SHARPS REDMORE

ACOUSTIC CONSULTANTS • Established 1990

Report

Aldi, Wyndham Way, Portishead, BS208LR

Assessment of noise from proposed replacement fixed plant equipment

Prepared by

K J Metcalfe BSc (Hons). MIOA

Date 28th March 2024
Project No: 2422427

Head Office
Sharps Redmore
The White House, London Road,
Copdock, Ipswich, IP8 3JH
T 01473 730073
E contact@sharpsredmore.co.uk
W sharpsredmore.co.uk

Regional Locations
South England (Head Office),
North England, Wales, Scotland

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Appendices

1.0 Introduction

1.1 Sharps Redmore (SR) has been instructed to undertake a noise assessment of proposed replacement refrigeration plant equipment at the Aldi store at Wyndham Way, Portishead.

1.2 The existing plant equipment is located at ground level to the rear of the covered service yard area. The proposal is to relocate the majority of the plant (refrigeration park, gas cooler and five air source heat pumps (ASHPs) to the roof of the store, with two condenser units to be located at ground floor level adjacent to the delivery loading bay. The closest residential properties to the proposed plant are in Victoria Square to the south and west of the store. The proposed plant locations and residential properties are indicated on the plan at Appendix A.

1.3 The objective of the assessment is to determine how noise that may be generated as a result of the replacement plant equipment would affect the amenity of adjacent residences. The proposed plant details are presented at Appendix B.

1.4 Section 2 of this report contains a discussion of the available methods of assessment and assessment criteria.

1.5 Section 3 of this report sets out the findings of an environmental noise survey and section 4 presents an assessment of noise from the proposed replacement fixed plant equipment.

1.6 The assessment conclusions are contained in section 5 of this report.

2.0 Assessment methodology and criteria

2.1 The National Planning Policy Framework (NPPF), December 2023, sets out the Government's planning policies for England and "these policies articulate the Government's vision of sustainable development." In respect of noise, Paragraph 191 of the NPPF states the following:

"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 life;

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".

2.2 Guidance on the interpretation of the policy aims contained within the NPPF is contained within National Planning Policy Guidance (NPPG). The NPPG introduces the concept of a noise exposure hierarchy based on likely average response. The guidance contained in the NPPG (NPPG paragraph 005) is summarised in the table below:

TABLE 1: Noise Exposure Hierarchy

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

2.3 The NPPF and NPPG reinforces the March 2010 DEFRA publication, "Noise Policy Statement for England" (NPSE), which states three policy aims, as follows:

"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

- *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."*

2.4 Together, the first two aims require that no significant adverse impact should occur and that, where a noise level which falls between a level which represents the lowest observable adverse effect and a level which represents a significant observed adverse effect, then according to the explanatory notes in the statement:

"… all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life whilst also taking into consideration the guiding principles of sustainable development. This does not mean that such effects cannot occur."

2.5 Taking an overview of national policy aims and guidance it is clear that when considering the impact of noise, the fact noise can be heard and causes impact, is not a reason to refuse an application as consideration should also be given to the significance of the impact and the mitigation measures available.

2.6 It is standard and good practice to apply objective standards to the assessment of noise and the effect produced by the introduction of a certain noise source may be determined by several methods, as follows:

i) The effect may be determined by reference to guideline noise values, such as those contained in the World Health Organisation (WHO) "*Guidelines for Community Noise"*.

ii) Alternatively, the impact may be determined by considering the change in noise level that would result from the proposal, in an appropriate noise index for the characteristic of the noise in question. There are various criteria linking change in noise level to effect. This is the method that is suited to, for example, the assessment of noise from road traffic because it is capable of displaying impact to all properties adjacent to a road link irrespective of their distance from the road.

iii) Another method is described within BS 4142:2014+A1:2019 which focuses on determining the significance of sound impact from sources of industrial and/or commercial nature. The sources that the newly revised standard is intended to assess are sound from industrial and manufacturing processes, sound from fixed plant installations, sound from loading and unloading of goods at industrial and/or commercial premises and the sound from mobile plant and vehicles, such as forklift, train or ship movements.

2.7 The assessment of fixed plant noise is principally undertaken in accordance with the methodology in BS 4142:2014+A1:2019. The scope of this standard states that it is suitable for the assessment of:

"a) sound from industrial and manufacturing processes;

b) sound from fixed installations which comprise mechanical and electrical plant and equipment;

c) sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and

d) 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."

2.8 The significance of sound impact is to be determined according, in summary, to the following process:

i) Determine the typical background sound levels, in terms of the index L_{A90}, at the receptor locations of interest.

ii) Determine the specific sound level of the source being assessed, in terms of its L_{AeqT} level (T = 1 hour for day or 15 minutes for night), at the receptor location of interest.

iii) Apply a rating level acoustic feature correction if the source sound has tonal, impulsive, intermittent, or other characteristics which attract attention.

iv) Compare the rating sound level with the background sound level; the greater the difference between the two, the higher the likelihood of adverse impact.

v) A difference (rating – background) of around +10 dB is an indication of significant adverse impact, depending on the context; a difference of +5 dB is an indication of an adverse impact, depending on the context. 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 upon context.

2.9 BS4142:2014+A1:2019 explains the importance of '*context*' to the process of identifying noise impact. Section 11 of BS 4142:2014 explains "*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* (our emphasis). A*n 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"* (our emphasis).

2.10 There are many *context* points to consider when undertaking an assessment of sound impact including:

- The absolute level of sound;
- The character and level of the specific sound in the context of the existing noise climate; for example is the sound to occur in a location already characterised by similar activities as those proposed?
- The sensitivity of the receptors;

- The time and duration that the specific sound is to occur;
- The conclusions of assessments undertaken using alternative assessment methods, for example WHO guidelines noise values or change in noise level;

2.11 It is therefore entirely possible that whilst the numerical outcome of a BS 4142:2014+A1:2019 assessment is indicative of adverse or significant adverse impact, when the proposal is considered in *context* the significance of the impact is reduced to an acceptable level.

3.0 Environmental noise survey details

3.1 Sharps Redmore have undertaken a couple of noise surveys at this store; firstly, in March 2020 just prior to the Covid pandemic, and recently in March 2024. Both surveys were carried out at the same monitoring location, indicated at Figure 1 below:

3.2 The measurement location was chosen to be representative of the existing noise climate at the nearest residential receptors in Victoria Square to the south and west of the Aldi store.

FIGURE 1: Noise measurement location

<u>2020 noise survey</u>

3.3 Noise measurements were carried out during the evening and night time of Thursday 5th/Friday 6th March 2020. Attended noise measurements were carried out using a Norsonic 118 sound level meter. The sound level meter was calibrated at the start and end of each set of measurements and no variation in levels were observed. Noise measurements were taken over 15-minute sample periods.

3.4 The sound level meter was positioned approximately 1.6 metres above local ground level in free field conditions, as indicated above.

3.5 Weather conditions were dry and mostly cloudy, with temperatures of around 5°C; winds were light (<5m/s) and predominantly from the west. Weather conditions are not considered to have affected the noise measurements.

3.6 Attended sample noise measurements were collected during the last hour of the daytime period (between 2200 and 2300 hours) and in the middle of the night (between 0200 and 0300 hours). At these times typically, the lowest noise levels are found, which can be used to set robust plant noise limits.

3.7 The dominant noise source during the measurements were from road traffic sources.

2024 noise survey

3.8 Noise measurements were carried out during the evening and night time of Monday 18th/Tuesday 19th March 2024. Attended noise measurements were carried out using a Norsonic 140 sound level meter. The sound level meter was calibrated at the start and end of each set of measurements and no variation in levels were observed. Noise measurements were taken over 15-minute sample periods.

3.9 The sound level meter was positioned approximately 1.6 metres above local ground level in free field conditions.

3.10 Weather conditions were dry and mostly cloudy, with temperatures of around 11°C; winds were light (<5m/s) and predominantly from the southwest. Weather conditions are not considered to have affected the noise measurements.

3.11 Similarly to the 2020 noise survey, attended sample noise measurements were collected during the last hour of the daytime period and in the middle of the night, when typically, the lowest background noise levels occur. The dominant noise source during the most recent March 2024 measurements was from local road traffic sources.

3.12 The measured noise levels from the 2020 and 2024 noise surveys are indicated in the Table below:

TABLE 2: Aldi Portishead noise survey results

Date	Time	Sound level dB				
		L_{A10}	L_{A90}	$L_{Aeq\ T}$	L_{Amax}	L_{Amin}
5.3.20	22:00	47.2	38.1	44.9	70.4	34.9
	22:15	46.8	38.5	43.5	53.2	35.6
	22:30	47.5	39.1	44.2	55.3	35.0
	22:45	47.1	37.6	45.5	65.0	35.1
6.3.20	01:45	41.6	33.4	39.8	53.9	32.0
	02:00	40.2	32.6	38.4	50.4	30.3
	02:15	42.5	35.4	40.0	54.1	33.1
	02:30	43.1	36.3	41.8	56.7	34.0
	02:45	42.4	35.7	41.2	57.8	33.6
18.3.24	22:00	45.9	42.5	44.8	62.1	41.2
	22:15	44.4	41.6	43.0	52.8	39.9
	22:30	44.8	41.1	43.9	61.6	39.7
	22:45	43.0	40.4	41.8	52.3	39.0
19.3.24	01:00	40.8	37.8	39.4	45.6	36.2
	01:15	41.3	37.7	39.9	55.3	36.3

3.13 It is noted that slightly lower noise levels were measured during the 2020 survey, compared to the recent March 2024 survey. The assessment uses the lowest typical background noise levels to set plant noise limits; this represents a robust assessment approach. The lowest daytime background noise level is typically 38 dB L_{A90}, whilst at night the typical value was 33 dB L_{A90}.

4.0 Fixed plant noise assessment

4.1 The objective assessment of plant sound sources in commercial premises should be undertaken in accordance with British Standard 4142:2014+A1:2019. This Standard enables the resultant sound levels from new plant equipment to be compared against the existing background sound level (L_{A90}) of an area to establish the significance of the sound impact.

4.2 In terms of seeking to set appropriate plant rating sound limits, the advice in BS 4142:2014+A1:2019 is that *"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 of having a low impact, depending on the context*" (clause 11, note 'd').

4.3 Hence in relation to the guidance above from BS 4142:2014+A1:2019 there is a robust technical case to seek to set plant sound limits that match the typical background sound climate. It therefore proposed to adopt a daytime plant rating noise level limit of 38 dB daytime and 33 dB night time at the closest properties in Victoria Square.

4.4 The following planning condition is recommended to secure the above criteria:

"No fixed plant and/or machinery shall come into operation until details of the fixed plant and machinery serving the development hereby permitted, and any mitigation measures to achieve this condition, are submitted to and approved in writing by the local planning authority. The rating level of the sound emitted from the site shall not exceed 38 dB between 0700 and 2300 hours and 33 dB at all other times, at the closest residential properties. The measurements and assessment shall be made according to BS 4142:2014+A1:2019."

4.5 The table below indicates the source noise level of the proposed replacement refrigeration plant equipment.

TABLE 3: Proposed plant source noise levels

Description	Octave band (Hz) sound power levels dB L_W							
	63	125	250	500	1K	2K	4K	8K
Gas cooler	30 dBA at 10 metres							
CO_2 refrigeration pack	33 dBA at 10 metres							
LT condenser	36 dBA at 10 metres							
MT condenser	33 dBA at 10 metres							
5x ASHP (per unit)	-	63	63	51	54	51	49	42

4.6 SR uses an environmental noise modelling software package called 'NoysPlot'. This software enables coordinates to be entered for the relative positions of noise sources, receivers and barriers to calculate a resultant noise level at a given noise receptor. The software carries out 'text book' atmospheric side calculations with regard to distance and screening attenuation by referencing relative source and receiver positions.

4.7 The height coordinates used in the 'NoysPlot' model have been extrapolated from the site drawings, from site observations, and using Google Earth. The horizontal coordinates are referenced from an arbitrary 'x', 'y' position on a grid system.

4.8 The software considers these noise sources which are detailed in the noise source input schedule in Appendix C1. From the manufacturers noise level data that has been supplied there is no indication that the plant has any tonal component. The refrigeration plant may operate intermittently. BS 4142 allows for a rating level correction of 3 dB to added to the specific noise level for the acoustic characteristic of intermittency; this has been achieved within the NoysPlot model by inputting the operating duty at 200%.

4.9 NoysPlot uses operating time information to calculate noise levels for daytime and night time operation. The time period that the equipment is assumed to be operating is denoted by 'D' to indicate daytime only operation; an 'N' to denote night time usage and 'A' to indicate that the equipment runs all the time. For this assessment it is assumed that all of the replacement equipment operates all of the time.

4.10 NoysPlot has the capability to accept input noise data in a number of formats. Where available, the ventilation plant manufacturer's sound power level data (designated by the letter W in the L_p/L_w column of the input schedule) is used. Where the sound power level data is not available the manufacturer's un-weighted octave band sound pressure levels at a stated distance are used (designated P but with an N in the dBA column of the schedule to indicate un-weighted). Alternatively, the manufacturer's A-weighted, single figure, averaged level at the stated distance is used (designated 'P' with 'Y' in the dBA column of the schedule). For this assessment, single figure A-weighted noise level data has been used for the gas cooler, refrigeration pack, HT and MT condenser units, whilst the air source heat pumps have been inputted as octave band sound power levels.

4.11 The surface directivity is also assessed for all cases – this depends on the number of adjacent reflective surfaces – the number can be seen in the column headed Q in the input schedule.

4.12 A summary of the atmospheric noise calculations for daytime and night time are displayed in Appendix C3. Calculations for each source to receiver can be made available upon request. These calculations consider the attenuation afforded by distance, outlet reflection, angular and surface directivity and acoustic screening. The software maintains a logarithmic summation for each receiver position and ranks the individual noise sources in order of contribution to the overall noise level (highest at the top of the list). This assists with the identification of those noise sources requiring additional noise control.

4.13 The input data defining the locations of the noise sources, the receivers and screening are shown in Appendix C2. The NoysPlot noise model principally considers two noise barrier types; the barrier descriptor 'R' is used in the schedule to denote a ring type whereby only noise transmitted over the top of the barrier is considered; whilst noise barriers denoted 'F' for finite consider noise transmitted over the top and around the ends of the barrier. A ring type barrier has been used in this assessment to model the parapet around the store roof, and a finite barrier to model the wall around the corner of the Aldi service yard.

4.14 The NoysPlot calculations (see Appendix C3) show the following resultant plant rating noise levels:

TABLE 4: Predicted plant (rating) sound levels

Noise sensitive receptor	Predicted rating sound level dB(A)	
	Daytime	Night time
13 Victoria Square	30	30
15 Victoria Square	30	30
16 Victoria Square	30	30
19 Victoria Square	25	26
21 Victoria Square	25	26
24 Victoria Square	24	26

4.15 The predicted replacement plant rating noise levels are at least 8 dB below the existing lowest typical daytime (evening) background noise level and are at least 3 dB below the night time background noise level.

4.16 BS 4142:2014 explains that where the rating noise level is below the existing background noise climate this situation is indicative of low impact (depending upon context). The predicted rating noise levels are therefore shown to comply with the requirements of paragraph 191 of the NPPF to avoid significant adverse impact.

5.0 Assessment conclusions

5.1 This assessment considers noise associated with the proposed replacement fixed plant equipment at the Aldi store at Wyndham Way, Portishead.

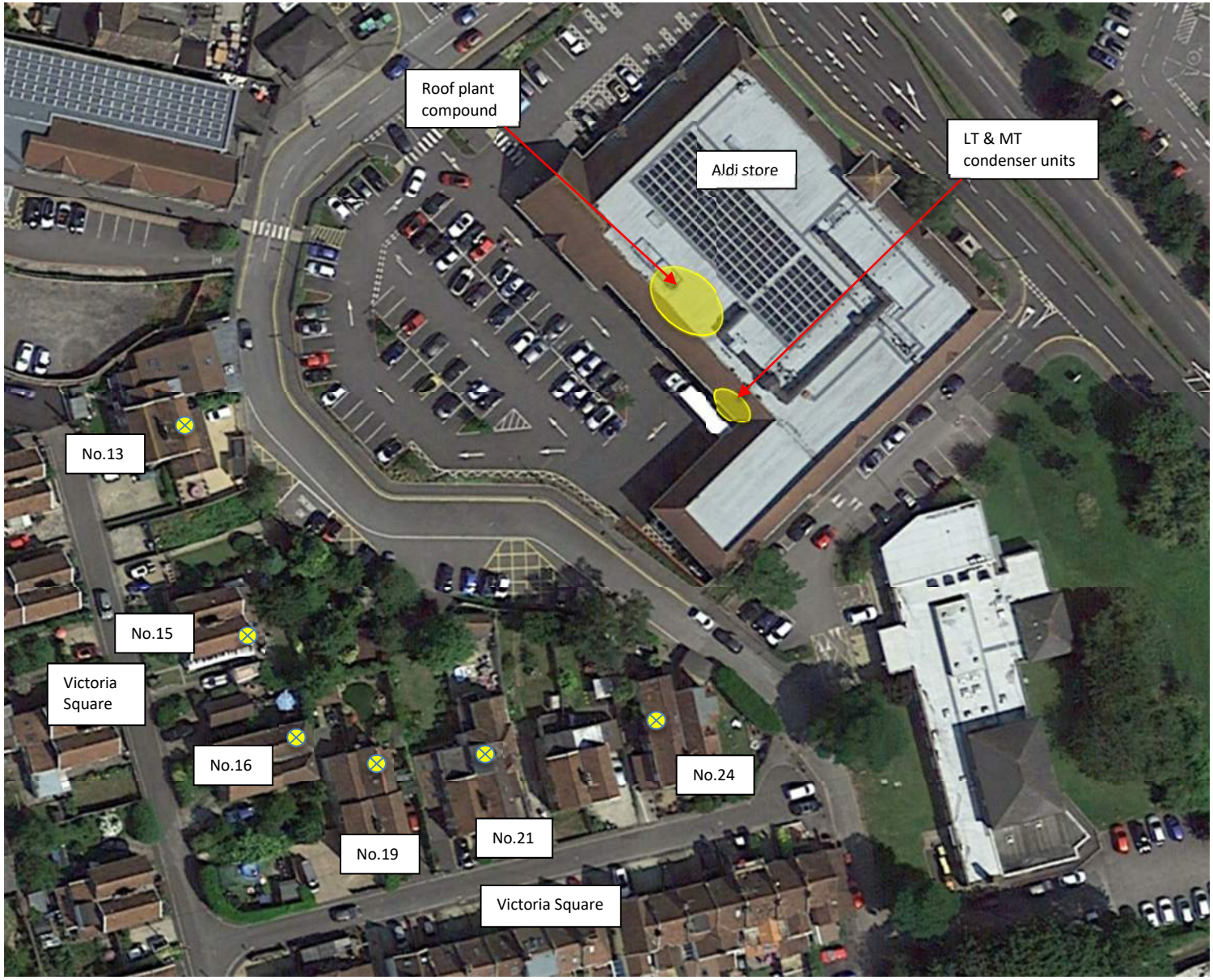
5.2 Predicted rating noise levels from the proposed replacement fixed plant equipment are below the existing daytime and night time background noise levels. On this basis it is concluded that noise from the proposed replacement plant would be indicative of low impact at the closest residential properties.

5.3 This assessment objectively demonstrates that noise associated with the proposed replacement plant equipment would comply with the requirements of national planning policy to avoid significant adverse impact.

APPENDIX A

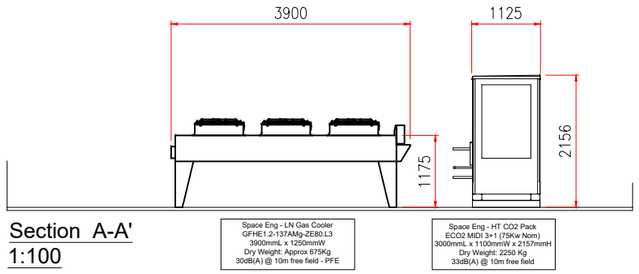
SITE LAYOUT

APPENDIX A: Site layout

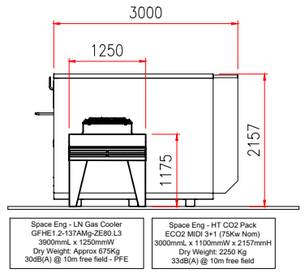


APPENDIX B

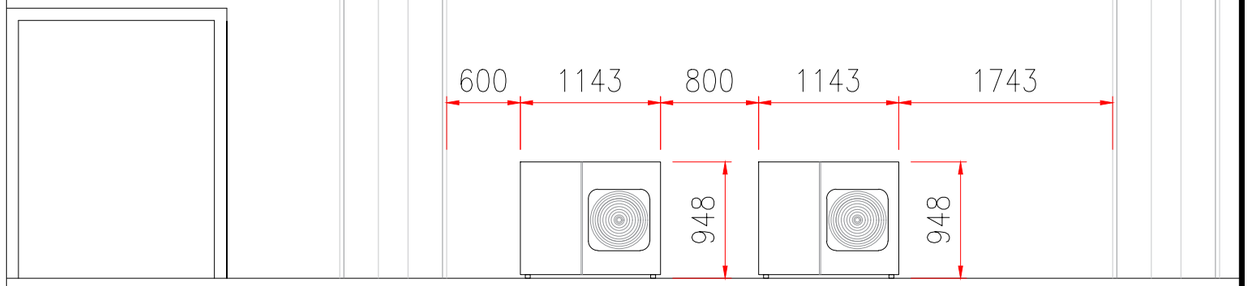
PROPOSED PLANT DETAILS



Section A-A'
1:100



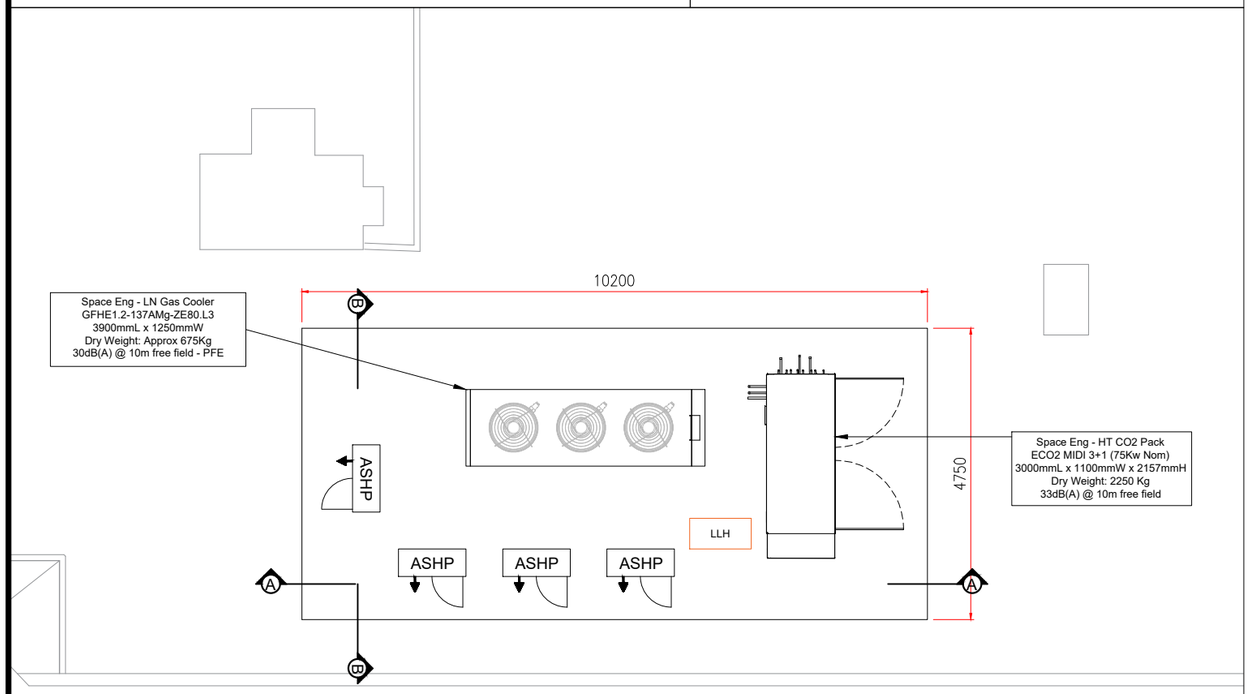
Section B-B
1:100

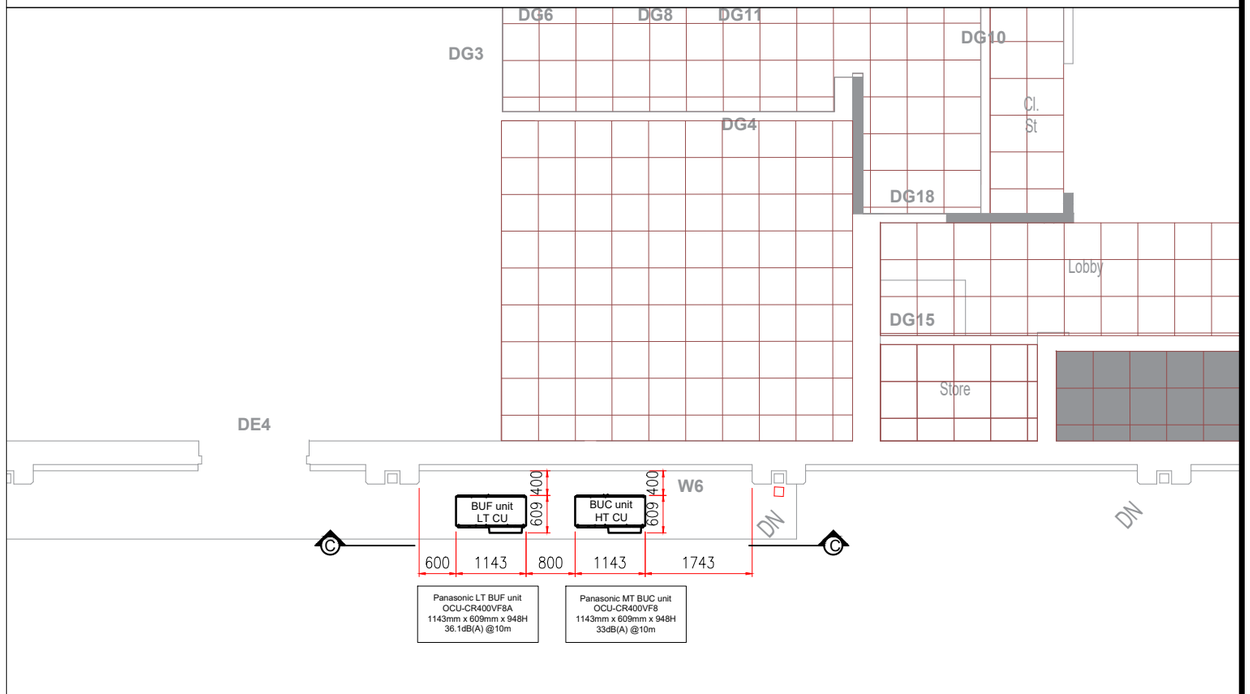


Section C-C
1:50

Panasonic LT BUF unit
OCU-CR400VF8A
1143mm x 609mm x 948H
36.1dB(A) @10m

Panasonic MT BUC unit
OCU-CR400VF8
1143mm x 609mm x 948H
33dB(A) @10m





CLIENT

ALDI Stores Ltd

REVISIONS

REV.	DESCRIPTION	DRAWN	APPD.	DATE
-	Original issue.	A.A.	R.P.	22-02-2024
A	Condensing Unit plant added.	A.A.	R.P.	21-03-2024

PROJECT
Bristol, Portishead #35

DRAWING TITLE
Plant Compound

DRAWING NUMBER	Rev	SCALE	SHEET SIZE
2989-R6	A	1:100	A3

STATUS
INFORMATION

K2 Engineering (Cooling) Ltd
Specialists in Refrigeration and Air Conditioning

K2 Engineering (Cooling) Ltd
2 The Parade
Brighton Road
Burgh Heath, Surrey
KT20 6AT

Tel: +44 (0) 20 8394 0900
Email: david@k2cooling.com

APPENDIX C

PLANT NOISE MODELLING CALCULATIONS

Client: Aldi Stores Limited				Appendix C1.1					Page: 1 of 1		
Project: Aldi Portishead				Project no: 2422427							
Consultant: K J Metcalfe				Date: 28 March 2024							
Sound power levels (Lw) & sound pressure levels (Lp) for fans & other equipment											
Equipment name/reference	Lw/ Lp	Dist. (m)	On time D/N/A	Mid-frequency Octave Bands (Hz)							
				63	125	250	500	1k	2k	4k	8k
Refrigeration pack	Lp	10	A	30	dBA						
Gas cooler	Lp	10	A	33	dBA						
ASHP #1	Lw		A	0	63	63	51	54	51	49	42
ASHP #2	Lw		A	0	63	63	51	54	51	49	42
ASHP #3	Lw		A	0	63	63	51	54	51	49	42
ASHP #4	Lw		A	0	63	63	51	54	51	49	42
ASHP #5	Lw		A	0	63	63	51	54	51	49	42
LT condenser unit	Lp	10	A	36	dBA						
MT condenser unit	Lp	10	A	33	dBA						

Notes:

1. Lw/Lp
   Lw means sound power level (dB)
   Lp means sound pressure level at the stated distance (dB@m)
2. On times (On.time D/N/A):
   D (Day) means that the fan/equipment could operate at any time between 0700 and 2300 hours
   N (Night) means that the fan/equipment could operate at any time between 2300 and 0700 hours
   A (All) means that the fan/equipment could operate at any time during the day and night

Appendix C2: NoysPlot input data, source, receptor and barrier data

Sharps Redmore Partnership
The White House, London Road, Copdock, Ipswich, IP8 3JH

Filename:	p:\24 - Projects\2422427 Aldi Portishead-KJM\NoysPlot\Portishead
Date:	28 March 2024
Entries by:	K J Metcalfe
Project no:	2422427
Project title:	Aldi Portishead
Client's name:	Aldi Stores Limited

Map/plot details:	Length:	400
	Width:	400
	Height:	250

Source data - description, co-ordinates, outlet size, percentage to atmosphere, directivity, sound levels and running period

Source description	Co-ordinates			Outlet details			%	Q	Run	Lp/	dBA	Dist	Noise level - Octave band centre frequency Hz							
	X m	Y m	Z m	Amm	Bmm	Ang.			d/n/a	Lw	Y/N	(m)	63	125	250	500	1k	2k	4k	8k
Refrigeration pack	173.0	203.0	9.0	0	0	0	200	2	A	P	Y	10.0	30 dBA							
Gas cooler	170.0	204.0	8.5	0	0	0	200	2	A	P	Y	10.0	33 dBA							
ASHP #1	170.0	202.0	8.0	0	0	0	200	2	A	W	N	0.0	0	63	63	51	54	51	49	42
ASHP #2	168.5	202.0	8.0	0	0	0	200	2	A	W	N	0.0	0	63	63	51	54	51	49	42
ASHP #3	167.0	202.0	8.0	0	0	0	200	2	A	W	N	0.0	0	63	63	51	54	51	49	42
ASHP #4	166.5	203.0	8.0	0	0	0	200	2	A	W	N	0.0	0	63	63	51	54	51	49	42
ASHP #5	166.5	205.0	8.0	0	0	0	200	2	A	W	N	0.0	0	63	63	51	54	51	49	42
LT condenser unit	194.0	197.0	0.7	0	0	0	200	3	A	P	Y	10.0	36 dBA							
MT condenser unit	195.5	197.0	0.7	0	0	0	200	3	A	P	Y	10.0	33 dBA							

Receptor data - description and co-ordinates

Receptor description	Co-ordinates			DNA
	X m	Y m	Z m	
13 Victoria Square	141.0	134.0	1.5	D
13 Victoria Square	141.0	134.0	4.5	N
15 Victoria Square	168.0	120.0	1.5	D
15 Victoria Square	168.0	120.0	4.5	N
16 Victoria Square	186.0	114.0	1.5	D
16 Victoria Square	186.0	114.0	4.5	N
19 Victoria Square	200.0	118.0	1.5	D
19 Victoria Square	200.0	118.0	4.5	N
21 Victoria Square	209.0	130.0	1.5	D
21 Victoria Square	209.0	130.0	4.5	N
24 Victoria Square	216.0	159.0	1.5	D
24 Victoria Square	216.0	159.0	4.5	N

Barrier data - description and co-ordinates

Barrier description	Co-ordinates					
	Start			End		
	X m	Y m	Z m	X m	Y m	Z m
Ring barrier	200.0	200.0	8.0	158.0	200.0	8.0
Ring barrier	158.0	200.0	8.0	158.0	233.0	8.0
Ring barrier	158.0	233.0	8.0	209.0	233.0	8.0
Ring barrier	209.0	233.0	8.0	209.0	180.0	8.0
Ring barrier	209.0	180.0	8.0	200.0	180.0	8.0
Ring barrier	200.0	180.0	8.0	200.0	200.0	8.0
Finite barrier	209.0	180.0	4.0	209.0	173.0	4.0
Ring barrier	209.0	173.0	4.0	195.0	171.0	4.0

Appendix C3: Predicted daytime noise levels

Overall receptor listings
Period: Day time

Overall predicted plant noise levels (dB)	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
13 Victoria Square	46	37	31	24	22	20	20	21	**30**
15 Victoria Square	46	36	31	24	21	20	20	22	**30**
16 Victoria Square	46	36	30	24	21	20	20	22	**30**
19 Victoria Square	43	33	28	19	17	15	12	14	**25**
21 Victoria Square	43	32	27	18	17	14	12	14	**25**
24 Victoria Square	40	31	28	17	17	13	10	10	**24**

Source noise levels at receiver: 13 Victoria Square

Period: Day time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
LT condenser unit	44	34	27	21	18	17	17	19	27
MT condenser unit	41	31	24	18	15	14	14	16	24
Refrigeration pack	31	22	18	12	9	8	8	10	17
Gas cooler	33	23	16	10	7	7	7	10	17
ASHP #1	0	19	19	7	9	5	2	0	15
ASHP #3	0	19	19	7	9	5	2	0	15
ASHP #2	0	19	19	7	9	5	2	0	15
ASHP #4	0	19	19	6	8	4	0	0	14
ASHP #5	0	18	17	5	7	2	0	0	12
Total Free field Lp and dBA	46	37	31	24	22	20	20	21	**30**

Source noise levels at receiver: 15 Victoria Square

Period: Day time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
LT condenser unit	44	34	27	21	18	17	17	19	27
MT condenser unit	41	31	24	18	15	14	14	16	24
Refrigeration pack	31	23	18	12	9	8	8	10	18
Gas cooler	32	22	15	10	7	7	9	12	17
ASHP #1	0	18	18	6	8	4	1	0	14
ASHP #3	0	18	18	6	8	4	1	0	14
ASHP #2	0	18	18	6	8	4	1	0	14
ASHP #4	0	18	18	5	8	4	0	0	13
ASHP #5	0	17	17	4	6	2	0	0	12
Total Free field Lp and dBA	46	36	31	24	21	20	20	22	**30**

Source noise levels at receiver: 16 Victoria Square

Period: Day time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
LT condenser unit	44	34	27	21	18	17	17	19	27
MT condenser unit	41	31	24	18	15	14	14	16	24
Gas cooler	32	22	15	10	7	7	10	12	17
Refrigeration pack	30	22	17	11	8	7	7	9	17
ASHP #1	0	17	17	5	7	4	1	0	13
ASHP #3	0	17	17	5	7	4	1	0	13
ASHP #2	0	17	17	5	7	4	1	0	13
ASHP #4	0	17	17	5	7	3	0	0	12
ASHP #5	0	17	17	4	6	2	0	0	12
Total Free field Lp and dBA	46	36	30	24	21	20	20	22	**30**

Source noise levels at receiver: 19 Victoria Square

Period: Day time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
LT condenser unit	41	30	23	15	11	8	6	5	21
Gas cooler	32	22	15	10	7	7	9	12	17
MT condenser unit	38	27	18	10	5	1	0	0	17
Refrigeration pack	30	22	17	11	8	7	7	9	17
ASHP #1	0	17	17	5	7	4	0	0	13
ASHP #3	0	17	17	5	7	4	0	0	13
ASHP #2	0	17	17	5	7	4	0	0	13
ASHP #4	0	17	17	5	7	3	0	0	12
ASHP #5	0	17	17	4	6	2	0	0	12
Total Free field Lp and dBA	43	33	28	19	17	15	12	14	**25**

Source noise levels at receiver: 21 Victoria Square

Period: Day time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
LT condenser unit	40	28	19	11	5	1	0	0	18
Refrigeration pack	31	22	18	12	9	8	8	10	17
Gas cooler	33	23	16	10	8	7	8	11	17
MT condenser unit	37	25	16	7	2	0	0	0	15
ASHP #1	0	18	18	6	8	4	1	0	14
ASHP #3	0	18	18	6	8	4	1	0	14
ASHP #2	0	18	18	6	8	4	1	0	14
ASHP #4	0	17	17	4	7	3	0	0	12
ASHP #5	0	17	17	4	6	1	0	0	12
Total Free field Lp and dBA	43	32	27	18	17	14	12	14	**25**

Source noise levels at receiver: 24 Victoria Square

Period: Day time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
Gas cooler	36	26	18	12	8	6	5	5	17
ASHP #3	0	20	20	7	9	5	1	0	15
ASHP #1	0	20	20	7	9	5	1	0	15
ASHP #2	0	20	20	7	9	5	1	0	15
Refrigeration pack	33	23	15	9	6	4	4	5	15
LT condenser unit	35	23	13	6	3	2	2	4	14
ASHP #4	0	20	19	7	8	4	0	0	14
ASHP #5	0	18	18	5	6	1	0	0	12
MT condenser unit	32	19	9	3	0	0	0	1	8
Total Free field Lp and dBA	40	31	28	17	17	13	10	10	**24**

Appendix C4: Predicted night time noise levels

Overall receptor listings
Period: Night-time

Overall predicted plant noise levels (dB)	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
13 Victoria Square	46	37	31	24	22	21	20	22	**30**
15 Victoria Square	46	37	31	24	22	20	20	22	**30**
16 Victoria Square	46	36	30	24	21	20	20	22	**30**
19 Victoria Square	44	34	28	20	18	16	14	14	**26**
21 Victoria Square	43	33	28	19	18	16	15	15	**26**
24 Victoria Square	40	31	28	19	19	16	15	17	**26**

Source noise levels at receiver: 13 Victoria Square

Period: Night-time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
LT condenser unit	44	34	27	21	18	17	17	19	27
MT condenser unit	41	31	24	18	15	14	14	16	24
Gas cooler	33	23	17	11	9	11	11	13	19
Refrigeration pack	31	23	18	12	9	8	8	10	18
ASHP #2	0	19	19	7	10	6	4	0	15
ASHP #3	0	19	19	7	10	6	4	0	15
ASHP #1	0	19	19	7	10	6	4	0	15
ASHP #4	0	19	19	7	10	6	3	0	15
ASHP #5	0	18	18	6	8	5	1	0	14
Total Free field Lp and dBA	46	37	31	24	22	21	20	22	**30**

Source noise levels at receiver: 15 Victoria Square

Period: Night-time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
LT condenser unit	44	34	27	21	18	17	17	19	27
MT condenser unit	41	31	24	18	15	14	14	16	24
Gas cooler	33	24	17	11	10	11	11	13	19
Refrigeration pack	32	24	18	12	9	8	8	10	18
ASHP #2	0	18	18	6	9	6	3	0	14
ASHP #3	0	18	18	6	9	6	3	0	14
ASHP #1	0	18	18	6	9	6	3	0	14
ASHP #4	0	18	18	6	9	5	3	0	14
ASHP #5	0	17	17	5	8	4	1	0	13
Total Free field Lp and dBA	46	37	31	24	22	20	20	22	**30**

Source noise levels at receiver: 16 Victoria Square

Period: Night-time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
LT condenser unit	44	34	27	21	18	17	17	19	27
MT condenser unit	41	31	24	18	15	14	14	16	24
Gas cooler	32	23	16	11	9	10	10	12	18
Refrigeration pack	31	23	17	11	8	7	7	9	17
ASHP #2	0	17	17	5	8	5	2	0	14
ASHP #3	0	17	17	5	8	5	2	0	14
ASHP #1	0	17	17	5	8	5	2	0	14
ASHP #4	0	17	17	5	8	4	2	0	13
ASHP #5	0	17	17	5	8	4	1	0	13
Total Free field Lp and dBA	46	36	30	24	21	20	20	22	**30**

Source noise levels at receiver: 19 Victoria Square

Period: Night-time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
LT condenser unit	42	31	23	16	11	8	6	5	22
Gas cooler	32	22	16	10	9	10	10	12	18
MT condenser unit	38	27	19	11	6	2	0	0	17
Refrigeration pack	31	23	17	11	8	7	7	9	17
ASHP #2	0	17	17	5	8	5	2	0	14
ASHP #3	0	17	17	5	8	5	2	0	14
ASHP #1	0	17	17	5	8	5	2	0	14
ASHP #4	0	17	17	5	8	4	2	0	13
ASHP #5	0	17	17	5	8	4	1	0	13
Total Free field Lp and dBA	44	34	28	20	18	16	14	14	**26**

Source noise levels at receiver: 21 Victoria Square

Period: Night-time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
LT condenser unit	41	30	21	13	8	4	1	0	20
Gas cooler	33	23	17	11	9	11	11	13	19
Refrigeration pack	31	23	18	12	9	8	8	10	18
MT condenser unit	38	26	18	10	5	1	0	0	16
ASHP #2	0	18	18	6	9	6	3	0	14
ASHP #3	0	18	18	6	9	6	3	0	14
ASHP #1	0	18	18	6	9	6	3	0	14
ASHP #4	0	17	17	5	8	4	1	0	13
ASHP #5	0	17	17	5	7	4	1	0	13
Total Free field Lp and dBA	43	33	28	19	18	16	15	15	**26**

Source noise levels at receiver: 24 Victoria Square

Period: Night-time

Plant item	Mid frequency octave bands (Hz)								
	63	125	250	500	1k	2k	4k	8k	dBA
Gas cooler	35	25	18	12	10	9	10	15	20
Refrigeration pack	33	24	19	14	11	10	10	12	19
ASHP #3	0	20	20	8	11	7	4	0	16
ASHP #2	0	20	20	8	10	7	4	0	16
ASHP #1	0	20	20	8	10	7	4	0	16
ASHP #4	0	20	20	8	10	6	3	0	16
LT condenser unit	36	24	14	6	3	2	2	4	15
ASHP #5	0	19	19	6	9	5	1	0	15
MT condenser unit	33	20	10	3	0	0	0	1	10
Total Free field Lp and dBA	40	31	28	19	19	16	15	17	**26**

APPENDIX D

ACOUSTIC TERMINOLOGY

Acoustic Terminology

D1 Noise, defined as unwanted sound, is measured in units of decibels, dB. The range of audible sounds is from 0 dB to 140 dB. Two equal sources of sound, if added together will result in an increase in level of 3 dB, i.e. 50 dB + 50 dB = 53 dB. Increases in continuous sound are perceived in the following manner:

1 dB increase - barely perceptible.

3 dB increase - just noticeable.

10 dB increase - perceived as twice as loud.

D2 Frequency (or pitch) of sound is measured in units of Hertz. 1 Hertz (Hz) = 1 cycle/second. The range of frequencies audible to the human ear is around 20Hz to 18000Hz (or 18kHz). The capability of a person to hear higher frequencies will reduce with age. The ear is more sensitive to medium frequency than high or low frequencies.

D3 To take account of the varying sensitivity of people to different frequencies a weighting scale has been universally adopted called "A-weighting". The measuring equipment has the ability automatically to weight (or filter) a sound to this A scale so that the sound level it measures best correlates to the subjective response of a person. The unit of measurement thus becomes dBA (decibel, A-weighted).

D4 The second important characteristic of sound is amplitude or level. Two units are used to express level, a) sound power level - L_w and b) sound pressure level - L_p. Sound power level is an inherent property of a source whilst sound pressure level is dependent on surroundings/distance/directivity, etc. The sound level that is measured on a meter is the sound pressure level, L_p.

D5 External sound levels are rarely steady but rise or fall in response to the activity in the area - cars, voices, planes, birdsong, etc. A person's subjective response to different noises has been found to vary dependent on the type and temporal distribution of a particular type of noise. A set of statistical indices have been developed for the subjective response to these different noise sources.

D6 The main noise indices in use in the UK are:

L_{A90}: The sound level (in dBA) exceeded for 90% of the time. This level gives an indication of the sound level during the quieter periods of time in any given sample. It is used to describe the "background sound level" of an area.

L_{Aeq}: The equivalent continuous sound level in dBA. This unit may be described as "the notional steady noise level that would provide, over a period, the same energy as the intermittent noise". In other words, the energy average level. This unit is now used to measure a wide variety of different types of noise of an industrial or commercial nature, as well as aircraft and trains.

L_{A10}: The sound level (in dBA) exceeded for 10% of the time. This level gives an indication of the sound level during the noisier periods of time in any given

sample. It has been used over many years to measure and assess road traffic noise.

L_{AMAX}: The maximum level of sound measured in any given period. This unit is used to measure and assess transient noises, i.e. gun shots, individual vehicles, etc.

D7 The sound energy of a transient event may be described by a term SEL - Sound Exposure Level. This is the L_{Aeq} level normalised to one second. That is the constant level in dBA which lasting for one second has the same amount of acoustic energy as a given A weighted noise event lasting for a period of time. The use of this unit allows the prediction of the L_{Aeq} level over any period and for any number of events using the equation;

$$L_{AeqT} = SEL + 10 \log n - 10 \log T \text{ dB}.$$

Where

n = Number of events in time period T.

T = Total sample period in seconds.

D8 In the open, known as free field, sound attenuates at a rate of 6 dB per each doubling of distance. This is known as geometric spreading or sometimes referred to as the Inverse Square Law. As noise is measured on a Logarithmic scale, this attenuation in distance = 20 Log (ratio of distances), e.g. for a noise level of 60 dB at ten metres, the corresponding level at 160 metres is:

$$60 - 20 \text{ Log } {}^{160}/_{10} = 60 - 24 = 36 \text{ dB}.$$