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20th July 2022

One Stop

Assessment of External Plant Noise
for Proposed Store at Lloyd St
South, M14 7HT

Prepared for :-

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1.0 **SUMMARY**

During the evening period the noise was mainly local and distant road traffic, mainly Lloyd St. Burdith Avenue also appeared to be a cut-through for cars driving quickly. During the night, the traffic was obviously less and a buzz from the BT box was audible at the measurement position and more so at the nearest residential positions.

Based on an assumption of all equipment running on full load throughout the night, the predicted noise from the external mechanical plant in the proposed positions is likely to require mitigation in the form of very modest performance acoustic enclosures to Units B, C and D. This should ensure that there is negligible impact at the nearby residential properties.

This can be built into planning conditions and should be entirely feasible.

The effect of a simple acoustic fence around Unit A is also presented but it is in our view an unnecessary addition to the mitigation for no worthwhile benefit.



A R Raymond



P J Durell

2.0 INTRODUCTION

ADC was asked to carry out an independent assessment of the plant area of the proposed new One Stop store and predict the overall impact at the nearest noise-sensitive positions.

This report begins by discussing the various assessment criteria applicable to this situation. We follow by describing in simple terms our basic approach to calculations and modelling. After a short description of survey details, we discuss our results and present our conclusions and recommendations.

3.0 ASSESSMENT STANDARDS

3.1 NPPF, NPSE and NPPG

The National Planning Policy Framework (NPPF), the Noise Policy Statement for England (NPSE) and the National Planning Practice Guidance (NPPG) provide nothing in the way of quantitative criteria but instead provide general policy aims and statements and some guidance on how certain situations can be interpreted.

The NPPF's main statement on noise is to be found in paragraph 185:-

185. Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:
- a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life⁶⁵;
 - b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and
 - c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.

Paragraph 187 is also relevant:-

187. Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed.

The NPPF refers to the NPSE which sets out the following aims:-

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

It also introduces the concepts of:

- *NOEL – No Observed Effect Level. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.*
- *LOAEL – Lowest Observed Adverse Effect Level. This is the level above which adverse effects on health and quality of life can be detected.*
- *SOAEL – Significant Observed Adverse Effect Level. This is the level above which significant adverse effects on health and quality of life occur.*

SOAEL is clearly something the policy seeks to avoid in aim 1. Aim 2 represents situations between SOAEL and LOAEL, and seeks to minimise and mitigate the effects.

The NPPG section on noise adds some further detail, much of it reproducing the NPPF and NPSE, but some useful qualitative guidance is provided Noise Exposure Hierarchy, as follows:-

Response	Examples of outcomes	Increasing effect level	Action
No Observed Effect Level			
Not present	No Effect	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

It also makes the point that the subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation, including the level of the noise in absolute terms and how it might compare with the underlying background noise, the impulsiveness or intermittence pattern of the noise, its spectral content, and the time of day. It discusses in very general terms the issues to consider when introducing noise sources to existing noise sensitive area, new residential development in areas affected by existing noise sources (most of which have their own specific guidance, such as BS 4142, BS 8233, etc.) and the potential impact on wildlife.

3.2 BS 8233

BS 8233 was updated in March 2014. Quantitatively, however, the design criteria are little changed – just expressed differently to reduce ambiguity in certain situations. Its guidance is primarily intended for new buildings, but the criteria are routinely referred to for putting general noise climates into context.

Table 4 of BS 8233 gives the desirable criteria for indoor ambient noise levels for dwellings as follows:-

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq,16hour}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hour}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,16hour}$

Note that the standard accepts the widely used rule of thumb that, for a partly open window, the levels just outside will be 15dB higher than those just inside. This brings us to an external equivalent of the above table, as follows:-

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	50 dB $L_{Aeq,16hour}$	-
Dining	Dining room/area	55 dB $L_{Aeq,16hour}$	-
Sleeping (daytime resting)	Bedroom	50 dB $L_{Aeq,16hour}$	45 dB $L_{Aeq,16hour}$

It goes on to state that, where necessary, the criteria can be relaxed by up to 5 dB and still achieve reasonable conditions. Note that the new version does not explicitly state criteria for bedroom noise in terms of dB L_{Amax} .

Garden area criteria are unchanged with 50 dB L_{Aeq} and 55 dB L_{Aeq} being considered desirable and reasonable respectively.

Note that the new version of BS 8233 more explicitly specifies the assessment periods as 16 hour and 8 hour for daytime and night time respectively.

3.3 BS 4142

BS 4142 was updated in November 2014. The standard is very complicated but, basically, it describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

- sound from industrial and manufacturing processes
- sound from fixed installations which comprise mechanical and electrical plant and equipment
- sound from the loading and unloading of goods and materials at industrial and/or commercial premises
- sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that

from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

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

Characteristics and Context

Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, we need to add a character correction to the specific sound level to obtain the rating level.

These features can include tonality, impulsivity and intermittency with corrections typically ranging potentially from 0dB to 9 dB. Corrections at the higher end would represent characteristics which are highly perceptible in the context of the ambient noise as a whole. Corrections at the lower end would represent characteristics which are just perceptible in the presence of the ambient noise as a whole,

The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs. An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context.

Assessment

We obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level and considering the following.

- a) Typically, the greater this difference, the greater the magnitude of the impact.
- b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- d) 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, pertinent factors need to be taken into consideration, including the following.

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.

We need to 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.

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.

3.4 Local Authority

We are not aware of any specific criteria requested for this site. However, MCC have document, *Noise and Planning Technical Guidance*. An extract from the most relevant section is reproduced below:-

3.6.1.5 Industrial / commercial developments

BS 4142 should be used to assess the likely impact of noise from industrial and commercial sources at noise sensitive premises (section 3.5). One of the indications of the impact of a BS 4142 assessment is 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*.

The Council consider that new developments should contribute and enhance the area in which they are located and where possible, contribute to the improvement of people's health and quality of life as per the NPSE. With this in mind, the design objective should be:

'The development should be designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location'.

Where this criterion cannot be achieved, the various noise control measures considered as part of the assessment should be fully explained (i.e. relocation of noise sources, use of quieter equipment, enclosures, screening, restriction of the hours of operation) and the achievable noise level should be identified. This information will allow us to make a judgement concerning the application and its likely impact on the surrounding area.

The criterion in bold type is very stringent and makes no reference to context, which is a very important aspect of BS 4142. However, the paragraph which follows it suggests that a pragmatic approach will be taken by officers when assessing the proposals. See later.

4.0 BASIC APPROACH TO MODELLING

We have used our CadnaA modelling software which calculates noise propagation based on the processes of *ISO 9613 : Acoustics – Attenuation of sound during propagation outdoors*. Obviously, modelling software is reliant on the inputs and assumptions. The keys ones are:-

1. The ground is mainly reflective (coefficient of 0.11 assumed).
2. Calculations are based on two orders of reflections.
3. The proposed site buildings and the surrounding buildings are assumed to be mainly reflective (0.5 dB loss on reflection assumed).
4. Where acoustic fences are used, they are also assumed to be reflective the same as the buildings, unless specified otherwise.
5. The source data is based on manufacturers' literature. This is entered into the model along with the conditions under which the data was established (eg. free field, over hard ground, etc.) and tested to ensure the manufacturers' figure are faithfully reproduced in the model. When enclosures or silencers are specified, these are built into the figures.
6. All units are assumed to run continuously on full load.

5.0 SURVEY DETAILS

5.1 Site Times and Personnel

The site surveys were carried out by Mark Pickering of ADC Acoustics from shortly after 20:30 to shortly after 23:00 on 13th July 2022, and from approximately 02:00 to 04:00 the following night. The times were chosen to represent evening opening times of the store, and through the quietest times of the night.

5.2 Instrumentation

Instrumentation used was a Rion NL-52 Class I sound level meter which holds a current calibration certificate and which was field-calibrated as required with no drift noted. It was set up to measure continuous 5 minute samples in terms of dB L_{eq} , L_{max} and L_{90} in overall dB(A) terms and in octave bands across the frequency range. See Definitions of Acoustic terms in Appendix 1.

5.3 Measurement Positions

The main measurement position was as shown by the yellow star on the following plan.



The position was chosen to represent surrounding residential locations. It was quite a sheltered position with high walls all around and so we would expect residential positions to be a little higher, especially at first floor level. In other words it adds to the robustness of the assessment.

The microphone was 1.5 m above ground and well away from other reflecting surfaces.

5.4 Survey Conditions

Weather conditions were as follows :-

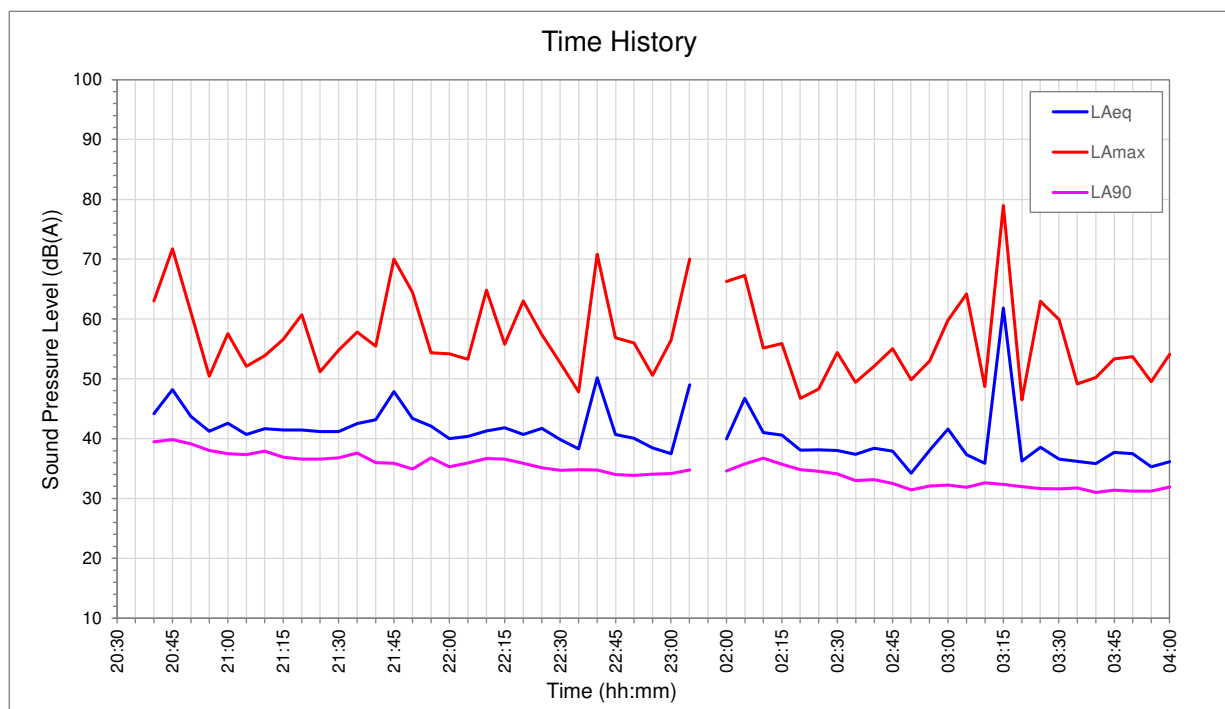
Rain	:	none, dry roads
Cloud	:	10%
Temperature	:	12 to 15 Celsius
Wind	:	negligible

6.0 RESULTS AND DISCUSSIONS

6.1 Background Noise and Design Targets

During the evening period the noise was mainly local and distant road traffic, mainly Lloyd St. Burdith Avenue also appeared to be a cut-through for cars driving quickly. During the night, the traffic was obviously less and a buzz from the BT box was audible at the measurement position and more so at the nearest residential positions.

Full results are shown in Appendix 2. They are summarised graphically below.



We have used the lowest 15 minute periods for the evening and night time measurements in the assessments. BS 4142 does not require us to use the lowest periods but it is a means mitigating against potential uncertainty of varying conditions, for instance on different days of the week. The levels for these periods are as follows:-

<i>Time Period</i>	<i>Index</i>	<i>dB(A)</i>
Lowest Evening Period	Leq	39
	Lmax	55
	L90	34
Lowest Night Time Period	Leq	37
	Lmax	53
	L90	31

6.2 Manufacturer's Noise Data

The following data was provided:-

Unit A - Profroid QC-MT30 (Size h1028mm x w1200mm x d360mm) : Noise - 29dB(A) @ 10m
Unit B - Daikin RZASG140MV1 (Size h990mm x w940mm x d320mm) : Noise - 57dB(A) @ 1m
Unit C - Daikin RZASG140MV1 (Size h990mm x w940mm x d320mm) : Noise - 57dB(A) @ 1m
Unit D - Daikin RZASG100MV1 (Size h990mm x w940mm x d320mm) : Noise - 57dB(A) @ 1m

Where only the single figure (dB(A) or dB LA) are available but no octave band data (spectral shape or noise levels across the frequency range), for calculation purposes we have assumed a spectral shape based on similar units.

6.3 Predicted Noise Levels

Based on all items operating on full load throughout the night¹, the predicted levels at the residential windows are as shown below:-



¹This is an extremely unlikely scenario, with most items rarely running beyond 70% for night time and rarely all items at the same time.

Note that:-

- The beige shapes are surrounding buildings and the application site building in its proposed form.
- The yellow crosses are the mechanical equipment point sources.
- The coloured numbers are the noise levels at the residential facades. Note that the software is set up to present the noisiest floor level.
- Note that the noise contours are shown for guidance as to how the noise propagates. The contours are at a height of 4 m.

The following 3D should help to visualise the model.



6.4 Assessments

For the assessment of proposed noise, BS 4142 requires us to assess the predicted industrial noise against the “background sound level” which is the noise climate without development described in terms of the underlying dB L_{A90} index.

The proposed equipment can potentially run 24 hour and so only the night time BS 4142 assessment is presented as follows:-

Specific Sound Level:	27 dB L_{Aeq}
Feature Corrections ²	
tonality:	0 dB L_{Aeq}
impulsivity:	0 dB L_{Aeq}
intermittency:	0 dB L_{Aeq}
other:	0 dB L_{Aeq}
Rating Level:	27 dB L_{Ar}
Background Sound Level:	31 dB L_{A90}
Rating Level Excess re. Background	-4 dB

² Unlikely to be audible so no character corrections applyxxxx

This is well below what BS 4142 rates as “*low impact depending on the context*”.

The context of course is an established commercial area and the impact, even under these somewhat extreme assumptions is likely to be negligible.

Another aspect to the context is especially crucial here due to the low predicted noise levels. BS 4142 states:-

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

- 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.

The current version of BS 4142 does not define what is “low”, but previous versions defined it as a background level below 30 dB L_{A90} and a rating level below 35 dB L_{Aeq} . Here, levels the predicted levels are well below these figures and it is unlikely that the units will be audible inside bedrooms at night. For the reason as well, we would suggest that the impact will be negligible.

Finally, it is also important to the context is that we assume that all units run at full load at the same time, which is very unlikely ever to occur.

We note that the predicted levels are 1 dB above the Manchester City Council typical criterion discussed in section 3.4. It is a stringent criterion in any circumstance, but especially here, given the contextual points discussed above. See mitigation below.

6.5 Mitigation

The above modelling assumes that Units B, C and D (but not Unit A) are fitted with acoustic enclosures. The assumed performance is as follows:-

OB Centre Frequency (Hz)	63	125	250	500	1k	2k	4k	8k
Enclosure Performance (dB)	0	11	14	18	20	18	13	3

Even the simplest acoustic enclosures should perform better than this and One Stop has used acoustic enclosures on condensers in the past. Their stated acoustic performance is shown in Appendix 3, which is far greater than the performance assumed in the calculations.

As shown in 6.4 above, this gives predicted levels 4 dB below background and the impact is likely to be negligible. Although the predicted levels are 1 dB above the Manchester City Council criterion of 5 dB below background, we have to recommend that these proposals are acceptable by any reasonable standard.

However, to achieve an extra 1 dB reduction overall, then further reductions will be required to Unit A. It needs to run through the night and so the only realistic options would be enclosing and acoustic fencing. We are advised that it cannot practicably be enclosed for ventilation reasons. We are also advised that an acoustic fence would impinge on access requirements in the yard and is therefore highly undesirable. The final paragraph of the extract copied in *MCC Noise and Planning Technical Guidance* copied into section 3.4 above suggests that officers will take a pragmatic approach to assessing situation where the desirable criterion cannot be met.

The following shows the effect of building an acoustic fence around Unit A into the model.



We can see that the predicted levels meet the MCC criterion, but it is only a 1 dB reduction overall and will be an imperceptible change.

Again, the following 3D view should help to visualise the proposal.



This model assumes a simple 1.8 m acoustic fence located approximately as shown. It does not need to be particularly high-spec. Theoretically, a barrier which is required to provide a 10 dB reduction only needs a density of 3 kg/m² which would be equivalent to around 6 mm thick timber. Of course the fence would be far thicker than this for structural purposes. The important point is that there are no gaps, including allowance for shrinkage and warping. An overlapping 15 to 18 mm fence would be a typical example of a simple acoustic fence.

6.6 Discussion of Uncertainty

BS4142 requires us to

“Consider the level of uncertainty in the data and associated calculations. Where the level of uncertainty could affect the conclusion, take reasonably practicable steps to reduce the level of uncertainty”.

The measurements of Background/Residual Sound were taken at times regarded as representing what are likely to be the worst case (quietest) parts of the opening times and through the night. We have no reason to believe that the conditions were anything other than representative of normal conditions. BS 4142 does not state what would be a representative background noise but there is certainly no suggestion that it should be the lowest and practices vary widely. However, in order to allow for the possibility of variation in levels, we have used the lowest 15 minute period.

Source data is assumed to be reliable. Where uncertainty may exist for this we have mitigated it assuming that all equipment is running on full load all of the time, which would in our experience would rarely occur, if ever. We have also assumed enclosures made entirely from acoustic louvres. Even the simplest solid acoustic enclosures can be expected to perform much better.

Calculations are based on the processes of *ISO 9613 : Acoustics – Attenuation of sound during propagation outdoors*. We know of no concerns within our industry as to the basic reliability of these methods and it is cited in BS 4142 as “*a validated method of calculating sound levels*”. The CadnaA software uses this standard and the input assumptions err on the side of caution and are stated in Section 4.

Varying meteorological conditions are unlikely to have a significant impact on results as the distances involved are small.

7.0 CONCLUSIONS/RECOMMENDATIONS

Based on an assumption of all equipment running on full load throughout the night, the predicted noise from the external mechanical plant in the proposed positions is likely to require mitigation in the form of very modest performance acoustic enclosures to Units B, C and D. This should ensure that there is negligible impact at the nearby residential properties.

This can be built into planning conditions and should be entirely feasible.

The effect of a simple acoustic fence around Unit A is also presented but it is in our view an unnecessary addition to the mitigation for no worthwhile benefit.

We recommend that you issue this to planners. It is important that officers are invited to contact us directly with any queries.

Appendix 1

Definition of Acoustic Terms

The Decibel

The decibel is the basic unit of noise measurement and is denoted dB. Technically, it is a means of expressing the difference in noise level between the measured noise and a standard level of noise. Most often the threshold of human hearing is used as the standard reference but it really should be stated. The threshold of human hearing is a sound pressure of 20 μ Pa or a sound power of 1pW.

A sound pressure level or SPL should be expressed in dB(re. 20 μ Pa). A sound power level or SWL should be expressed in dB(re. 1pW). If the reference levels are omitted, it will often (but not always) be safe to assume that they are referenced to the threshold of human hearing.

A-Weighting and dB(A)

The human hearing system responds differently to different frequencies. The A-weighting system takes account of this by emphasising mid and high frequencies more than low frequencies to give an overall level. An A-Weighted noise level, therefore, reflects the way normal, healthy hearing would perceive the overall level of the noise. The basic unit is dB(A), although other systems of expressing an A-weighted levels are discussed below.

Other weighting systems, such as C-Weighting, denoted dB(C), reflect the human hearing system's response at higher noise levels.

NR and NC Levels

NR curves and NC curves are a series of curves representing noise levels across the frequency range. A given noise climate has an NR level or NC level if it equals a point on the curve at any frequency. They are particularly, although by no means exclusively, used as a means of specifying noise limits in an indoor environment, for instance from mechanical services or traffic noise break-in from the outside. They are typically expressed as NR or NC followed by a number, e.g. NR40, NC55, etc.

Equivalent Continuous Sound Level, L_{eq}

This can be simplistically described as a way of expressing the average noise level.

The unit is dB L_{eq} . For A-weighted levels the unit is dB(A) L_{eq} or, in more modern units, dB L_{Aeq} .

Maximum Level, $L_{\max}$

This is the maximum level reached (usually for a fraction of a second) in the measurement period.

The unit is dB $L_{\max}$. For A-weighted levels the unit is dB(A) $L_{\max}$ or, in more modern units, dB $L_{A\max}$.

Statistical (Percentile) Levels, L_n

During a measurement of fluctuating noise, it is often useful to establish the levels exceeded for a percentage of the time. L_n is the index representing the level exceeded for $n\%$ of the measurement period.

The unit is dB L_n . For A-weighted levels, the unit is dB(A) L_n or, in more modern units, dB L_{An} .

Common examples are as follows :-

dB L_{A90} is the A-weighted level exceeded for 90% of the time and is often used to describe the underlying background noise.

dB L_{A50} is the A-weighted level exceeded for 50% of the time. Mathematically, it is the median, another kind of average.

dB L_{A10} is the A-weighted level exceeded for 10% of the time and has traditionally been used to describe the intermittent highs in the noise climate such as passing cars or aircraft.

Frequency Analysis

Here the audible frequency range is divided up into bands and the noise level is expressed in each frequency band from low pitches to high pitches.

Octave Band analysis is where the frequency range is divided into 8 bands from 63 Hz to 8kHz, or sometimes into 10 bands from 31.5 Hz to 16kHz.

1/3 Octave Band analysis provides more detailed subdivision into 24 bands from 50 Hz to 10kHz, or sometimes into 30 bands from 20Hz to 20kHz.

Narrow Band analysis takes this further with the possibility of many thousands of bands, possibly only 1Hz wide, or even less.

In all types of frequency analysis, the level in each band can be expressed in terms of L_{eq} , $L_{\max}$, L_n , etc. as defined above.

Sound Insulation

Sound insulation is best expressed across the frequency range in octave bands or third octave bands. Often, however, in known environments such as domestic sound insulation and speech privacy, it is simpler to express the sound insulation as a single figure. A higher value means better sound insulation.

The most common ways are dB D_{nTw} , dB R_w and dB_(mean 100-3150Hz). The first two are ways of expressing average sound insulation, weighted to account for speech frequencies. The third is simply an un-weighted mean value.

The Building Regulations Approved Document E (ADE) routinely refer to $D_{nTw} + C_{tr}$. The C_{tr} term is a negative number which is used to modify the D_{nTw} value for the insulation properties at lower frequencies.

ADE also uses the L_{nTw} index for impact sound transmission. It is a measure of the level of noise in the room below a room in which a standard tapping machine is being used. It represents the impact sound transfer such as footfall noise, scraping chairs, washing machines, etc. A lower value means better insulation.

Reverberation Time

The most common measure of Reverberation Time is, effectively the time taken for sound from a steady source to decay by 60 dB after it has been abruptly cut off. In practice it is often difficult to measure a 60 dB decay and so decays of 30 dB, 20 dB, or even 10 dB are often used and adjusted pro rata, although the exact measure is not quite the same.

Reverberation Time is generally expressed as RT in seconds. We may, if we are being precise, add subscripts 60, 30, etc to show whether the basis of the measure is 60 dB decay, 30 dB decay, etc. E.g. the $RT_{60} = 0.52s$, the $RT_{30} = 0.49s$, etc.

RT can be expressed in octave bands or 1/3 octave bands across the frequency range, or at central frequencies such as 500 Hz or 1kHz.

Appendix 2

Measurement and Calculation Details

Time Period	Index	dB(A)	63	125	250	500	1k	2k	4k	8k
20:40	Leq	44	54	48	42	40	40	35	31	26
	Lmax	63	69	69	61	60	58	54	53	46
	L90	39	46	40	38	36	37	30	20	14
20:45	Leq	48	57	52	48	42	44	40	36	32
	Lmax	72	81	78	68	65	69	60	59	60
	L90	40	47	40	38	36	37	29	21	14
20:50	Leq	44	56	50	43	41	40	33	24	18
	Lmax	61	76	71	59	61	53	42	36	33
	L90	39	48	42	38	36	36	29	18	13
20:55	Leq	41	53	44	39	37	38	32	21	16
	Lmax	50	68	56	47	45	46	40	39	37
	L90	38	46	39	37	34	35	28	16	13
21:00	Leq	43	57	46	41	38	39	33	24	23
	Lmax	58	76	67	55	49	50	46	36	52
	L90	37	46	40	37	33	34	28	17	13
21:05	Leq	41	53	43	39	36	38	32	23	16
	Lmax	52	68	52	46	49	45	44	43	41
	L90	37	45	39	37	33	34	27	16	13
21:10	Leq	42	52	42	40	37	39	33	23	19
	Lmax	54	64	52	52	46	50	45	43	42
	L90	38	46	39	37	34	35	28	17	13
21:15	Leq	41	56	42	39	38	38	31	22	16
	Lmax	57	74	52	47	56	52	43	42	38
	L90	37	47	38	36	32	34	27	16	13
21:20	Leq	41	54	43	39	37	38	32	31	17
	Lmax	61	67	54	48	48	46	51	59	41
	L90	37	46	39	37	33	33	26	16	13
21:25	Leq	41	54	44	39	36	38	32	21	14
	Lmax	51	70	56	46	44	45	46	36	24
	L90	37	47	39	37	32	33	27	15	13
21:30	Leq	41	55	42	39	37	38	32	21	14
	Lmax	55	75	54	50	54	47	41	37	28
	L90	37	46	38	36	33	34	27	16	13
21:35	Leq	43	54	45	41	39	39	33	24	15
	Lmax	58	71	65	59	53	54	45	40	31
	L90	38	46	39	37	34	35	28	17	13
21:40	Leq	43	56	49	46	39	38	32	22	14
	Lmax	56	71	62	59	52	49	43	34	28
	L90	36	46	38	36	32	33	26	15	13
21:45	Leq	48	71	58	44	39	38	33	24	16
	Lmax	70	93	83	64	55	48	43	37	30
	L90	36	45	38	36	32	33	26	16	13
21:50	Leq	43	58	54	43	38	38	32	22	16
	Lmax	64	76	79	64	55	49	45	40	31
	L90	35	44	37	36	31	32	24	15	13
21:55	Leq	42	59	44	39	37	39	33	23	14
	Lmax	54	73	59	49	46	50	45	40	31
	L90	37	50	39	37	33	33	27	17	13
22:00	Leq	40	53	42	38	35	37	31	21	14
	Lmax	54	75	56	52	46	49	46	37	25
	L90	35	46	38	36	31	32	25	15	13
22:05	Leq	40	54	42	39	36	37	31	21	13
	Lmax	53	71	58	53	50	49	40	36	21
	L90	36	46	38	36	32	33	26	15	13
22:10	Leq	41	53	42	39	37	37	34	26	20
	Lmax	65	68	54	58	58	57	61	54	49
	L90	37	46	39	36	33	34	26	15	13
22:15	Leq	42	53	44	42	37	39	32	21	15
	Lmax	56	68	58	56	52	52	46	37	30
	L90	37	46	40	37	32	33	26	16	13
22:20	Leq	41	54	43	40	37	37	31	24	14
	Lmax	63	71	65	65	64	53	46	49	36
	L90	36	46	39	36	32	32	26	15	13
22:25	Leq	42	55	48	45	37	36	29	20	15
	Lmax	57	76	60	59	56	49	43	42	39
	L90	35	46	40	36	31	32	24	14	13
22:30	Leq	40	52	45	39	36	36	31	21	15
	Lmax	53	65	61	53	48	45	42	42	40
	L90	35	45	39	36	31	31	24	14	13
22:35	Leq	38	52	41	37	34	35	29	18	13
	Lmax	48	68	51	46	43	42	39	28	21
	L90	35	46	38	35	31	31	25	15	13
22:40	Leq	50	57	53	49	49	44	41	38	26
	Lmax	71	77	74	68	70	64	62	61	50
	L90	35	46	38	36	31	31	24	15	13
22:45	Leq	41	53	42	40	36	38	31	20	13
	Lmax	57	76	59	59	52	52	44	32	26
	L90	34	44	38	35	30	30	24	14	13
22:50	Leq	40	53	46	42	36	35	30	21	15
	Lmax	56	68	67	57	53	46	44	38	30
	L90	34	46	39	35	30	30	23	14	13
22:55	Leq	38	53	43	38	33	35	29	19	18
	Lmax	51	70	55	50	43	46	41	36	37
	L90	34	44	38	35	30	30	23	14	13
23:00	Leq	37	49	41	37	33	34	28	19	14
	Lmax	56	65	55	50	55	52	48	44	38
	L90	34	44	38	35	30	31	24	14	13
23:05	Leq	49	56	52	41	38	43	44	41	34
	Lmax	70	74	75	60	58	64	65	62	50
	L90	35	44	38	35	31	31	25	18	14

<i>Time Period</i>	<i>Index</i>	<i>dB(A)</i>	<i>63</i>	<i>125</i>	<i>250</i>	<i>500</i>	<i>1k</i>	<i>2k</i>	<i>4k</i>	<i>8k</i>
02:00	Leq	40	48	42	40	38	36	30	23	18
	Lmax	66	70	70	68	67	57	51	51	44
	L90	35	41	36	36	31	31	24	14	13
02:05	Leq	47	68	58	46	38	37	32	24	17
	Lmax	67	89	80	67	52	47	48	40	34
	L90	36	44	38	36	32	32	25	15	13
02:10	Leq	41	52	42	39	38	38	32	22	15
	Lmax	55	70	54	50	53	51	46	38	35
	L90	37	44	38	37	33	34	26	15	13
02:15	Leq	41	49	42	40	37	37	31	23	16
	Lmax	56	64	57	55	54	51	46	42	35
	L90	36	43	37	36	32	33	25	15	13
02:20	Leq	38	49	40	37	33	35	29	19	13
	Lmax	47	60	52	43	41	44	37	33	31
	L90	35	43	37	36	31	32	24	14	13
02:25	Leq	38	47	40	37	34	35	28	18	13
	Lmax	48	60	51	44	43	46	39	33	23
	L90	35	42	37	36	31	31	24	14	13
02:30	Leq	38	46	40	39	36	34	27	16	13
	Lmax	54	59	53	56	56	42	38	27	22
	L90	34	42	38	35	30	30	23	14	13
02:35	Leq	37	47	40	37	33	34	28	18	13
	Lmax	49	64	47	44	42	45	44	38	28
	L90	33	42	37	35	29	29	22	14	13
02:40	Leq	38	49	41	38	34	35	29	24	18
	Lmax	52	66	55	48	47	48	44	41	37
	L90	33	42	36	35	29	29	23	14	13
02:45	Leq	38	49	41	39	34	34	29	20	14
	Lmax	55	67	56	57	49	50	48	42	29
	L90	33	43	37	35	29	28	22	14	13
02:50	Leq	34	44	37	35	30	30	25	15	13
	Lmax	50	63	53	45	46	47	41	31	22
	L90	31	41	35	34	27	27	21	13	12
02:55	Leq	38	50	39	38	34	35	29	20	15
	Lmax	53	70	53	50	45	51	42	36	30
	L90	32	42	35	35	28	27	22	14	13
03:00	Leq	42	53	48	44	38	36	32	25	19
	Lmax	60	73	67	61	55	55	49	45	38
	L90	32	43	37	35	28	27	21	14	13
03:05	Leq	37	49	38	36	32	33	28	30	20
	Lmax	64	67	56	46	48	49	52	63	48
	L90	32	41	35	34	28	27	21	13	13
03:10	Leq	36	48	41	38	32	31	26	17	14
	Lmax	49	66	56	48	44	42	40	37	33
	L90	33	42	37	35	29	28	21	13	13
03:15	Leq	62	48	42	39	36	35	38	61	30
	Lmax	79	68	69	67	63	54	55	78	46
	L90	32	42	37	35	29	28	21	13	13
03:20	Leq	36	46	40	37	32	33	27	17	13
	Lmax	47	61	47	44	41	43	40	28	26
	L90	32	42	37	35	28	27	21	13	13
03:25	Leq	39	49	42	39	35	34	30	25	21
	Lmax	63	71	64	66	62	52	51	53	50
	L90	32	41	36	34	28	27	21	13	13
03:30	Leq	37	46	39	37	34	32	27	20	14
	Lmax	60	63	59	59	61	50	49	48	38
	L90	32	41	36	35	28	26	20	13	12
03:35	Leq	36	49	40	37	32	32	26	17	13
	Lmax	49	66	51	47	45	46	40	31	20
	L90	32	42	37	35	29	26	20	13	13
03:40	Leq	36	46	40	37	32	31	26	18	13
	Lmax	50	62	61	48	46	45	40	34	25
	L90	31	42	37	35	28	24	20	13	13
03:45	Leq	38	47	42	39	34	33	29	21	16
	Lmax	53	63	56	53	50	48	46	39	34
	L90	31	42	38	35	28	24	19	13	12
03:50	Leq	38	48	41	39	33	33	29	20	14
	Lmax	54	66	61	53	50	49	44	38	30
	L90	31	42	37	35	28	24	20	13	13
03:55	Leq	35	47	43	37	31	30	26	17	13
	Lmax	50	61	60	48	42	43	43	34	27
	L90	31	43	38	35	28	24	20	13	13
04:00	Leq	36	36	33	32	31	29	32	24	18
	Lmax	54	51	46	50	50	47	50	43	37
	L90	32	42	39	36	28	24	20	14	13

<i>Time Period</i>	<i>Index</i>	<i>dB(A)</i>	<i>63</i>	<i>125</i>	<i>250</i>	<i>500</i>	<i>1k</i>	<i>2k</i>	<i>4k</i>	<i>8k</i>
Lowest Evening Period	Leq	39	52	44	39	34	35	29	20	16
	Lmax	55	68	63	54	52	49	45	41	36
	L90	34	45	38	35	30	30	23	14	13
Lowest Night Time Period	Leq	37	47	41	38	33	33	28	20	15
	Lmax	53	64	60	52	49	48	44	37	31
	L90	31	42	37	35	28	24	20	13	12

Appendix 3

Example Acoustic Enclosure Used by One Stop

CLASSIC ACOUSTICS LTD

UNIT B6A HALDANE, HALESFIELD 8, TELFORD, SHROPSHIRE. TF7 4QN
TEL. 01952 587360 FAX. 01952 680102 EMAIL. CLASSICACOUSTICS@HOTMAIL.COM

ACOUSTIC ENCLOSURES

Typical before and after acoustic enclosures



Transmission Loss Data:

Transmission Loss – Classic Standard Enclosure							
Octave Frequency in Hertz (dB ref 2×10^{-5} Pascal's)							
63	125	250	500	1K	2K	4K	8K
14	16	23	30	37	39	38	39
<u>Summary</u>							
Transmission Loss Equates to an Overall Reduction of 26 dB(A)							