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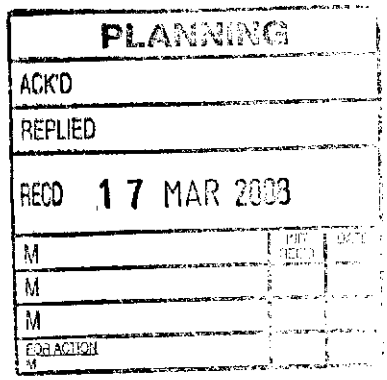
Acoustics

Castlefield Chapel, Manchester

Environmental Noise Assessment –

Proposed Office Conversion – Revision C



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1.0 INTRODUCTION

BDP Acoustics has been commissioned by Bluetree Estates Ltd to undertake an acoustic survey to appraise environmental noise levels, and to provide appropriate acoustic design advice in support of the planning application for a proposed office conversion at Castlefield Chapel, 380 Deansgate, Manchester. The existing building is Grade II listed and is presently unoccupied.

It is proposed to create two self contained office units with independent access, over three floors.

The existing noise levels are evaluated in line with design targets given in BREEAM Offices 2006 and the BREEAM Offices 2006 'Design and Procurement Pre-Assessment Estimator. It is understood it is proposed to achieve a BREEAM rating of 'excellent' for the office development. BS 8233:1999, BS EN ISO 9241-6:2000 and 2005 guidance from the British Council of Offices have also been considered in the recommendations made.

In summary this report considers the existing noise climate and addresses the following issues:

- Noise climate in the vicinity of the existing building.
- BREEAM noise criteria and internal noise targets in the proposed office accommodation.
- Recommendations for an appropriate scheme of glazing and ventilation.

A glossary of acoustic terms is presented in Appendix I.

2.0 NOISE MEASUREMENT

2.1. Local Area Description

The site is located on Bridgewater Viaduct (Deansgate) in Manchester City Centre. Bridgewater Viaduct is part of the A56 which links central Manchester to the ring road and is therefore in frequent use by general traffic, buses and HGV's. Immediately adjacent to the site is a railway viaduct with a tram viaduct located further along Deansgate. The immediate surrounding area contains Deansgate Station, residential property, offices, commercial premises and pubs and bars.

2.2. Survey Details

Noise measurements were undertaken between 15:44 hours on 6th March 2006 and 14:00 hours on 7th March 2006. A fixed monitoring location was used throughout the survey period with the sound level meter being positioned out of the first floor window of the existing building overlooking Bridgewater Viaduct.

Spot measurements were undertaken between 15:55 and 16:43 hours on 6th March 2006 and 13:35 and 13:50 hours on 7th March 2006. The measurement positions give comparable levels around the site. Weather conditions throughout the surveys were mild and dry with an occasional shower. The spot measurement readings were taken at a height of 1.5m. A site plan detailing all of the measurement positions is given within Appendix II.

2.3. Survey Procedure

The instrumentation used during both the long term and spot measurement surveys was a Brüel & Kjær Precision Sound Level Meter type 2260. The sound level meters were calibrated before and after each survey using a Brüel & Kjær calibrator type 4231 and no drift in level was observed. A-weighted fast response levels were measured throughout, with the long term survey meter recording 5 minute sample measurements over the 22 hour period and the spot measurement meter recording 5 minute sample measurements over 15 minute periods.

2.4. Survey Results Summary

Table 1 below summarises the levels measured during the survey period. It is understood that the working hours of the offices are yet to be decided, therefore typical office hours have been assumed to categorise the data. The survey time is broken down into 'office hours' measurements from 08:00 to 19:00 hours and 'out of office hours' measurements from 19:00 to 08:00 hours.

Table 1: Summary of survey noise levels, 6th–7th March 2006

Date	*Period*	L_{Aeq} *dB*	L_{Amax} * *dB*
6th March 2006	Office hours -- 15:44 to 19:00 hrs	74.1	82.4
	Out of hours – 19:00 to 08:00 hrs	69.7	81.1
7th March 2006	Office Hours – 08:00 to 14:00 hrs	74.8	84.8

* arithmetic average

A graph showing the main time varying statistical parameters of the total survey can be found in Appendix III.

Table 2 illustrates the levels obtained from the spot measurements taken around the site.

Table 2: Summary of spot measurement noise levels, 6th and 7th March 2006

6th March 2006					
Position	***Time***	L_{Aeq} ***dB***	L_{Amax} * ***dB***	L_{A10} * ***dB***	L_{A90} * ***dB***
1 – Wooden Decking SW façade	15:55 – 16:10 hrs	58.3	65.8	60.8	54.2
2 – Castle Street NW façade	16:12 – 16:27 hrs	66.5	79.8	69.1	56.5
3 – Bridgewater Viaduct SE façade	16:28 – 16:43 hrs	75.2	83.6	78.5	66.7
7th March 2006					
4 – Courtyard behind Knott Bar	13:35 – 13:50 hrs	63.6	75.3	64.0	61.2

* arithmetic average

2.5. Description of Noise Climate

Castlefield Chapel lies on Bridgewater Viaduct (Deansgate) in Manchester City Centre where the dominant source of noise is road traffic during the daytime and night time. The A56 Bridgewater Viaduct, leads to the Manchester inner ring road which is busy with general traffic, HGVs and buses. The building is boarded by a railway viaduct at second floor level on the north east façade, however due to the close proximity of Deansgate station the majority of trains are fairly slow moving.

Castle Street, which boarders the building to the north west, is a cobbled street which produces higher noise levels than a standard road surface, however the road is mainly used for access and therefore traffic is infrequent. There are some items of plant located behind the Knott Bar in the north east courtyard. These were operating throughout the spot measurement taken at position 4 on the 7th March 2006 and were the dominant source of noise; however the maximum level is attributable to the close proximity of trains on the adjacent viaduct.

3.0 NOISE ASSESSMENT CRITERIA

3.1. British Standard 8233:1999, Sound Insulation and Noise Reduction for Buildings – Code of Practice

The BS 8233:1999 suggests the following criteria for offices:

Table 3: BS 8233 recommended internal ambient noise levels for office conditions

Typical Situations	*Design Range $L_{Aeq,T}$ dB*	
	Good	*Reasonable*
Meeting Room	35	40
Cellular Office	40	50

3.2. BCO 2005

The British Council for Offices 2005 document gives the following guidance on the noise levels for offices as shown below.

Table 4: BCO Guide 2005 recommendations for office noise levels

Typical Situations	*NR (L_{eq})*
Open Plan Offices	38
Cellular Offices	35

These values are for residual external noise, after attenuation by the building façade, and BCO 2005 states that for naturally ventilated buildings, it may be appropriate to accept higher values.

3.3. BREEAM Offices 2006 – Design & Procurement Pre-Assessment Estimator

This document supersedes recommendations given in BREEAM 2002 and 2005 for Offices, and gives the following guidelines for office internal noise levels:

Table 5: Internal noise criteria from BREEAM Offices 2006 – Design & Procurement Pre-Assessment Estimator

Typical Situations	*$L_{Aeq,T}$ dB*
Singular occupancy, cellular offices	35 – 40
Medium sized, multi-occupancy open plan offices – ≤ 4 work stations ≤ 40m^2	40 – 45
Large, multi-occupancy open plan offices – > 4 work stations > 40m^2	45 – 50

3.4. Proposed Internal Noise Criteria

Based on the guidance contained in BS 8233:1999, BS EN ISO 9241-6:2000, Ergonomic Requirements for Office Work with Visual Displays Terminals – Part 6: Guidance on the Work Environment, BREEAM 2006 for Offices and the 2005 guidance from the British Council of Offices it is recommended that the criteria for internal ambient noise levels for the proposed offices should be as detailed in Table 6.

Table 6: Recommended internal ambient noise levels, L_{Aeq} dB

Area Type	***$L_{Aeq,\ 1\ hour}$ (dB)***
Open plan offices > 40 m^2	45 – 50
Open plan offices ≤ 40m^2	40 – 45
Meeting rooms/board rooms	35 – 40
Cellular offices	35 – 40
Corridors/WC's/store rooms/stairwells	40 – 45
Reception area	40 – 45

These values are in line with current guidelines, including BREEAM. It is understood that ventilation is to be provided mechanically, therefore to meet the BREEAM criteria internal measurements can be made with windows closed.

It must be noted that the above noise levels relate to both break-in noise from external noise sources and noise from building services. The noise level ranges above are to be seen as targets and should not be taken as upper limits. Resultant noise levels that are far below these targets can lead to problems of inadequate privacy between adjacent spaces.

4.0 BREAK-IN NOISE PREDICTIONS

4.1. Assumptions

It is the glazing and background ventilation elements that usually provide the least resistance to airborne sound when considering a building façade. Therefore noise break-in calculations have been undertaken to identify which glazing and ventilation specifications will achieve the required internal acoustic rating criteria.

In order to assess noise break-in to the proposed offices, predictions were made for each of the offices on the building perimeter.

The following assumptions were made for the calculations:

- The worst case daytime measurement measured between 08:24 and 09:24 hours on the 7th March 2006 was used to calculate the expected internal level.
- Room and glazing dimensions are taken from OMI architectural drawings received February 2008. It is understood that the final fit-out of the offices is yet to be finalised therefore predictions are made for the internal levels within an open plan office and for a typical single occupant office. The dimensions may be found in Appendix V.
- Numerous types of sealed double-glazing systems were assessed based upon manufacturer sound insulation data.
- It is understood that the offices are to be mechanically ventilated.
- Offices are assumed to have reverberation time of 0.5 seconds for a cellular office and between 0.7 – 0.9 seconds for the open plan office spaces (See Section 5.3).

4.2. Acoustic Specification

Glazing

The tables within Appendix IV give the required acoustic performance for the glazing systems for each room, along with the calculated resultant internal L_{Aeq} levels.

The glazing specified for the Southwest and Southeast façades is R_w 32 dB with mechanical ventilation. The glazing specified for the Northeast and Northwest façades is R_w 32 dB with mechanical ventilation.

It is understood that the replacement glazing is to have a maximum thickness of 18mm for conservation purposes. R_w 32 dB can be achieved by a glazing build-up of 5/6/5mm (16mm total); the sound reduction indices values used in the calculations are detailed in Appendix IV.

N.B. The above window specifications refer to the performance of the entire window system, i.e. glazing and frame. The frame should not degrade the performance of the window system as a whole.

Based on these specifications, the calculations indicate that the offices will meet the target internal noise levels outlined in Section 3.4 and therefore comply with BREEAM 2006 for Offices. We consider that a good acoustic environment will be achieved by the installation of the proposed glazing and ventilation systems.

In addition to the L_{Aeq} equivalent levels predicted in the offices, calculations have also been undertaken looking at the L_{Amax} maximum expected levels. The calculated L_{Amax} levels within each area are detailed in Appendix IV. For the offices located on the southwest façade, the predicted L_{Amax} levels are within the criteria for the L_{Aeq} levels outlined in Section 3.4. Based on the glazing specification for the offices on the Northeast façade, the calculated L_{Amax} levels are between 59 and 61 dB. This is due to slow moving trains on the nearby railway viaduct and although the noise levels are not excessive they will be audible within the office environment. In the Office B Foyer Space on the Southeast façade the calculated L_{Amax} level is 53 dB. This is due to traffic directly outside the building and again although not excessive will be audible within the foyer space.

Roofing System

Noise break-in calculations have been completed for offices on the top floor where the roof is exposed to the external noise climate. In order that noise break-in through the roof structure does not result in the internal design criteria being exceeded, the existing roofing system must have an acoustic rating of no less than R_w 38 dB. This may require that additional layers of board and mineral wool insulation be installed to the underside of the roof.

Fixed Plant Installations

Details of any fixed plant installations have not yet been finalised and therefore a detailed analysis cannot be completed. It is understood that current Manchester City Council Environmental Health criterion is that fixed items of plant are designed to a rating level 5 dB below the existing background level, based on the principles of BS4142 '*Rating industrial noise affecting mixed residential and industrial areas.*'. It is recommend that if the plant were to operate 24 hours, the cumulative rating level of all fixed plant installations should not exceed 38 dB(A) at the closest residential dwelling. This figure has been set 5 dB below the lowest measured background (L_{A90}) level recorded during the survey. If the plant were to operate during typical office hours only (08:00 to 19:00 hours), the cumulative rating level of all fixed plant installations should not exceed 56 dB(A) at the closest residential dwelling. This figure has been set 5 dB below the lowest measured background (L_{A90}) level recorded between 08:00 and 19:00 hours.

All plant should be mounted on manufacturer's proprietary anti-vibration mounts to ensure that vibration is not an issue.

The level in the northeast courtyard was dominated by plant at the rear of the Knott Bar. Although it is unknown if this plant is to be relocated, with the glazing specification outlined above, calculations suggest the internal L_{Aeq} level will meet the proposed criteria.

5.0 OTHER ACOUSTIC CRITERIA

5.1. Building Envelope

The sound insulation properties of a building façade as a whole are primarily controlled by the acoustically weakest element, which is usually the glazing system. From architects drawings the existing masonry walls are a minimum of approximately 300mm thick. Providing that any gaps or other acoustic weaknesses are sealed, the existing masonry walls are considered acoustically acceptable. Penetrations in the external façade for building services, etc, may require appropriate acoustic treatment.

5.2. Acoustic Separation

The objective is to attenuate airborne sound transmitted between spaces via the walls and floors. The minimum required sound insulation between areas is dependent on the required level of privacy within an area, the background noise level and room adjacencies. Airborne sound insulation is commonly described by R_w, a single figure descriptor of the sound insulation performance of an element measured under laboratory conditions.

For a good level of privacy between independent offices the floor and wall constructions should be designed to achieve an airborne sound insulation performance of R_w 55 dB, assuming the internal noise targets in Section 3.4 are met. In addition the floor should have an impact sound insulation performance of no greater than $L'_{nT,w}$ 60 dB.

Partitions between adjacent WCs and between WCs and corridors should be designed to achieve R_w 45 dB. Doorsets to these areas should be selected to achieve R_w 30 dB and be fitted with full perimeter seals (including the threshold).

5.3. Reverberation Time

Reverberation is the continuation of a sound in an enclosed space after the source has stopped; a result of reflections from the boundary surfaces of the room. Reverberation time affects the clarity of communication within an area, and therefore is an important design parameter with respect to an open plan office. A long reverberation time will cause syllables to be prolonged and hence degrade speech intelligibility; as well as increasing reverberant noise levels within a room. The reverberation time is primarily a function of the room volume and the amount of absorption within a room, therefore the surface finishes within the room play an important part in the room acoustics of a space.

BS 8233:1999 offers guidance on reverberation times in unoccupied rooms for speech dependent on room volume. For the open plan offices proposed, the reverberation times should be between 0.7 and 0.9 seconds. For any single offices, a reverberation time of 0.5 seconds will be suitable. Appropriate acoustic surface finishes will need to be considered at detailed design stage.

Table 7: Guide to reverberation time at 500Hz in unoccupied rooms for speech, from BS 8233:1999

Room volume (m^3)	***Reverberation time (seconds)***
50	0.4
100	0.5
200	0.6
500	0.7
1000	0.9
2000	1.0

6.0 CONCLUSIONS

An environmental assessment for the proposed office conversion at Castlefield Chapel, 380 Deansgate, Manchester has been completed.

A long term survey with additional spot measurements has been undertaken to determine the current external noise levels at the existing building.

Using relevant guidance documents, including BREEAM 2006 office guidelines, internal noise level criteria for the open plan offices have been recommended.

Break-in calculations have been undertaken to predict internal noise levels and suitable glazing and ventilation schemes have been recommended that should satisfy the requirements of the Local Planning and Environmental Health Authorities.

APPENDIX I – GLOSSARY OF ACOUSTIC TERMS

Decibel, dB

This is the unit used to measure sound. The human ear has an approximately logarithmic response to acoustic pressure over a very large dynamic range (typically 20 micro-Pascals to 100 Pascals). An increase of 10dB in sound pressure level subjectively corresponds to a doubling in the perceived loudness of sound.

Octave and Third Octave Bands

The human ear is sensitive to sound over a range of approximately 20 Hz to 20 kHz, and is generally more sensitive to medium and high frequencies than to low frequencies. In order to define the frequency content of a noise, the spectrum is divided into frequency bands, and the sound pressure level is measured in each band. The most commonly used frequency bands are octave bands, in which the mid frequency of each band is twice that of the band below it. For finer analysis, each octave band may be split into three one-third octave bands.

A-Weighting

Normal hearing covers the frequency range from about 20Hz to 20 kHz but sensitivity is greatest between about 500Hz and 8 kHz. The 'A-Weighting' is an electronic filters network incorporated in sound level meters which approximately corresponds to the frequency response of the ear. The unit of measurement of A-weighted sound level is dBA.

Equivalent Continuous Sound Level, L_{eq}

The continuous equivalent sound level, L_{eq} is a notional sound level. It is the sound level which, if maintained for a given length of time, would produce the same acoustic energy as a fluctuating noise over the same time period. The A-weighted L_{eq} is widely used to measure any environmental noise which varies considerably with time and is denoted as the L_{Aeq}.

Statistical Level: L_{90}

Sound pressure level that is exceeded for 90% of the measurement time. Consequently it is indicative of the general background noise level in the absence of any higher level short duration events that occur during the period.

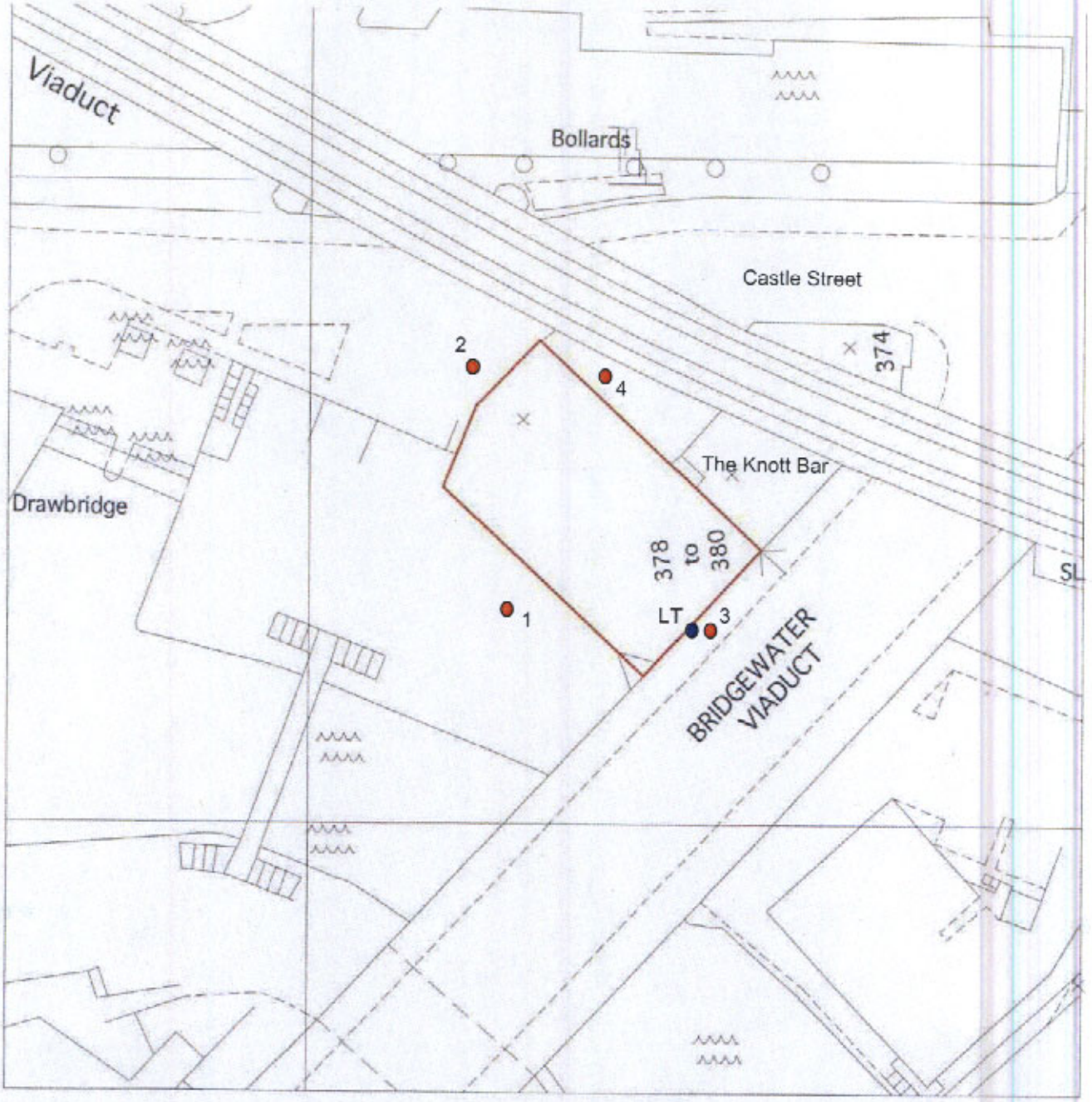
Statistical Level: L_{10}

This is the sound pressure level exceeded for 10% of the measurement time. It is widely used to measure traffic noise. For a given measurement period, the L_{10} level is by definition greater than or equal to the L_{90} level.

Statistical Level: L_{max}

This is the maximum RMS sound pressure level measured during the measurement period.

APPENDIX II – SITE MAP AND MEASUREMENT POSITIONS



● Long Term Measurement

● Spot Measurements

APPENDIX III – NOISE SURVEY RESULTS

Table 8: Summary of long term measurement data at Castlefield Chapel on the 6th-7th March 2006 (dB)

Time	Date	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}
15:44:20	6th March 2006	73.5	85.3	77.2	63.2
15:59:20	6th March 2006	73.3	85.1	76.6	65.2
16:14:20	6th March 2006	73.5	83.3	77.0	64.5
16:29:20	6th March 2006	74.0	81.9	77.4	64.1
16:44:20	6th March 2006	74.2	85.8	77.3	65.5
16:59:20	6th March 2006	77.7	101.3	77.2	66.5
17:14:20	6th March 2006	72.9	82.8	75.8	65.9
17:29:20	6th March 2006	74.0	81.2	77.1	65.5
17:44:20	6th March 2006	74.0	85.5	77.2	64.8
17:59:20	6th March 2006	74.0	82.4	77.1	66.1
18:14:20	6th March 2006	73.8	84.4	77.0	65.5
18:29:20	6th March 2006	73.2	85.9	76.6	62.1
18:44:20	6th March 2006	72.6	83.1	76.6	62.6
18:59:20	6th March 2006	72.3	82.9	76.0	63.5
19:14:20	6th March 2006	72.4	82.4	76.1	63.7
19:29:20	6th March 2006	71.8	81.4	75.9	61.0
19:44:20	6th March 2006	72.0	86.6	75.9	61.3
19:59:20	6th March 2006	71.0	84.0	75.0	59.0
20:14:20	6th March 2006	71.0	82.0	75.1	59.7
20:29:20	6th March 2006	70.1	82.5	74.6	55.7
20:44:20	6th March 2006	70.9	83.1	74.9	58.1
20:59:20	6th March 2006	70.0	82.4	74.2	56.1
21:14:20	6th March 2006	70.1	79.9	74.7	56.3
21:29:20	6th March 2006	70.2	83.1	74.1	58.1
21:44:20	6th March 2006	70.2	81.8	74.5	56.6
21:59:20	6th March 2006	68.9	80.9	73.1	56.0
22:14:20	6th March 2006	70.7	87.6	74.6	55.6
22:29:20	6th March 2006	68.8	83.1	73.1	54.7
22:44:20	6th March 2006	68.4	82.3	72.7	52.3
22:59:20	6th March 2006	68.5	82.0	72.8	54.3
23:14:20	6th March 2006	69.3	82.4	73.7	55.3
23:29:20	6th March 2006	68.9	84.4	73.7	52.6
23:44:20	6th March 2006	69.0	83.5	73.0	53.6
23:59:20	6th March 2006	67.6	81.7	72.4	51.5
00:14:20	6th March 2006	66.7	87.1	71.5	50.6
00:29:20	6th March 2006	66.0	83.3	70.7	49.7
00:44:20	6th March 2006	65.4	78.6	70.1	48.3
00:59:20	7th March 2006	65.1	79.6	70.1	50.4
01:14:20	7th March 2006	68.4	93.1	70.7	48.9
01:29:20	7th March 2006	64.9	82.1	69.7	49.4
01:44:20	7th March 2006	64.5	78.8	69.8	49.0
01:59:20	7th March 2006	65.8	80.1	70.4	49.5
02:14:20	7th March 2006	66.3	80.7	71.1	51.8

Time	Date	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}
02:29:20	7th March 2006	67.0	80.6	71.9	50.8
02:44:20	7th March 2006	64.7	78.3	69.7	47.8
02:59:20	7th March 2006	60.3	78.5	59.7	48.5
03:14:20	7th March 2006	63.7	81.3	67.8	44.1
03:29:20	7th March 2006	66.2	85.5	69.3	50.4
03:44:20	7th March 2006	62.8	82.7	64.7	43.3
03:59:20	7th March 2006	64.6	83.7	65.5	46.2
04:14:20	7th March 2006	61.7	81.0	64.1	46.5
04:29:20	7th March 2006	64.4	88.8	68.0	44.7
04:44:20	7th March 2006	65.3	85.5	68.4	46.0
04:59:20	7th March 2006	65.6	80.5	69.7	50.5
05:14:20	7th March 2006	65.9	84.9	69.6	48.9
05:29:20	7th March 2006	65.7	83.3	69.3	49.1
05:44:20	7th March 2006	68.3	83.0	72.4	52.7
05:59:20	7th March 2006	69.4	83.5	74.1	53.8
06:14:20	7th March 2006	68.8	82.1	73.3	53.2
06:29:20	7th March 2006	71.6	88.7	75.6	57.2
06:44:20	7th March 2006	73.4	83.2	77.5	62.3
06:59:20	7th March 2006	74.3	84.4	78.1	62.8
07:14:20	7th March 2006	74.8	84.7	78.6	64.4
07:29:20	7th March 2006	75.4	85.9	79.0	65.3
07:44:20	7th March 2006	75.8	88.5	78.8	67.3
07:59:20	7th March 2006	74.5	88.6	77.8	66.1
08:14:20	7th March 2006	75.1	85.9	78.3	65.8
08:29:20	7th March 2006	75.5	87.5	78.7	67.3
08:44:20	7th March 2006	75.8	91.2	79.2	66.9
08:59:20	7th March 2006	75.5	88.2	78.9	66.9
09:14:20	7th March 2006	75.1	88.6	78.5	66.7
09:29:20	7th March 2006	74.0	85.7	78.0	65.1
09:44:20	7th March 2006	74.6	87.6	78.4	65.4
09:59:20	7th March 2006	74.8	91.0	78.5	65.3
10:14:20	7th March 2006	74.9	85.2	78.7	63.7
10:29:20	7th March 2006	74.8	86.6	78.8	64.8
10:44:20	7th March 2006	75.1	93.2	78.2	65.8
10:59:20	7th March 2006	75.5	85.1	79.2	65.9
11:14:20	7th March 2006	74.9	86.5	78.6	65.6
11:29:20	7th March 2006	76.2	96.5	79.1	66.5
11:44:20	7th March 2006	74.7	83.8	78.6	64.0
11:59:20	7th March 2006	75.0	83.8	78.9	65.0
12:14:20	7th March 2006	74.6	85.5	78.6	64.6
12:29:20	7th March 2006	74.7	86.1	78.5	64.6
12:44:20	7th March 2006	73.5	87.6	77.0	64.6
12:59:20	7th March 2006	73.9	86.1	77.4	65.1
13:14:20	7th March 2006	73.7	82.4	77.8	64.1
13:29:20	7th March 2006	74.3	86.0	77.9	64.9
13:44:20	7th March 2006	74.1	87.6	77.7	64.1

Castlefield Chapel Noise Survey 6-7th March 2006

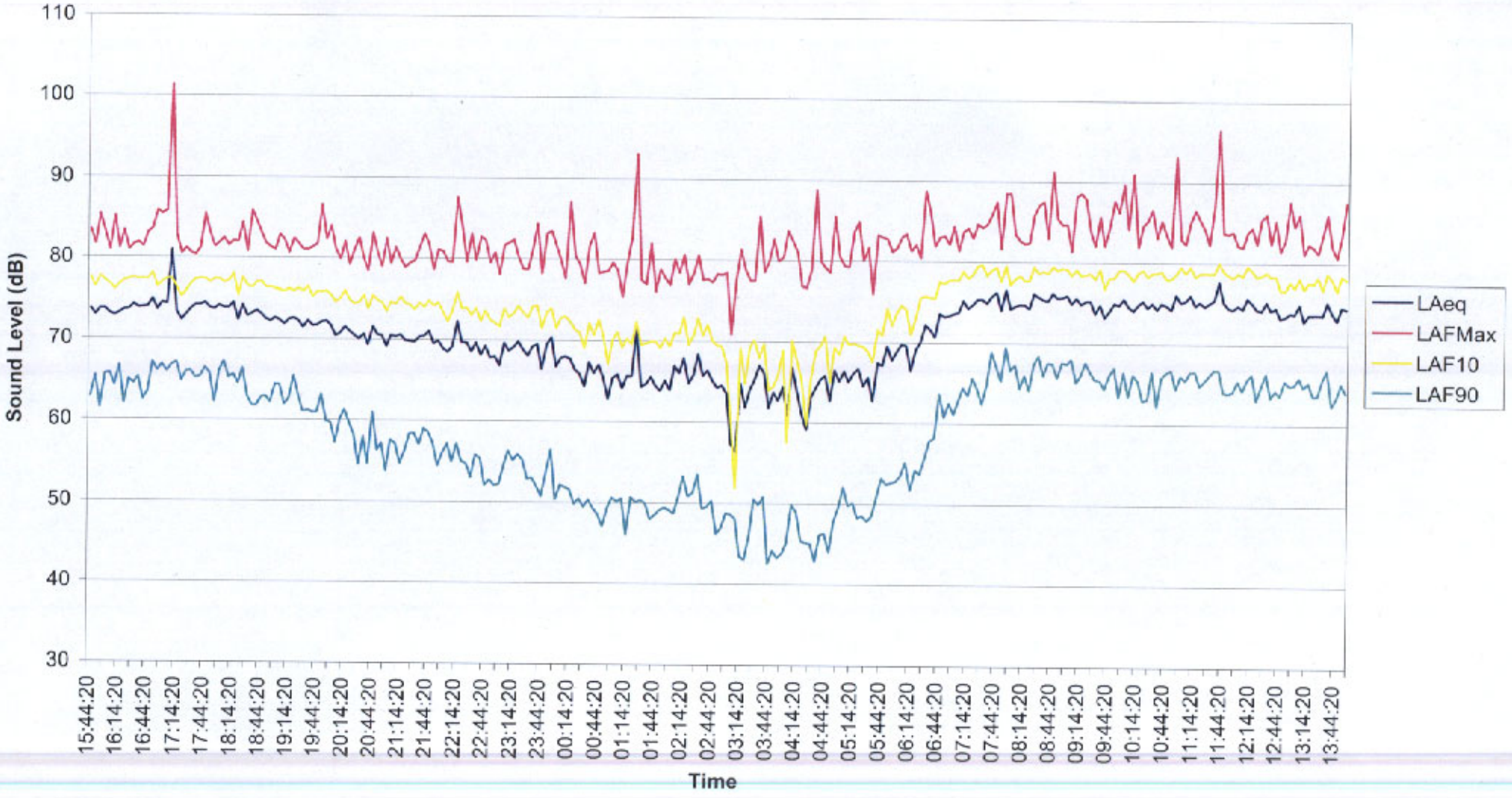


Table 9: Summary of spot measurement data, Castlefield Chapel on the 6th and 7th March 2006 (dB)

Position	Start Time	L_{eq} (Centre Band Frequency Hz)								
		63	125	250	500	1000	2000	4000	8000	dB(A)
6th March 2006										
1	15:55 – 16:10 hrs	64.6	61.0	56.0	54.9	54.9	49.4	39.9	32.9	58.3
2	16:12 – 16:27 hrs	75.4	69.4	64.7	63.3	63.5	56.1	48.5	37.3	66.5
3	16:28 – 16:43 hrs	79.4	71.8	70.6	70.0	72.1	68.6	59.2	50.8	75.2
7th March 2006										
4	13:35 – 13:50 hrs	67.0	70.6	65.3	61.3	57.4	54.0	48.7	39.7	63.6

APPENDIX IV – GLAZING AND VENTILATION SPECIFICATIONS

Offices

Façade	*Floor*	*Rooms*	*Min. R_w of Glazing (dB)*	** Example Glazing Thickness*	*Ventilation*	*Target L_{Aeq} (dB)*	*Internal L_{Aeq} (dB)*	*Internal L_{Amax} (dB)*
Southwest	LG	Office B	32	5/6/5 mm	Mechanical	45-50	36	45
Southwest	LG	Cellular Office B	32	5/6/5 mm	Mechanical	35-40	35	44
Southwest	G	Office A	32	5/6/5 mm	Mechanical	45-50	41	47
Northeast	G	Office A	32	5/6/5 mm	Mechanical	45-50	43	61
Southwest	G-1	Cellular Office A	32	5/6/5 mm	Mechanical	35-40	36	46
Northeast	G-1	Cellular Office A	32	5/6/5 mm	Mechanical	35-40	39	59
Northeast	1	Office A	32	5/6/5 mm	Mechanical	45-50	45	61
Southwest	1	Office A	32	5/6/5 mm	Mechanical	45-50	43	49
Southeast	1	Office A	32	5/6/5 mm	Mechanical	45-50	44	54
Northeast	2	Office A	32	5/6/5 mm	Mechanical	45-50	47	59
Ancillary Spaces								
Southeast	G	Office B Foyer Space	32	5/6/5 mm	Mechanical	40-45	41	53
Northwest	G-2	Fire Escape Stairs	32	5/6/5 mm	Mechanical	40-45	44	54
Southeast	1	WC	32	5/6/5 mm	Mechanical	40-45	41	53

N.B. The above window specifications refer to the performance of the entire window system, i.e. glazing and frame. The frame should not degrade the performance of the window system as a whole.

* It is understood that the glazing is to have a maximum thickness of 18mm. Example thickness is for guidance only, R_w figures should be confirmed with the manufacturer and supported by laboratory test reports if necessary.

The R_w 32 dB glazing unit used in the calculation is a Planilux DG 5/6/5mm (16mm) unit manufactured by Saint-Gobain with the following sound reduction indices values.

		Sound Reduction Index, Octave Band Centre Frequency					
	R_w	***125***	***250***	***500***	***1k***	***2k***	***4k***
5/6/5mm	32	26	26	25	34	35	38

APPENDIX V – GLAZING & ROOM DIMENSIONS TABLE

Façade	Floor	Rooms	Glazing			External Wall			Room		
			Width m	Height m*	Area m^2	Width m	Height m	Area m^2	Floor Area m^2	Height m	Volume m^3
Southwest	LG	Office B – Cellular	5.9	1.0	5.9	3.0	3.5	10.5	4.0	3.5	42.0
Southwest	LG	Office B	26.7	1.0	26.7	17.0	4.1	69.7	261.0	4.1	1070.1
Southeast	G	Office B Foyer Space	5.9	1.0	5.9	8.5	2.7	22.8	36.6	2.7	98.8
Southwest	G	Office A	17.9	1.0	17.9	17.0	2.6	44.2	238.0	2.6	618.8
Northeast	G	Office A	14.8	1.0	14.8	13.7	2.6	35.6	238.0	2.6	618.8
Southwest / Northeast	G	Office A – Cellular	2.6	1.0	2.6	3.0	2.6	7.8	4.0	2.6	31.2
Southeast	1	Office A	10.7	1.0	10.7	11.2	4.1	45.9	323.0	4.1	1324.3
Northeast	1	Office A	14.8	1.0	14.8	13.7	2.6	35.6	323.0	3.5	1130.5
Southwest	1	Office A	26.7	1.0	26.7	17.0	2.6	44.2	323.0	3.5	1130.5
Southeast	1	Toilet	0.4	1.0	0.4	4.0	2.6	10.4	12.5	2.6	32.5
Northwest	1	Stairs	2.6	1.0	2.6	4.5	2.6	11.7	12.8	2.6	33.3
Northeast	2	Office A	6.9	1.0	6.9	25.0	2.3	57.5	161.0	4.2	676.2

*Where height is equal to 1, the area has been measured directly from PDF Drawing