ArupAcoustics

West London and
Suburban Property
Investments Ltd

105 Tottenham Court Road

Stage 1 - Acoustic Issues

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ISSUE

ArupAcoustics

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105 Tottenham Court Road

Stage 1 - Acoustic Issues

May 2005

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Arup Acoustics
Boston House, 36-38 Fitzroy Square, London W1T 6EY, UK
Tel +44 (0)20 7636 2853 Fax +44 (0)20 7755 3665
www.arup.com/acoustics

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		Name	David Owen BEng, MIOA	Malcolm Wright CEng, MCIBSE MIOA	Malcolm Wright CEng, MCIBSE MIOA
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		Name	David Owen BEng, MIOA	Malcolm Wright CEng, MCIBSE MIOA	Malcolm Wright CEng, MCIBSE MIOA
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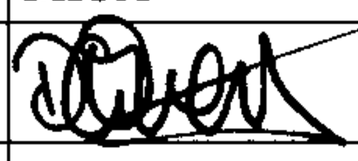
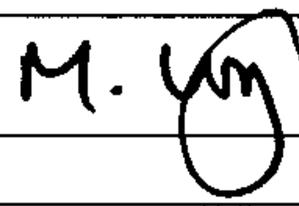
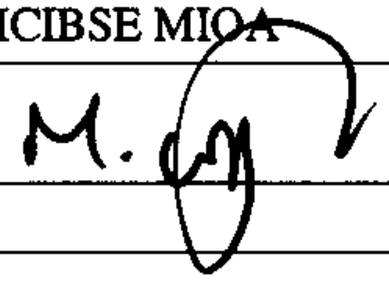
		Name	David Owen BEng, MIOA	Malcolm Wright CEng, MCIBSE MIOA	Malcolm Wright CEng, MCIBSE MIOA
		Signature			
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			Prepared by	Checked by	Approved by
		Name			
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EXECUTIVE SUMMARY

Arup Acoustics has reviewed the scheme proposals for the proposed office / residential development at 105 Tottenham Court Road. This has been with regard to building envelope sound insulation, potential vibration effects of underground trains and noise emissions from roof top plant, these issues have been targeted in order to satisfy four planning conditions considering noise and vibration within the LBC Planning Condition Schedule. Where applicable the design targets have been derived from those documents specified within the Planning conditions however, for areas where suitable guidance was not specified the design targets were derived from BS 8233: 1999 and BS 6472: 1992.

The main conclusions of this work are:

- **Office Building Envelope Sound Insulation**
  The required sound insulation performance in order to control the level of intrusive road traffic noise for the office development to the recommended design targets are specified below for each façade:

Elevation	Octave Band Centre Frequency, Hz					
	125	250	500	1k	2k	4k
North	21	24	29	36	33	33
East	20	23	28	35	32	32
South	15	20	23	30	30	23
West	15	20	23	30	30	23

  The required level of sound insulation performance can be achieved by provision of 10/12/6 (10 mm glass +12 mm air-gap + 6 mm glass) glazing for the north and east elevation and, 10/12/4 glazing for the south and west elevation.

- **Residential Building Envelope Sound Insulation**
  In accordance with Planning Condition 9, an assessment has been undertaken in accordance with PPG 24 and the residential development is shown to fall within Noise Exposure Category 'B' which indicates that:

  "Noise should be taken into account when determining planning applications and, where, appropriate, conditions imposed to ensure an adequate level of protection against noise"

  The UDP also specifies noise criteria regarding road traffic noise for day, evening and night. The road traffic noise incident on the development exceeds these criteria and therefore internal design noise targets have been specified and the required sound insulation performance in order to control the level of intrusive road traffic noise to the recommended design targets are specified below for each room type:

Elevation	Octave Band Centre Frequency, Hz					
	125	250	500	1k	2k	4k
Living Rooms	23	27	32	36	36	30
Bedrooms	23	27	32	36	36	30
Toilets and Corridors	8	14	17	21	21	15

  The required level of sound insulation performance can be achieved by provision of 10/12/6 (10 mm glass +12 mm air-gap + 6 mm glass) glazing for the bedrooms and living rooms and 6/12/6 glazing for the toilets and corridors.

- **Roof Top Plant**
  The noise emissions from the proposed roof top plant comply with the Planning Conditions 8, 10, 11 and 12 assuming that the office toilet extract fan, the residential kitchen fan and bathroom fans are fitted with suitable attenuators.

The rooftop equipment has been selected such that the noise levels incident at the nearest noise sensitive receptors are (at least) 3 dB(A) below the building services plant noise limits. This is to make allowance for any additional plant which maybe required by a future tenant. Any additional plant will be limited to the same noise levels as the landlord plant to ensure compliance with the policy requirements.

- **Emergency Equipment**

  Noise levels from the standby generator, and if applicable associated supply and extract fans, are to be limited such that they will ensure compliance with the requirements of planning condition 11.

- **Vibration from Underground Trains**
  We were unable to measure any vibration levels that we could associate directly with underground train movements. We did undertake a longer-term measurement and these levels did not exceed curve 1 as specified in BS 6472:1992. It was concluded therefore that vibration and re-radiated noise should not be considered an issue for the proposed development.

1. INTRODUCTION

Arup Acoustics has been commissioned to review certain elements of the scheme proposals for the proposed office / residential development at 105 Tottenham Court Road. These elements are:

- Building envelope sound insulation;
- Potential vibration effects of underground trains; and,
- Noise emissions from roof top plant.

The report shall initially derive design targets for these elements and then review the scheme design based upon these design targets.

The acoustic terminology used in this report is explained in Appendix A.

2. RESIDENTIAL DEVELOPMENT PLANNING CONDITIONS

The residential part of the development is subject to Planning Condition 9 of the LBC Planning Condition Schedule, which specifies that:

"Before occupation of the residential units hereby granted permission, a scheme for the sound isolation of the residential units shall be submitted to and approved in writing by the Council to ensure that the operation of the proposed plant and office uses can occur without detriment to the amenity of adjoining residential premises by reason of noise. Thereafter all works which form part of the scheme shall be completed before any occupation of the residential units and shall retained thereafter.

To ensure that the use can be accommodated without detriment to the amenity of the surrounding premises by reason of noise in accordance with the requirements of policies RE2(Residential amenity), EN5 (Noise and vibration) and EN6 (Disturbance from plant and machinery)of the London Borough of Camden Unitary Development Plan 2000."

The condition refers to sections EN5 and EN6 of the LBC Unitary Development Plan (UDP) 2000. These sections refer to an assessment in accordance with Planning Policy Guidance Note PPG 24 'Planning and Noise' and additional considerations for properties subject to noise level from transportation sources over particular levels.

2.1 PPG 24

2.1.1 Assessment Methodology

The Government Planning Guidance for noise is contained in the Department of the Environment, Transport and Regions (formerly the Department of the Environment) publication PPG24 'Planning and Noise'.

For assessing proposals for new residential developments potentially affected by noise, the guidance defines four Noise Exposure Categories (NECs), as follows:

A: Noise need not be considered as a determining factor for planning applications

B: Noise should be taken into account when determining planning applications and, where, appropriate, conditions imposed to ensure an adequate level of protection against noise

C: Planning permission should not normally be granted. Where it is considered that permission should be given, conditions should be imposed to ensure a commensurate level of protection against noise

D: Planning permission should normally be refused

The guidelines provide a 'recommended range of noise levels ...for each of the NECs for dwellings exposed to noise from road, rail ...and mixed sources' as set out below.

NOISE LEVELS CORRESPONDING TO THE NOISE EXPOSURE CATEGORIES FOR NEW DWELLINGS $L_{Aeq,t}$ dB (free-field levels)					
	NOISE EXPOSURE CATEGORY				
Noise Source	Time	A	B	C	D
Road traffic	0700-2300 2300-0700	<55 <45	55-63 45-57	63-72 57-66	>72 >66
Rail traffic	0700-2300 2300-0700	<55 <45	55-66 45-59	66-74 59-66	>74 >66
Air traffic	0700-2300 2300-0700	<57 <48	57-66 48-57	66-72 57-66	>72 >66
Mixed sources	0700-2300 2300-0700	<55 <45	55-63 45-57	63-72 57-66	>72 >66

The derivation or calculation of the boundaries of each of the NECs are explained within PPG24, but take into account the acceptability of both external and internal noise levels from each noise source.

Each noise source is calculated / predicted separately and if there is a dominant noise source, the site is assessed against the appropriate NEC for that source. Otherwise the mixed source NEC values are used.

The Local Planning Authority may have their own guidelines/local policy for the assessment of noise sensitive developments. These should be based on PPG24, but the Local Planning Authority would need to be consulted once a site layout has been established.

2.1.2 Assessment and Results

Based on the survey work carried out to date and reported within AAc report, AAc/67527/R01, the noise levels incident on the façades of the residential development for the period 07:00 to 23:00 and 23:00 to 07:00 have been derived.

The survey undertaken and reported within our previous report did not measure adjacent to the southern façade (Cypress Place), and thus a short noise survey was undertaken to assess the difference between the noise incident on the west and south elevations. Details of the survey are included within Appendix B and the data is included in Appendix C.

The survey indicated that there is very little difference in noise level on between Whitfield Street and Cypress Place, therefore the measured data for the Whitfield Street elevation will be used to assess the Noise Exposure Category (NEC) for the Cypress Place elevation.

Table 1 lists the façade-incident noise levels alongside the relevant NEC for 'road traffic noise' according to PPG 24.

PPG 24 includes requirements relating to maximum (transient) noise levels. If the $L_{Amax,slow}$ parameter 'regularly exceeds' 82 dB during the night-time period, the façade-incident noise should be ranked as Noise Exposure Category C or above. This condition does not occur on this site.

Facade	Daytime period (07:00-23:00)		Night-time period (23:00-07:00)	
	L_{Aeq} [dB]	NEC	L_{Aeq} [dB]	NEC
Whitfield Street	59	B	56	B
Cypress Place	59	B	56	B

TABLE 1: Façade-incident road noise levels and Noise Exposure Categories (NECs)

2.1.3 Conclusion

The residential development falls within the NEC B category, which the guidance states that:

"Noise should be taken into account when determining planning applications and, where, appropriate, conditions imposed to ensure an adequate level of protection against noise"

This is considered within Section 4.2.

2.2 Additional Consideration of Transportation Noise

An additional set of criteria are specified within the LBC UDP 2000 regarding road traffic noise incident upon proposed residential development.

The criteria within LBC UDP 2000 along with the measured noise levels are included within Table 2.

Facade	Day Noise Level [$dBL_{Aeq, 12hr}$] (07:00 -19:00)		Evening Noise Level [$dBL_{Aeq, 4hr}$] (19:00 – 23:00)		Night Noise Level [$dBL_{Aeq, 1hr}$] (23:00 – 07:00)	
	UDP	Measured	UDP	Measured	UDP	Measured
Whitfield and Cypress Place	62	64	57	59	52	56

TABLE 2: Measured façade-incident road traffic noise levels and LBC UDP criteria for residential developments

The measured noise levels are greater than those specified in the LBC UDP and as such the policy states that:

"... developers should introduce measures such as acoustic secondary glazing in combination with acoustic ventilation, to reduce the internal impact of this external noise."

In order to select suitable glazing internal design targets for the residential development have been specified within Section 3.2 and suitable glazing systems specified within Section 4.2.

3. DESIGN TARGETS

The Client's acceptance of the design targets proposed herein should be sought at the earliest opportunity, in particular with regard to residual noise levels.

3.1 Office Ambient Noise Levels

The ambient noise levels in the offices will be a combination of the residual road traffic noise and the cumulative mechanical services noise.

Table 3 presents the recommended design targets for the background noise levels in the principal office areas and is based on typical noise spectra for residual road traffic and fan coil units.

The overall ambient noise criteria has been sourced from BS8233: 1999 *Sound insulation and noise reductions for buildings*, which specifies design targets appropriate for study and work requiring concentration.

Services noise targets have been obtained from details of the base-build proposals produced by the services engineers, which are generally in agreement with those detailed in the CIBSE guide and recommendations from the British Council for Offices.

The residual road traffic noise limits have been selected to achieve the 'reasonable' design target for the overall ambient noise level.

Area	Cumulative Mechanical Services Noise Target, dBL_{eq}	Residual Road Traffic Noise Limit, dBL_{Aeq}	Overall Ambient Noise Criteria, dBL_{Aeq}
Open Plan Office	NR 38	45	45 – 50
Entrance/Reception Atrium Toilets Circulation Areas Corridors	NR 40	47	45 – 55
Storage Areas	NR 45	50	50-55

TABLE 3: Recommended design targets for ambient noise

It is emphasized that, if the resulting background noise levels fall short of these targets, appropriate privacy between adjacent areas will be difficult to achieve, and conversely if they are too high, normal communication within the offices will become more difficult.

3.2 Residential Ambient Noise Level

The ambient noise levels in the residential development will be due to the intrusive road traffic noise (from Whitfield Street or Cypress Place), the potential mechanical services noise from the office development and mechanical services noise from the plant serving the flats themselves.

Table 4 presents the recommended design targets for the ambient noise levels.

BS8233: 1999 *Sound insulation and noise reductions for buildings*, specifies 'Good' and 'Reasonable' design ranges for particular criterion and situations. The information appropriate for reasonable resting / sleeping in living rooms or bedrooms has been used to collate Table 4.

Area	Ambient Noise Criteria, dBL_{Aeq}	
	Good	Reasonable
Bedroom	30	35
Living Rooms, Dining Rooms	30	40

TABLE 4: Recommended design targets for ambient noise

Based upon the information within Table 4 and given that the residential properties are to be of a reasonably high specification, but within a busy urban area, it is considered unwarranted to achieve the 'good' noise criterion in a spaces at all times, therefore separate criteria for intrusive road traffic noise have been derived for the daytime period (07:00-19:00), evening period (19:00-23:00) and night-time period (23:00-07:00) and a presented in Table 5.

Area	Period Design Ranges		
	Daytime	Evening	Night-time
Bedroom	Reasonable	Good	Good
Living Rooms, Dining Rooms	Reasonable	Good	Good

TABLE 5: Period design ranges for each residential space

3.3 Mechanical Services Noise Emissions

The noise emissions from the mechanical services from the development are subject to Planning Conditions 8, 10, 11 and 12 of the LBC Planning Condition Schedule.

Condition 8 specifies that:

"No process shall be carried on or machinery installed which is not such as could be carried on in any residential area without detriment to the amenity of that area by reason of noise, vibration, smell, fumes, smoke, soot, ash, dust or grit.

To safeguard the amenities of the adjoining premises and the area generally in accordance with the requirements of policy RE2 (Residential amenity) of the London Borough of Camden Unitary Development Plan 2000."

Condition 10 specifies that:

"Before the use commences all plant and machinery shall be sound attenuated and isolated from the structure in accordance with a scheme to be submitted to and approved by the Council such that the use can be carried out without detriment to the amenity of adjoining or surrounding premises.
To safeguard the amenities of the adjoining premises and in the area generally noise in accordance with the requirements of policies RE2(Residential amenity), EN5 (Noise and vibration) and EN6 (Disturbance from plant and machinery)of the London Borough of Camden Unitary Development Plan 2000."

Condition 11 states that:

"Noise levels at a point 1 metre external to sensitive facades shall be at least 5dB(A) less than the existing background measurement (LA90), expressed in dB(A) when ALL plant/equipment are in operation. Where it is anticipated that any plant/equipment will have a noise that has a distinguishable, discrete continuous note (whine, hiss, screech, hum) and/or if there are distinct impulses (bangs, clicks, clatters, thumps) special attention should be given to reducing the noise levels from that piece of plant/equipment at any sensitive façade to at least 10 dB(A) below the LA90, expressed in dB(A). The applicant is therefore required to undertake a full acoustic background noise assessment, the full details of which shall be submitted to the Council, in order that the design criteria for the acoustic enclosure of plant equipment can be properly assessed."

Condition 12 states that:

"For each of the octave band of centre frequencies 63Hz-8kHz inclusive, noise levels from all plant/equipment (measured in L_{Aeq}) when in operation shall at all times add not more than 1 decibel to the existing background noise level L_{A90}, expressed in dB(A), in the same octave band as measured 1 metre external to sensitive facades."

Building services noise emissions to the environment are discussed within Section 4.1 of a previous AAc report, AAc/67527/R01. Table 1 of the report specifies building services plant noise limits (dBL_{Aeq}) in order to achieve compliance with Condition 11. Table 1 from the previous report is recreated as Table 6, below.

NSR	Building Services Plant Noise Limits (dBL_{Aeq})		
	Day (07:00 –19:00)	Evening (19:00 – 23:00)	Night(23:00 – 07:00)
1	54	52	46
2	54	52	46
3	55	54	47
4	51	47	44

TABLE 6: Daytime, evening and night-time building services plant noise limits at the nearest noise sensitive receptors (NSRs)

If the plant is considered to be tonal in nature the above limits will need to be decreased by a further 5 dB(A).

Where,

- NSR 1 – 108 Tottenham Court Road (public house)
- NSR 2 – 162 Tottenham Court Road (flats at high level)
- NSR 3 – 163-169 Tottenham Court Road (flats at high level)
- NSR 4 – 109-113 Whitfield Street (flats at high level)

The report also discusses noise from emergency plant and states that:

"It is recommended that the noise emission limits for emergency (landlord and tenant) plant operation and testing are controlled to the existing lowest background noise levels measured at each NSR for each particular period. This means that the noise limits given in Table 1 [Table 6] *can be 5 dB(A) higher for emergency plant. This will result in a temporary increase of 3 dB(A) in the existing background noise levels".*

The report also discusses noise from tenants' plant and states that:

"It should be borne in mind that all tenant's plant must be controlled so that the noise emission limits specified in Table 1[Table 6] *are not exceeded when both landlord and tenant plant operate."*

The building services noise emissions shall be controlled so as to comply with planning conditions 8, 10, 11 and 12.

3.4 Vibration

Vibration caused by any building services or due to the operation of underground trains must be controlled sufficiently to ensure that consequent re-radiated noise does not exceed the ambient noise targets within the offices..

BS6472: 1992 *Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)* recommends appropriate magnitudes of vibration within various building categories for human comfort. These are specified within Table 7, below:

Type	Period	Exposure to continuous vibration should not exceed curve
Residential	Day	2 to 4
	Night	1.4
Offices	Day	4
	Night	4

TABLE 7: Recommended continuous vibration exposure curves

4. SCHEME DESIGN REVIEW

This section presents our findings and recommendations with regard to achieving the recommended acoustic design targets. Where assumptions have been made, they are detailed.

4.1 Office Building Envelope Sound Insulation

It is understood that Levels 1 to 5 will be open plan office space and the road traffic residual noise levels have been designed to achieve 45 dBL_{Aeq} , as specified in Table 3.

The residential segment of the building will be considered within Section 4.2.

4.1.1 Road traffic noise levels

Based on the survey work carried out to date and reported within AAc report, AAc/67527/R01, it was shown that that road traffic flow, and hence façade noise levels, are relatively constant during normal offices hours (07:00 to 19:00).

As discussed earlier the noise incident upon the southern elevation has been derived from the measured information for the western elevation.

	dB(A)	Octave Band Centre Frequency, Hz					
		125	250	500	1k	2k	4k
North (Maple Street)	69	71	65	64	66	62	59
East (Tottenham Court Road)	68	70	64	63	65	61	58
South (Cypress Place)	64	65	61	58	60	58	49
West (Whitfield Street)	64	65	61	58	60	58	49

TABLE 8: Typical road traffic noise exposures, dBL_{eq}

The difference in façade exposure with increased height above the roads has been assumed as negligible, and so the minimum acoustic requirements should remain the same over the entire elevations.

4.1.2 Minimum façade performance

The overall facade performance will be dictated by the glazed elements. Data is, therefore, only presented over the frequency range 125 Hz to 4 kHz, as glazing supplier's rarely provide information outside this frequency range and should be assessed in accordance with BS EN ISO 140: Part 3.

The assessment assumes typical mid-frequency reverberation time for open plan offices with carpeted floor and absorptive ceiling, with a fully glazed façade.

Elevation	Octave Band Centre Frequency, Hz					
	125	250	500	1k	2k	4k
North	21	24	29	36	33	33
East	20	23	28	35	32	32
West	15	20	23	30	30	23
South	15	20	23	30	30	23

TABLE 9: Office minimum façade sound reduction indices

4.1.3 Typical glazing

Details of typical glazing configurations that could satisfy the minimum performance requirements are presented in Table 10. It is envisaged that the same glazing would be used on both the north and east elevations to control the similar façade exposures that exist in these locations.

Area	Glazing Example
North and East Elevations	10 mm glass +12 mm air gap + 6 mm glass
West and South Elevation	10 mm glass + 12 mm air gap + 4 mm glass

TABLE 10: Typical glazing configurations

4.2 Residential Building Envelope Sound Insulation

It is understood that the residential building associated with the development will be arranged such that the living areas are on the western façade overlooking Whitfield Street and the bedroom windows will be overlooking Cypress Place. Details of the façade locations are included within Figure B1 in Appendix B.

4.2.1 Road traffic noise levels

Based on the survey work carried out to date and reported within our previous report, the traffic noise levels incident on the west elevation for the daytime (07:00 to 19:00), evening (19:00 to 23:00) and night-time period (23:00 to 07:00) are indicated within Table 11.

		Octave Band Centre Frequency, Hz					
	dB(A)	125	250	500	1k	2k	4k
Daytime (07:00- 23:00)	64	65	61	58	60	58	49
Evening (19:00 – 23:00)	59	60	57	55	54	51	44
Night-time (23:00-07:00)	56	57	54	52	52	49	39

TABLE 11: Typical road traffic noise exposures, dBL_{eq}

The difference in façade exposure with increased height above the roads has been assumed as negligible, and so the minimum acoustic requirements should remain the same over the entire elevations.

4.2.2 Minimum façade performance

Table 12 presents the calculated minimum sound insulation performances for the front and rear façades of the residential block. The overall facade performance will be dictated by the glazed elements. Data is, therefore, only presented over the frequency range 125 Hz to 4 kHz, as glazing supplier's rarely provide information outside this frequency range and should be assessed in accordance with BS EN ISO 140: Part 3.

The assessment assumes a conservative mid-frequency reverberation time for residential dwellings with reasonably hard finishes and the façade as shown within EPR drawing ref.: 8954/LO/0312 (Figure 1).

The assessment has considered that the air cooling plant shall be located on the roof to the north of the office atrium.

Elevation	Space	Octave Band Centre Frequency, Hz					
		125	250	500	1k	2k	4k
Whitfield Street	Living Rooms	23	27	32	36	36	30
Cypress Place	Bedroom	23	27	32	36	36	30

TABLE 12: Residential minimum façade sound reduction indices

4.2.3 Typical glazing

Details of typical glazing configurations that could satisfy the minimum performance requirements are presented in Table 13. It is envisaged that the same glazing would be used on both the north and east elevations to control the similar façade exposures that exist in these locations.

Area	Glazing Example
West Elevation (Whitfield Street)	
Living Room	10 mm +12 mm air gap + 6 mm glass
East Elevation (Cypress Place)	
Bedroom	10 mm +12 mm air gap + 6 mm glass

TABLE 13: Typical glazing configurations

4.3 Building Services

4.3.1 Rooftop equipment

The following plant will be located on the roof of the building:

- 3No Dry Air Coolers (10 fan) Units
- 1No Twin toilet extract fan (offices)
- 1No Twin bathroom extract fan (residential)
- 1No Twin kitchen extract fan (residential)

Based upon the proposed plant selections for these items an assessment has been completed to assess compliance with the specified criterion. The rooftop plant layout is shown in Figure 2 and details of the plant used within the assessment are included within Appendix D.

Compliance with clauses 8, 10, 11 and 12 of the LBC Planning Condition Schedule is achieved for all periods (day, evening and night) assuming that the office toilet extract fan, the residential kitchen fan and the residential bathroom fan are all fitted with the fan suppliers attenuators referenced in Appendix D.

The rooftop equipment has been selected such that the noise levels incident at the nearest noise sensitive receptors are (at least) 3 dB(A) below the building services plant noise limits (specified in Table 6). This is to make allowance for any additional plant which maybe

required by a future tenant. Any additional plant will be limited to the same noise levels as the landlord plant to ensure compliance with the policy requirements. Noise limits based upon the information included within Table 6 (minus 3 dB) are to be included within any tenant agreements.

4.3.2 Emergency Equipment

Noise levels from the standby generator and if applicable, associated supply and extract fans, are to be limited by the following specification to be included within the equipment tender documentation which will ensure compliance with the requirements of planning condition 11.

The maximum permissible noise levels derived for the supply, extract and exhaust for the standby generator are based upon the layout shown within drawing reference: M-1-098 / T1 and M-1-006 / T1.

Supply Louvre
The maximum permissible noise level as measured at a distance of 1 m from the standby generator external supply lourve shall not exceed 52 dB(A), when the generator and (if applicable) supply fan are operating under emergency conditions.

Extract Louvre
The maximum permissible noise level as measured at a distance of 1 m from the standby generator external extract lourve shall not exceed 57 dB(A), when the generator and (if applicable) extract fan are operating under emergency conditions.

Exhaust flue
The maximum permissible noise level as measured at a distance of 1 m horizontally from the exhaust flue of the standby generator shall not exceed 63 dB(A), when the generator is operating. If the flue is fitted with an appropriate cowl directing the airflow away from the new residential development (i.e. to the north), then the maximum permissible noise level may be increased to 75 dB(A).

4.3.3 Vibration isolation of building services

The mechanical services installation will need to be sufficiently isolated from the building structure to control received vibration and/or re-radiated noise to within the recommended design targets. Suggested anti-vibration (AV) mountings have been derived for each of the items of rooftop plant and are included within Table 14. This will need be reviewed when details of the static deflections of the suspended slabs under the applied loads are provided by the post tensioned concrete contractor.

Fan Type	Minimum Static Deflection	Typical Mount Type
Dry Air Coolers (10 fan) Units	50 mm	Open Coil Springs
Twin toilet extract fan (offices)	Fan provide with suitable AV mounts	
Twin bathroom extract fan (residential)	8 mm	Rubber/Elastomer
Twin kitchen extract fan (residential)	8 mm	Rubber/Elastomer

TABLE 14: Typical AVM selection

Deflection may need to be revised subject to structural slab deflection under equipment load. Details of the fan speed are included within Appendix D.

4.4 Vibration and Re-radiated Noise (LUL)

A vibration survey was undertaken within the existing building in order to assess the vibration levels associated with the movement of LUL train on the Northern Line that runs in close proximity to the site. Details of the survey are included within Appendix B.

During the survey period we were unable to measure any vibration levels, which we could associate with the LUL movements, as they were not perceptible within the existing building. We did however, undertake a longer-term measurement and recorded the highest 1/3-octave band levels during the period. These levels did not exceed Curve 1 as specified in BS 6472:1992.

It is concluded therefore that vibration and re-radiated noise should not be considered an issue for the proposed development.

4.5 Planning Condition 8 response

The following response is proposed to the noise and vibration requirements contained within planning condition 8:

"All plant associated with the development has been selected in order to maintain the requirements of the LBC policy RE2 at the existing and the new residential dwellings.

The noise levels shall be achieved through the careful selection and positioning of plant, and where applicable the inclusion of suitable mitigation, specifically:

- *If applicable, in-duct sound attenuation within the air handling unit intake duct to be located at roof level;*
- *If applicable, mitigation to be included within the exhaust path of the air handling unit louvres;*
- *Suitable in-line attenuators for the office toilet extract fan and the residential kitchen and bathroom extract fans;*
- *The office heat rejection equipment has been located away from the residential units and has been designed to comply with the specified plant noise limits;*
- *Noise limits to be included within any tenant agreements to limit noise emissions from any additional tenant plant such that the overall noise level shall comply with the policy requirements;*
- *Emergency equipment for the office landlord shall be designed in accordance with the recommendations of the London Borough of Camden Unitary Development Plan 2000, that a 5 dB relaxation of the normal noise limits for these items shall be applied. The stand-by generators to be located at the ground floor level have been selected accordingly. Ventilation system intake and discharge at ground floor level shall also be suitably attenuated.*

Vibration associated with the building services plant shall be limited by the provision of suitable vibration isolation mountings.

With the exception of the building services plant and emergency equipment discussed above there are not considered to be any further significant noise or vibration generating sources associated with the development."

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FIGURES

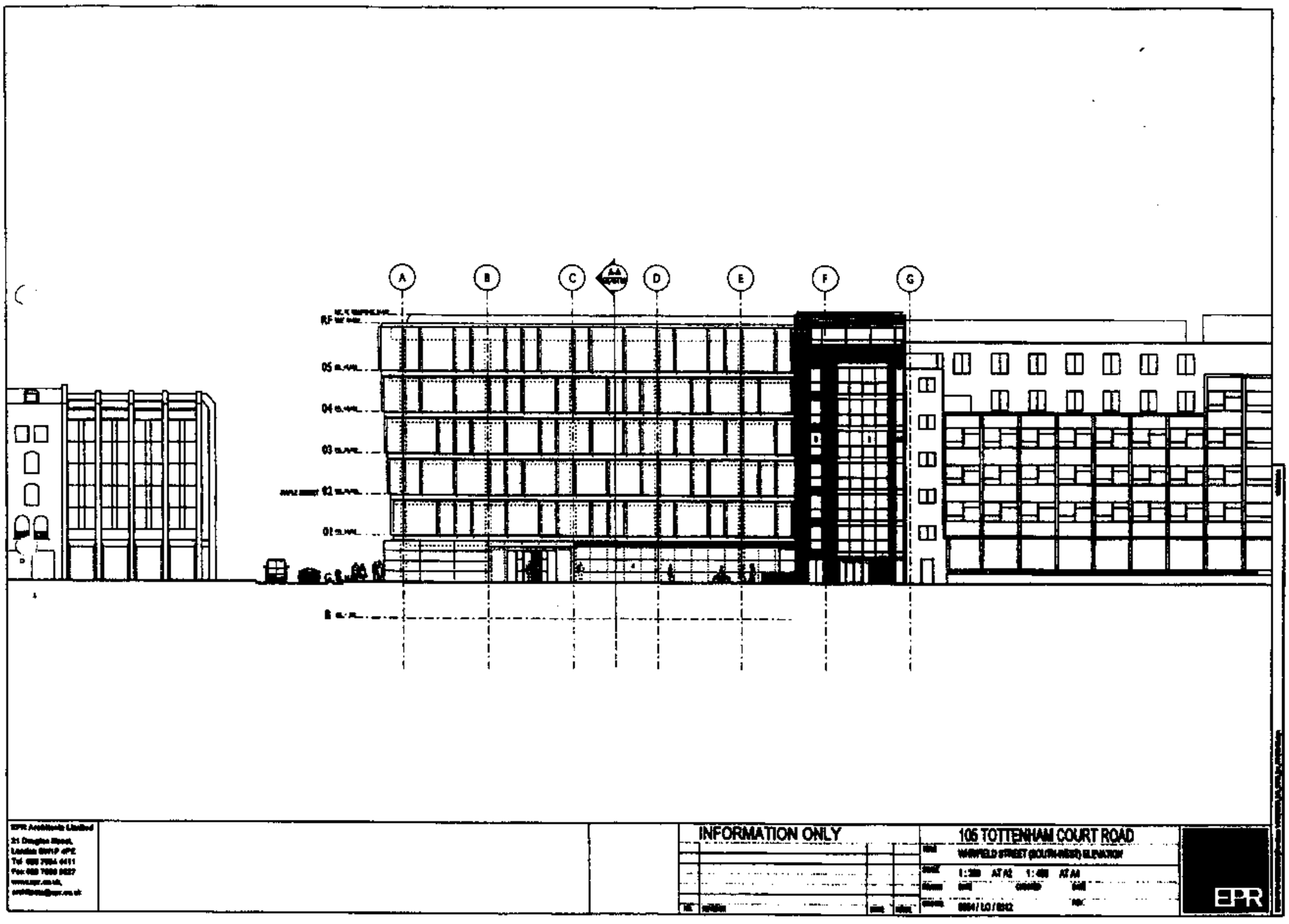

FIGURE 1: Whitfield Street elevation of the proposed development

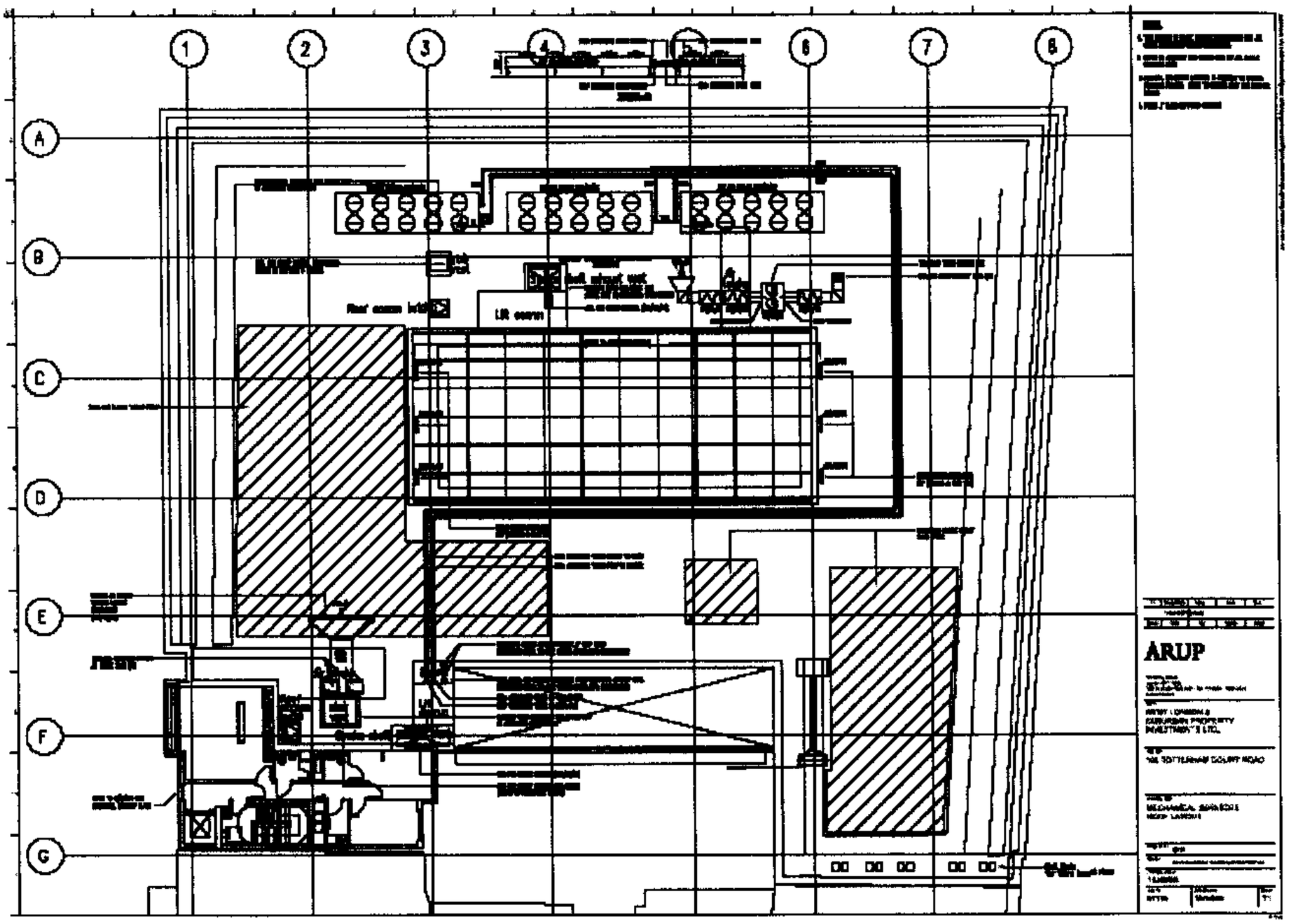

FIGURE 2: Rooftop plant locations

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APPENDIX A

GLOSSARY OF ACOUSTIC TERMINOLOGY

L_N	The dB(A) level, or octave band dB level, exceeded for N% of the time period of measurement e.g. L_{A01}, L_{A10}, $L_{A\,50}$, $L_{A\,90}$, $L_{A\,99}$ or L_{01}, L_{10}, L_{50}, L_{90}, L_{99}. Where a time period for the measurement is defined it is shown by $L_{A90,T}$, e.g. $L_{A\,90,5\ minutes}$. Where the response of the sound level meter is specified it is shown by adding the detail in brackets e.g. $L_{A\,90,\,(slow)}$. L_{90} is generally regarded as the background noise level.
L_{eq}	The equivalent continuous sound level, in dB(A) or dB for octave bands, is a notional steady sound level which would produce the same sound energy over a given time period as the measured, time varying sound, denoted by L_{Aeq} or L_{eq}. Where a time period for the measurement is defined it is shown by $L_{Aeq,T}$, e.g. $L_{Aeq,1\ hour}$. Where the response of the sound level meter is specified it is shown by adding the detail in brackets e.g. $L_{Aeq,(slow)}$.
Noise rating (NR) curves	Noise rating (NR) curves are a set of internationally agreed octave band sound pressure level curves, based on the concept of equal loudness. The curves are commonly used to define building services noise limits. The NR value of a noise is obtained by plotting the octave band spectrum on the set of standard curves. The highest value curve that is reached by the spectrum is the NR value.
R_W	The sound reduction index, R, (or transmission loss) of a building element covering the 16 third octave bands from 100 Hz to 3150 Hz, measured in a laboratory in accordance with BS EN ISO 140-3. It is a measure of the loss of sound through the material, i.e. its attenuation properties. It is a property of the component, unlike the sound level difference that is affected by the common area between rooms and the acoustic of the receiving room. The weighted sound reduction index, R_W, is a single figure description of sound reduction index, using the third octave band data and rated in accordance with BS EN ISO 717-1. The higher the figure the better the sound insulation. When the R_W is calculated from site measurements it includes the effects of the flanking routes and is referred to as the apparent weighted sound reduction index, R'_W.
VDV	Vibration Dose Values (VDV) is a complex metric that has been identified as being the best objective measure of human disturbance from intermittent/transient vibration. The VDV is the fourth root of the time integral of the fourth power of the weighted acceleration. VDV are measured in units of $m/s^{1.75}$. The frequency weightings are defined in BS 6472: 1992 and in BS 6841: 1987. The VDV doubles in magnitude with a doubling of vibration amplitude. However, a 16-fold increase in the duration of exposure to the vibration is required to double the VDV (without any change in amplitude).
PPV	Peak Particle Velocity (PPV) is the parameter most often used for the quantification of groundborne and structure-borne vibration. It is the maximum positive or negative magnitude of vibration in a defined direction caused by the passage of a wave front during a specified interval. Particle velocity is used in most cases because this parameter has been found to correlate best with the onset of structural damage. It is directly proportional to dynamic strain during the passage of a wave. It can also be used to provide some guidance on disturbance to people and the sensitivity of equipment and processes to vibration.

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APPENDIX B

SURVEY DETAILS

NOISE SURVEY

Date/time:	September 29, 2004 between 09:53 and 11:37.
Sample duration:	10 minute measurement at each location.
Measurement locations:	N1 At the approximate location of the western façade of the proposed residential block. N2 At the approximate location of the eastern façade of the proposed residential block. All measurements were carried out at a height of approximately 1.5 m above local ground. Measurement locations are indicated in Figure B1.
Personnel:	Rachel Capstick (Arup Acoustics)
Equipment:	1 x Bruel & Kjaer 2260 modular real time analyser; Calibration was checked by means of suitable calibrator before and after use. A drift of less than 0.1 dB was observed.

VIBRATION SURVEY

Date/time:	September 24, 2004 between 10:30-12:00
Measurement location:	Location V1 within the entrance lobby of the existing building. All measurements were taken at local ground level on a large area of solidly supported concrete slab. Measurement locations are indicated in Figure B1.
Personnel:	David Owen and Vahndi Minah (Arup Acoustics)
Equipment:	Svan 948 real time analyser 1 x PCB393B12 accelerometer
Accelerometer fixing:	Sacrificial ground plate + magnetic mount

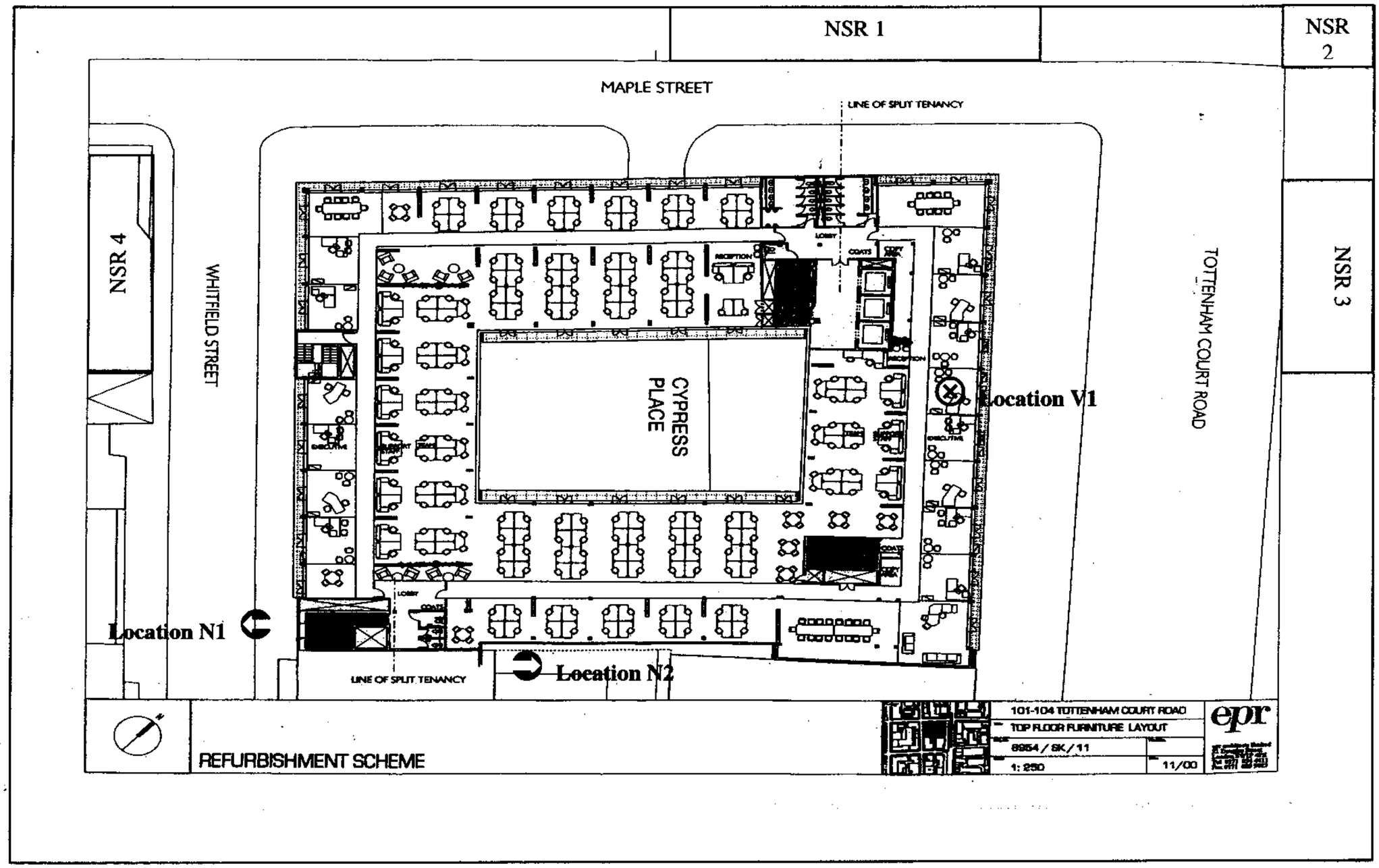

FIGURE B1: Existing site plan and noise measurement locations

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APPENDIX C

SURVEY DATA

NOISE MEASUREMENTS

				Job No	67135-60
				By	RXC
Project	105 Tottenham Court Road	**Date**	29-Sep-04	**Pre-Cal**	93.9
Description	Whitfield Street and Cypress Place	**Equip.**	2260 Kit A	**Post Cal**	93.9-0.07
Weather	Overcast, very little wind. 14-17 degrees			**Checked**	
Location	Marked N1 and N2 on map.				

Location	Start	Elapsed	L_{eq}	L_1	L_{10}	L_{90}	Description
1	09:53:22	00:10:00	61.1	70.4	62.8	55.2	Quiet one-way street. Busier roads at ends. Few pedestrians and cyclists. Distant construction. 6 cars, 1 motorbike.
1	10:21:22	00:10:00	62.4	72.2	65.2	56	7 cars, 3 motorbikes. Siren on Tottenham Court Road. Car boot slam nearby.
1	10:46:50	00:10:00	63.9	75.6	65.2	55.6	4 car, 5 motorbikes, 3 trucks. Odd spot of rain.
1	11:13:44	00:10:00	61	71.2	63.2	55.6	7 cars, 2 motorbikes. Odd spot of rain.
2	10:08:15	00:10:00	62	72.4	62.4	57.4	Enclosed area with 5-6 floor buildings around. Plant from nearby office. Few pedestrians. Traffic at ends of road. 5 cars, 1 motorbike
2	10:34:02	00:10:00	60.5	68.2	61.6	57.6	1 car, 1 motorbike. Car horn nearby.
2	11:00:14	00:10:00	62.6	72.8	63.8	57.8	2 cars, 2 motorbikes. Helicopter flew over. Man wheeling metal trolley.
2	11:26:47	00:10:00	61.9	70.4	63.6	57.4	0 cars, 2 motorbikes. Light plane overhead. Man sweeping street.
2	11:37:07	00:10:00	60.3	68.2	61.4	57.2	0 cars, 2 motorbikes. Made additional measurement due to man sweeping road.

VIBRATION MEASUREMENT

Project	105 Tottenham Court Road	**Date**	24-Sep-04	**Job No**	67135-60
Description	Whitfield Street and Cypress Place	**Equip.**	SVAN 948	**By**	DGO
Location	Marked V1 on map.				

	One third octave band centre frequency [Hz]										
	1	**1.3**	**1.6**	**2**	**2.5**	**3.1**	**4**	**5**	**6.3**	**8**	**10**
PPV [mm/s]	1.57E-03	6.92E-04	1.32E-03	8.81E-04	9.33E-04	2.43E-03	7.50E-03	1.48E-02	1.24E-02	1.01E-02	1.14E-02

	One third octave band centre frequency [Hz]									
	12.5	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**
PPV [mm/s]	1.24E-02	9.77E-03	5.82E-03	4.47E-03	3.89E-03	3.89E-03	1.35E-02	5.43E-03	6.92E-03	6.76E-03

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APPENDIX D

ROOF TOP PLANT NOISE LEVELS

PLANT NOISE LEVELS

A) Dry Air Coolers

Manufacturer: Carrier
Model: 09GE-CA-E-174-10-09-10-9-V -102-DN 100
Fan Speed: 554 rpm

	dB(A)	Octave Band Centre Frequency, Hz [dB(A)]						
		125	250	500	1k	2k	4k	8k
Daytime Operation: Sound Pressure Level @ 20m	**48**	51	50	47	43	35	33	34
Evening Operation[1]: Sound Pressure Level @ 20 m	**33**	35	34	31	28	20	18	18

The assessment of night-time noise has assumed a 'worst-case' in that the dry air coolers will be operating at the evening noise level.

B) Office Toilet Extract Fan (and associated attenuator)

Manufacturer: Nuaire
Model: EST – 18
Fan Speed: 1250 rpm
Casing Sound Pressure Level: 62 dB(A) @ 3m

Exhaust Fan Noise Level

	dB(A)	Octave Band Centre Frequency, Hz						
		125	250	500	1k	2k	4k	8k
Sound Power Level	-	89	82	89	86	83	82	78
Attenuator ref.: CA63LP	-	-8	-13	-26	-34	-25	-22	-18

C) Residential Bathroom / Kitchen Extract Fan (and associated attenuator)

Manufacturer: Nuaire
Model: ESTCP11-X
Fan Speed: 1250 rpm
Casing Sound Pressure Level: 49 dB(A) @ 3m

Exhaust Fan Noise Level

	dB(A)	Octave Band Centre Frequency, Hz						
		125	250	500	1k	2k	4k	8k
Sound Power Level	-	73	74	73	76	64	61	56
Attenuator ref.: CA25LP	-	-4	-10	-21	-27	-29	-19	-12

[1] 75% cooling duty at 25°C Ambient