BS4142 Assessment Report

Report No. YS1901152NR

Client: Ms Joanne Close

Date of Issue: 18th September 2015

The Windmill, Ash Bank Rd, Stoke on Trent, ST9 0DT

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Contents

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Executive Summary

A noise assessment has been undertaken for Ms Joanne Close, at land next to "The Windmill" public house at Ash Bank Rd, Stoke on Trent, ST9 0DT. This is to assess the noise impact from a Standard Inverter Heat Pump and an Air Conditioning Heat Pump that will serve a new convenience shop, placed on site. Both units are planned to be placed in an external plant yard located in the right corner at the back of the shop.

Gardens of residential dwellings immediately adjacent to the plant yard, have been identified as the nearest sensitive receptors with regard to noise impact from the proposed heat pumps.

Background noise level has been measured at a representative location, close to the nearest sensitive receptor, as being **39.4dB** $L_{A90,\,1h}$ at its lowest. The measurement has been taken between 22:00-23:00 when the background noise would be at its lowest during the overall period of the site operation.

Noise criteria at the nearest sensitive receptors have been assessed, based on BS4142:2014[1]. Recommendations on the mitigations to reduce specific sound level of the heat pumps have been suggested**.**

Considering recommendations are implemented, the rating levels at the nearest sensitive receptors NSR_1 and NSR_2 would achieve the outcome of **>10dB BELOW** the background noise levels and thus place them in the category of "**Low impact**".

Further considerations with regards to noise emissions from increased use of the car park on site and deliveries to the store and have been taken into account and shown to have minimal impact on the NSR locations.

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Introduction

Peak Acoustics LTD has been commissioned by Ms Joanne Close, to undertake a noise survey at land adjacent to “The Windmill” public house at Ash Bank Rd, Stoke on Trent, ST9 0DT (hereafter called “site”). This is to assess noise impact from two heat pumps that will serve a new convenience shop erected at the site. A new shop is planned to occupy a car park of the public house at the address.

Current background noise levels have been measured at the site nearby the nearest sensitive receptor NSR1, the garden of the house immediately adjacent to the proposed convenience shop. Recommendations on the specific noise level and mitigation strategies to reduce noise emitted by the pumps have been suggested following the procedure described in BS4142:2014 “Method for Rating and Assessing Industrial and Commercial Sound”.

The assessment of noise rating at the nearest sensitive receptor is based on guidance in BS4142:2014, where rating noise due to the heat pumps ($L_{Aeq,\ T}$) must be compared to the background noise level ($L_{A90,T}$).

All the standards, legislation, guidance and methods followed to carry out this assessment report are described in Section 0.1.

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0.1 Legislation and Guidance References

[1] BS4142:2014 – *"Method for Rating and Assessing Industrial and Commercial Sound"* [British Standards Institution]

BS 4142:2014 provides a method of rating and assessing impact from industrial and commercial sounds. It was first published in 1967 and has been extensively used by local authorities and consultants to rate noise from fixed installations. The standard was considerably revised in 1990, clarified in 1997, and finally significantly altered in 2014. The methods described in this British Standard use outdoor sound levels to assess the likely impacts of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

BS 4142:2014 advocates the use of $L_{Aeq,T}$ - a level, which is directly measurable and termed the **Specific Sound Level**.

Subjectively the Specific Sound Level may be corrected as follows:

The Specific Sound Level is subject to a correction for *tonality* between 0dB to +6dB for sound ranging from not tonal to prominently tonal. Subjectively, this can be converted to a penalty of 2dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible, and 6dB where it is highly perceptible.

The Specific Sound Level may be also corrected to *impulsivity*. A correction of up to +9dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level. Subjectively, this can be converted to a penalty of +3dB for impulsivity which is just perceptible at the noise receptor, 6dB where it is clearly perceptible, and 9dB where it is highly perceptible.

Other sound characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual acoustic environment, can have a penalty of 3dB applied.

Where tonal and impulsive characteristics are present in the specific sound within the same reference period then these two corrections can both be taken into account. If one feature is dominant then it might be appropriate to apply a single correction. Where both features are likely to affect perception and response, the corrections ought normally to be added in a linear fashion.

Further corrections may be applied due to *intermittency*. When the specific sound has identifiable on/off conditions, the specific sound level ought to be representative of the time period of length equal to the reference time interval which contains the greatest total amount of on time. This can necessitate measuring the specific sound over a number of shorter sampling periods that are in combination less than the reference time interval in total, and then calculating the specific sound level for the reference time interval allowing for time when the specific sound is not present. If the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3dB can be applied.

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If the subjective method is not sufficient for assessing the audibility of tones in sound or the prominence of impulsive sounds, BS4142:2014 suggests using the one-third octave method and/or the reference methods, as appropriate.

The **one-third octave method** tests for the presence of a prominent, discrete-frequency spectral component (tone) typically compares the $L_{Zeq,T}$ sound pressure level averaged over the time when the tone is present in a one-third-octave band with the time-average linear sound pressure levels in the adjacent one-third-octave bands. For a prominent, discrete tone to be identified as present, the time-averaged sound pressure level in the one-third-octave band of interest is required to exceed the time-averaged sound pressure levels of both adjacent one-third-octave bands by some constant level difference. The level differences between adjacent one-third-octave bands that identify a tone are:

• 15 dB in the low-frequency one-third-octave bands (25Hz to 125Hz);

• 8 dB in the middle-frequency one-third-octave bands (160Hz to 400Hz); and

• 5 dB in the high-frequency one-third-octave bands (500Hz to 10,000Hz).

The **reference (objective)** method. If the presence of audible tones is in dispute, a special measurement procedure can be used to verify their presence. Based on the prominence of the tones this procedure also provides recommended level adjustments. The aim of the reference method is to assess the prominence of tones in the same way as listeners do on average. The method is based on the psychoacoustic concept of critical bands, which are defined so that sound outside a critical band does not contribute significantly to the audibility of tones inside that critical band. The method includes procedures for steady and varying tones, narrow-band sound and low-frequency tones, and the result is a graduated 0dB to 6dB adjustment. It is known as the Joint Nordic Method 2 and is to be found in ISO 1996-2. The reference method is also described in BS4142:2014.

Specific Sound Level with (or without) added contentions is termed the **Rating Level**. When used to assess industrial or commercial sound, the Rating Level is determined and the L_{A90} background level is subtracted from it. 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 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.

Where the initial estimate of the impact needs to be modified due to the context, all pertinent factors should be taken into consideration, including the following.

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1) The absolute level of sound. For a given difference between the rating level and the background sound level, the magnitude of the overall impact might be greater for an acoustic environment where the residual sound level is high than for an acoustic environment where the residual sound level is low. Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night. Where residual sound levels are very high, the residual sound might itself result in adverse impacts or significant adverse impacts, and the margin by which the rating level exceeds the background might simply be an indication of the extent to which the specific sound source is likely to make those impacts worse.

2) The character and level of the residual sound compared to the character and level of the specific sound. Consider whether it would be beneficial to compare the frequency spectrum and temporal variation of the specific sound with that of the ambient or residual sound, to assess the degree to which the specific sound source is likely to be distinguishable and will represent an incongruous sound by comparison to the acoustic environment that would occur in the absence of the specific sound. Any sound parameters, sampling periods and averaging time periods used to undertake character comparisons should reflect the way in which sound of an industrial and/or commercial nature is likely to be perceived and how people react to it.

Consideration ought to be given to evidence on human response to sound and, in particular, industrial and/or commercial sound where it is available.

3) The sensitivity of the receptor and whether dwellings or other premises used for residential purposes will already incorporate design measures that secure good internal and/or outdoor acoustic conditions, such as:

i) Façade insulation treatment;

ii) Ventilation and/or cooling that will reduce the need to have windows open so as to provide rapid or purge ventilation; and

iii) Acoustic screening.

BS4142:2014 states that the measurement locations should be ≥3.5m away from any other reflecting façade and at a preferred height of 1.2m – 1.5m above ground level. Should sources be located at 1st floor or above, a 4m measurement should be taken. All prevailing weather conditions should be noted, with a subjective impression of noise levels also included within any documentation.

Daytime measurement periods are defined in BS4142:2014 as being between 07:00 and 23:00 hours, with nighttime periods being between 23:00 and 07:00.

BS4142:2014 compares the **highest noise rating level** with the **lowest background noise level** and effectively sets out the **worst possible outcome** based on the levels measured.

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1. Site description

1.1 Existing site conditions

The site under investigation is the land currently used as a car park next to "The Windmill" public house at Ash Bank Rd, Stoke on Trent, ST9 0DT. The site is located upon Ash Bank Road which is a busy single-carriageway road. Buildings within the vicinity of the site are a mixture of residential dwellings with some commercial entities.

Appendix C shows the site location in greater detail.

1.2 Proposed site conditions

The site development is to be a new convenience shop placed at the existing car park to the right of the "The Windmill" public house. The right side of the shop will be in very close proximity to existing residential dwellings. Two heat pumps, namely a Standard Inverted Heat Pump and an Air Conditioning Heat Pump, which will serve the new development will be placed on site. The pumps are planned to be located at the back of the shop at the place indicated as a "plant yard" on the architecture drawings.

The new shop hours of operations will be 07:00-23:00.

1.3 Nearest sensitive receptors

The plant yard will frank the boundary of the residential dwelling identified as the first Nearest Sensitive Receptor (NSR_1). The window of the residential dwelling located at about 14m away from the proposed plant yard has been identified as NSR_1. The second Nearest Sensitive Receptor (NSR_2) has been identified as the window of the dwelling located at the rear of the proposed shop at about 28m away from the plant yard.

Appendix C shows architecture plans of the new development and of NSRs.

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2. Environmental noise survey

Daytime and night-time ($L_{Aeq,\ T}$) background noise measurements have been carried out close to NSR_1, between 17:00-08:00 on 27th and 28th January 2015. From the measured data, only noise levels measured during 22:00-23:00 on 27th January have been taken into further consideration. The above period represents the **lowest background** climate from the overall period of the shop operation due to environmental noise emissions.

2.1 Measurement Location

Noise measurements have been carried out at the right of the site, close to the boundary of the Nearest Sensitive Receptor (NSR_1), 1.2m above the ground and >3m away from any reflective surface.

Site view and details of measurement location are shown in **Appendix C**.

2.2 Measurement Equipment

A Class 1 sound level meter with an outdoor measurement equipment was used. The outdoor kit is particularly useful for measurements with higher than maximum permitted wind speeds ($5ms^{-1}$) conditions. The whole measurement system was calibrated before and after the measurements. The summary of measurement equipment and calibration information can be found in **Appendix B**.

2.3 Weather conditions

Weather Conditions

Climate	7°C, Dry, clear
Wind Speed	$3.3\ ms^{-1}$
Humidity	88%
Precipitation	0mm

2.4 Measured Background Noise Levels

A summary of background noise levels measured is shown below. Detailed measured levels can be found in **Appendix D.**

Measured background noise levels (NRS1)

Description	$L_{AFmax,\ 1hr}$	$L_{Aeq,\ 1hr}$	$L_{A90,\ 1hr}$
Measured level, dB	79.0	51.4	39.4

2.5 Subjective Impressions

The noise climate at the site was perceptibly high. Primary noise was perceived from Ash Bank Road, deemed to be a mixture of aerodynamic and road/tyre noise from passing traffic. Further noise from engine idling in the nearby car park was noted. Perceptible secondary noise sources were public house patrons and birds.

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3. Assessment

3.1 Ambient sound level

The ambient sound level is the level of specific noise source in operation (heat pumps) + residual sound sources (background sources).

Since at the time of writing this noise survey, the new heat pumps were not installed yet, it was not possible to measure the ambient sound level.

3.2 Specific sound level

Specific sound level, $L_s = L_{Aeq,Tr}$, is equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, *Tr*. In other words, *specific noise level is the level of the noise produced by the heat pumps at the assessment point.*

The specific sound level emitted by two heat pumps have been calculated as a logarithmic summation of the sound pressure levels produced by each of the pumps separately. Details of the sound pressure of Standard Inverted Heat Pump and an Air Conditioning Heat Pump have been obtained from the manufacturer specifications and recorded as 59dB(A) and 60dB(A), respectively.

Combining these two levels results in a **Specific Sound Level** of **62.5dB(A)** at the location of the plant.

Applying distance attenuation of 14m and 28m, respectively, results in a **Specific Sound Level** of **39.6dB(A)** and **33.6dB(A)** at, respectively, NSR_1 and NSR_2.

3.3 Rating Level

According to BS4142, a correction may be applied to the specific sound level to account for certain acoustic characteristics that may make the noise generated by the heat pumps more noticeable, this is called the **Rating Level** (see Section 0.1). Since the heat pumps are not in operation yet, but is likely to be constant, aerodynamic noise, no correction is deemed necessary. Thus, the **Rating Levels** would be equal to the Specific Sound Levels.

3.4 Noise criteria

Subtracting the measured background noise level at the nearest receivers from the rating level determines the noise levels at the nearest sensitive receptors. This level will determine likelihood of impact.

Outcome = Rating Level – Background Level

With regards to BS4142 difference between the rating and background level is assessed as follows:

*A difference of around +10dB or more is likely to be an indication of a **"Significant Adverse Impact"**, depending on the context.*

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*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 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.*

3.5 Noise criteria outcomes

Subtracting background ($L_{A90,\ 1h}$) from the Rating Level at NSR_1 and NSR_2 results in **0.2dB ABOVE** the existing background noise level and **5.8dB BELOW** the existing background noise level, respectively. Considering the fact that NSR_1 will be is not in line of sign of the with the proposed plant yard it may be concluded that there will be low impact at NSR_1. At NSR_2 noise level from the plant also falls in the category ***"low impact"*** as it is already below the existing background noise. A degree of headroom has been maintained throughout this assessment, ensuring that noise levels due to the heat pumps are 10dB BELOW background levels, despite the BS4142:2014 requirement of only value below background level. This is to ensure that the NSRs are protected from any noise nuisance due to the development.

3.6 Further Noise Considerations, Increased Car Park Use

It is likely that the addition of a convenience store will result in more cars using the car park. By measuring the typical specific sound level of a car with it's engine running idle in low revs, we can determine the noise impact due to more cars using the car park.

The specific sound level of a diesel car was measured as **58.1dB L_{Aeq}**. Distance correcting this value to NSR to take into account distance attenuation gives the sound level at the NSR from one car as **46.6dB L_{Aeq}**. The measured background sound level during the quietest daytime period was **51.4dB $L_{Aeq\ 1hr}$** and thus the sound level of one car at low revs is **4.8dB BELOW** the measured equivalent level at the NSR. The car park was in use when the measurements were taken and thus the current influence of cars using the car park is *included within the background measurements*. By considering that in a worst-case scenario the car park usage will *double*, the influence of cars using the car park within the background measurement will increase by **3dB L_{Aeq}** (doubling of sound pressure equates to a 3dB increase), and will thus be **1.8dB BELOW** the equivalent levels measured at the NSR.

3.7 Further Noise Considerations; Deliveries

Co-operative have signed up to the *Quiet Delivery Scheme (Department of Transport)*, meaning that freight operators will employ quiet delivery techniques that will ensure noise impact during early morning or night deliveries will be minimal. The scheme has been developed with a focus on low noise emissions to allow deliveries to be conducted out of hours where background noise is lower, but without causing noise impact upon sensitive receptors.

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4. Further recommendations

In order to further attenuate noise generated by plants of the proposed shop at the nearest sensitive receptors it would be recommended to place an acoustic barrier around all three side of the plants.

An **acoustic fence** completely enclosing the heat pumps around all sides should be high enough to break the line of sight between the neat pumps and the NSR_1 and NSR_2. The acoustic barrier should be at least 0.5m above the top of the heat pumps and should be placed as close as possible to them.

Barrier effect calculations have made considered the source (pumps) height of 2m and the receivers height of 4m (as locations of the first floor windows) and a barrier of 2.5m placed all around the pumps.

In the case of NSR_1 it has been demonstrated that considering a path difference of $\delta = 0.15$m between the source and receiver it gives about **12.7dB noise attenuation** when the barrier is inserted. In the case of NSR_2 a path difference $\delta = 0.1$m gives about **11.5dB** of noise attenuation with the inserted barrier. Calculations have been based on the Maekawa barrier attenuation formula:

$\Delta_{barrier, f} = 10*Log[3 + (20N)]$,

where $N = 2*\delta/\lambda$ is a Fresnel Number and λ is a wavelength.

Peak Acoustics Ltd. recommends placing *Jakoustic* noise barrier of *Jacksons* or similar one. It may be noted that even the simple barrier reduces noise in NSR_1 and NSR_2 by more than 10dB. Noise attenuation provided by *Jacksons* or similar one would be greater and thus it is safe to conclude that the noise emissions from the pumps at NSR_1 and NSR_2 will be reduced to the level of more then **10dB BELOW** the background noise and thus place them in the category of ***"low impact".***

5. Conclusions

A noise assessment has been undertaken at land next to "The Windmill" public house at Ash Bank Rd, Stoke on Trent, ST9 0DT to assess the noise impact arising from a Standard Inverted Heat Pump and an Air Conditioning Heat Pump that will serve a new convenience shop, placed on site. The both units are planned to be placed in an external plant yard located at the right corner at the back of the shop.

Following on-site measurement of pre-existing noise levels, recommendations have been made relating to the rating levels at the nearest sensitive reception points. Suggestions have been made for screening the proposed plants with an acoustic fence.

BS4142:2014 assessment shows that the rating noise from the heat pumps at the nearest sensitive receptors will achieve a level of *"Low Impact"* provided the recommendations and design are implemented.

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6. References

[1] BS4142:2014 – Method for Rating and Assessing Industrial and Commercial Sound. British Standards Institute, 2014.

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APPENDIX A – Glossary of Acoustic Terminology

To aid the understanding of acoustic terminology and the relative difference between noise levels the following background information is provided.

We perceive sound when the ear detects fluctuations in air pressure (sound waves), which are then processed by the brain and perceived as sound. Humans can hear an incredibly wide range of sound intensities ranging from jet engines to fingertips lightly brushing against each other. This range is quantified using a logarithmic scale called the decibel scale (dB). The comfortable range of the decibel scale typically ranges from 0dB (the threshold of hearing) to around 140dB. Here are some examples common environments and their typical noise levels.

Noise Level	Environment
0 dB(A)	Threshold of hearing
20 to 30 dB(A)	Quiet bedroom at night
30 to 40 dB(A)	Living room during the day
40 to 50 dB(A)	Typical office
50 to 60 dB(A)	Inside a moving car
60 to 70 dB(A)	Typical high street
100 to 110 dB(A)	Fire alarm at 1 metre away
140 dB(A)	Threshold of pain

Terminology

dB (decibel) – A unit used to quantify the pressure level of sound. Defined as 20 times the logarithm of the ratio between the root-mean-square pressure of a given sound field and a reference pressure level ($2x10^{-5}$ Pa – threshold of hearing).

dB(A) – A-weighted decibel. A-weighting is a correction factor applied to decibel values in order to give a more accurate representation of human hearing which compensates for the varying sensitivity of the human ear with frequency.

$L_{Aeq, h}$ – The equivalent continuous sound level over a stated period. Quantifies a fluctuating sound level over a given period as the equivalent continuous sound level in which the same amount of acoustic energy is contained over.

L_{A90} – The sound level exceeded 90% of the time. Typically used to describe background noise the L_{90} is regarded as the 'average minimum level' and quantifies the common sound level of a fluctuation sound field i.e. the sound level that occurs 90% of the time. Alternatively L_{10} describes the sound level exceeded 10% of the time and therefore quantifies the 'average maximum level' of sound which is often used during the calculation of road traffic noise.

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L_{AFmax} **–** The maximum, fast A-weighted sound pressure level. This effectively describes the highest noise level recorded at an instant in time, over a given time period. It is used to measure individual, short lived noise events that may not have a significant effect on the L_{Aeq} of that period.

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APPENDIX B - Measurement Equipment and Calibration Information

Measurement equipment details

Manufacturer	Type	Name	Serial No.
Svantek	Sound Level Meter	971	40305
Svantek	Calibrator	SV31	2438870
Svantek	Microphone	SV18	41651

Calibration information

Calibrator Reference Level	113.0 dB
Pre-measurement Level	112.48dB/-0.52dB
Post-measurement Level	112.40/-0.6dB

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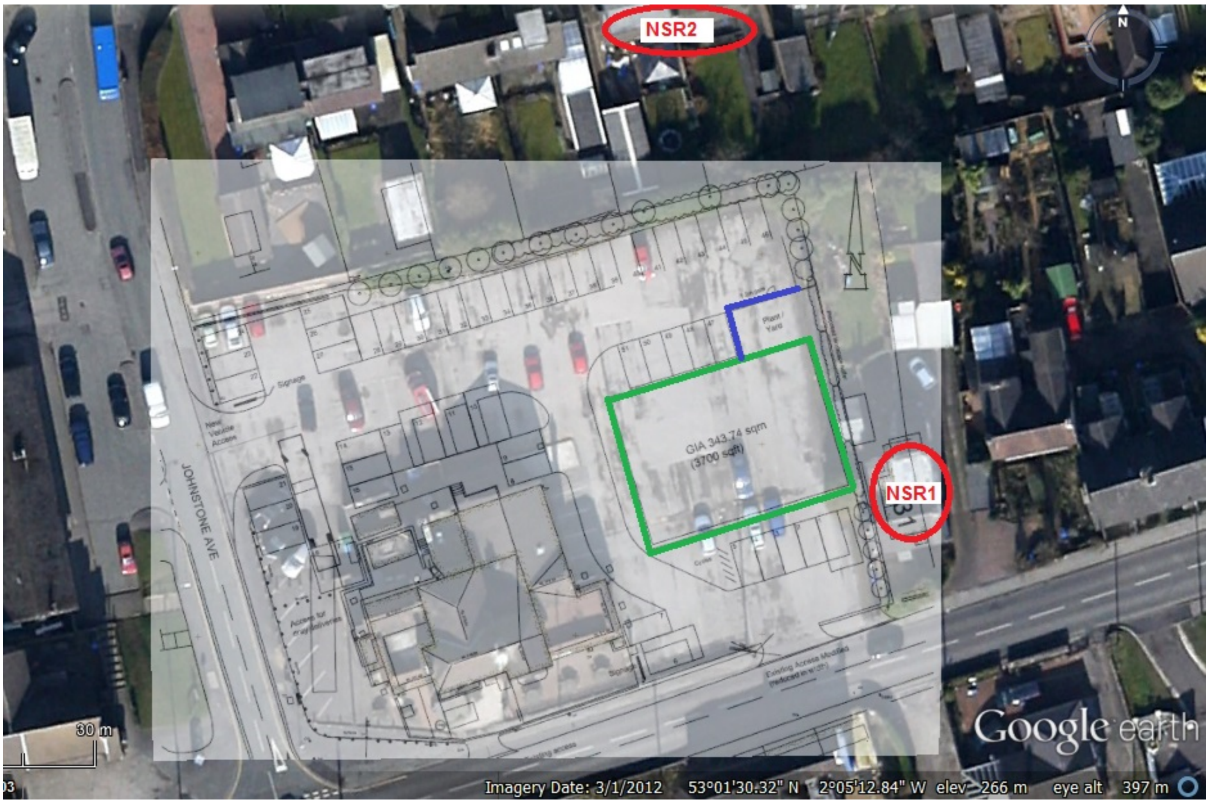
APPENDIX C – Plans & Site Measurement Location

Site view and noise measurement location



- Nearest sensitive receptors (red line)
- Site under development (green line)
- Proposed location of the plant yard for the heat pumps (blue line)

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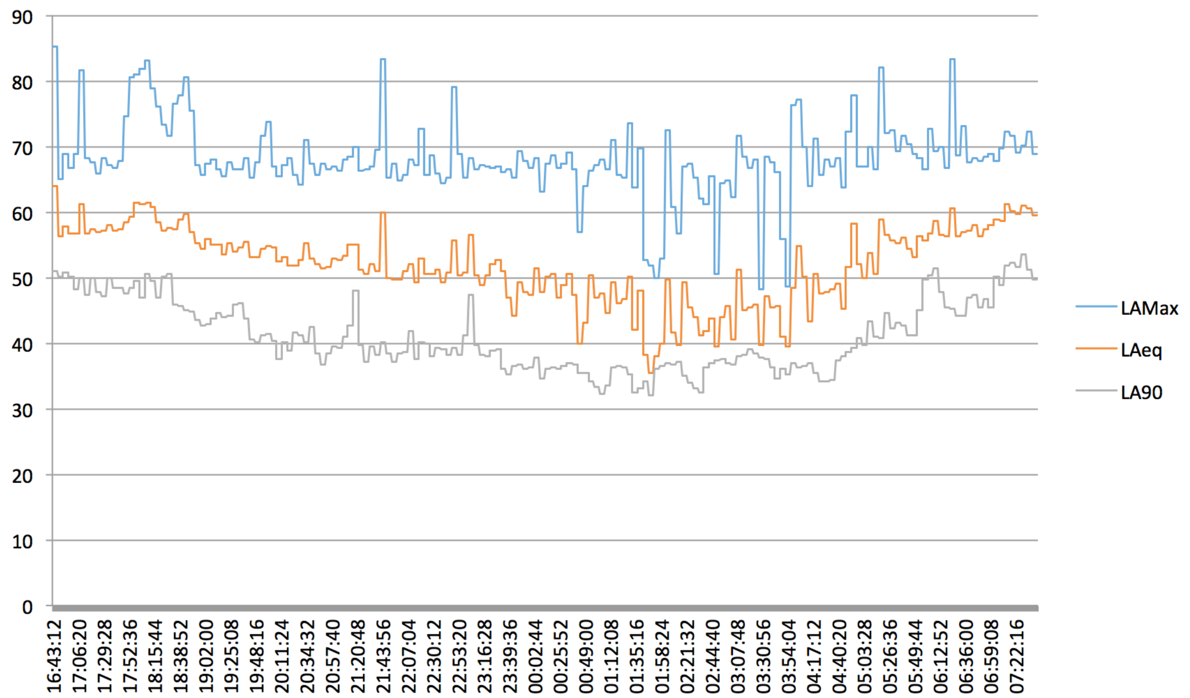
APPENDIX D – Noise Measurement Details

Measured background noise levels, 16:43-07:22, 27-28th January 2015



Environmental noise, 22:00-23:00 27th January 2015

Description	$L_{AMax, 1hr}$	$L_{Aeq, 1hr}$	$L_{A90, 1hr}$
Measured level, dB	79.0	51.4	39.4

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APPENDIX E – Limitations

This report requires a physical investigation of the site with an appropriate number of measurements in order to provide quantifiable information concerning the type and magnitude of noise affecting the site. The objectives have been limited to identifying sources of noise in order to carry out a suitable assessment for the proposed development.

The number and duration of noise measurements have been strategically selected to give reasonably representative information on the environment within the agreed time. Also, measurement locations have been limited to the areas unoccupied by any building that are easily accessible without imposing any form of risk to Peak Acoustics staff.

With any sampling, the number of samples and methods of sampling and measuring cannot exclude the existence of 'hotspots' where noise or vibration levels may transpire to be significantly more than those actually measured due to previously unknown or unrecognised sources of noise and vibration. Additionally, sources of noise or vibration may be irregular or fluctuate in intensity to an unpredictable degree and consequently may not be present in full intensity for some of the survey period or the entire survey period.

The report does not consider the effects of long-distance meteorological effects such as refraction (due to temperature inversions, wind propagation). All measurements taken on site are subject to a margin of uncertainty of ±1dB due to manufacturer's specification of equipment.

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