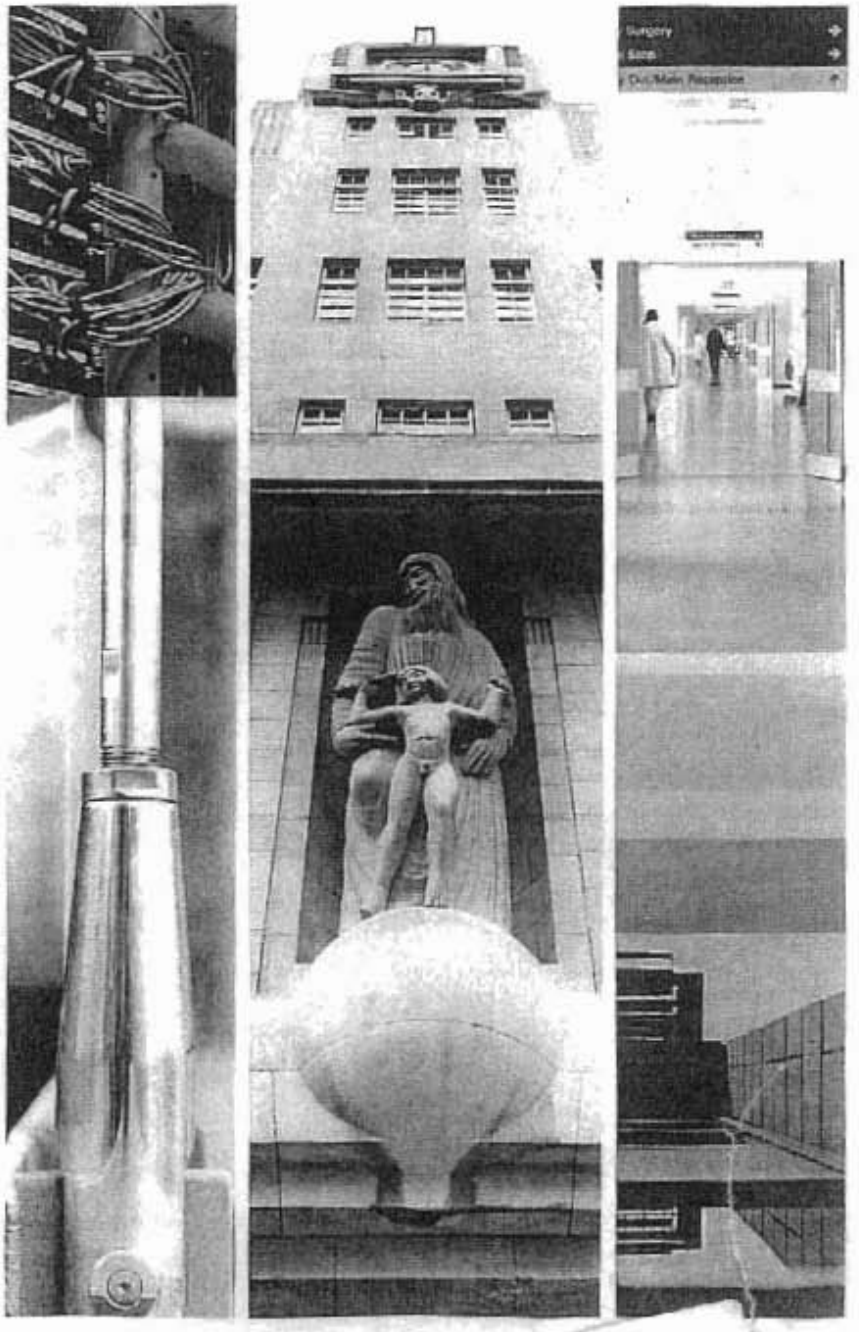
Piccadilly Plaza, Manchester
Area B Podium Refurbishment

Acoustic Study



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Area B Podium Refurbishment

Acoustic Study

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Appendix A : Noise Measurement Results

1. Introduction

1.1 It is proposed to carry out major refurbishment works at the Area B Podium level of Piccadilly Plaza, Manchester. An acoustic study has been carried out to determine the prevailing ambient noise levels in the vicinity of Area B Podium prior to the refurbishment. This report presents the findings of the noise survey.

1.2 As part of the proposed refurbishment works, several new items of external building services plant are expected to be introduced. This report contains an assessment of the potential for noise complaints from surrounding noise sensitive locations, and sets down appropriate noise emission limits for the proposed external plant.

1.3 The results of the measurements have also been used to calculate the required sound insulation performance of the façade of the 1st floor office area.

1.4 The following sections of this report describe the measurement work undertaken and present all of the measurement data in conjunction with predictions of future noise emissions and a commentary on the findings. Full measurement results from the acoustic survey are contained in Appendix A.

2. Noise Level Measurements

2.1 An acoustic survey was carried out at Piccadilly Plaza between Friday 3rd and Monday 6th September 2004. The objective of the survey was to measure the existing ambient and background noise levels impacting upon Area B Podium.

2.2 The measurement results have been used to establish the following :-

- Noise emission limits from the proposed external plant items associated with the refurbishment works, and
- The required sound insulation performance of the 1st floor office façade.

2.3 The results of the measurement survey may also be used as a record of predevelopment noise levels should there be future complaints about noise after or during the construction process.

2.4 The measurement locations are identified in Figures 1 and 2.

2.5 A noise logger was installed in order to continuously measure the prevailing ambient noise levels at the external façade of a bedroom at Jarvis Piccadilly Plaza Hotel (the closest noise sensitive location) between 5pm on Friday 3rd and 2am on Monday 6th September 2004.

2.6 During the measurement period a number of statistical indices used to describe the short and medium-term fluctuations in noise level were measured in 30 minute samples. The indices included the L_{A90} (the level in dBA exceeded for 90% of the measurement sample period) commonly used for describing the background noise level. Other indices measured included the L_{Aeq} (a form of energy average), and L_{Amax} (maximum level recorded).

2.7 Attended measurements of the frequency spectrum of the background noise were made between 3pm and 4:30 pm on Friday 3rd September, at three different locations chosen to represent the ambient noise currently impacting upon the different elevations of Area B Podium.

2.8 All attended measurements were made from the car park podium level, at 2nd floor level. At each of the locations, the microphone was at a height of approximately 1.5m above the deck of the car park podium, and located approximately 1m from the edge of the building.

2.9 During the measurements, the weather conditions were suitable for reliable readings. There was no rain and road surfaces remained dry.

2.10 Equipment used for the measurements included:

NOR 118	Real TimeAnalyser	s/n 30537
Gras 41AL	Weather Protected Microphone	s/n 36021
NOR 1251	Calibrator	s/n 28375

2.10 The measurement equipment was checked against the calibrator at the beginning and end of the measurements in accordance with recommended practice. No drift in calibration was observed. The accuracy of the calibrator may be traced to National Physical Laboratory Standards.

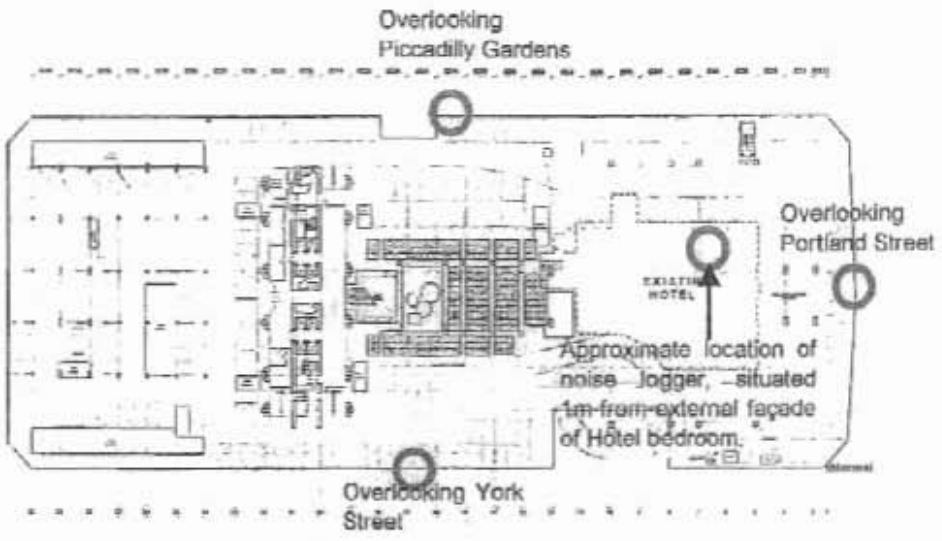


Figure 1 : Plan View of Car Park Podium Level, Showing Measurement Locations

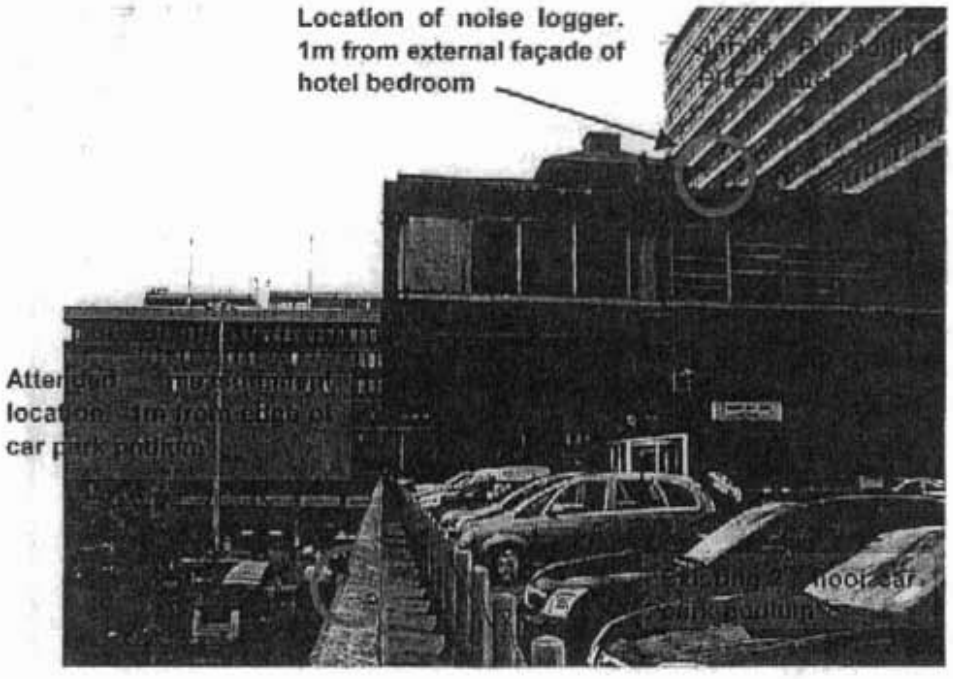


Figure 2 : Photograph of Car Park Podium Area, and Measurement Locations.

3. Measurement Results

3.1 The existing noise environment at the Area B Podium area is dominated by road traffic.

3.2 Immediately below the Podium, to the north-east is Piccadilly bus station, that generates significant noise from the many idling and moving buses. The metrolink tram service also runs through the bus station, approximately 15 metres from the facade of Piccadilly Plaza.

3.3 To the south-east is Portland Road, a very busy city centre road with high traffic numbers and many heavy vehicles. York Street, to the south-west, is a much quieter road, experiencing noise from middle distant traffic and occasional local traffic movements.

3.4 Other noise sources audible during the survey included general noise from pedestrian activities (conversation, footstep noise) and occasional high altitude aircraft movements.

3.5 There was an item of existing building services plant, thought to be associated with the Hotel, located on the car deck at the time of the survey. The noise from this was measured to be approximately 78 dBA at 2m, and it was a significant noise source. The ambient noise measurements were taken sufficiently far from this item of plant so as not to be affected by it.

3.6 Full measurement results are contained within Appendix A.

3.7 The lowest ambient noise levels, described using the L_{A90} index, at 1m from the external of the Jarvis Hotel have been obtained from the continuous noise logging measurements, and are summarised in Table 3.1 below. These will be used to set noise emission limits for new external items of building services plant associated with the redevelopment.

Time Period		Lowest $L_{A90,\ 30\ min}$
Daytime	07:00 – 19:00 hrs	50dB at 07:30 hrs on 5/9/04
Evening	19:00 – 23:00 hrs	52dB at 20:30 hrs on 5/9/04
Night time	23:00 – 07:00 hrs	48dB at 04:00 hrs on 5/9/04

All values are sound pressure levels in dB re $2x10^{-5}$ Pa

Table 3.1 : Lowest Background Noise Levels Measured at Noise Logger Location

3.8 The measurements taken at the location of the noise logger are deemed representative of the ambient noise levels experienced 1m from the external façade of the bedrooms of Jarvis Hotel.

3.9 The highest ambient noise levels impacting upon the external elevations of the 1st floor office area have been obtained from the attended noise measurement data, presented in Table A5 of Appendix A, and are summarised in Table 3.2 below.

Measurement Location	L_{eq} (dB), in octave bands with center frequency (Hz)								dBA
	63	125	250	500	1000	2000	4000	8000	
Overlooking Piccadilly gardens and Portland Street	83	74	70	69	70	66	63	56	74
Overlooking York Street	75	69	66	64.2	63	61	56	48	68

All values are sound pressure levels in dB re $2x10^{-5}$ Pa

Table 3.2 : Highest Ambient Noise Levels Measured at Attended Locations

3.10 The values in Table 3.2 above will be used to determine the sound insulation performance required of the external façade of the office, in order to achieve an appropriate internal noise level.

3.11 It can be seen from inspection of Table A5 that the noise levels impacting upon the Piccadilly Gardens and the Portland Street elevations are very similar, and assumed to be identical for the purpose of the sound insulation calculation exercise.

3.12 The noise levels impacting upon the York Street elevation are significantly lower than on the other two elevations. Given the difference in traffic flows, this is in line with expectations.

4. Building Services Noise Emission Limits

4.1 As part of the proposed refurbishment works, it is expected that there will be some new items of building services plant mounted externally to the building. This section of the report sets down noise emission limits for these future external plant items, to protect the existing amenity of surrounding noise sensitive premises.

4.2 The surrounding premises consist of office accomodation within Piccadilly Tower, and Hotel accomodation within the Jarvis Piccadilly Plaza Hotel.

4.3 The Hotel accomodation is regarded to be the more noise sensitive premises, and noise from the future external plant items will be designed so as not to affect sleep for occupants of the Hotel.

4.4 Daytime noise limits have also been set down below, with regards to office accomodation located within Piccadilly Tower.

4.5 There are a number of different methods that can be considered to determine whether a noise is likely to be disturbing. Perhaps the most common approach is to consider the difference between the noise in question and the prevailing underlying background noise level. The greater the positive difference between the two, the higher the likelihood of noise disturbance.

4.6 British Standard 4142 describes a methodology for assessing whether noise from industrial sites is likely to give rise to complaints from nearby residential properties. It is noted in the Standard that the method is not suitable for assessing noise *inside* buildings, and therefore the Standard has been used as a guide to determine whether the *external* noise levels are likely to give rise to complaints.

4.7 In assessing the noise from the development using the method noted in BS 4142, a rated noise level must be determined. The rated noise level is the predicted noise level outside the residential property corrected to allow for the character of the noise.

4.8 There are also objective standards available that relate to the level of noise which is considered acceptable within dwellings, set down in British Standard 8233. These standards are referenced in the following Table.

4.9 During the nighttime, the potential for the plant noise to cause sleep disturbance within Hotel accommodation needs to be considered. Guidelines produced by the World Health Organisation (WHO) are commonly used to assess the likelihood of noise causing sleep disturbance during the night time. The guidelines are intended to be a reflection of what has been found to be the onset of sleep disturbance to the majority of the population, but do not account for increased sensitivity in some individuals.

4.10 It has been assumed that the noise level experienced inside the Hotel, assuming that the window is open, will be around 10 dB less than the external noise levels.

4.11 In summary, there are a number of methods that can be used assess the likelihood of noise disturbance arising from the installation of the new items of building services plant associated with the proposed refurbishment. Table 4.1 below summarises the applicable noise limits (expressed as L_{Aeq} in dB), derived from the different assessment methods, and assuming a continuous, non-tonal noise: -

Published Guidance	Time Period		
	Daytime (07:00 – 19:00)	Evening (19:00 – 23:00)	Night time (23:00 – 07:00)
BS4142 (specific noise 5dB below underlying background noise)	45	47	43
BS8233 (to achieve reasonable standard)	50	50	45
WHO (sleep disturbance, night time only)	n/a	n/a	45
Recommended criteria	**45**	**47**	**45**

All values are sound pressure levels in dB re 2 x 10^{-5} Pa, and include a 3dB façade correction.

Table 4.1 : Summary of Applicable External Noise Limits

4.12 The figures in Table 4.1 relate to the maximum permissible noise level, caused by all proposed items of mechanical services plant operating simultaneously, as measured 1m from the façade of any bedroom within the Jarvis Hotel.

4.13 Given the similarity between the noise emission limits for the different times of the day, it is recommended that one limit be adopted for all time periods.

4.14 It is expected that the above noise emission limits would be deemed acceptable by Manchester City Council.

4.15 Provided the external noise levels due to all of the proposed plant does not exceed L_{Aeq} = 53 dB at 1m from any office façade of Piccadilly Tower, and assuming a loss of 10 dB across a façade with open windows, it is predicted that noise levels within the Piccadilly Tower Offices would not exceed L_{Aeq} = 40 dB. This would satisfy all criteria relating to internal noise levels within office environments.

4.16 The total noise emissions from all new items of building services plant be limited so as not to exceed the following limits :-

- L_{Aeq} = 45 dBA, measured 1m from the external façade of any bedroom within the Jarvis Hotel,
- L_{Aeq} = 53 dBA, measured 1m from the façade of any office.

5. Façade Sound Insulation Requirements

5.1 The results of the attended noise level measurements have been used to determine the sound insulation performance required of the external facade of the 1st Floor Office accommodation within Area B.

5.2 The office area has elevations overlooking Piccadilly Gardens, Portland Street and York Street, and the facade construction is predominantly glazed. The facade will be required to attenuate the considerable level of road traffic noise outside the building.

5.3 The office accommodation is to be fully mechanically ventilated and the facade sealed. It is understood therefore, that all glazing is to be fixed (not openable) and there are no air paths through the facade for ventilation and the like (e.g trickle ventilators).

5.4 Recommendations for internal noise levels within office accommodation are set down in the document "BCO Guide 2000 : Best practice in the specification for offices", published by British Council for Offices (BCO). Guidance within this document is summmarised below :

" Residual external noise, after attenuation by the building façade, should meet the following criteria within the relevant space :

- Open plan offices 45 – 50 L_{Aeq}
- Cellular offices 40 – 45 L_{Aeq}

In the case of naturally ventilated buildings, it may be appropriate to accept higher values. "

5.5 In addition to the above, British Standard 8233: 1999 makes recommendations as to the level of noise which is considered acceptable within offices. The recommendation for internal noise levels within a cellular office, assuming a steady intrusive noise, is L_{Aeq} = 40 dB (good standard), and L_{Aeq} = 50 dB (reasonable standard).

5.6 A calculation exercise has been undertaken, using the methodology set down in BS8233, in order to predict the sound insulation performance required of the façade. It has been assumed that the external noise levels are as set down in Table 3.2, and therefore two performances have been calculated in order to account for the lower external noise on the York Street Elevation.

5.7 Based on the above, the curtain walling should achieve the following minmum sound reductions :-

	Octave Band Centre Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Piccadilly and Portland Street Elevations	20	26	27	34	40	38	46	49
York Street elevation	20	24	20	25	35	38	35	38

All values are sound reduction indices (R) in dB re $2x10^{-5}$, measured in accordance with BS EN ISO 140-3.

5.8 The calculations indicate that, provided the façade achieves the above sound insulation performance, and there are no air paths through the façade for ventilation and the like, the internal noise levels due to external traffic noise will be around L_{Aeq} = 42 dB.

5.9 The predicted internal noise level is better than the standard recommended for open plan offices, and within the recommended range for cellular offices.

5.10 It is expected that the following glazing types would achieve the required acoustic performance :-

- Piccadilly and Portland Street Elevations – 10 / 12 / 6 double glazing (10mm glass / 12mm gap / 6mm glass)
- York Street Elevation - 4 / 12 / 4 double glazing (4mm glass / 12mm gap / 4mm glass)

6. Conclusions

6.1 It is proposed to refurbish the Area B Podium at Piccadilly Plaza, a building in the centre of Manchester. A noise survey has been carried out, and full results are presented within Appendix A of this report.

6.2 As part of this development, it is expected that several new items of building services plant will be introduced to the external environment. Published guidance relating to appropriate external noise design targets has been reviewed and summarised, and appropriate noise emission limits set.

6.3 The total noise emissions from all new items of building services plant is to be limited so as not to exceed the following limits :-

- L_{Aeq} = 45 dBA, measured 1m from the external façade of any bedroom within the Jarvis Hotel,
- L_{Aeq} = 53 dBA, measured 1m from the façade of any office.

6.4 It is expected that the above noise emission limits may be readily achieved by appropriate selection and sensible locating of the external plant.

6.5 The results of the measurements have also been used to calculate the required sound insulation performance of the façade of the 1st floor office area.

6.6 The curtain walling should achieve the following minimum sound reduction :-

	Octave Band Centre Frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Piccadilly and Portland Street Elevations	20	26	27	34	40	38	46	49
York Street elevation	20	24	20	25	35	38	35	38

All values are sound reduction indices (R) in dB re $2x10^{-5}$, measured in accordance with BS EN ISO 140-3.

6.7 It is expected that the following glazing types would achieve the required acoustic performance :-

- Piccadilly and Portland Street Elevations – 10 / 12 / 6 double glazing (10mm glass / 12mm gap / 6mm glass)
- York Street Elevation - 4 / 12 / 4 double glazing (4mm glass / 12mm gap / 4mm glass)

Appendix A – Noise Measurement Results

Full results of the measurements are presented in Tables A1-A2. All values reported are sound pressure levels in dB re: 2 x 10^{-5} Pa.

Start Time (15 min. duration)	L_{Aeq}	L_{Amax}	$L_{A0.1}$	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
16:54	64.4	90.9	86.7	72.5	62.9	57.0	55.6	54.9
17:24	60.8	80.3	74.0	67.1	63.1	57.0	55.3	53.9
17:54	60.4	74.4	71.5	66.7	62.6	56.6	54.5	53.1
18:24	60.8	76.5	70.4	66.6	63.2	56.5	54.5	53.3
18:54	59.6	72.3	67.0	64.5	62.1	55.5	53.4	52.1
19:24	61.1	84.5	80.1	71.4	61.9	54.5	53.1	52.1
19:54	59.7	76.5	70.8	67.5	62.0	55.1	52.8	51.5
20:24	58.5	74.6	68.4	64.5	61.0	54.4	52.8	51.8
20:54	65.6	89.1	86.8	78.5	61.8	54.6	52.9	51.4
21:24	58.6	76.4	69.6	64.7	61.0	54.6	53.3	52.4
21:55	58.8	76.8	69.6	65.2	61.3	54.6	52.9	51.5
22:25	58.6	77.8	68.9	64.3	60.7	55.1	53.9	52.4
22:55	59.8	71.3	67.8	65.3	62.2	56.3	54.8	53.7
23:25	59.5	75.4	71.9	66.4	61.6	55.7	54.4	52.8
23:55	59.0	73.6	69.0	64.7	61.3	55.0	53.2	50.7

All values are sound pressure levels in dB re $2x10^{-5}$ Pa

Table A1 : Façade Reflected External Ambient Noise Levels on Friday 3/9/04. Measured 1m from Bedroom Window of Hotel.

Start Time (15 min. duration)	L_{Aeq}	L_{Amax}	$L_{A0.1}$	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
00:25	59.2	78.7	74.6	66.3	61.4	54.6	53.0	51.8
00:55	58.9	72.6	69.9	66.8	61.3	54.8	53.6	52.2
01:25	58.2	72.1	68.5	64.7	60.9	53.2	51.6	50.4
01:55	57.7	72.5	68.3	64.2	60.1	53.6	52.2	50.1
02:25	62.9	90.0	86.9	69.2	60.5	54.2	52.7	50.9
02:55	57.5	73.1	70.3	64.1	60.2	53.0	51.4	50.0
03:25	60.9	80.6	79.3	73.9	61.4	52.0	49.8	47.6
03:55	53.8	68.8	66.6	62.2	57.2	48.2	47.1	46.1
04:25	52.1	63.7	62.0	59.8	55.4	47.8	46.9	46.0
04:55	53.9	74.4	67.0	61.7	56.0	49.9	47.3	46.1
05:25	55.9	76.2	74.9	65.6	57.1	50.2	49.5	48.8
05:55	55.5	69.8	65.8	63.1	58.4	51.2	50.2	49.2
06:25	56.0	72.0	68.6	64.9	58.9	50.3	48.3	47.1
06:55	56.5	70.8	66.9	63.9	59.5	51.4	50.2	49.4
07:25	58.2	73.2	68.7	65.8	61.3	53.4	51.2	50.1
07:55	58.6	72.6	68.6	66.3	61.4	53.6	52.2	51.2
08:25	58.8	73.7	69.5	64.9	61.3	54.3	52.3	50.8
08:55	60.1	74.1	69.4	66.8	62.5	56.1	54.9	53.5
09:26	59.8	73.5	70.6	66.1	62.1	56.0	54.3	52.6
09:56	60.2	74.0	70.8	66.8	62.4	56.6	55.0	53.3
10:26	60.0	73.9	69.2	66.8	62.5	55.9	53.6	52.2
10:56	60.4	71.3	69.2	66.9	62.9	56.1	54.4	52.9
11:26	60.0	74.0	68.4	66.2	62.6	56.0	54.3	52.8
11:56	61.9	89.7	77.6	69.0	63.1	56.6	54.3	53.0
12:26	60.2	72.7	70.1	66.6	62.8	55.7	54.2	53.2
12:56	60.7	78.5	72.5	67.9	63.0	56.5	54.9	53.6
13:26	64.4	87.5	85.0	75.8	63.6	57.3	55.7	54.3
13:56	60.8	73.5	70.0	66.8	63.3	57.4	55.5	53.6
14:26	60.5	74.7	71.2	67.1	62.9	56.5	54.7	53.1
14:56	61.2	73.2	70.0	66.7	63.5	57.9	56.2	54.8
15:26	61.9	79.7	73.0	67.3	63.9	58.7	57.3	55.7
15:56	61.4	79.7	71.4	67.3	63.5	58.0	56.3	55.1
16:26	62.1	79.6	74.4	69.5	64.2	58.4	56.8	55.8
16:56	60.7	72.0	70.0	67.4	63.2	56.7	54.9	54.0
17:26	60.3	75.9	69.4	66.3	62.5	56.9	55.4	53.7
17:56	60.4	80.1	75.5	66.5	62.6	56.4	55.2	54.1
18:26	59.9	82.3	72.5	66.3	62.0	55.8	54.4	53.3
18:56	59.2	72.9	69.0	66.1	61.4	55.5	54.1	53.0
19:26	59.1	77.0	72.2	66.1	61.3	55.1	53.3	51.6
19:56	59.2	75.8	70.0	65.5	61.5	55.4	53.8	52.8
20:26	59.8	82.5	77.0	66.4	61.2	55.1	53.6	52.5
20:57	59.4	71.9	68.3	65.1	61.8	56.0	54.6	52.9
21:27	62.3	87.1	83.4	72.3	62.3	56.1	54.2	52.7
21:57	62.3	87.4	79.6	73.4	62.1	56.6	55.2	53.5
22:27	60.0	76.4	71.4	65.6	61.9	56.7	55.3	53.6
22:57	60.5	79.3	76.9	68.6	61.8	56.6	55.2	53.5
23:27	59.7	82.4	72.1	65.3	61.5	56.2	54.4	52.5
23:57	63.3	89.3	84.8	68.2	62.2	56.3	54.8	53.0

All values are sound pressure levels in dB re $2x10^{-5}$ Pa

Table A2 : Façade Reflected External Ambient Noise Levels on Saturday 4/9/04. Measured 1m from Bedroom Window of Hotel.

Start Time (15 min. duration)	L_{Aeq}	L_{Amax}	$L_{A0.1}$	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
00:27	62.7	93.7	81.7	70.0	62.1	55.7	54.0	52.3
00:57	59.0	70.2	68.1	65.3	61.4	55.4	54.0	52.4
01:27	59.4	82.3	74.8	65.7	61.2	55.5	54.3	52.2
01:57	61.3	83.0	78.8	68.4	62.7	56.9	55.4	53.9
02:27	59.6	79.1	74.2	67.3	61.4	54.9	53.5	51.7
02:57	61.8	87.4	83.6	73.2	60.7	53.4	51.7	50.0
03:27	59.0	74.0	69.7	66.0	62.0	52.6	50.6	49.5
03:57	55.8	70.1	67.4	62.8	58.8	50.0	48.2	46.8
04:27	54.0	71.0	68.5	61.6	57.1	49.4	48.3	47.5
04:57	52.1	67.0	64.5	60.7	55.0	47.7	47.0	46.4
05:27	51.9	68.6	65.4	60.1	54.1	48.1	47.1	46.4
05:57	53.8	68.2	66.4	61.4	56.7	48.4	47.1	46.3
06:27	53.7	70.4	66.6	62.0	56.9	48.3	47.3	46.4
06:57	55.9	69.6	66.8	62.8	58.7	50.7	48.7	47.6
07:27	55.8	69.0	66.4	63.0	58.7	50.3	48.8	47.8
07:57	57.3	69.7	67.5	64.6	59.8	52.2	50.8	49.7
08:28	56.5	72.4	68.6	65.1	59.2	51.3	49.9	48.4
08:58	59.2	78.8	76.0	71.1	60.9	52.6	51.0	50.3
09:28	58.3	73.1	69.9	66.2	61.0	53.1	51.9	50.9
09:58	58.4	70.8	67.9	65.5	61.1	53.8	52.4	51.3
10:28	58.4	70.0	66.5	64.6	60.9	54.8	53.6	52.7
10:58	58.7	72.9	68.6	64.9	61.0	54.9	53.2	51.4
11:28	58.8	72.7	68.6	65.0	61.0	55.0	53.5	51.6
11:58	58.9	71.0	68.3	65.0	61.3	54.9	52.8	51.4
12:28	58.9	72.2	68.5	65.2	61.4	54.8	53.4	52.0
12:58	58.8	73.7	69.2	64.8	61.0	55.0	53.5	52.4
13:28	61.6	91.7	76.0	65.6	61.2	55.1	53.6	52.2
13:58	59.2	85.6	68.5	65.4	61.2	55.3	53.5	52.2
14:28	59.6	73.1	70.1	65.4	61.9	55.4	53.1	51.9
14:58	59.4	79.2	69.8	65.5	61.5	55.4	53.4	52.3
15:28	59.5	70.6	68.3	65.4	61.5	55.6	54.0	52.7
15:58	62.9	87.1	82.6	74.4	62.4	55.5	53.9	52.9
16:28	60.0	73.3	69.2	66.0	62.3	56.1	54.1	52.7
16:58	59.6	76.6	72.1	67.2	62.0	55.1	53.8	52.5
17:28	58.8	73.7	69.3	64.8	61.0	54.7	53.5	51.9
17:58	58.8	72.9	69.4	66.0	61.3	54.2	52.5	51.2
18:28	58.1	74.1	68.5	64.3	60.6	54.1	52.0	50.7
18:58	59.9	79.7	78.2	68.9	61.3	54.1	52.5	51.4
19:29	61.3	73.7	71.9	69.1	65.2	54.7	52.5	50.4
19:59	58.3	73.1	67.6	64.8	61.1	53.5	51.9	50.9
20:29	62.5	89.0	84.6	73.7	60.7	52.4	50.7	49.8
20:59	62.1	80.7	79.3	76.8	60.9	53.5	52.3	51.4
21:29	57.6	76.4	69.2	64.0	60.1	53.0	51.7	50.4
21:59	57.1	71.4	66.9	63.8	59.8	53.0	51.7	50.4
22:29	57.3	73.5	68.5	64.3	59.9	53.0	51.5	50.3
22:59	57.3	78.4	70.3	65.2	60.1	52.1	50.8	49.8
23:29	57.7	79.3	76.6	66.2	59.7	51.2	49.1	47.5
23:59	54.0	66.2	62.6	60.8	57.3	49.2	48.0	46.9

All values are sound pressure levels in dB re $2x10^{-5}$ Pa

Table A3 : Façade Reflected External Ambient Noise Levels on Sunday 5/9/04. Measured 1m from Bedroom Window of Hotel.

Start Time (15 min. duration)	L_{Aeq}	L_{Amax}	$L_{A0.1}$	L_{A1}	L_{A10}	L_{A90}	L_{A99}	L_{Amin}
00:29	55.7	70.3	67.9	63.8	58.9	49.9	48.7	47.8
00:59	54.1	65.3	63.6	60.3	57.1	49.5	48.4	47.6
01:29	52.5	70.2	67.0	60.4	55.4	48.1	47.2	46.3
01:59	51.3	65.1	63.2	59.1	54.2	47.5	46.8	46.2

All values are sound pressure levels in dB re $2x10^{-5}$ Pa

Table A4 : Façade Reflected External Ambient Noise Levels on Monday 6/9/04. Measured 1m from Bedroom Window of Hotel.

	Start time and date of measurement (5 min duration)		L_{eq} (dB), in octave bands with center frequency (Hz)									L_{Aeq}
			31.5	63	125	250	500	1000	2000	4000	8000	
Overlooking Piccadilly Gardens and Bus Station	14:58	3/9/04	77.1	76.2	69.5	66.8	66.1	65.6	63.8	59.1	54.3	**70.4**
	15:42	3/9/04	80.4	79.3	72.0	70.0	69.6	69.0	65.9	63.4	57.2	**73.6**
	16:04	3/9/04	76.9	77.5	69.6	68.7	67.6	67.8	65.8	60.5	52.6	**72.3**
	09:54	7/9/04	80.3	77.5	69.4	68.2	67.9	68.4	65.3	60.0	54.8	**72.4**
Overlooking Portland Street	15:04	3/9/04	79.8	80.9	74.1	70.3	69.2	68.4	65.2	61.7	56.6	**73.0**
	15:49	3/9/04	77.6	79.9	73.9	70.9	67.2	66.9	64.3	61.1	53.8	**71.7**
	16:11	3/9/04	79.8	82.5	74.0	70.0	69.1	69.8	65.8	63.3	56.2	**73.8**
Overlooking York Street	15:12	3/9/04	70.0	73.7	67.2	64.2	63.2	61.3	58.2	52.8	44.5	**66.0**
	15:56	3/9/04	70.9	74.7	68.7	65.9	64.2	62.8	61.3	56.3	47.9	**68.0**
	16:17	3/9/04	70.3	72.1	67.8	65.6	63.9	62.3	59.5	54.1	46.7	**67.1**

All values are sound pressure levels in dB, re $2x10^{-5}$ Pa.

Measurements taken 1m from a facade.

Table A5 : Spectral Data from Attended Measurements