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Request No. 4690.

Newham Council

Royal Docks Community School

Ambient Noise Survey and Natural Ventilation

July 1996

Arup Acoustics

Report No. AAc/51748/R01

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CONTENTS

AIMS

- To report the findings of an ambient noise survey carried out by Arup Acoustics.
- To make an initial assessment of the potential for natural ventilation.

SUMMARY

Arup Acoustics has been commissioned to provide acoustic advice for the proposed Royal Docks Community School. This first report gives the results of an ambient noise survey of the site, sets criteria for intrusive noise levels and assesses the potential for natural ventilation, in relation to the measured noise levels. A mechanically assisted natural ventilation system is proposed with attenuated openings in the building envelope to control the break-in of road traffic noise and, in particular, aircraft noise from London Docklands Airport.

1 INTRODUCTION

Arup Acoustics has been appointed to provide acoustic advice for the proposed Royal Docks Community School. This preliminary report describes the findings of an ambient noise survey of the site which will be used during the subsequent design. The potential for natural ventilation in relation to the measured noise levels is assessed.

2 AMBIENT NOISE SURVEY

2.1 Survey Conditions

The noise survey was carried out between 08.50 hours and 12.20 hours on 4 June 1996. Weather conditions were dry, with a light wind varying between 1m/s and 3m/s. The site was mostly grass covered open ground with some existing buildings, due for demolition. These are indicated on the site plan on Figure 1. Although demolition work is taking place at the site, this was not in progress during the survey.

The Docklands Light Railway (DLR), which runs through a station and along an elevated length of track to the south of the site, was not operational during the survey.

2.2 Equipment

The survey was carried out using a Brüel & Kjaer Sound Analyser Type 2260 on a tripod, with the microphone at approximately 1.2m above the ground. The calibration was checked before and after the survey using a Brüel & Kjaer Sound Level Calibrator Type 4231.

2.3 Survey Method

Ten-minute samples were taken, sequentially, at the locations shown on Figure 1 and described in Table 1. All of these locations were well away from any significant reflecting surfaces other than the ground. Statistical noise level indices and

frequency spectra were measured, the terms used for these being explained in the Appendix.

2.4 Noise Sources

The dominant continuous noise sources were traffic on Prince Regent Lane and Connaught Road. The highest, intermittent, noise levels across the site were caused by occasional jet aircraft taking off to the west from London City Airport.

Mainline trains to the south of the site were audible, but were not a dominant noise source. There were occasional vehicles on the existing roads across the site. These were mostly slow moving vehicles, with drivers under tuition. These would not form part of the noise environment following development.

2.5 Results

The measured statistical indices together with notes on the noise sources at each location are given on Table 2. The measured noise spectra at each location are given in Table 3.

Noise levels across the site are generally in the range 55dB to 60dB L_{Aeq} with L_{A1} values up to approximately 70dB. Noise levels close to Prince Regent Lane were up to 70dB L_{Aeq}. Turbo-prop aircraft taking off to the west from London City Airport (LCA) caused noise levels of up to 77dB(A). Jet aircraft taking off to the west resulted in levels up to 82dB(A). Aircraft turn to the right on take-off, 1.5 nautical miles from the site, when taking off to the west. Most then circle the site to turn south and hence all facades of the proposed building are expected to be exposed to the noise levels measured.

From an assessment of the current timetable and information on aircraft types supplied by LDA, the maximum number of aircraft in any one hour period is likely to comprise three jet aircraft and three turbo-prop aircraft. From this and the results of the noise survey, a design value of 85dB $L_{A1(1hr)}$ has been derived for external aircraft noise at the site. Restrictions on the noise levels produced by individual aircraft, imposed as part of the planning permission for the airport, are such that the maximum event noise levels produced are unlikely to increase significantly. Current

aircraft movements are, however, far fewer than the permitted daily capacity. Increased operations at LDA could change the noise climate at the site significantly.

3 DOCKLANDS LIGHT RAILWAY

A further site visit by Arup Acoustics was made on 9 July 1996, when the DLR was operating normally. Construction and demolition works restricted the qualitative analysis of noise due to the railway, although it was found that the DLR trains, running on the elevated structure to the south of the site were audible, but less significant than main line trains. Noise levels from the DLR were estimated to be in the range 60dB(A) - 65dB(A) and did not exceed 70dB(A). The DLR is not, therefore considered as significant a noise source as road traffic and aircraft.

4 CRITERIA FOR INTRUSIVE NOISE

Advice on background noise levels in schools is given in BS 8233 (Reference 2), Design Note 17 (Reference 3) and, in more detail, in Building Bulletin 51 (Reference 4). Design Note 25 (Reference 5) gives specific advice on acoustic criteria for visually handicapped and hearing impaired in schools. The criteria in the Building Bulletins and Design Notes are in terms of the "Background Noise Level" (BNL - see Appendix for explanation), whereas those in BS 8233 are expressed as an L_{Aeq}, and are the total noise levels in the absence of teaching activity.

Design Note 17 has recently been the subject of a revision which has now been accepted for publication (Reference 6). A key element in this revision is the expression of criteria, which are now in terms of the $L_{Aeq(1hr)}$ for continuous noise. The $L_{Aeq(1hr)}$ criteria are generally equivalent to the noise level which would be experienced with the previously used BNL values. It is also recognised that the disturbance from intermittent events causing high levels of noise, such as aircraft movements, is different from that caused by continuous noise sources, such as road traffic and recommended that, as a guide, aircraft noise in classrooms should not exceed 55dB$L_{A1(1hr)}$.

In Design Note 25, it is stated that, for hearing impaired children, external noise should be controlled to no higher than the levels set down in Building Bulletin 51,

but it is generally recommended that all extraneous noise (from external and internal sources) should be limited to a BNL of 10dB below that given for the various activities in Building Bulletin 51. The importance of low frequency information (below 500Hz) to hearing impaired children is also emphasised and adequate control of low frequency extraneous noise is also required. Specific BNL targets are given for particular areas.

BS 8233 provides general criteria, which are broadly in line with the other guidance. As the latter are more specific, they have been used in preference to the British Standard.

There is no advice available for totally integrated schools, such as the Royal Docks Community School. It is considered that the criteria for schools specifically designed for the hearing impaired are likely to be too onerous in this case, except for special use group rooms, whilst the criteria for normal schools would be disadvantageous to pupils with learning difficulties such as hearing impairment. Noise criteria between those for normal schools (based on the revised Design Note 17) and schools for the hearing impaired (Design Note 25) have, therefore, been proposed for most noise sensitive spaces. For group rooms, which are likely to be used for pupils with special needs, the more stringent criteria recommended in Design Note 25 have been adopted.

The proposed criteria are given in Table 4.

5 SOUND INSULATION AND VENTILATION

5.1 Natural Ventilation

The means of ventilation will control the level of sound insulation achievable from the building envelope. The sound insulation obtainable with various ventilation methods is discussed in Sections 5.1 and 5.2 and a planning strategy for the school based on these developed in Section 6.

Various strategies for natural ventilation are discussed below and an approximate indication of their sound insulation given.

- Sound reduction across an open window is limited to 5dB to 10dB, depending on the proportion of open area.

- Increased sound insulation can be achieved by deep double glazing with staggered openings (see Figure 2). An average sound reduction index (125Hz to 2kHz) of 15dB is achievable with this type of arrangement.

- Further increased sound insulation may be achieved using a specially designed facade incorporating tortuous air inlet and outlet paths with acoustically absorptive linings. An alternative would be a glazed curtain wall incorporated into the briese-soleil with acoustic absorption in the cavity, perhaps in the form of vertical dividers. Sound insulation of the order of an average sound reduction index of 25dB is achievable. However, the higher the attenuation, the more restricted the air flow.

- Attenuated trickle ventilators provide a high degree of sound insulation, up to an average sound reduction index of 35dB, but are unlikely to provide sufficient air flow at all times (see Figure 4).

5.2 Mechanical and Partially Mechanical Systems

In some situations, high external noise levels may prohibit the use of natural ventilation openings, or cause them to be restricted to an extent whereby it is not possible to achieve sufficient air flow. In these cases the following strategies may be considered.

- An assisted natural ventilation system or hybrid system, with, for example, natural ventilation openings in quieter facades, or the roofs of circulation areas, and attenuated fans elsewhere. Such a strategy can make use of any of the natural ventilation methods in Section 5.1.

- Noise attenuated ventilator units, similar to those specified for housing under the Noise Insulation Regulations.

- Fully ducted mechanical ventilation.

6 STRATEGY

6.1 General

Design Note 25 states that good planning is the first essential in tackling noise and recommends planning the disposition of the building as a way in which many problems can be reduced or avoided.

Table 5 gives the types of natural ventilation which would be suitable for various facades on this site to achieve the required internal noise criteria. Figure 4 shows the proposed plan of the school showing the road traffic noise levels affecting the various facades which are given in Table 5. The conclusions which may be drawn from this table are given below.

External noise levels have been shown to be such that, if natural ventilation, with open windows or other unattenuated openings, is to be adopted throughout the building, intrusive noise limits would be exceeded in almost all of the most noise sensitive spaces.

A satisfactory ventilation strategy could be achieved by having attenuated openings in the classroom facades and openings in the roofs above circulation spaces. Openings to circulation spaces may be unattenuated if more than 20m from Prince Regent Lane. Such a system would require mechanical assistance to overcome the pressure drops across the attenuation of the facade and any attenuation required between the classrooms and corridors. Attenuated extract fans or individual attenuated ventilator units, similar to those specified for domestic use near motorways, may be considered.

Alternatively, a fully ducted ventilation system is possible.

It should be noted that that the sound insulation requirements are dominated by aircraft noise from the LDA, rather than road traffic noise. With appropriate measures to control aircraft noise, it would be possible to relocate teaching space to a distance of not less than 10m from Prince Regent Lane.

6.2 Particular Areas of the Building

Theatre and Theatre Control Room

This area should be mechanically ventilated. If it has a sealed building envelope with no windows, it may be re-planned close to Prince Regent Lane.

Sports Facilities

As these are likely to be mechanically ventilated to achieve a sufficient air change, the location next to Prince Regent Lane is satisfactory.

Acoustically Non-Sensitive Areas

The following areas are acoustically non-sensitive and can be used as buffer zones, or re-located adjacent to Prince Regent Lane:

Stores, Boiler Room, Intake, Battery Charging

Studios

Depending on the intended use of these areas, it is likely to be appropriate to have attenuated mechanical ventilation (ducted or individual units).

Meeting Rooms and Interview Room

These areas will be considered in more detail as the design develops.

7 CONCLUSIONS

A noise survey has been carried out and ambient noise conditions across the site established. The main noise sources have been shown to be road traffic noise and aircraft noise from LDA. Criteria have been set for intrusive noise at the school, based on the most current guidance. An assessment has been carried out showing that these criteria would be exceeded if natural ventilation with openable windows was adopted. Mechanically assisted natural ventilation with attenuated ventilation openings is proposed.

REFERENCES

1 Docklands Light Railway February 1988
Noise Levels in the Local Community
Report by Transnet and South Bank Acoustic
Engineering for Docklands Forum.

2 BS 8233:1987
Sound Insulation and Noise Reduction for Buildings
British Standards Institution

3 Department of Education and Science, 1979
Architects and Building Branch
Design Note 17
Guidelines for Environmental Design and Fuel
Conservation in Educational Buildings
HMSO

4 Department of Education and Science, 1975
Building Bulletin 51
Acoustics in Educational Buildings
HMSO

5 Department of Education and Science, 1987
Architects and Building Branch
Design Note 25
Lighting and Acoustic Criteria for the
Visually Handicapped and Hearing Impaired
in Schools.
HMSO

6 Building Bulletin XX, May 1996
Guidelines for Environmental Design in Schools
(Revision of Design Note 17)
Department for Education and Employment
Draft Revision

Location	Description
1	Prince Regent Lane. Approximately 2m from kerb.
2	Connaught Road. Approximately 1.5m from kerb.
3	Middle of site. Approximately 120m from Prince Regent Lane and 110m from Connaught Road.
4	Middle of site. Approximately 60m from Prince Regent Lane.
5	Between existing church and proposed school in the middle of the site.
6	Approximately 3.5m from the kerb of Alnwick Road, and 160m from Prince Regent Lane.
7	Approximately 3.5m from the kerb of Alnwick Road, and 60m from Prince Regent Lane.

TABLE 1: Measurement locations

Location	Start Time Time (hh:mm:ss)	dB L_{Amax}	dB L_{A1}	dB L_{A10}	dB L_{A90}	dB L_{Amin}	dB L_{Aeq}	Notes
1	08:51:14	84	80	74	59	54	70	Prince Regent Lane traffic, buses at nearby stops (82dB(A)), trains audible, HGVs, turbo-prop take off to west (77dB(A)).
	10:44:02	84	78	72	52	45	69	Traffic, high level aircraft, voices, buses, high number of vans, 81 light vehicles +7 HGVs.
	approx 10:56	79						Jet aircraft take off to west.
	11:56:45	87	79	72	56	48	69	Prince Regent Lane traffic, turbo-prop take off to west (72dB(A)), lorry (87dB(A)).
2	09:11:40	90	82	76	58	51	72	Connaught Road traffic, trains audible, birdsong, buses in station opposite, train horn.
	approx 12:25	94	84	75	52		73	Traffic, 59 light vehicles +12 HGVs +5 buses in station, HGV (94dB(A)), birdsong, high number of vans.
3	09:27:49	80	75	57	50	47	61	Connaught Road/Prince Regent Lane traffic, birdsong, quiet vehicles on site, aircraft take off to west.
	approx 09:39	82						Jet aircraft take off to west.
	11:12:03	69	59	55	46	43	52	Helicopter (60dB(A)).
	12:10:48	77	70	53	46	43	56	Traffic, voices, turbo-prop take off to west (77dB(A)).

TABLE 2: Measured noise levels, dB re 2 x 10^{-5}Pa

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Location	Start Time Time (hh:mm:ss)	dB L_{Amax}	dB L_{A1}	dB L_{A10}	dB L_{A90}	dB L_{Amin}	dB L_{Aeq}	Notes
4	09:42:53	76	66	59	50	47	57	Traffic mainly from Prince Regent Road, voices, birdsong, vehicles on the site (58dB(A), 77dB(A)), man shouted, train (60dB(A)), horses snorting.
	10:59:08	69	64	58	48	45	55	Connaught Road/Prince Regent Lane traffic, occasional vehicles on the site, birdsong, trains.
5	10:00:19	78	71	60	46	44	58	Birdsong, occasional vehicles on the site (64 to 73dB(A)), twin turbo-prop take off to west (68dB(A)).
	11:26:21	73	68	58	47	44	56	Connaught Road/Prince Regent Lane traffic, occasional vehicles on the site, car idling, birdsong, distant aircraft, helicopter (68dB(A)).
6	10:17:02	74	68	57	48	45	56	Trains audible, Main source is Connaught Road/Prince Regent Lane traffic, occasional vehicles on Alnwick St, birdsong.
7	10:30:04	74	68	60	46	43	57	Occasional vehicles on Alnwick St, Prince Regent Lane traffic, birdsong.
	11:42:13	76	71	62	48	44	59	Prince Regent Lane traffic, occasional vehicles on Alnwick St, distant aircraft, birdsong.

TABLE 2: Measured ambient noise levels, dB re 2 x 10^{-5}Pa

Location	Start Time (hh:mm:ss)	Index	Octave Band Centre Frequency (Hz)							
			63	125	250	500	1k	2k	4k	8k
1	08:51:14	L_1	90	80	77	74	75	73	67	63
		L_{10}	80	73	70	68	69	66	59	53
		L_{90}	66	59	56	53	54	51	43	32
		L_{eq}	78	70	67	65	66	63	57	54
	10:44:02	L_1	89	79	76	73	74	71	66	65
		L_{10}	80	71	68	67	68	65	58	52
		L_{90}	63	53	50	47	47	43	35	25
		L_{eq}	78	70	65	63	64	62	56	56
	11:56:45	L_1	86	79	77	74	75	71	65	59
		L_{10}	79	71	69	66	67	65	58	51
		L_{90}	65	57	53	51	51	47	40	30
		L_{eq}	77	70	67	64	65	62	55	52
2	09:11:40	L_1	88	81	78	76	78	74	68	64
		L_{10}	80	74	71	70	72	69	62	56
		L_{90}	63	55	52	52	54	50	41	29
		L_{eq}	77	71	68	67	69	65	59	53
	approx 12:25	L_{10}	79	73	70	70	71	67	61	54
3	09:27:49	L_1	77	72	76	72	70	66	58	42
		L_{10}	72	64	58	50	52	49	44	35
		L_{90}	62	53	46	42	44	41	33	
		L_{eq}	69	62	62	58	56	52	45	32
	11:12:03	L_1	75	68	57	55	55	51	44	35
		L_{10}	70	61	53	49	49	46	38	28
		L_{90}	61	51	43	40	41	37	29	
		L_{eq}	68	59	50	46	47	44	37	27
	12:10:48	L_1	72	77	74	65	63	57	48	36
		L_{10}	68	62	53	48	48	44	38	27
		L_{90}	61	51	44	40	41	36	29	
		L_{eq}	66	63	60	51	50	45	37	25

TABLE 3: Measured ambient noise spectra, dB re 20 x 10^{-5}Pa

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Location	Start Time (hh:mm:ss)	Index	Octave Band Centre Frequency (Hz)							
			63	125	250	500	1k	2k	4k	8k
4	09:42:53	L_1	83	75	67	61	58	57	53	44
		L_{10}	74	66	59	53	52	50	44	35
		L_{90}	63	54	47	43	44	41	33	22
		L_{eq}	73	64	58	51	51	48	44	37
	10:59:08	L_1	78	69	64	60	59	57	53	49
		L_{10}	71	63	57	53	52	49	46	36
		L_{90}	61	52	46	41	42	38	31	
		L_{eq}	69	61	54	50	49	47	43	37
5	10:00:19	L_1	80	71	68	66	65	64	57	51
		L_{10}	71	63	59	57	53	51	46	38
		L_{90}	61	51	41	40	41	37	32	
		L_{eq}	70	61	57	54	53	52	46	38
	11:26:21	L_1	77	70	66	64	62	61	55	50
		L_{10}	69	62	56	53	53	50	45	37
		L_{90}	61	52	43	40	41	38	33	22
		L_{eq}	69	60	54	51	51	49	44	38
6	10:17:02	L_1	78	70	66	62	62	61	55	51
		L_{10}	70	62	52	52	53	49	46	37
		L_{90}	61	57	43	40	42	40	34	23
		L_{eq}	68	61	54	50	51	49	45	43
7	10:30:04	L_1	81	72	65	62	62	62	57	52
		L_{10}	71	63	58	55	55	52	46	38
		L_{90}	59	50	42	40	40	36	34	22
		L_{eq}	70	61	56	52	52	50	45	39
	11:42:13	L_1	83	74	68	67	66	64	58	52
		L_{10}	74	64	58	56	56	55	50	41
		L_{90}	61	52	45	42	42	39	36	26
		L_{eq}	73	63	57	54	55	52	47	40

TABLE 3: Measured ambient noise spectra, dB re 2 x 10^{-5}Pa

Area of School	Criterion recommended for ordinary schools		Criterion recommended for special schools for hearing impaired	Criterion recommended for Royal Docks School	
	dB $L_{Aeq(1hr)}$	dB $L_{A1(1hr)}$	dB $L_{Aeq(1hr)}$	dB $L_{Aeq(1hr)}$	dB $L_{A1(1hr)}$
General Teaching	40	55	30	35	55
Music and Drama	30	55	30	30	55
Group Rooms	-	-	35	35	55
Sports	50	-	40	45	-
Arts, Crafts and Laboratories	45	55	40	40	55
Multi Materials	45	-	40	40	-
Resource	45	-	40	40	-
Offices and Staff Rooms	40	-	-	40	-
Circulation, Changing, W/C, Kitchen	50	-	-	50	-
Adult Education	40	55	30	35	55

TABLE 4: Criteria for background noise levels

Facade	External Noise Level		Internal Criteria (dB)					
	dB $L_{Aeq(1hr)}$	dB $L_{A1(1hr)}$	30dB $L_{Aeq(1hr)}$ and 55dB $L_{A1(1hr)}$	35dB $L_{Aeq(1hr)}$ and 55dB $L_{A1(1hr)}$	40dB $L_{Aeq(hr)}$ and 55dB $L_{A1(1hr)}$	40dB $L_{Aeq(1hr)}$	45dB $L_{Aeq(1hr)}$	50dB $L_{Aeq(1hr)}$
>20m from Prince Regent Lane and facing away from Connaught Road	50	80 - 85	Attenuated trickle ventilation possible or attenuated openings with mechanically assisted ventilation	Attenuated trickle ventilation possible or attenuated openings with mechanically assisted ventilation	Attenuated trickle ventilation possible or attenuated openings with mechanically assisted ventilation	Open window with open area controlled by design	Open window	Open window
>20m from Prince Regent Lane	55 - 60	80 - 85	Attenuated trickle ventilation possible or attenuated openings with mechanically assisted ventilation	Attenuated trickle ventilation possible or attenuated openings with mechanically assisted ventilation	Attenuated trickle ventilation possible or attenuated openings with mechanically assisted ventilation	Specially designed facade or attenuated openings with mechanically assisted ventilation	Deep double glazing with staggered openings or specially designed facade	Open window with open area controlled by design

TABLE 5: Proposed natural ventilation methods (see Section 5.1) for the various facades

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Facade	External Noise Level		Internal Criteria (dB)					
	dB $L_{Aeq(1hr)}$	dB $L_{A1(1hr)}$	30dB $L_{Aeq(1hr)}$ and 55dB $L_{A1(1hr)}$	35dB $L_{Aeq(1hr)}$ and 55dB $L_{A1(1hr)}$	40dB $L_{Aeq(1hr)}$ and 55dB $L_{A1(1hr)}$	40dB $L_{Aeq(1hr)}$	45dB $L_{Aeq(1hr)}$	50dB $L_{Aeq(1hr)}$
Roof >20m from Prince Regent Lane	55 - 60	80 - 85	Attenuated trickle ventilation possible or attenuated openings with mechanically assisted ventilation	Attenuated trickle ventilation possible or attenuated openings with mechanically assisted ventilation	Attenuated trickle ventilation possible or attenuated openings with mechanically assisted ventilation	Specially designed facade or attenuated openings with mechanically assisted ventilation	Deep double glazing with staggered openings or specially designed facade	Open window with open area controlled by design

TABLE 5: Proposed natural ventilation methods (see Section 5.1) for the various facades

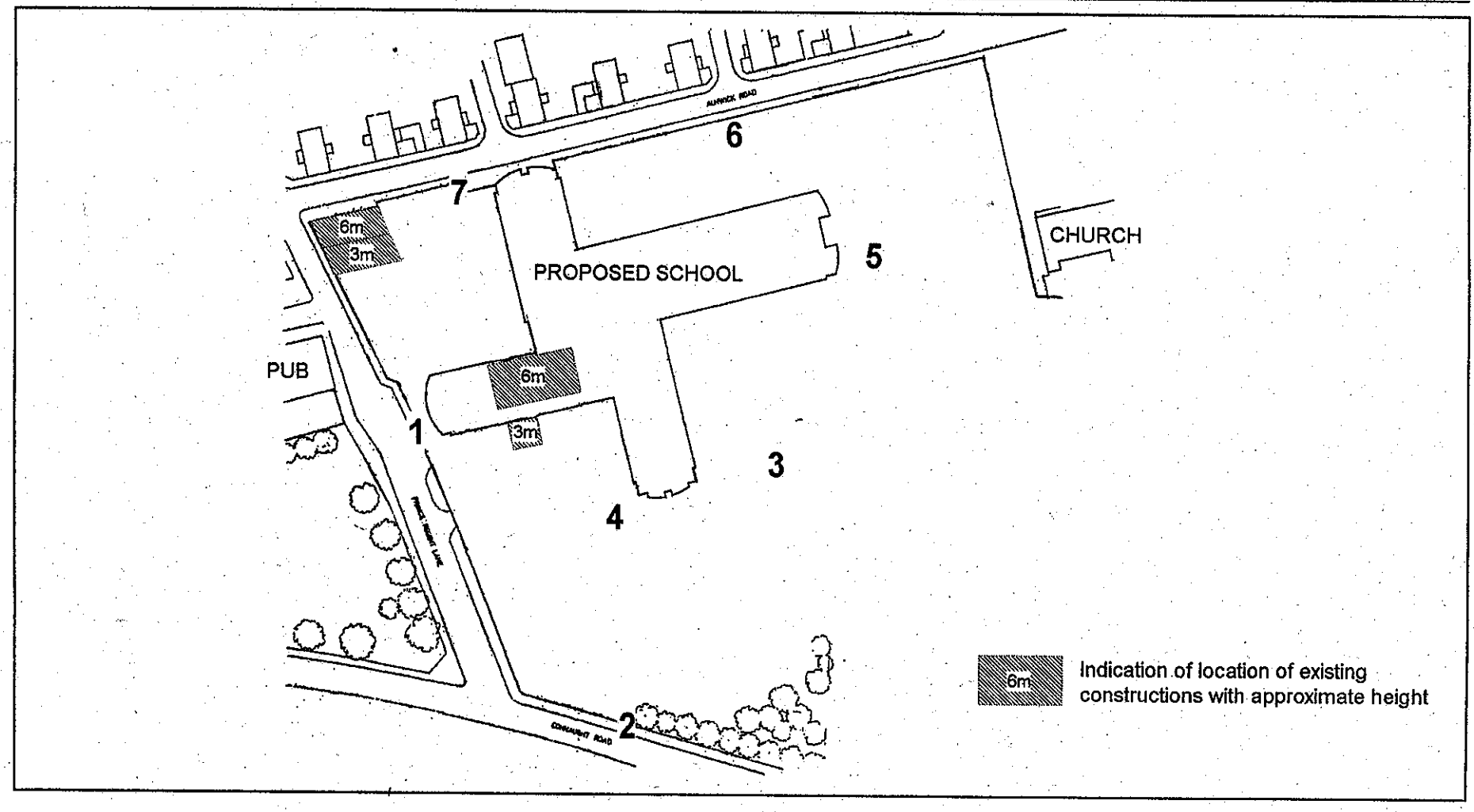

FIGURE 1: Site Plan Showing Measurement Locations, 1 to 7

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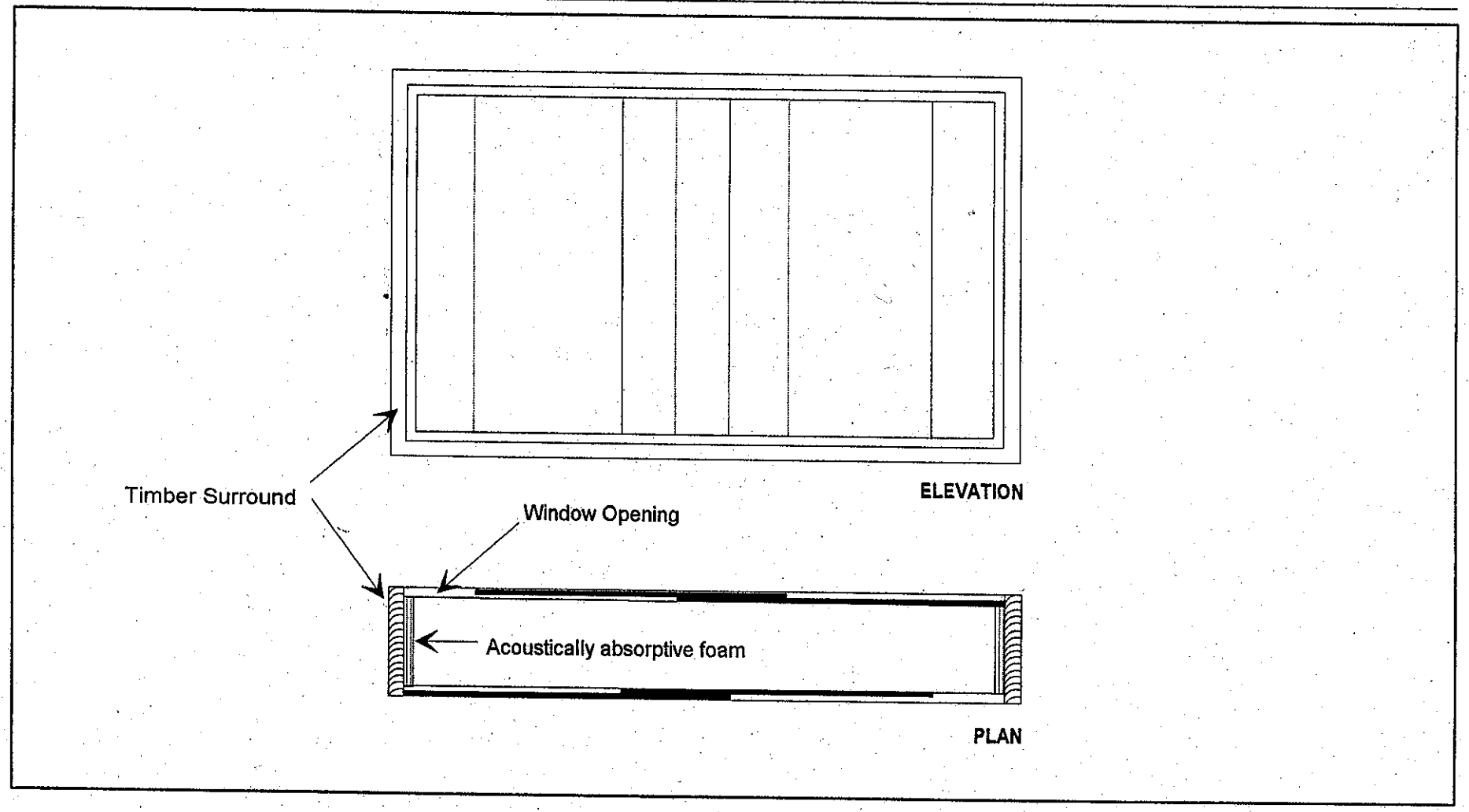

FIGURE 2: Deep Double Glazing with Staggered Openings

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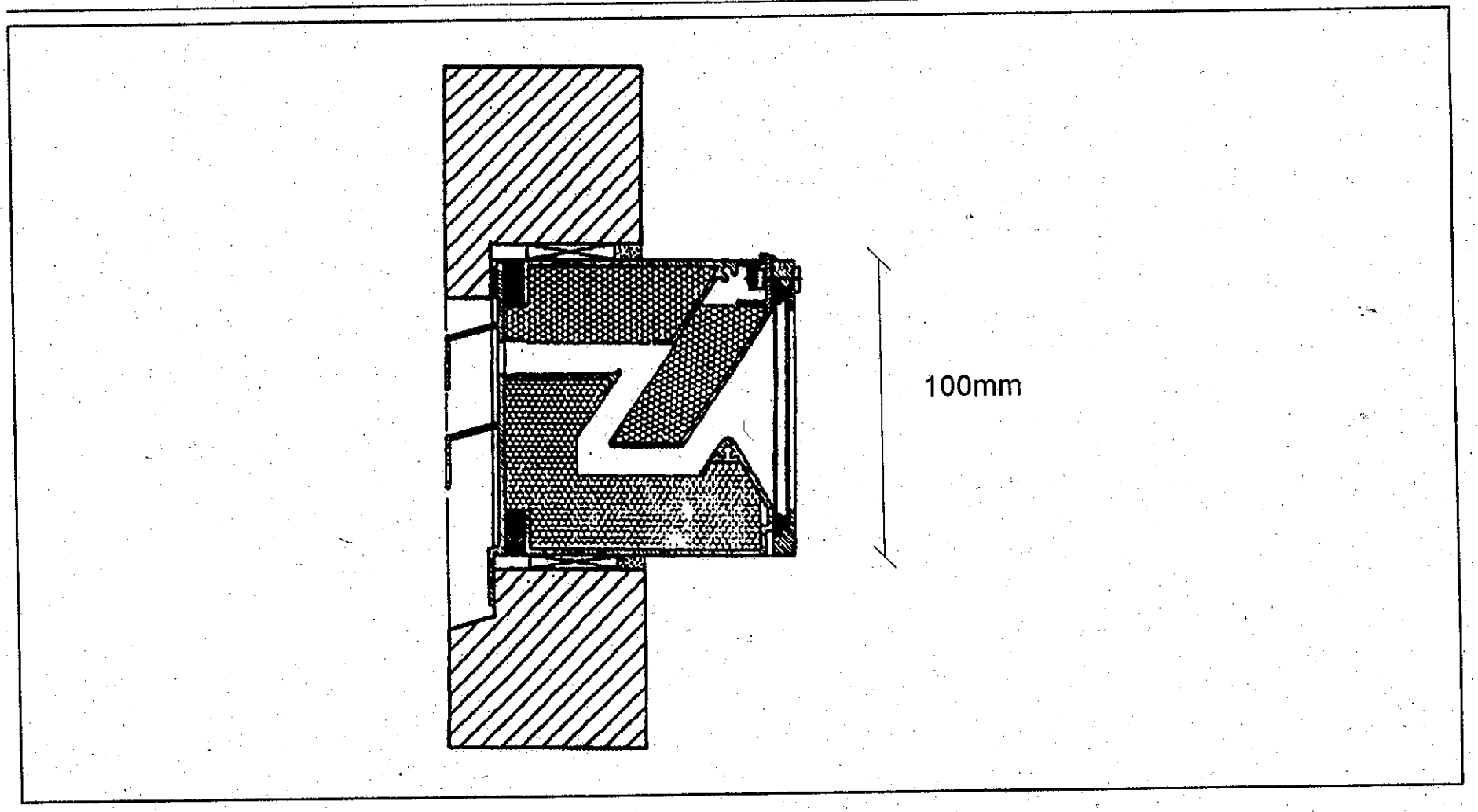

FIGURE 3: Atenuated Trickle Ventilator

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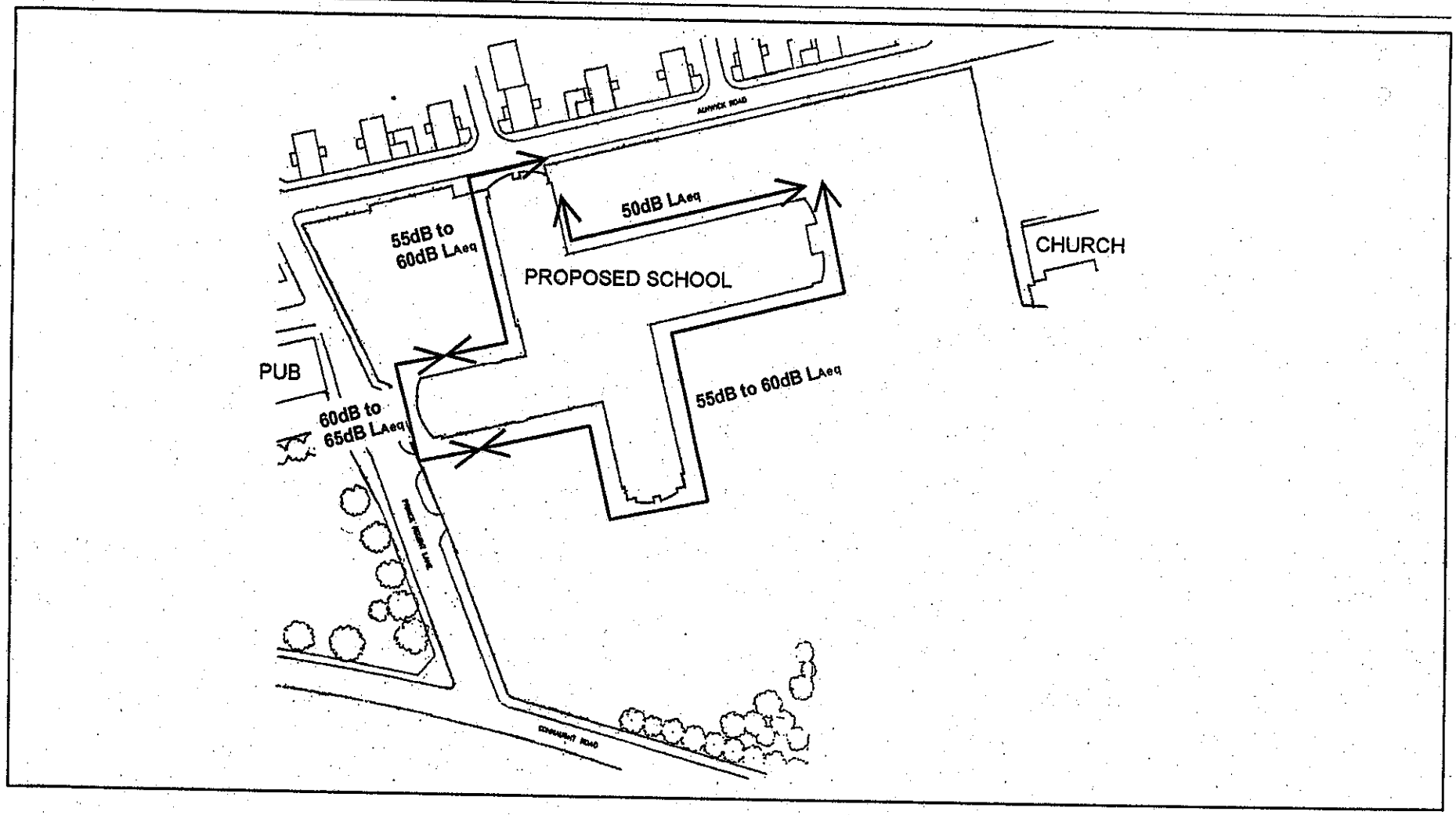

FIGURE 4: Proposed Building Plan with External Free-Field Road Traffic Noise Levels

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APPENDIX

ACOUSTIC TERMINOLOGY AND UNITS

The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dB(A). An A-weighting network can be built into a sound level measuring instrument such that direct sound levels in dB(A) can be read from a meter. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. It is worth noting that an increase or decrease of approximately 10dB(A) corresponds to a subjective doubling or halving of the loudness of a noise, and a change of 2dB(A) to 3dB(A) is subjectively barely perceptible.

For levels of noise that vary with time, it is necessary to employ a statistical index which allows for this variation. These statistical indices are expressed as the sound level which is exceeded for a percentage of the time period of interest. In the UK, traffic noise is measured as the L_{A10}, the noise level exceeded for 10% of the measurement period. The L_{A90} is the level exceeded for 90% of the time and has been adopted to represent the background noise level in the absence of discrete events. The L_{A1}, the noise level exceeded for 1% of the time is representative of the short term, peak events occurring in the period.

An alternative way of assessing time varying noise levels is to use the equivalent continuous sound level, L_{Aeq}. This is a notional steady level which would, over a given period of time, deliver the same sound energy as the actual fluctuating sound.

Background Noise Level (BNL) curves are used to define the ambient noise level in a room using a single figure value. The background noise level is important, to provide masking of intrusive sound without being itself intrusive or disturbing. BNL curves have been designed to provide a balanced and unobtrusive spectrum and the measured ambient noise should be within 5dB of these curves for each octave band. Each curve is identified by the sound level at 1kHz. The curves are given in Building Bulletin 51.