**	5
Unit Model	AIR-HRU 4 / SL / IM / BAC / X / X / X / X	**Date**	23/02/2022

PERFORMANCE DATA

SUPPLY			EXTRACT			SFP
Air Volume	0.230	m^3/s	Air Volume	0.230	m^3/s	1.40 W/l/s
Ext. Stat. Pressure	200	Pa	Ext. Stat. Pressure	200	Pa	

UNIT DIMENSIONS

O/ALL			O/ALL			CONNECTIONS	
Width	1,195	mm	Length	1,950	mm	Spigot WxH	425x294 mm
Height	394	mm	Weight	190	kg	Access	SL

COUNTERFLOW HEAT EXCHANGER

INLET			OUTLET			STANDARD OPTIONS	
Air On	-5.0	°C	Air Off	15.9	°C	Bypass Damper	YES
Return Air	19.0	°C	Efficiency (EN308)	87	%	Drain Tray	YES

ACOUSTICS

Sound Power Levels (Lw)	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Supply Fan Inlet (dB)	66	66	65	65	63	59	54
Supply Fan Outlet (dB)	71	71	70	70	68	64	59
Extract Fan Inlet (dB)	64	70	65	65	63	59	54
Extract Fan Outlet (dB)	69	70	70	70	68	64	59

BREAKOUT NOISE			ROOM SIDE ATTENUATORS	AIR SIDE ATTENUATORS
Free Field SPL	36 dbA	@3m	Excluded	Excluded

CONTROLS

Controller	BACnet	Constant Volume/Constant Temp

SELECTED OPTIONS

ELECTRICAL DETAILS (EXCLUDES SELECTED ANCILLARIES)

Electrical Supply	230V/1PH	F.L.C.	5.40	A	Protection Level	IP54

PLEASE NOTE : All specific data points (noise levels, specific fan power, etc) are subject to design fluctuations and are to be used for indicitive purposes only.

W: www.ahs.uk.com | E: info@ahs.uk.com

HEAD OFFICE : 3-5 Furnace Industrial Estate | Shildon | County Durham | DL4 1QB | T: +44 (0)1388 776 287 | F: +44 (0)1388 775 494

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TECHNICAL SPECIFICATION

PROJECT DETAILS

Project Name	Bus Station	**Quote No.**	22994
Unit Reference	WCs	**Revision**	2
Unit Model	AIR-HRU 4 / SL / IM / BAC / X / X / X / X	**Date**	16/12/2021

PERFORMANCE DATA

SUPPLY			EXTRACT			SFP
Air Volume	0.300	m^3/s	Air Volume	0.300	m^3/s	1.60 W/l/s
Ext. Stat. Pressure	200	Pa	Ext. Stat. Pressure	200	Pa	

UNIT DIMENSIONS

O/ALL			O/ALL			CONNECTIONS		
Width	1,195	mm	Length	1,950	mm	Spigot WxH	425x294	mm
Height	394	mm	Weight	190	kg	Access	SL	

COUNTERFLOW HEAT EXCHANGER

INLET			OUTLET			STANDARD OPTIONS	
Air On	-5.0	°C	Air Off	17.6	°C	Bypass Damper	YES
Return Air	21.0	°C	Efficiency (EN308)	87	%	Drain Tray	YES

ACOUSTICS

Sound Power Levels (Lw)	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Supply Fan Inlet (dB)	70	69	68	68	66	62	58
Supply Fan Outlet (dB)	75	74	73	73	71	67	63
Extract Fan Inlet (dB)	70	69	68	68	66	62	58
Extract Fan Outlet (dB)	75	74	73	73	71	67	63

BREAKOUT NOISE			ROOM SIDE ATTENUATORS	AIR SIDE ATTENUATORS
Free Field SPL	39 dbA	@3m	Excluded	Excluded

CONTROLS

Controller	BACnet	Constant Volume/Constant Temp

SELECTED OPTIONS

ELECTRICAL DETAILS (EXCLUDES SELECTED ANCILLARIES)

Electrical Supply	230V/1PH	F.L.C.	5.40	A	Protection Level	IP54

PLEASE NOTE : All specific data points (noise levels, specific fan power, etc) are subject to design fluctuations and are to be used for indicitive purposes only.

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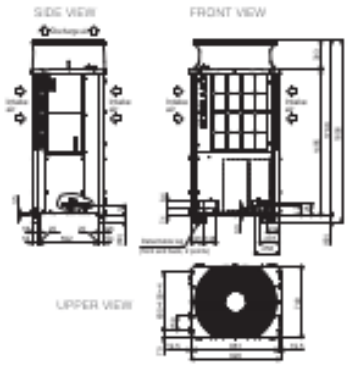
Air Conditioning | **Product Information**

R2 Series VRF
Standard Efficiency (22.4-45kW)
Simultaneous Heating and Cooling with Heat Recovery Outdoor Unit

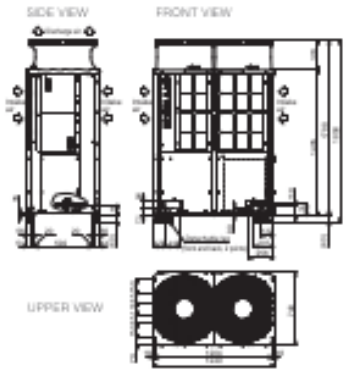
OUTDOOR UNITS		PURY-P200YNW-A1	PURY-P250YNW-A1	PURY-P300YNW-A1	PURY-P350YNW-A1	PURY-P400YSNW-A1	PURY-P450YSNW-A1
CAPACITY (kW)	Heating (nominal)	25.0	31.5	37.5	45.0	50.0	50.0
	Cooling (nominal)	22.4	28.0	33.5	40.0	45.0	45.0
	High Performance Heating (SP)	25.0	31.5	35.8	42.8	45.0	50.0
	COP Priority Heating (SP)	22.8	28.7	34.1	41.8	43.0	45.5
	Cooling (UK)	20.1	25.1	32.0	35.8	40.3	40.3
POWER INPUT (kW)	Heating (nominal)	5.33	7.42	9.54	11.13	13.77	10.98
	Cooling (nominal)	5.27	7.25	8.98	10.98	14.61	10.92
	High Performance Heating (SP)	6.72	9.35	12.69	14.80	15.56	14.05
	COP Priority Heating (SP)	5.33	7.42	9.54	11.13	13.36	10.98
	Cooling (UK)	3.08	4.21	5.21	6.37	9.35	8.33
COP / EER (nominal)		4.69 / 4.25	4.24 / 3.80	3.93 / 3.73	4.04 / 3.64	3.63 / 3.08	4.55 / 4.12
MAX NO. OF CONNECTABLE INDOOR UNITS		20	25	30	35	40	40
MAX CONNECTABLE CAPACITY		50–150% OU Capacity	50–150% OU Capacity	50–150% OU Capacity	50–150% OU Capacity	50–150% OU Capacity	50–150% OU Capacity
AIRFLOW (m³/min)	High	170	185	240	260	315	170 / 170
PIPE SIZE mm (in)	Gas	19.05 (3/4")	22.2 (7/8")	22.2 (7/8")	28.58 (1-1/8")	28.58 (1-1/8")	28.58 (1-1/8")
	Liquid	15.88 (5/8")	19.05 (3/4")	19.05 (3/4")	19.05 (3/4")	22.2 (7/8")	22.2 (7/8")
SOUND PRESSURE LEVEL (dBA) @ 1m	Heating / Cooling	59.0 / 59.0	61.0 / 60.5	67.0 / 61.0	64.0 / 62.5	69.0 / 65.0	62.0 / 62.0
SOUND POWER LEVEL (dBA) @ 100% CAPACITY	Heating / Cooling	76.0 / 78.0	80.0 / 78.0	86.0 / 80.0	83.0 / 81.0	86.0 / 83.0	81.0 / 79.0
SOUND POWER LEVEL (dBA) @ 90% CAPACITY	Heating / Cooling	74.5 / 71.0	76.0 / 73.5	78.5 / 74.5	81.0 / 76.0	81.0 / 77.0	77.5 / 74.0
SOUND POWER LEVEL (dBA) @ 75% CAPACITY	Heating / Cooling	71.5 / 68.5	74.5 / 69.5	74.5 / 70.5	77.0 / 73.0	75.0 / 73.0	74.5 / 69.5
WEIGHT (kg)		214	225	225	269	269	214 + 214
DIMENSIONS (mm)	Width	920	920	920	1240	1240	920 + 920
	Depth	740	740	740	740	740	740
(1708mm without legs)	Height	1858	1858	1858	1858	1858	1858
ELECTRICAL SUPPLY*1		380-415v 50Hz	380-415v 50Hz	380-415v 50Hz	380-415v 50Hz	380-415v 50Hz	380-415v 50Hz
PHASE*1		Three	Three	Three	Three	Three	Three
STARTING CURRENT (A)*1		8	8	8	8	8	8
NOMINAL SYSTEM RUNNING CURRENT (A)*1	Heating / Cooling (max)	8.5 / 8.4 (16.1)	11.8 / 11.6 (17.8)	15.2 / 14.4 (22.7)	17.8 / 17.8 (27.8)	22.0 / 23.4 (35.1)	17.8 / 17.5 (16.1 + 16.1)
GUARANTEED OPERATING RANGE (°C)	Heating / Cooling	-25~15.5 / -5~52	-25~15.5 / -5~52	-25~15.5 / -5~52	-25~15.5 / -5~52	-25~15.5 / -5~52	-20~15.5 / -5~52
FUSE RATING (MCB sizes BS EN 60947-2) - (A)*1		1 x 20	1 x 20	1 x 25	1 x 32	1 x 40	1 x 20 / 1 x 20
MAINS CABLE No. Cores*1		4 + earth	4 + earth	4 + earth	4 + earth	4 + earth	4 + earth / 4 + earth
CHARGE REFRIGERANT (kg) / CO_2 EQUIVALENT (T) R410A (GWP 2088)		5.2 / 10.9	5.2 / 10.9	5.2 / 10.9	8 / 16.7	8 / 16.7	10.4 / 21.7
MAX ADDITIONAL REFRIGERANT (kg) / CO_2 EQUIVALENT (T) R410A (GWP 2088)		31.8 / 66.4	37.8 / 78.9	37.8 / 78.9	41.3 / 86.2	47.3 / 98.8	60.8 / 126.9

Notes: *SEER/SCOP available separately in the 'City Multi VRF Seasonal Efficiency' document. Based on Ecodesign Lot 21/6 to EN14825 standard.
*1 A separate power supply is required for each module. Where more than one figure is quoted there are multiple modules.

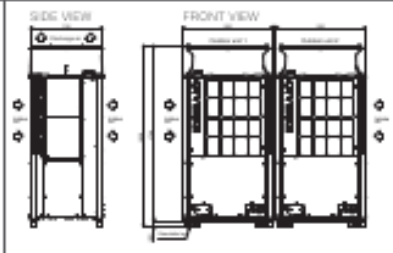
PURY-P200/250/300YNW-A1 DIMENSIONS



PURY-P350/400YNW-A1 DIMENSIONS



PURY-P400YSNW-A1 DIMENSIONS



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Telephone: 01707 282880
email: air.conditioning@meuk.mee.com
les.mitsubishielectric.co.uk

@meuk_les
@green_gateway
Mitsubishi Electric Living Environmental Systems UK
Mitsubishi Electric Cooling and Heating UK
mitsubishielectricuk_les
Mitsubishi Electric Living Environmental Systems UK
hvhub.mitsubishielectric.co.uk

UNITED KINGDOM Mitsubishi Electric Europe Living Environment Systems Division, Travellers Lane, Hatfield, Hertfordshire, AL10 8XB, England. Telephone: 01707 282880 Fax: 01707 278881
IRELAND Mitsubishi Electric Europe, Westgate Business Park, Ballymount, Dublin 24, Ireland. Telephone: (01) 419 8800 Fax: (01) 419 8890 International code: (353531)

Note: The fuse rating is for guidance only. Please refer to the relevant databook for detailed specification. It is the responsibility of a qualified electrician/electrical engineer to select the correct cable size and fuse rating based on current regulation and site specific conditions. Mitsubishi Electric's air conditioning equipment and heat pump systems contain a fluorinated greenhouse gas. R410A (GWP:2088), R32 (GWP:675), R407C (GWP:1774), R134a (GWP:1430), R513A (GWP:631), R454B (GWP:466), R1234ze (GWP:7) or R1234yf (GWP:4). *These GWP values are based on Regulation (EU) No 517/2014 from IPCC 4th edition. In case of Regulation (EU) No 626/2011 from IPCC 3rd edition, these are as follows. R410A (GWP:1975), R32 (GWP:550), R407C (GWP:1652) or R134a (GWP:1300).

Effective as of May 2020

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Appendix D. Plant noise calculations with and without mitigation

Plant noise calculations - no mitigation

13 Tenters Street

Plant item	SWL, dB(A)	Mitigation insertion loss	Distance, m	Screening, dB	Sound Pressure Level at receptor, dB(A)
AHU Supply Louvre	75	0	50	10	23
AHU Discharge Louvre	80	0	50	5	33
VRF	71	0	55	10	15
Condenser	76	0	50	10	24
Transformer	75	0	55	15	17
				Cumulative SPL, dB(A)	34

3 Clayton Court

Plant item	SWL, dB(A)	Mitigation insertion loss	Distance, m	Screening, dB	Sound Pressure Level at receptor, dB(A)
AHU Supply Louvre	75	0	45	10	24
AHU Discharge Louvre	80	0	50	5	33
VRF	71	0	40	10	18
Condenser	76	0	45	10	25
Transformer	75	0	55	15	17
				Cumulative SPL, dB(A)	34

14 Edgar Grove

Plant item	SWL, dB(A)	Mitigation insertion loss	Distance, m	Screening, dB	Sound Pressure Level at receptor, dB(A)
AHU Supply Louvre	75	0	170	10	12
AHU Discharge Louvre	80	0	180	5	22
VRF	71	0	175	10	5
Condenser	76	0	170	10	13
Transformer	75	0	55	15	17
				Cumulative SPL, dB(A)	24

Plant noise calculations - with mitigation

13 Tenters Street

Plant item	SWL, dB(A)	Mitigation insertion loss	Distance, m	Screening, dB	Sound Pressure Level at receptor, dB(A)
AHU Supply Louvre	75	15	50	10	8
AHU Discharge Louvre	80	15	50	5	18
VRF	71	-	55	10	15
Condenser	76	10	50	10	14
Transformer	75	-	55	15	17
				Cumulative SPL, dB(A)	23

3 Clayton Court

Plant item	SWL, dB(A)	Mitigation insertion loss	Distance, m	Screening, dB	Sound Pressure Level at receptor, dB(A)
AHU Supply Louvre	75	15	45	10	9
AHU Discharge Louvre	80	15	50	5	18
VRF	71	-	40	10	18
Condenser	76	10	45	10	15
Transformer	75	-	55	15	17
				Cumulative SPL, dB(A)	23

14 Edgar Grove

Plant item	SWL, dB(A)	Mitigation insertion loss	Distance, m	Screening, dB	Sound Pressure Level at receptor, dB(A)
AHU Supply Louvre	75	15	170	10	-3
AHU Discharge Louvre	80	15	180	5	7
VRF	71	-	175	10	5
Condenser	76	10	170	10	3
Transformer	75	-	55	15	17
				Cumulative SPL, dB(A)	18