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LVMH

Assessment of Noise
from two Proposed
Condenser Units

Prepared for :-

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1.0 SUMMARY

The noise created by the proposed new condenser units will be negligible at the nearest residential noise-sensitive property (No.1 Deansgate).

Even close-to, the impact is negligible and well below the general levels already present on the Selfridges Building roof.



R W Porter



A R Raymond

2.0 INTRODUCTION

ADC was asked to carry out an independent assessment of the proposed new condensers for LVMH on the roof of the Selfridges building and to 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, discuss our results and present our conclusions and recommendations.

3.0 ASSESSMENT STANDARDS

3.1 BS8233

BS8233 is a wide-ranging document which covers many aspects of noise in buildings but includes recommended "Reasonable" and "Good" noise climates in its Table 5. Of most significance to environmental noise assessments are the levels given for living rooms and bedrooms.

The significant are summarised below:

Environment Experiencing the Noise	Criterion or Health Effect	Implied Limit		
		L_{Aeq} (0700–2300)	L_{Aeq} (2300–0700)	L_{Amax} (2300–0700)
Outdoor Living Area	Moderate Annoyance Serious Annoyance	50dB 55dB		
Living Rooms	Good Resting Conditions Moderate Annoyance Reasonable Conditions	30dB 35dB 40dB		
Bedrooms	Good Sleeping Conditions Reasonable Sleeping Conditions		30dB 35dB	45dB 45dB

Note that the standard accepts the widely used rule of thumb that, for a partly open window, that the levels just outside will be 15dB higher than those just inside.

Note also the standard is aimed at general annoyances noise such as traffic and not necessarily at specific sources of noise such as music or industrial noise.

3.2 BS4142

BS 4142 was updated in 1997. The standard is very complicated but, basically, it describes methods for determining;

a) external noise level 'from factories, industrial premises or fixed installations and sources of an industrial nature in commercial premises'.

b) the background noise level, measured in the absence of any noise from the factory, etc.

An involved method of comparing a) and b) is then described, the results of which lead to conclusions as to the likelihood of complaints.

First the measured noise level is corrected for the effect of the residual noise (a slightly different index to the background noise but still a descriptor of the noise which exists without the source in question). Secondly, and where applicable it is corrected for its duration, and any difference between measurement position and receiver position. This leads us to the specific noise level.

Where the noise source produces a tonal element, i.e. whines, hisses, hums, etc. then for assessment purposes, BS:4142 recommends that 5 dB(A) is added to the measured (or calculated) noise level. Similarly, where the noise source produces impulsive noises, for example bangs, clicks, clatters, etc. or where the noise is intermittent, BS:4142 recommends that 5 dB(A) is added. If both characteristics are present, only one adjustment is made and this is called the feature correction.

The Specific Noise Level and the feature correction leads us to the Rating Level. It is this that we compare with the background noise level.

According to BS: 4142, a Rating Level of:

a) 10 dB(A) or more above background is a positive indication that complaints are likely.

b) 5 dB(A) above background is of marginal significance.

c) 10 dB(A) below background is a positive indication that complaints are unlikely.

3.3 Planning Conditions

There are no planning conditions as yet, but there is a general requirement in Manchester for new mechanical equipment to be 5 dB below background noise in all octave bands. The planners have requested the following:-

> *Details regarding the noise output form the units, including the cumulative impact of all units operating simultaneously, and any acoustic measures you are proposing to install to limit the breakout of noise from the units. You should also provide details of the ambient noise levels during the daytime, night and weekends and assess how noise from the units will impact on ambient noise levels.*

It was not possible to establish the ambient noise at the facades of No.1 Deansgate for obvious reasons and so it was agreed with Environmental

Health that we would use the existing noise on the Selfridges Building roof in order to draw comparisons.

3.4 Other Criteria

We are not aware of any other criteria associated with this project.

4.0 BASIC APPROACH TO MODELLING

Calculations are summarised in Appendix 2.

The modelling is relatively simple in essence, complicated by the multiple items contributing to the overall noise level, and the fact that all calculations are carried out for each octave band. The process is roughly as follows:

1. We start with the manufacturers' noise data. This can come in many forms and so, we standardise it all to sound power levels.

2. We then adjust this figure for the number of items of that type in that position, the presence of hard or soft ground (spherical or hemispherical radiation), and distance to the receiver. We have assumed that the nearest noise sensitive properties are the apartments at No.1 Deansgate.

3. We normally provide for other reductions such as inlet and discharge silencers, barriers, etc. Here, however, the levels are so low that there is no need for additional noise control and any barrier effects provided by other equipment has been ignored.

4. The predicted levels for the sources at the receiver position are then added together to give an overall prediction.

5. If the overall levels exceed the design targets, we return to the section described in point 3 above and apply further reductions they will need to meet the design targets. Here, however, it is not necessary.

In addition to the predicted levels at the apartments, we have used the same modelling approach to predict the noise form the new equipment at various points on the roof. This is then added to the existing noise to create a noise map showing the impact across the roof.

5.0 SURVEY DETAILS

5.1 Site Times and Personnel

Two surveys were carried out, one on 19th March 2008 between 14:00-15:00 and 02:00-03:00 hours and one on 30th March 2008 at similar times. These were week days and weekends respectively. Robert Porter of ADC Acoustics under the supervision of Andrew Raymond, author this report.

5.2 Instrumentation

Instrumentation used was a CEL 593. This is a precision grade sound level meter which holds a current calibration certificate and which was field- calibrated as required.

5.3 Survey Conditions

The climate consisted entirely of noise from the existing machinery on the roof of Selfridges and the adjacent M&S roof. All measured ambient noise was steady and constant.

Daytime weather conditions were very similar on both surveys as follows:-

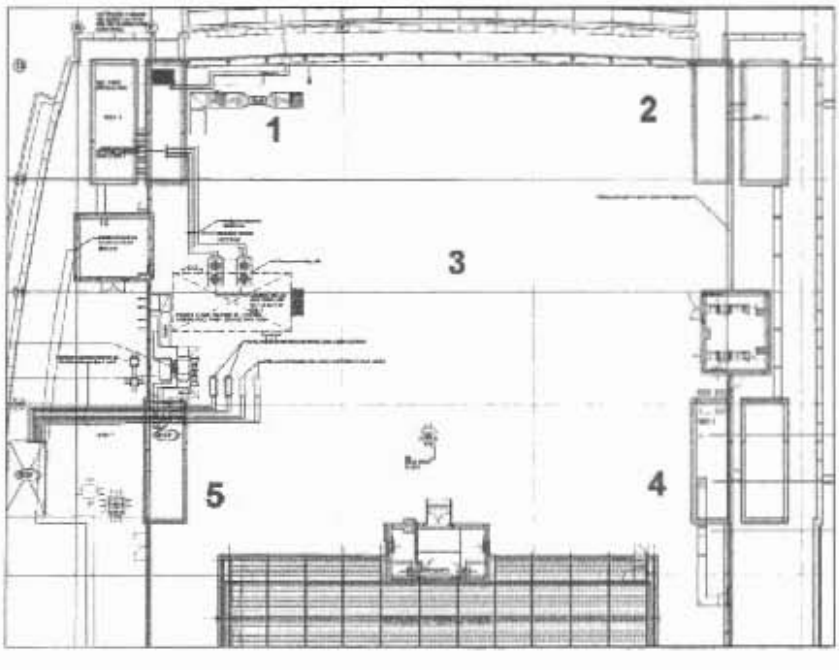
Rain	:	none, dry roads
Cloud	:	20% low
Temperature	:	10 to 15 Celsius
Wind	:	less than 5m/s

Night time weather conditions were ideal as follows :-

Rain	:	none, dry roads
Cloud	:	20% low
Temperature	:	0 to 5 Celsius
Wind	:	less than 5m/s

5.5 Measurement Positions

Main assessment positions were as shown on the following sketch. In all cases, measurements were about 1.5 m above the ground but well away from other reflecting surfaces.



6.0 RESULTS AND DISCUSSIONS

6.1 Background Noise and Design Targets

Note that we were asked by the local authority to assess weekday and weekend periods. However, the weekends were nosier so the results presented are for weekdays only (a quieter existing noise climate makes for a greater impact from new equipment).

We were unable to access the facades of No. 1 Deansgate and so the measurements were made on the Selfridges Building roof. In fact this was dominated by other equipment already working. Levels ranged from 61 to 73 dB L_{Aeq} by day and 63 to 69 dB L_{Aeq} by night.

By way of making some sort of statement of background noise at the façade of No.1 Deansgate, other measurements at similar locations in Manchester show levels around 60 dB L_{A90} by day and 50 dB L_{A90} at night. An example from the Portland street is as follows:-

Background Noise	***dB(A)***	*63*	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
Daytime L90	**60**	66	60	58	56	56	52	43	26
Night Time L90	**50**	54	51	50	47	45	42	33	19

6.2 Manufacturers' Noise Data

The proposed equipment comprises two Daikin RZQS125CV1 Inverter Controlled Heat Pumps which we refer to as condensers. The manufacturer's stated daytime sound power levels are 67 dB L_{Aeq}, with a 2 dB reduction at night time while on "Quiet Mode". Full frequency spectrum data was not available, so the spectral shape for a typical condenser unit was used in our calculations.

6.3 Predicted Noise Levels, Assessments and Discussions

Calculation details are given in Appendix 2. Predicted results are as follows:

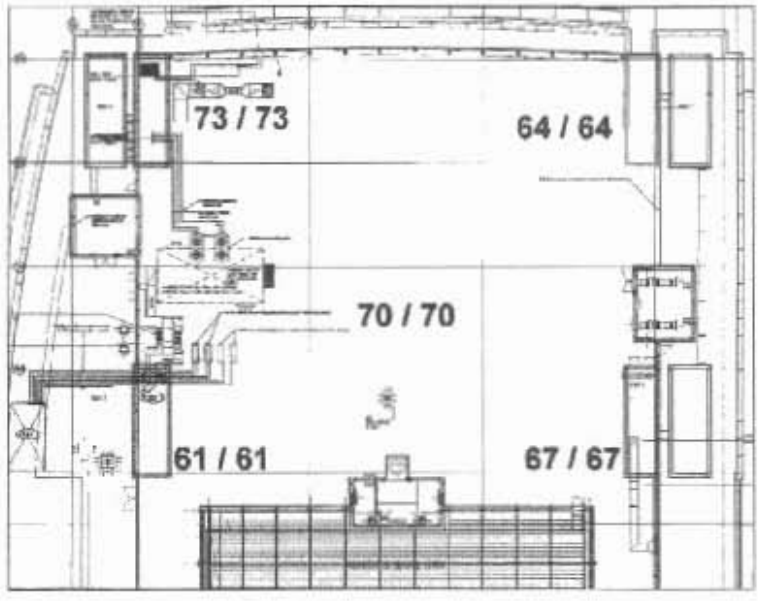
Modelled Levels at the No.1 Deansgate (hard ground assumed)	***dB(A)***	*63*	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
Daikin RZQS125CV1 Inverter Controlled Heat Pump (1)	**25**	36	31	28	23	16	16	12	8
Daikin RZQS125CV1 Inverter Controlled Heat Pump (2)	**25**	36	31	28	23	16	16	12	8
Total	**28**	39	34	31	26	19	19	15	11

This shows that with the proposed condensers running simultaneously at full power the predicted noise will be 28 dB L_{Aeq} we have not allowed for the barrier effects of existing equipment and so it is a significantly worst case prediction. Also the results will be 2 dB lower at night when running on "Quiet Mode".

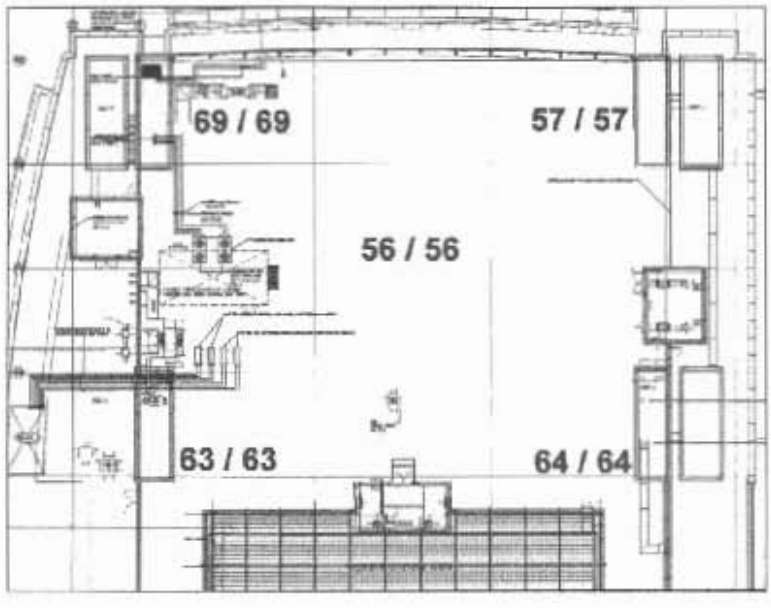
It is clear that the predicted results are well below background noise (Portland Street example) at all times and in all conditions, and in all octave bands. They are also well below the BS8233 criteria at all times and under all conditions.

To add further robustness, we also compared the noise from the proposed condensers to the existing noise climate of the roof. The following two noise maps show the impact (note that levels show are without/with the new condensers running:-

Afternoon Noise Map Model



Night Time Noise Map Model



We can clearly see that the noise climate at all positions remains unchanged with the inclusion of the proposed condensers. Our noise maps demonstrate that in comparison with the existing machinery noise, the proposed condensers will have no significant acoustic effect whatsoever.

7.0 CONCLUSIONS/RECOMMENDATIONS

Our conclusions are quite simply that the proposed condensers will have negligible impact on any nearby noise sensitive location. In fact they do not even have a significant impact on their own vicinity on the roof.

We have no further recommendations other than that you submit this report to Planners and to invite Environmental Health to call us if they have 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 is really should be stated. The threshold of human hearing is a sound pressure of 20μPa or a sound power of 1pW.

A sound pressure level or SPL should be expressed in dB(re. 20μPa). 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_{Amax}.

Statistical (Percentile) Levels, L_n

During a measurement of fluctuating noise, it is often useful to establish the levels exceed 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 exceed 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 $dB_{(mean\ 100\text{-}3150Hz)}$. 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

Calculations

Basic Data	*Index (SPL/SWL)*	*Distance of Data (SPL Only)*	***dB(A)***	*63*	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
Delkin RZQS125CV1 Inverter Controlled Heat Pump (1)	SWL		**67**	78	73	70	65	58	58	54	50
Delkin RZQS125CV1 Inverter Controlled Heat Pump (2)	SWL		**67**	78	73	70	65	58	58	54	50

Equivalent Point Source SWL	*Index*	*Distance of Data*	***dB(A)***	*63*	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
Delkin RZQS125CV1 Inverter Controlled Heat Pump (1)	SWL	n/a	**67**	78	73	70	65	58	58	54	50
Delkin RZQS125CV1 Inverter Controlled Heat Pump (2)	SWL	n/a	**67**	78	73	70	65	58	58	54	50

Distance Correction	*Distance to Receiver*	***dB(A)***	*63*	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
Delkin RZQS125CV1 Inverter Controlled Heat Pump (1)	48	n/a	34	34	34	34	34	34	34	34
Delkin RZQS125CV1 Inverter Controlled Heat Pump (2)	48	n/a	34	34	34	34	34	34	34	34

Reduction (or Increase eg. Reflections)		***dB(A)***	*63*	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
No reduction assumed	Delkin RZQS125CV1 Inverter (	n/a								
No reduction assumed	Delkin RZQS125CV1 Inverter (	n/a								

Modelled Levels at the No.1 Deansgate (hard ground assumed)	***dB(A)***	*63*	*125*	*250*	*500*	*1k*	*2k*	*4k*	*8k*
Delkin RZQS125CV1 Inverter Controlled Heat Pump (1)	**25**	36	31	28	23	16	16	12	9
Delkin RZQS125CV1 Inverter Controlled Heat Pump (2)	**25**	36	31	28	23	16	16	12	8
Total	**28**	39	34	31	26	19	19	15	11