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# Report on Plant Noise survey at London School of Barbering 186 Drury Lane, Covent Garden, London WC2.

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|---|---|
| **Date of report** | **24th April 2015** |
| Dates of visits. | 17th, 20th April 2015 |
| | Present: Justis McEvilly; Shaun Murkett. |
| Location. | London School of Barbering, 186 Drury Lane, London WC2B 5QD |
| Purpose. | To conduct a plant noise survey and investigation. |
| Author of report. | Shaun Murkett BSc. C.Eng. MIEE. MIOA. |

## 1 Executive summary

**1.1** The management are refurbishing this building as a Barbering School. Planning permission is currently being sought for the installation of external plant, both external air conditioning condensors and mechanical ventilation. Accordingly, the management have commissioned a professional noise survey and report to assess the potential impact of this installation for the potential for noise break-out. This report addresses and gives professional advice on these matters.

**1.2** The background noise levels have been measured at typical times of operation, over a period of at least one full day. The published plant noise information has been researched, and noise measurements made of the plant in existing locations, and calculations made to predict the noise from the external plant.

**1.3** An assessment under BS 4142 has been made, and also regard to BS 8233, and it is has been confirmed that the noise from the plant will be well within the local authority criteria, if all the recommendations in this report are followed.

**1.4** The owners are well aware of the implications of the noise issues surrounding the ventilation and air conditioning plant, and have taken professional advice in commissioning this report to investigate the noise situation. They have put recommendations into place as quickly as possible in order to keep any disturbance from plant noise reaching nearby residents to the absolute minimum.

**1.5** When all the building works are complete then a final sound test may be required. This will ensure that the plant systems are working correctly and there is no excessive noise breakout, and confirm that all the local authority noise planning criteria have been met.



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Report on Plant Noise survey at London School of Barbering 186 Drury Lane, Covent Garden, London WC2.

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## 2 Introduction and Background.

**2.1** The management are refurbishing this building as a new London School of Barbering. Planning permission is currently being sought for the installation of external plant including two air conditioning condensors and a ventilation system. The local authority have concerns over the potential for noise breakout to nearby residents. Accordingly, the management have commissioned a professional noise survey and report to assess the potential impact of this installation. This report addresses those concerns and gives professional advice on these matters.

### 2.2 History.

The original building dates back over one hundred and fifty years, and has always been in commercial use, and was recently set up as a School of Barbering. There have been some recent comments about the noise from the plant from nearby residents.

### 2.3 Location. (See the sketch map and photographs).

The three storey terraced building is located on the east side of Drury Lane, near the junction with High Holbourn. To the east is residential with a courtyard. To the north is commercial, with residential above. To the west over the main street is a hotel. To the south is commercial, with residential above and then more shops and cafes. The area is mixed commercial and residential with many shops, bars and pubs in the area. There is also existing plant from other commercial premises nearby. The school is located on the first floor. The ground floor is a restaurant, and there are residents on the second and third floors.

### 2.4 Nearby residents.

The nearest residents are located at second floor levels immediately above the school. There are also residents to the south, with windows overlooking the roof, at a distance of 5 m from one of the fan units. The residents above have windows that are close to the side of the building and so the windows are effectively screened from line of sight from the air conditioning plant.

### 2.5 Mode of Operation;

The school starts at 11 am in the morning and operates to 9 pm on some week days but usually finishes at 5.30 pm day during the week. The main external plant is running manually, and will be on only during these hours.

### 2.6 Layout and construction of building. (See sketch map and photos).

The building is three stories high, with all the plant located on the flat roof at the rear. The construction is substantial 350mm brick walls at the front, and sides and rear, and a substantial flat roof at the rear above the main school teaching room.

### 2.7 Plant proposed and location. ( see photos and sketches)

There is a mechanical ventilation system, with an intake and extract fan units set in the roof, and two air conditioning external condenser units, Hitachi SRC60ZMX-S , of power rating 2.9kW. At present the air conditioning units are space out on the roof but they are recommended to be relocated closer to the building and mounted more discretely on the side wall.

## 3 Noise criteria and regulations.

### 3.1 General awareness of noise regulations.

The owner must be made aware of the importance of meeting any noise limits or regulations imposed by the Local Authority, and any conditions stated on the premises licence or planning permission referring to noise in particular. He must also be aware of the criteria which are used to judge acceptability. The following is a brief summary of the noise criteria, the legal position, and the consequences of not complying. Note that if specific conditions are attached to a planning permission then these are the conditions that must be met, irrespective of any of the general guidelines.

### 3.2 Local authority noise criteria. Generally to BS 4142.

The usual local authority guideline criteria for noise from industrial plant is given in the British Standard BS 4142. Essentially this relates how loud the plant is when measured or predicted near the residents, in dB $L_{Aeq}$ relative to the underlying background noise, measured in dB $L_{A90}$. It gives an indication by a noise rating value as to the likelihood of complaints about plant noise from residents; if the source noise rating level, (including any correction for character), exceeds the background by more than 6 dBA then complaints are likely. It states that if the plant noise is at least 10 dBA below the background noise then this can be taken as an indication that complaints are unlikely. The usual criteria for local authorities is now for the plant noise to be at least 10 dBA below background, ie to have a rating value of below - 10 dBA. ( Some local authorities also require an octave band analysis to ensure that each octave band of the predicted plant noise in dB $L_{eq}$ is not above the measured background noise in dB $L_{90}$). Note that if the noise is 10 dBA below background it is generally accepted that this indicates inaudibility of the source noise compared to ambient background noise, and often a condition is stated in these terms.

### 3.3 Camden usual noise regulations in planning permission.

*The usual noise conditions on planning applications for new noise plant generally state that the noise of the plant at the residents should not exceed 10 dBA above the lowest measured ambient prevailing background noise, in* dB $L_{A90}$, *ie in accordance with BS 4142.*

### 3.4 General noise criteria. Design targets and BS 8233

The guidelines for external noise intrusion into buildings is described in British Standard BS 8233, which defines what is defined as “good conditions” and “reasonable conditions of internal noise level in various spaces. The local authority follow these guidelines for acceptable values for proposed developments, and planning permission is often granted conditionally on proposals which can show in a consultants report that the building design will achieve the required design targets.

**Residential**

“Good conditions” are defined as no more than 30 dB $L_{Aeq}$ in living rooms and bedrooms for day time, and night time. The design value for “reasonable conditions”, for the daytime ambient noise level inside residential lounges and living areas is 40 dB $L_{Aeq}$

For residential bedrooms at night the guideline design target is 35 dB $L_{Aeq}$, and with a 45 dB $L_{A\ Max}$. These internal noise levels are to include noise sources from inside and outside the building, including traffic noise, and any commercial noise source in adjacent buildings.

“Good conditions” are design targets to aim for, however most planning conditions generally stipulate achieving the “reasonable conditions” noise levels inside new developments.

It is generally accepted that the noise attenuation through a slightly open window is of at least 10dBA. This requirement to meet BS 8233 has not been specified in these planning conditions, although it is good practice to be aware of the standards and to check if the plant will meet the guidelines.

## 4 Measurements and Observations. 17th April 2015

**4.1** The noise visit was made to meet the management, to inspect the premises and to investigate and measure the background noise in the late afternoon and then leave the sound monitoring equipment unattended to monitor the background noise overnight when it would typically be at its lowest level. The background noise was measured outside in the yard near the residents.

### 4.2 Monitoring near the residents. (See photos)

The background noise early on in the survey in the afternoon was dominated by the noise of traffic. There were also overhead planes, sirens, and the distant sound of children playing heard.

### 4.3 Monitoring positions.

Sound measurements and monitoring were made at the location listed below:-

A outside at the rear on the roof near the residents overlooking the rear yard.

B outside at 1m from the ventilation fan unit in the direction of the residents

### 4.4 Sound measuring equipment.

The main sound level meter, a type 1 CEL 490 was set up on a tripod with full weather protection at a height of 3 m above the roof , level with the residents windows. The meter was calibrated before and after the survey. The meter was set to record in broad band environmental mode, including dB $L_{Aeq}$ and dB $L_{A90}$ in five minute periods. The weather at the start of the survey was about 12°C, dry, and with a slight breeze.

### 4.5 Measuring the plant noise.

The noise from the fan units was measured at 1m in the direction of the residents. The air conditioning units were on but the units were inaudible compared to the background noise. However the maximum sound power was clearly marked on the units and this would enable calculations to be made for the noise heard at the residents. It is considered that the noise from the ventilation units is the main source of complaint, as the condensors were modern and quiet running and only under extreme conditions are they both running together.

## 5 Results and Analysis. (17th April 2015)

### 5.1 Sound monitoring near the residents, Location A (see graphs at end of report).

Existing background noise level dB $L_{Amax}$ , dB $L_{Aeq}$ , and dB $L_{A90}$ was measured through the day and night, over at least one night

Sound level =

49 - 83 dB $L_{Amax\ (5\ min)}$
45 - 63 dB $L_{Aeq\ (5\ min)}$
44 - 60 dB $L_{A90\ (5\ min)}$

### 5.2 Lowest background noise measured location A (for hours of 11 am to 9 pm operation).

The lowest background noise level dB $L_{A90}$ occurred at 4.40 pm, Saturday afternoon.

Sound level = 48 dB $L_{Aeq\ (5\ min)}$

The corresponding background noise level dB $L_{Aeq}$ at the same time was

Sound level = 51 dB $L_{Aeq\ 5\ min}$

### 5.3 Measured octave band sound pressure level of ventilation Fan unit.

| Frequency HZ | 63 | 125 | 250 | 500 | 1k | 2k | 4k | dBA |
|---|---|---|---|---|---|---|---|---|
| **Sound pressure level in dB** | 63 | 62 | 64 | 62 | 55 | 48 | 43 | 62 |

***Table 2 Measured Octave band, Sound Pressure levels for noise of extract fan unit in dB at one meter at full duty.***

### 5.4 Calculation of noise levels at residents windows. ( See Appendix 4 ).

The noise levels at the residents are calculated from the sound power of the air conditioning condensors and also the measured level of the fan units, and the noise level is then reduced or attenuated, by various factors, including attenuation due to distance, and attenuation due to any barriers or acoustic screens.

This final predicted noise level at the residents' window is then used in the BS 4142 assessment to confirm acceptability of the proposal to meet local authority noise criteria.

The calculations for predicting the sound pressure level at the residents' window are shown in Appendix 4. The calculations have been made with the recommended acoustic screens around the fan units; and the two air conditioning units relocated to the side wall, one above the other and tight into the corner to preclude line of sight from the residents above the main office. The references for the calculations and attenuations have been taken from the manufacturers published data, and industry standard source reference hand book on fan noise "Woods Practical Guide to Noise Control". The calculations are for the fan motor running at maximum, at full duty, and any variable attenuations are calculated as conservative to indicate the worst case conditions.

**5.5 Calculation of Sound pressure levels from sound power from a point source.**
The sound pressure level is given by the equation below:-

SPL = SWL – 20 log r – 8 dB for hemispherical propagation.

Where SPL is sound pressure level, SWL is sound power level and r is the distance away.

(For full spherical propagation, with the source in free space away from any walls or large flat surface the last term would be -11 dB). In this case the condensors will be flush with the side wall and so -8 dB term has been used, as a worst case calculation.
The Mitsubishi units have a marked sound power level of 65 dBA for mounting on the ground or wall, and the distance to the residents at the rear, ( Residents B), is 18m.
The results indicate a sound pressure level of 32 dBA for the noise from one of the condensors heard at the residents' window. In an extreme condition there may be two running together which would then be a total of 35 dBA.

**5.6 Attenuation of sound due to distance, calculations.**
(Hemispherical propagation)
This is given by the equation $A = 20 \log r^1 / r^0$ dB
Where A is attenuation due to distance in dB
where $r^1$ is distance from source to receiver
where $r^0$ is distance from source to reference measurement distance ( usually 1m or 3m)

for example in this case
distance $r^1 = 5$ m (for residents B from the fan unit )
$r^0 = 1$ m (for units)
A = 14 dB attenuation

**5.7 Calculation for addition of incoherent sound sources**
The total sound level for a number of incoherent sources is given by the equation below:
Total dB = $10 \lg ( 10^{lp1/10} + 10^{lp2/10} + 10^{lp3/10} \ldots\ldots\ldots + 10^{lpn/10})$

It can be seen that a second unit of similar noise level will give an increase of 3 dB in noise level.

**5.8 Barrier Calculations** ( Maekawa Formula ) (see also Appendix 3 at end of report),

If the source noise is effectively screened from direct line of sight by a barrier then there is a reduction in noise depending on the frequency of the sound source, and the effective path length difference $\delta$ , and given by the Maekawa formula for noise screens.
The Fresnel number N is defined as

$$N = \frac{2\delta}{\lambda}$$

Where $\delta$ is the path length difference in m
$\lambda$ is the wavelength of the sound in m

The path length difference, $\delta = A + B - D$ as shown in the sketch in appendix 3
Where d or D is the direct distance from the source to the receiver.
The graph is also shown in appendix 3; the Fresnel number is calculated from path length difference and the wavelength and then the predicted attenuation is read off in dB from the graph.

(Note that at direct line of sight, ie δ = 0 , and N = 0, the line of sight just grazing the top of the barrier, looking from the source to the receiver, the attenuation is 5 dB.

The path length difference δ, has been calculated for the new acoustic screens around the fan units, as δ = 0.3m, giving an attenuation of 12 dBA. The path length difference has also been calculated for the two air conditioning units to the residents above ( residents A), as the line of sight is clearly blocked by the existing building construction, and δ = 0.7m , giving a predicted attenuation of 15 dBA.

**5.9 Calculation for total plant noise heard at residents A .**

The total noise can now be calculated from the nearest fan unit noise at a distance of 7m, (and the second, furthest one at 16m away), and the two air conditioning condensors at 4m but attenuated by the barrier effect.

| | |
|---|---|
| Fan noise (measured at 1m) | = 62 dBA |
| Less attenuation due to distance | - 17 dB |
| Less attenuation due to barrier | - 12 dBA |
| Nearest fan unit noise | 33 dBA |
| The second further unit | 26 dBA |
| Total fan unit noise | 34 dBA |

Air con noise:-

| | |
|---|---|
| Using the equation in section 5.5, each unit noise | = 45 dBA |
| Less attenuation due to barrier | - 15 dBA |
| Noise from one condenser | 30 dBA |
| Noise with both condensors running | = 33 dBA |

Total plant noise heard at residents A , both fan units and both condensers running, worst case situation = 37 dBA

**5.10 Calculation for total plant noise heard at residents B .**

The total noise can now be calculated from the nearest fan unit noise at a distance of 5m, (and the second, furthest one at 9m away), and the two air conditioning condensors at 18m.

| | |
|---|---|
| Fan noise (measured at 1m) | = 62 dBA |
| Less attenuation due to distance | - 14 dB |
| Less attenuation due to barrier | - 12 dBA |
| Nearest fan unit noise | 36 dBA |
| The second further unit | 30 dBA |
| Total fan unit noise | 37 dBA |

Air con noise:-

| | |
|---|---|
| Using the equation in section 5.6, | |
| Noise from one condenser | 32 dBA |
| Noise with both condensors running | = 35 dBA |

Total plant noise heard at residents A , both fan units and both condensers worst case situation = 39 dBA

This total noise level, although highly unlikely to happen in practise with all units running at maximum at the same time, is still slightly too high to meet the regulations, and so there are two options outlined below.

Option 1
This would be to install a similar acoustic screen to screen the condensors from line of sight to the residents B at the rear, which would reduce the condenser noise by 12 dBA to 23 dBA

Option 1
Total plant noise heard at residents A , both fan units and both condensers, (now screened) worst case situation = 37 dBA

Option 2
Another alternative, option 2, would be to reduce the speed of the intake fan unit , ( the fan which is nearest to residents B), by at least 25 % to give a 3 dBA reduction, to give a total fan noise of 35 dBA. This with the condenser noise of 35 dBA, will give a total noise level of 38 dBA.

Total plant noise heard at residents A , both fan units, ( intake reduced speed), and both condensers running,
worst case situation = 38 dBA

**5.11 BS 4142 analysis, for existing situation.**

BS 4142 gives an idea of the acceptable predicted source noise from the plant, at the rear, with the lower background noise, near the residents' window, relative to measured background noise.
The latest version (1997) of the BS 4142 has been used to make an assessment from the published sound source levels and the measured background noise levels.

**Day time use** 7 am – 11 pm

Measured background noise, lowest sound level at residents, during hours of operation ( 48 dB $L_{A90\ (5mins)}$)

| | | |
|---|---|---|
| Calculated noise level of all plant with residual correction | dB $L_{Aeq}$ | = 37 dBA |
| Specific noise level of plant | dB $L_{Aeq}$ | = 37 dBA |
| Correction factor for characteristic including tonality and regularity, | | = 0 dBA |
| Predicted noise level of fans at 1m from facade of residents windows | | = 37 dBA |
| Background level lowest (measured) | dB $L_{A90\ (5\ min)}$ | = 48 dBA |
| Rating level | | **= 37 dBA** |
| Excess of rating level over background | | = - 11 dBA |

This is **Acceptable**

This is acceptable according to BS 4142 analysis, with a small safety margin and is not likely to lead to complaints. Generally the local authority criteria is for the source noise to be at least 10 dBA below and so the result is acceptable.

**5.12 Camden Council usual noise regulations in planning permission.**

*The usual noise conditions on planning applications for new noise plant generally state that the noise of the plant at the residents should not exceed 10 dBA above the lowest measured ambient prevailing background noise, in* dB $L_{A90}$*, ie in accordance with BS 4142.*

It is indicated from the BS412 calculation that the plant noise is at least 11 dBA below the measured background noise, and this is therefore acceptable, if all the recommendations are put in place, with a good safety margin.

### 5.13 BS 8233 Assessment

The ”*reasonable conditions*” design value for the ambient noise level inside lounges and living areas is 40 dB $L_{Aeq}$ daytime..
For residential bedrooms the guideline acceptable design target is 35 dB $L_{Aeq}$, at night, and with a dB $L_{Amax}$ of 45 dBA, to include noise sources from outside the building, including traffic. It is generally accepted that a partially open window will give a noise reduction of at least 10 dBA. This would then indicate that for external noise to be acceptable with a good safely margin, for daytime the external noise level would need to be less than 50 dB $L_{Aeq}$ measured just outside the residents window, and for night time after 11pm the external noise should be less than 45 dB $L_{Aeq}$.
The predicted plant noise outside at the residents windows is 37 dBA, and this is much less than the requirement under BS 8233, and so meets the criteria with a good safety margin.

## 6 Discussion.

**6.1** The noise issue with the new ventilation and air conditioning systems has been investigated and the potential for noise break out has been considered. Existing ambient and background noise levels have been monitored, on the roof near to the residents, at typical times of the day, and overnight. The noise from the plant has also been measured. The construction of the building and the layout of plant and location of residents was examined and the potential sources of noise and vibration break out identified and pointed out to the owner. Calculations and assessments have been made in this report for the noise levels at the residents, and the calculations have confirmed that the proposed plant will meet the noise regulations, with a good safety margin, if all the recommendations in this report are implemented.

### 6.2 Monitoring at residents.

The existing ambient and background noise was monitored over a period of at least one day and night at the nearest noise sensitive residents to the proposed plant location. The noise climate was primarily traffic noise. The lowest background noise for the hours of operation was measured as 48 dBA $L_{A90}$.

### 6.3 Plant Machinery, and potential noise breakout routes.

The plant is all new, made by reputable manufacturers, and particularly specified to be as quiet running as possible. The fan units will have acoustic screens and the condensors to be relocated and screened.

### 6.4 Measured sound level at residents for present hours of operation.

The total plant sound level has been measured, calculated, and predicted at the nearest residents' windows to be no more than 37 dBA, as a worst case situation with all plant running at the same time at maximum. This is well below the measured background level, of 48 dBA, by 11 dBA.

### 6.5 BS 4142 Assessment.

*BS 4142 is the main British standard used for assessing the likelihood of complaints with industrial noise. This can be used to give a guide as to the relative levels of each noise source and if this constitutes a possible noise problem. The basis of BS 4142 is an interpretation of the difference in level between the problem noise source measured in* dB $L_{Aeq}$ *and the underlying background noise measured in* dB $L_{A90}$.

*It gives an indication of the likelihood of complaints about plant noise from residents; if the source noise exceeds the background by more than 6 dBA then complaints are likely, and up to 6 dBA there is marginal significance of complaints.*

The results from the measurements and calculations demonstrates that the calculated source noise of the plant will be acceptable if all the recommendations in this report are followed The calculated noise at the receiver, the residents windows is 37 dBA, and this will be below the background level by 11 dBA, which is completely acceptable, and has a small safety margin of 1 dB. Generally the local authority noise criteria is for the source noise to be 10 dBA below the ambient background level, and so the result is acceptable, and meets all current planning regulations.

### 6.7 Camden Council noise conditions in the planning permission.

The usual noise conditions on a planning applications for new noise plant in this local authority is for the noise of the plant at the residents to be at least 10 dBA below the lowest measured ambient background noise in dB $L_{A90}$, ie in accordance with BS 4142. The assessment shows that with all the new plant running at maximum, as a worst case situation, the predicted noise level outside the nearest residents' window is 37 dBA. This is well within the acceptable levels with a good safety margin, and therefore should meet the requirements, if all the recommendations are followed.

### 6.8 BS 8233 Assessment

The BS 8233 guidelines require that the predicted noise from external sources is ideally to be less than 50 dBA outside the nearest residents' window during the day. The assessment shows that with all the new plant running at maximum, as a worst case situation, the predicted noise level outside the nearest residents' window is 37 dBA. This is well within the acceptable levels with a good safety margin.

### 6.9 Recommendations for works at London School of Barbering, Drury Lane. (see sketches)

**A Install the acoustic screens around the ventilation fan units.**

The fan units should have simple acoustic screens, all around each unit to a height of 1m and lined with acoustic melatech foam, as specified.

**B Relocate the air conditioning condensors as shown on the wall.**

The condensors should be re located on the wall , one above the other, tight into the corner to preclude line of sight to the windows above at residents A.

**C Screen the condensors**

The condensors should also be screened from direct line of sight from residents B with a simple lined acoustic screen as shown.

or

**D Reduce the speed of the intake unit closest to Residents B**

If the speed of the intake unit , closest to the residents B, can be reduced in speed by 25 % , then the screen around the condensors is not needed in point C above, and this is option 2 in the calculations. For a greater safety margin, and greater reduction in noise level, both options could be implemented.

**E Completion Noise Monitoring.**

As each phase of the work is completed it is recommended that noise monitoring is considered. When all the building works are complete, and all the plant running correctly, then it is recommended to re-measure the plant noise. This will ensure that the plant is working correctly and the works have been successful and there is no excessive noise breakout from the plant, and confirm that all planning noise criteria have been met. A brief letter to the local authority noise team will then confirm the requirements of the planning criteria have been fulfilled.

## 7 Conclusion and Recommendations.

**7.1** The management are refurbishing this building as a Barbering School. Planning permission is currently being sought for the installation of external plant, both external air conditioning condensors and mechanical ventilation. Accordingly, the management have commissioned a professional noise survey and report to assess the potential impact of this installation for the potential for noise break-out. This report addresses and gives professional advice on these matters.

**7.2** The background noise levels have been measured at typical times of operation, over a period of at least one full day. The published plant noise information has been researched, and noise measurements made of the plant in existing locations, and calculations made to predict the noise from the external plant.

**7.3** An assessment under BS 4142 has been made, and also regard to BS 8233, and it is has been confirmed that the noise from the plant will be well within the local authority criteria, if all the recommendations in this report are followed.

**7.4** The owners are well aware of the implications of the noise issues surrounding the ventilation and air conditioning plant, and have taken professional advice in commissioning this report to investigate the noise situation. They have put recommendations into place as quickly as possible in order to keep any disturbance from plant noise reaching nearby residents to the absolute minimum.

**7.5** When all the building works are complete then a final sound test may be required. This will ensure that the plant systems are working correctly and there is no excessive noise breakout, and confirm that all the local authority noise planning criteria have been met.

Shaun Murkett 24th April 2015

## Appendix 1 Glossary of Acoustic terms. (Industrial noise).

**Annoyance** A feeling of displeasure associated with any agent or condition known or believed by an individual or a group to be adversely affecting them. Emotion associated with any noise perceived as irritating or a nuisance.

**A-weighting** A frequency dependent correction or weighting that is applied to the measured or calculated frequency spectrum of a sound or noise to correlate with the varying sensitivity of the ear to sound of different frequencies. The ear is less sensitive to sound at low and very high frequencies, compared to the mid range frequencies. This A weighted response corresponds more closely to the frequency response of the human ear, at lower sound levels.

**Ambient noise** All encompassing sound at a given place, usually a composite of sounds from many sources near and far. This is generally measured dBA $L_{Aeq\ T.}$ as recommended in ISO 1996.

**Background noise** Long term ambient noise or residual noise, generally expressed by dBA $L_{Aeq}$, as recommended in ISO 1996 and followed by PPG 24. (Still described in BS 4142 and many standards by dBA $L_{A90}$ , .and which is often stated to give a broader picture of the ambient background noise).

**BS 4142:** (1997) This is the main British Standard used for assessing the likelihood of complaints with industrial noise. In essence if a noise source measured in $L_{Aeq}$ exceeds the measured background noise $L_{A90}$ by more than 6dBA then complaints are likely. If the predicted source noise is 10 dBA below background noise it is taken as a positive indication that complaints are unlikely. There are also loading factors for impulsive and tonal sounds.

**BS 8233:** (1999) This British Standard covers control of noise from outside the building and noise from plant and services within the building. It gives basic design guidelines for target noise levels in various spaces, including homes and offices. These guidelines are primarily intended to guide the design of new or refurbished buildings, and were derived from the World Health Organisation documents,(ref WHO Community Noise Guidelines 1999),.

**Decibel (dB)** Decibel. A unit of logarithmic ratio between a sound pressure and a known reference pressure (which corresponds to the threshold of hearing). For sound pressure level the reference quantity is 20μPa, the threshold of normal hearing is in the region of 0 dB, and 140 dB is the threshold of pain. A change of 1dB is only perceptible under controlled conditions, but a 3 dB change is easily perceptible.

**dBA** "A" weighted dB. Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency, (pitch), in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessments of loudness. An increase of 10 dB(A) corresponds roughly to doubling of the perceived loudness of a sound.

**dB Lin** dB Linear. Un-weighted sound pressure level in dB, and is used as a more appropriate parameter to dBA when low frequencies predominate in the spectrum, and "A" weighting would under represent these low frequencies; as recommended in WHO 1999. This is of particular use when measuring music, as the dBA weighting would not give a fair representation of the low frequency content, which usually dominates modern music.

**dBC** dB "C" weighted sound pressure level. The C weighting curve is closer to the linear response than the A weighting curve, and often used as an alternative to dB Linear.

**Frequency . Spectrum** The range of audio frequency generally associated with the range human hearing from 20 Hz to 20 kHz., however by middle age most adults have reduced hearing ability at frequencies above 8 kHz. Usually shown graphically in octave bands, from 63 Hz to 8 k Hz.

**Hertz (Hz)** Unit of frequency, equal to one cycle per second. Frequency is related to the pitch of a sound.

**$L_{eq\ T}$** Equivalent continuous sound pressure level. This is a time averaged level taken over a specified time period, which gives a measure of the average sound energy over that period. The equivalent continuous sound level – the sound level of a notionally steady sound having the same energy as a fluctuating sound over the same specified measurement period (T). It is measured with a fast time weighting, over periods such as one minute, 5 minutes, 15 minutes, 1 hour etc.

**$L_{Aeq,T}$** "A" weighted equivalent continuous sound pressure level, over measurement period T. This is an average of the total sound energy measured over the time period. $L_{Aeq,\ T}$ is used to describe many types of noise and can be measured directly with an integrating sound level meter. This is the preferred sound measurement parameter for most types of environmental noise as recommended by ISO 1996.

**$L_{max}$** The highest linear un-weighted noise level recorded during a measurement period.

**$L_{Amax}$** The highest or maximum A weighted noise level recorded during a measurement period.

**$L_n$** This is the percentile sound level. Since the variation in sound level can be large over a long period of time, the sound level can be described statistically. Thus n refers to the percentage of the total measurement time for which that level is exceeded.

**$L_{A10,T}$** The A weighted level of noise exceeded for 10% of the specified measurement period (T). It gives an indication of the upper limit of fluctuating noise such as that from road traffic. $L_{A10,\ 18h}$ is the arithmetic average of the 18 hourly $L_{A10,\ 1h}$ values from 06.00 to 24.00.

**$L_{A90,T}$** The A weighted noise level exceeded for 90% of the specified measurement period (T) and used to be commonly taken to be the background noise level parameter in the UK. In BS 4142 it is still used to describe the nominal background noise level, although background noise level is now usually described by $L_{Aeq}$ according to ISO 1996.

| | |
|---|---|
| **Noise** | Undesired sound |
| **Noise induced Temporary Threshold shift** | Temporary hearing impairment occurring as a result of noise exposure, often phrased temporary threshold shift (adapted from ANSI 1994) The ears need a time to "recover" or settle, after exposure to high noise levels, and until that time will not perceive low sound levels as normally. |
| **Noise level** | Level of undesired sound, usually measured in dB $L_{Aeq}$ |
| **Octave bands** | The frequency spectrum can be divided into a number of octave bands centered around the frequencies 32 Hz, 63 Hz, 125 Hz, 250 Hz, 500 Hz, 1kHz, 2kHz, 4kHz, 8kHz and 16kHz to encompass the range of human hearing. Third octave spectrum divides each of these octave bands into three frequency bands to give even greater detail of the distribution of the sound across the frequency spectrum. |
| **Rating level** | The noise level of an industrial noise source which includes an adjustment for the character of the noise. Used in BS 4142. ( 1997) |
| **$R_w$** | Single number rating used to describe the sound insulation of building elements. It is defined in BS 5821: (1984). |
| **Sound level** | The level of sound measured, as Sound pressure level, usually in dBA. |
| **SPL** | Sound pressure level, usually measured in dBA |

**Typical everyday sound levels**

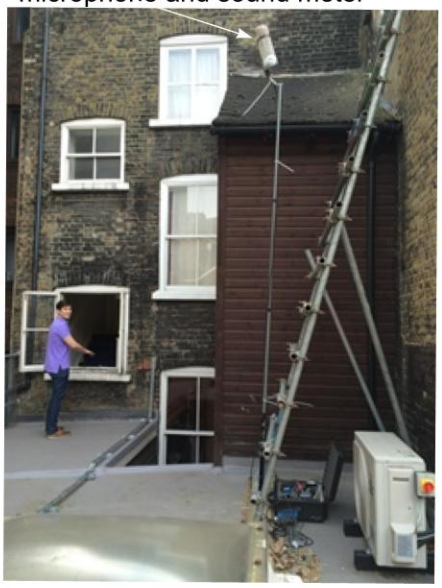
| | |
|---|---|
| 140 dBA | jet aircraft take off at 25m |
| 130 - 135 dBA | gunshot from revolver at 1m |
| 120 - 125 dBA | riveting workshop |
| 110 -115 dBA | circular saw on hardwood at 0.5m, chainsaw at 0.5m |
| 100 -110 dBA | police car, or ambulance, siren at 7m |
| 100 -110 dBA | music festival at 30 m from stage |
| 95 - 100 dBA | night club; |
| 90 - 95 dBA | heavy lorry at 7m |
| 90 - 95 dBA | bar or pub with music |
| 85 - 90 dBA | power drill at 0.5m, food blender at 0.5m; car horn at 7m |
| 80 - 85 dBA | inside London tube train |
| 75 - 85 dBA | busy restaurant or café |
| 75 - 80 dBA | vacuum cleaner at 1.5m |
| 70 - 80 dBA | busy street |
| 70 - 75 dBA | inside bus |
| 70 - 75 dBA | passing car 40 mph at 7m |
| 65 - 70 dBA | loud radio at 1m ; inside car at 50 - 60 mph |
| 60 - 65 dBA | general office; supermarket |
| 50 - 60 dBA | conversation between couple, at 1m |
| 40 - 50 dBA | quiet office; quiet living room, day time |
| 30 - 35 dBA | quiet bedroom, at night |
| 20 - 25 dBA | empty concert hall or theatre |
| 15 - 20 dBA | broadcast or recording studio |
| 10 - 20 dBA | faintest audible sounds |
| 0 dBA | threshold of hearing |

| | |
|---|---|
| **WHO 1999** | World Health Organisation . Guidelines for Community Noise 1999. This document sets out guideline limits on noise levels to prevent hearing damage, annoyance, and sleep disturbance in various situations, including residential, leisure, and workplace buildings. |


View of flat roof looking east, showing intake vent fan unit and residents windows.


View of Mitsubishi external condensor air conditioning unit.

View of inside of London School of Barbering, showing internal air conditioning unit in ceiling.




View looking back from roof towards main building showing residents windows blocked from line of sight of air con units.

# Photographs of noise survey at London School of Barbering Drury Lane, Covent Garden London .



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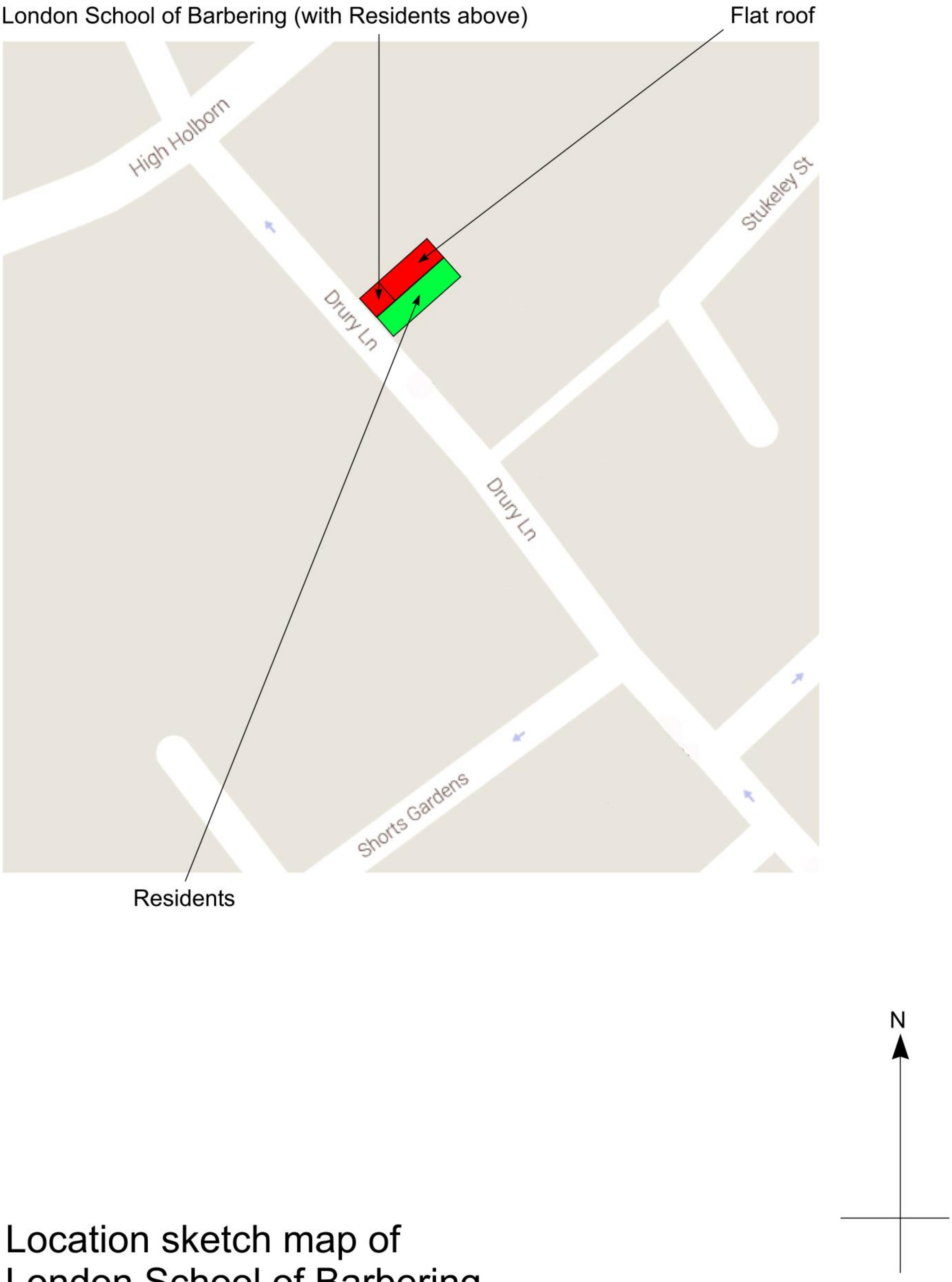


Location sketch map of
London School of Barbering,
1st Floor, 186 Drury Lane,
London WC2B 5QB.

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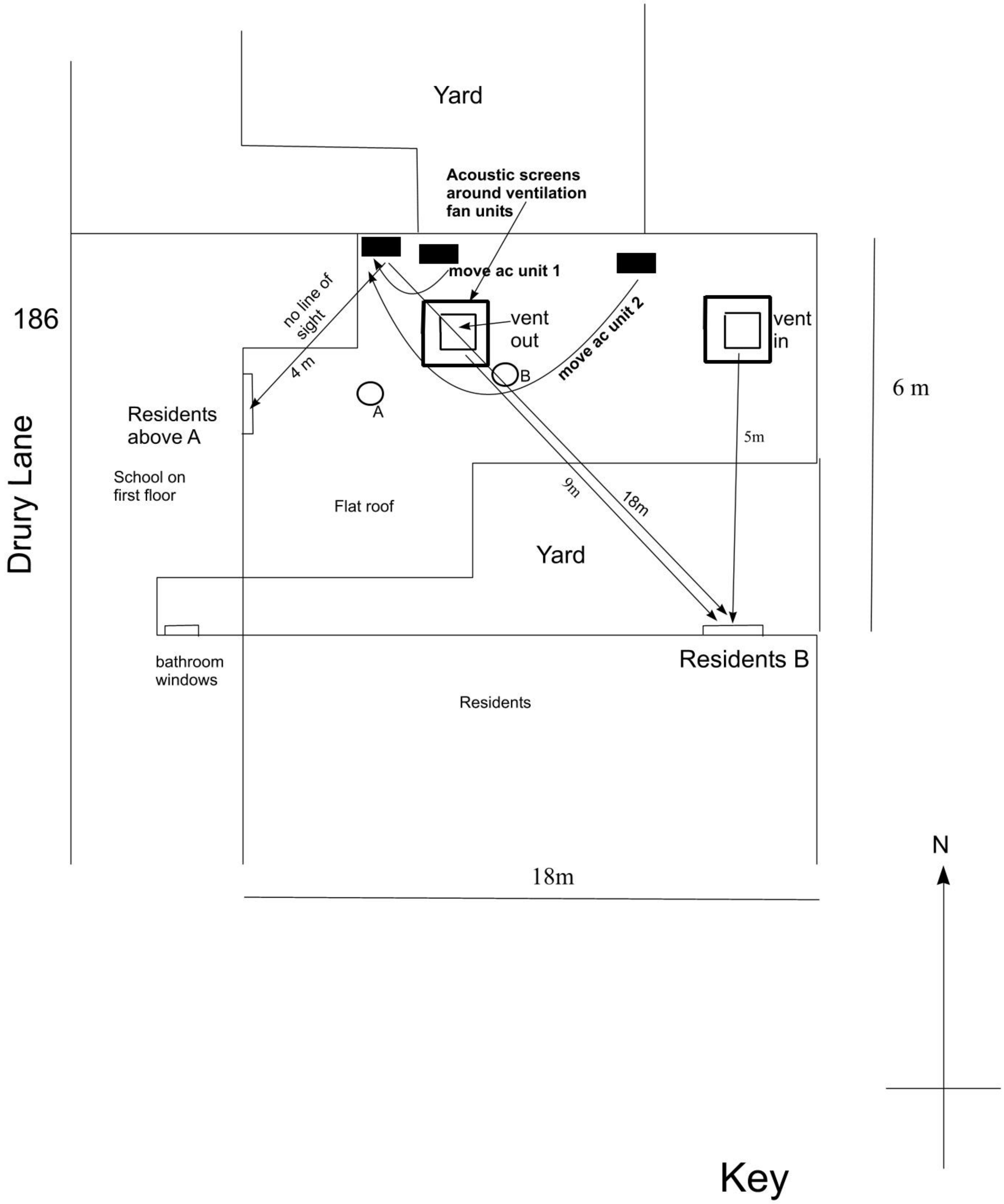


## Key

Recommendations are shown in **bold**

Plant position

Sound level monitor point

Layout of plant at London School of Barbering, 186 Drury Lane, Covent Garden, showing recommendations.



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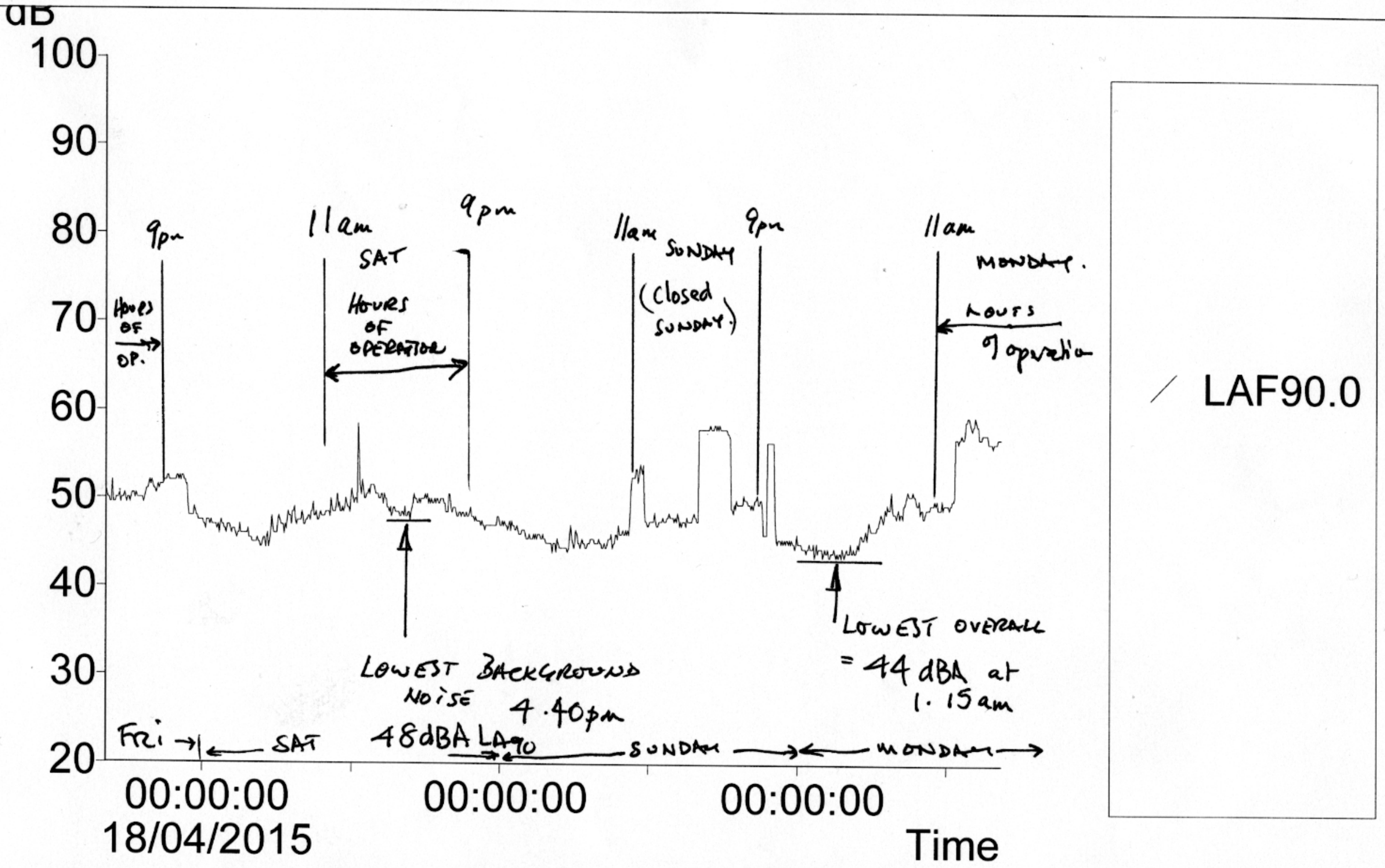
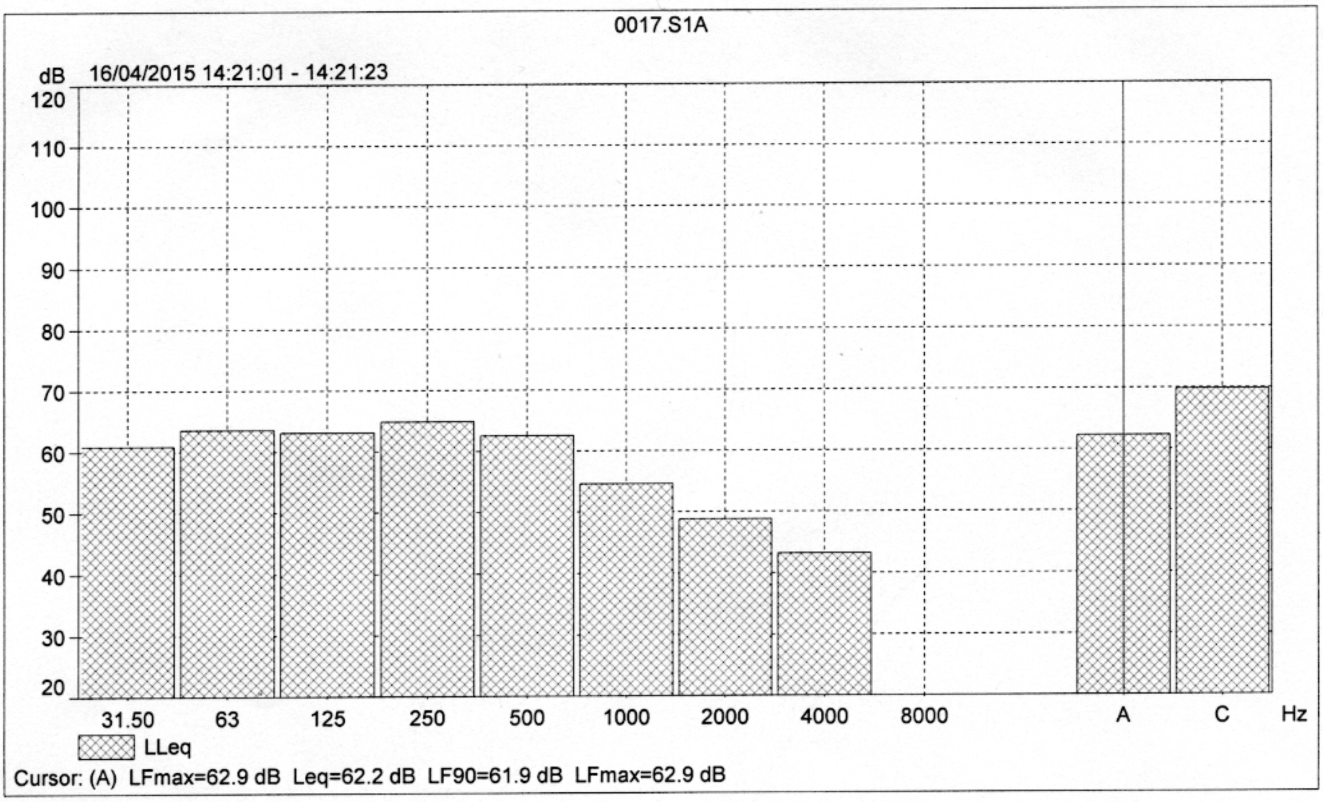



Sound profile of ambient background noise, as dB $L_{A90\ 5\ min}$, measured near residents windows, rear of 186 Drury Lane, location A on flat roof from 4 pm in afternoon Friday 17th to 5 pm Monday afternoon 20th April 2015
London School of Barbering, 186 Drury Lane, Covent garden, WC2B 5QD.
Lowest background noise in normal operating hours 48 dBA La90 at 4.40 pm.




Octave frequency spectrum of noise from extract ventilation fan

on flat roof, measured at 1m from unit in direction of residents.

location B

London School of Barbering,

186 Drury Lane, Covent Garden, London WC2B 5QD

16th April 2015,

Noise level = 62 dB $LA_{eq\ 1min}$ ,

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# Appendix 3. Barrier Calculations
# London School of Barbering,
# 186 Drury Lane, Covent Garden, London.

April 2015

**A3.1 Barrier Calculations** ( Maekawa Formula ) (see also sketches at end of report), and relevant supporting equations.
If the source noise is effectively screened from direct line of sight by a barrier then there is a reduction in noise depending on the frequency of the sound source, and the effective path length difference δ , and given by the Maekawa formula for noise screens.
The Fresnel number N is defined as

$$N = \frac{2\,\delta}{\lambda}$$

Where δ is the path length difference in m
λ is the wavelength of the sound in m

The path length difference, δ = A + B – d as shown in the sketch to the right below
The graph is shown below ; the Fresnel number is calculated from path length difference and the wavelength and then the predicted attenuation is read off in dB.

(Note that at direct line of sight, ie δ = 0 , and N = 0, the line of sight just grazing the top of the barrier, looking from the source to the receiver, the attenuation is 5 dB.

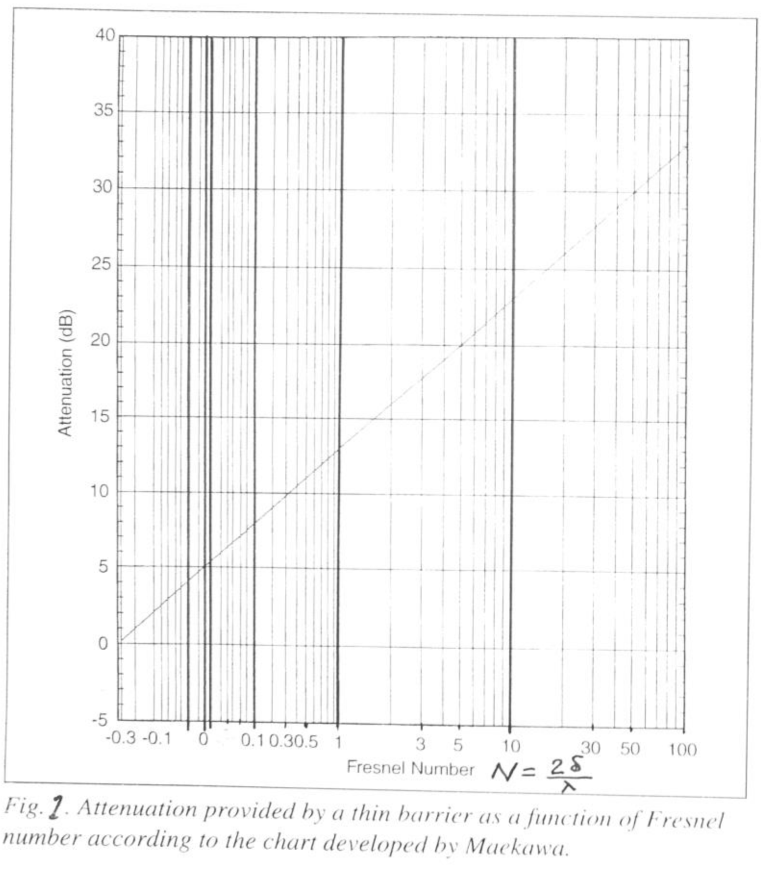
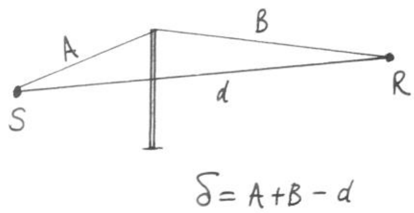



*Fig. 1. Attenuation provided by a thin barrier as a function of Fresnel number according to the chart developed by Maekawa.*



Graph 1 for the Attenuation in dB provided by a thin barrier
with Fresnel number N, from Maekawa.

**A 4.2 Barrier calculation.**

Measurements have been taken from the noise source to the barrier and from the barrier to 1m from the facade of the residents window, and so A, B, d and therefore δ can be calculated, or with the aid of a simple sketch drawn to scale.

The analysis is for the centre of the noise source to be assumed to be at roof top level, and to be 500mm from the edge of the barrier, the barrier height to be 1m , and the direct distance to the residents window from noise source of 5m.

A sketch similar to the one above indicated that the path length difference = δ = .3 m

This is then put into the Excel calculation with the path length difference, then the attenuation for each octave frequency band taken from the graph above.

This attenuation is then subtracted from the octave band level of the measured noise source, to give the new attenuated octave band levels .

This is then converted to a single A weighted figure by weighting and logarithmic addition.

The difference between the original noise source and the attenuated noise source will then give an indication in dBA of the effect of the new acoustic barrier.

**A 4.3 Effect of acoustic barrier, and predicted sound attenuation .**

The excel sheet 1 shows that using a simple acoustic screen barrier will give a predicted attenuation due to the barrier of 12 dBA. The predicted attenuation for each of the octave bands is shown below:-

| **Frequency Hz** | **dBA** | **63** | **125** | **250** | **500** | **1k** | **2k** | **4k** |
|---|---|---|---|---|---|---|---|---|
| **Attenuation due to barrier dB** | 12 | 8 | 9 | 11 | 12 | 15 | 17 | 20 |

**Table 1 Predicted attenuation in dB due to the effect of the acoustic barrier.**

**Attenuation due to a barrier, according to Maekawa Formula.**

| **Frequency Hz** | **dB(A)** | **63** | **125** | **250** | **500** | **1k** | **2k** | **4k** | |
|---|---|---|---|---|---|---|---|---|---|
| **SPL of plant noise on roof dB Leq** (measured at 1m) | **62** | **63** | **62** | **64** | **62** | **55** | **48** | **43** | |
| wavelength, $\lambda$ in m | | 5.4 | 2.7 | 1.4 | 0.68 | 0.34 | 0.17 | 0.09 | |
| path difference $\delta$, in m | 0.3 | | | | | | | | |
| N = Fresnel number = $2\delta/\lambda$ | | 0.1 | 0.22 | 0.43 | 0.88 | 1.76 | 3.53 | 6.67 | |
| attenuation due to barrier, (from graph) dB | | 8 | 9 | 11 | 12 | 15 | 17 | 20 | |
| **SPL after attenuation** | | **55** | **53** | **53** | **50** | **40** | **31** | **23** | |
| Conversion to dBA | Weighting | -26 | -16.1 | -8.6 | -3.2 | 0 | 1.2 | 1 | |
| weighted levels | Lpw | 29 | 37 | 44 | 47 | 40 | 32 | 24 | **Sum** |
| 10 to power Lpw/10 | | 794.33 | 4897.79 | 27542.3 | 47863 | 10000 | 1659.6 | 251.19 | 930 |

| | |
|---|---|
| dBA = 10 log ( sum) | **50 dB A** |
| Attenuation due to barrier, in dBA | **12 dB A** |

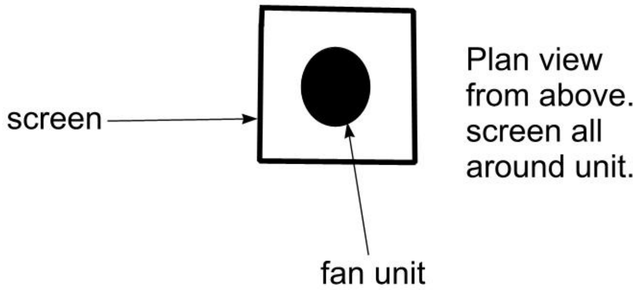
**Excel 1**

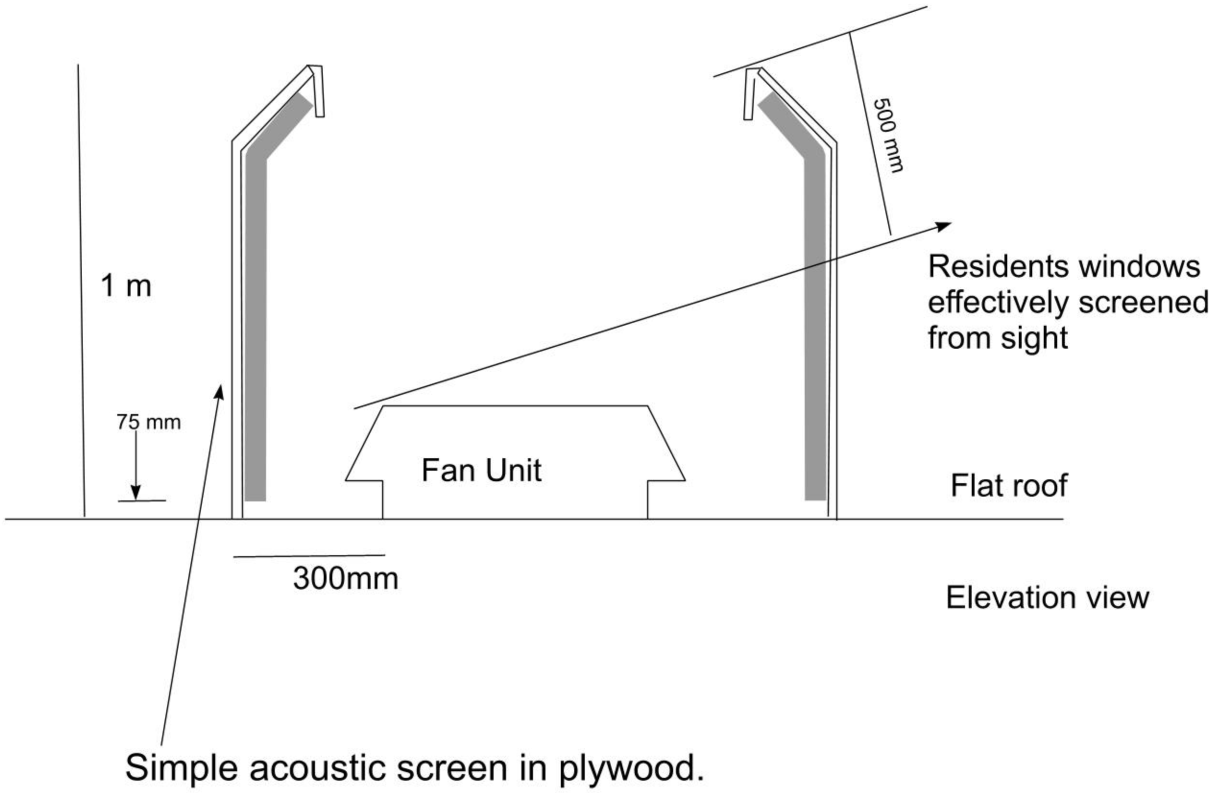
**Acoustic Barrier calculations to show improvements at residents windows due to acoustic screening from residents on roof top**

london school of barbering 186 Drury lane



april 2015




## Notes

1 Simple acoustic screen in 18mm plywood, all around the unit, at 1m high.

2 Line inside of screen with 50mm thick unfaced melatech acoustic foam, available from Hodgson and hodgson; leave bottom 75mm away from flat roof.

3. Screen overall height must be enough to effectively screen line of sight from residents windows, with at least 500mm of effective screening.

4 Good detailing and workmanship are essential to get the best acoustic performance; regular on site inspections by acoustic consultant are recommended at all major stages of the project.

# Simple melatech foam lined acoustic screen around roof top fan unit

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April 2015