Shaun Murkett
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Report on Plant Noise survey at 73 Grays Inn road, Holborn, London WC1.

Date of report	**21st August 2015**
Dates of visits.	4th August 2015
Present:	Jonathan Law, Architect, manager of Cibo, Shaun Murkett.
Location.	73 Grays Inn Road, London, WC1.
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 with new external plant. Planning permission has been applied for the installation of new external ventilation and extract plant, following enforcement action. Accordingly, the management have commissioned a professional noise survey and report to assess the potential impact of this new installation for the potential for noise break-out, and to meet planning conditions. This report addresses and gives professional advice on these matters. A previous noise report was issued in 2004 to previous owners but other works have been added and new additional plant installed.

1.2 The background noise levels have been measured at typical times of operation, over a period of 24 hours, and also the noise from the plant close to each of the units, and calculations made to predict the noise level at the residents 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 already 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 works are complete a final sound test will confirm that the plant systems are working correctly and there is no excessive noise breakout, and confirm that all the local authority noise planning criteria will have been met. The planning conditions can then be formally cleared.

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Report on Plant Noise survey at
73 Grays Inn road, Holborn, London WC1

Contents List.

2 Introduction and Background.

2.1 The management are refurbishing this building as a new café restaurant. Planning permission had been applied for the installation of external plant including kitchen extract flue and external condensors, following enforcement action ref RS/PE/EN15/0459. The local authority have concerns over the potential for noise breakout to nearby residents from the new plant. This noise survey and report was commissioned by the architect surveyor Jonathan Law on behalf of the freeholder owners. This report addresses those concerns and gives professional advice on these matters, on both the effect of the new plant and also the existing plant.

2.2 History.

Parts of the original building dates back over one hundred and fifty years, although many additions were made in the 1950s and 1960s. The building has always been in commercial use, as shops and more recently as the Cibo café. Planning permission has been applied for new plant and retrospective application for plant that has been added over the recent years. We issued a report in 2004 to previous owners , with some basic recommendations, however new plant has been added, an additional storey has been added, and not all the original recommendations were implemented from the early report. This new report has measured background noise again and all the new and old plant for a complete up to date assessment.

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

The large terraced building is located on the west side of the busy Grays Inn road, near the junction with Northington street. To the south adjoining is a dentist, with residential above, to the north adjoining is a solicitors. To the west at rear is a flat roof with new residential, and to the east over the road is commercial. The area is mixed commercial and residential with many shops, offices, and pubs in the area. There is also existing plant from other commercial premises nearby around.

2.4 Nearby residents. See layout map in appendix.

The nearest residents (no 1 on layout map) are located at first floor level, in flats at the rear to the west overlooking the plant on the flat roof of the building, at 8m distant from the units on the roof. There are also residents to the south west at 20 m away with line of sight to the units.

2.5 Mode of Operation

The café intends to start at 7 am in the morning and at present operates to around 5 pm, (but now closing early following complaints about plant noise), but proposes to operate to 10.30 pm. The main external plant is to be 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 four stories high, with the plant located at the rear on the flat roof on the west side and with a flue up to above the top roof level. The construction is understood to be substantial 350mm brick walls, with supporting joists and timber floors.

2.7 Plant and location. (see photos and sketches)

There is a large kitchen extract fan motor, with silencer and flue, and extending up in height to the top roof, at about 10m above. There is also a ventilation extract fan motor which has recently been added running horizontally on the roof and joining the extract flue. There are also some smaller toilet and ventilation fans in the south east corner near the wall. There is a large air conditioning external condenser, to the north, and also a much smaller Fujitsu chiller room condenser to the south near the party 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 LB Hackney usual noise regulations in planning permission for new plant.

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 an acoustic 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. Tuesday 4th August 2015

4.1 The first visit was made to meet the management, to inspect the premises and to investigate the layout of plant and relation to residents, and measure the plant noise in the afternoon. The background noise was measured, and each individual plant machine noise was measured separately, and a sound level meter was set up to measure the background noise overnight. Distances from the location of the plant to each of the residents was confirmed by use of Leica laser rangefinders, and photos and layout sketches taken.

4.2 Monitoring near the plant. (See photos)

The background noise early on in the survey in the afternoon was dominated by the noise of traffic from the main road Grays Inn road, and also other nearby plant noise. There were also overhead planes, sirens, and the occasional distant sound of construction work.

4.3 Monitoring positions.

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

A outside on the rear flat roof near the residents windows

B outside on the rear flat roof near the kitchen extract fan motor at 1m from unit.

C outside on the rear flat roof near the ventilation extract fan motor at 1m from unit.

D outside on the rear flat roof near the air con condensor at .5m from unit.

E outside on the rear flat roof near the chiller room condensor at .5m from unit.

4.4 Sound measuring equipment.

The main sound level meter, to measure the plant noise, a type 1 Bruel and Kjaer 2260 was used hand held up on the roof at 1m and .5 from each of the units separately with all other plant turned off. The meter had wind protection fitted, and was set to measure in octave band mode to measure dB L_{Aeq} and dB $L_{A90,}$, as well as other parameters.

For the background noise at location A.

A type 1 CEL 490 was set up on a tripod and with full weather protection with the microphone at a height of at least 1.5 m above the yard , near the residents windows. The meters were 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 16°C, dry, and with a slight breeze.

4.5 Subjective comments made at time of survey.

The background noise was dominated by traffic noise from the Grays Inn Road, and other plant from nearby. The kitchen fan motor, even with a simple acoustic screen was clearly heard, and was louder than the other fan units and the condenser units. The noise from the small toilet fans and the end of the top flue was not heard on the roof near the residents.

5 Results and Analysis. (4th August 2015)

5.1 Sound monitoring near the plant on the roof, Location B

(see graphs at end of report).
The plant noise was measured individually at maximum running speed, for a worst case.

Main kitchen fan motor, at 1m
Sound level = 63 dB $L_{Aeq\ (1\ min)}$
The octave band spectrum is shown in the graph in the appendix.

5.2 Sound monitoring near the plant on the roof, Location C

Ventilation extract fan motor at 1m
Sound level = 63 dB $L_{Aeq\ (1\ min)}$

5.3 Sound monitoring near the plant on the roof, Location D

Air con large condenser unit at .5m
Sound level = 62 dB $L_{Aeq\ (1\ min)}$

5.4 Sound monitoring near the plant on the roof, Location E

Chiller cool room small condenser unit at .5m
Sound level = 61 dB $L_{Aeq\ (1\ min)}$

5.5 Background noise measurements (see graph at end of report)

This was measured in 5 minute periods , for over 24 hours
The lowest background noise during hours of operation, in level dB L_{A90} occurred at 3.40 pm,

Sound level = 48 dB $L_{A90\ (5\ min)}$

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

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

The lowest background noise level through the night was at 3.25 am,
Background noise level = 47 dB $L_{A90\ (5\ min)}$

It can be seen from the graph that when all the café plant was on the noise level near the residents windows was around 56 dBA $L_{Aeq\ 5\ min}$, combined with the residual noise from other plant nearby and general background noise from traffic etc. (The residual noise with the café plant turned off was 51 dBA $L_{Aeq\ 5\ min}$).
A simple calculation to BS 4142 would indicate then that the source noise needs to be reduced substantially to be at least 10 dBA below the background noise of 48 dBA.

5.6 Initial recommendations.

As the external condensors must be outside, then acoustic enclosures can be designed to attenuate the noise level, and these units can remain on the flat roof. However the fan motors, (of which the kitchen unit already has an acoustic screen but was still the loudest unit measured), are able to be re-located inside the building which is the usual location for the motors in noise sensitive situations close to residents. This is strongly recommended, and they should both be relocated inside in the basement or ground floor, and suitably boxed in if internal noise levels are too loud. The acoustic enclosures will give an attenuation of at least 15 dBA if constructed effectively, and if arranged for the louvres to face away from the residents direction.

5.7 Calculation of noise levels at residents windows. (See Appendix).
The noise levels at the residents are calculated from the measured sound pressure levels of the plant at .5 m, 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 most sensitive residents' window is then used in the BS 4142 assessment to confirm acceptability of the proposal to meet local authority noise criteria.
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", also to various British Standards, including BS 5228 for duty on times assessment for the contribution to the total noise, if applicable. The calculations are for the plant running at maximum, at full duty, and any variable attenuations are calculated as conservative to indicate the worst case condition.

5.8 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 $r^1 = 8$ m (for residents 1 from the units)
$r^0 = .5$ m (for units)
A = 24 dB attenuation

5.9 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). For each reflecting surface a 3 dB increase in noise is indicated. In this case the unit will be flush with the wall of the building, and in a corner with the offices behind, as a worst case calculation.

5.10 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 = $10 \lg (10^{lp1/10} + 10^{lp2/10} + 10^{lp3/10} \ldots\ldots +10^{lpn/10})$

It can be seen that a second unit of similar noise level will give an increase of 3 dB in noise level, and three similar units will result in a 5 dB increase over one single unit.

5.11 Calculation for total new plant noise heard at residents 1,

The total noise can now be calculated from the plant noise at a distance of 8 m,

Condensor noise (measured at .5 m)	= 62 dBA
Less attenuation due to distance	- 24 dB
Less attenuation due to enclosure	- 15 dBA
Addition for reflections from surfaces	+ 6 dBA
Addition for second unit	+ 3 dBA
Total plant noise, with works	32 dBA

The total predicted noise of the plant, if all running together at worst case, at the most sensitive residents' location will be 32 dBA.

5.12 BS 4142 analysis.

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.

From the intended use of hours of operation, 8 am and up to around 10.30 pm, the day time section is considered the most relevant and sensitive.

Day time use 8am - 11 pm

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

Calculated noise level of all plant, existing and new proposed, with residual correction	dB L_{Aeq}	= 32 dBA
Specific noise level of plant	dB L_{Aeq}	= 32 dBA
Correction factor for characteristic including tonality and regularity,		= 0 dBA
Predicted noise level of fans at 1m from facade of most sensitive residents windows		= 32 dBA
Background level lowest (measured)	dB $L_{A90\ (1\ hr)}$	= 48 dBA
Rating level		**= 32 dBA**
Excess of rating level over background		= - 16 dBA

This will be **Acceptable**

This is acceptable according to BS 4142 analysis, with a 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.

5.13 Camden Council usual noise regulations in planning permission, and conditions 4 and 5.

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 16 dBA below the measured background noise, and this is therefore acceptable, with a good safety margin.

5.14 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 32 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 flue extract, and condensors 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. The noise from the plant has also been measured accurately at 1m and .5m away. 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 at the nearest noise sensitive residents. The noise climate was primarily nearby traffic noise. The lowest background noise for the hours of operation, 7 am to 10 pm, was measured as 48 dBA $L_{A90\ 5\ min}$.

6.3 Plant Machinery, and potential noise breakout routes.

Some of the plant has been replaced, and made by reputable manufacturers, and particularly specified to be as quiet running as possible. Some of the plant has simple screens, however this is still not sufficient to reduce the sound level to acceptable levels, as the four major units were clearly audible above the background noise when monitoring at the residents.

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

At present the plant noise needs to be reduced substantially as it is clearly audible above the background noise. The total plant sound level has been measured, calculated, and predicted at the nearest residents' windows to be no more than 32 dBA, as a worst case situation with all plant running at the same time at maximum, if all the recommendations in this report are followed effectively. This is below the measured background level, of 48 dBA, by 16 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 38 dBA, and this will be below the background level by 12 dBA, which is completely acceptable, and has a safety margin of 2 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.

6.6 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 23 dBA. This is well within the acceptable levels with a good safety margin.

6.7 Recommendations for works at 73 Grays Inn road. (see sketches)

A Relocate the main kitchen fan motor and new ventilation fan motor.
These two units are the major source of noise heard at the residents. They should be relocated internally to the basement kitchen or ground floor restaurant , and the ducting outside replaced as a continuous flue. This would remove the major noise sources from outside and internal to the building. If the noise in the kitchen or other location internally is un acceptable to the staff then the unit should be boxed in with plasterboard and timber frame, and lined inside with RW3 rockwool to a depth of 100mm all around; and ensuring there is enough air flow around the motor to prevent overheating and also access panels for maintenance. The silencers can be left outside if more convenient, but preferably located as close to the flat roof as possible; ideally these would be located internally to the building.

B Large acoustic enclosures around each of the condenser units on flat roof.
The two condenser units should each have a large acoustic enclosure built in 18mm plywood, lined with melatech acoustic foam, and with large acoustic louvres as per the sketch in the appendix. There should be plenty of room for air flow and to prevent overheating of the units, and the inlet louvres and outlet louvres should both face away from the residents direction.

C Toilet fans and small ventilation fans.
These will be effectively screened from direct line of sight by the new condenser acoustic enclosure, and are not major noise sources at present.

6.8 Final sound test after works completed.
Regular inspections and interim sound tests are recommended at all major stages of the project to be cost effective and to confirm effective reduction of noise levels.
When all the works are complete a final sound test will confirm that the plant systems are working correctly and there is no excessive noise breakout, and confirm that all the local authority noise planning criteria will have been met. The planning conditions can then be formally cleared.

7 Conclusion and Recommendations.

7.1 The management are refurbishing this building with new external plant. Planning permission has been applied for the installation of new external ventilation and extract plant, following enforcement action. Accordingly, the management have commissioned a professional noise survey and report to assess the potential impact of this new installation for the potential for noise break-out, and to meet planning conditions. This report addresses and gives professional advice on these matters. A previous noise report was issued in 2004 to previous owners but other works have been added and new additional plant installed.

7.2 The background noise levels have been measured at typical times of operation, over a period of 24 hours, and also the noise from the plant close to each of the units, and calculations made to predict the noise level at the residents 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 already 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 works are complete a final sound test will confirm that the plant systems are working correctly and there is no excessive noise breakout, and confirm that all the local authority noise planning criteria will have been met. The planning conditions can then be formally cleared.

Shaun Murkett 21st August 2015

View of Cibo restaurant at
73 Grays Inn road, Holborn.

View of sound level meter
measuring background noise
near residents at rear, on flat roof.

View of ground floor of
cibo restaurant.

Photographs 1 of noise survey at 73 Grays Inn road, Holborn.©

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View of fan motor and duct and flue and also fujitsu air conditioning unit at rear, on flat roof.

View of stainless acoustic screen around fan motor at rear, looking up towards top of flue above roof.

View of new fan motor, and horizontal duct, unscreened, near skylight.

Photographs 2 of noise survey at 73 Grays Inn road, Holborn.©

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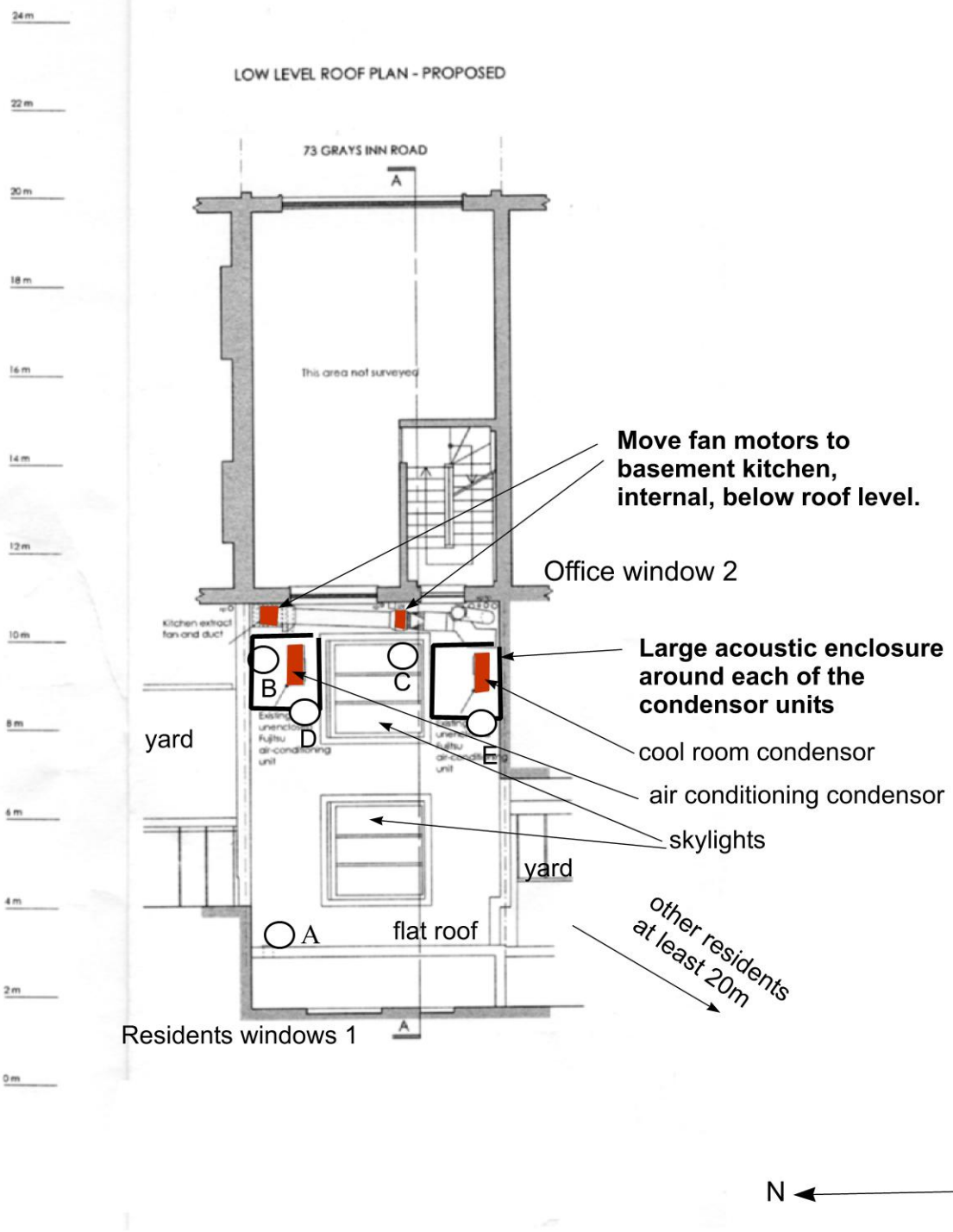

Key

Recommendations are shown in **bold**

Plant position ■

Sound level monitor point ○

Layout of plant at rear of 73 Grays Inn Road, showing recommendations.

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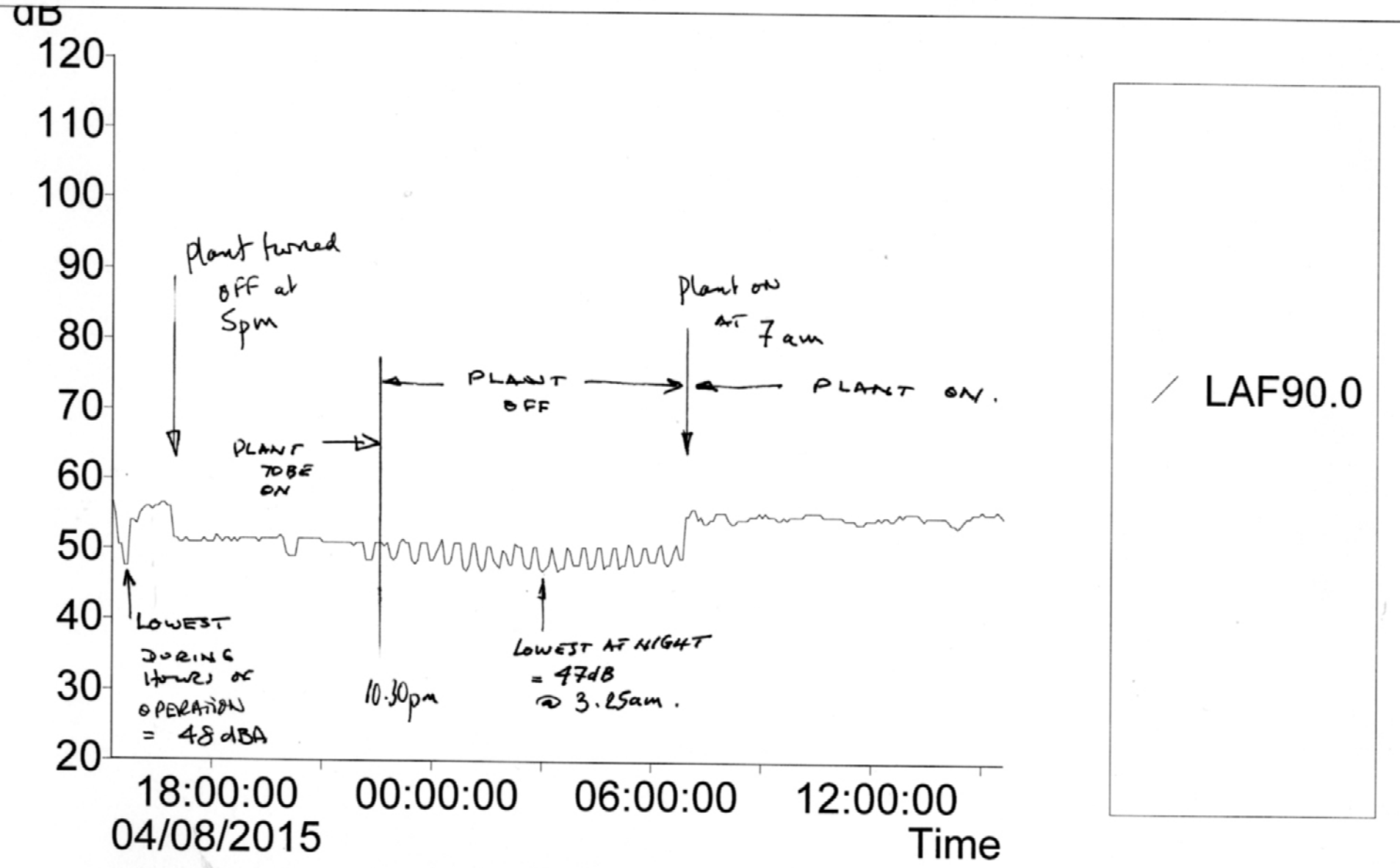

Sound profile of ambient background noise, as dB $L_{A90\ 5\ min}$, measured near residents windows, outside on flat roof at rear of premises, location A
from 3.20 pm in afternoon Tuesday 4th to 3.30pm Wednesday 5th August 2015.
73 Grays Inn road, Holborn, London, WC1.
Lowest background noise in hours of operation (7 am to 11pm) = 48 dBA L_{A90} at 3.40 pm.

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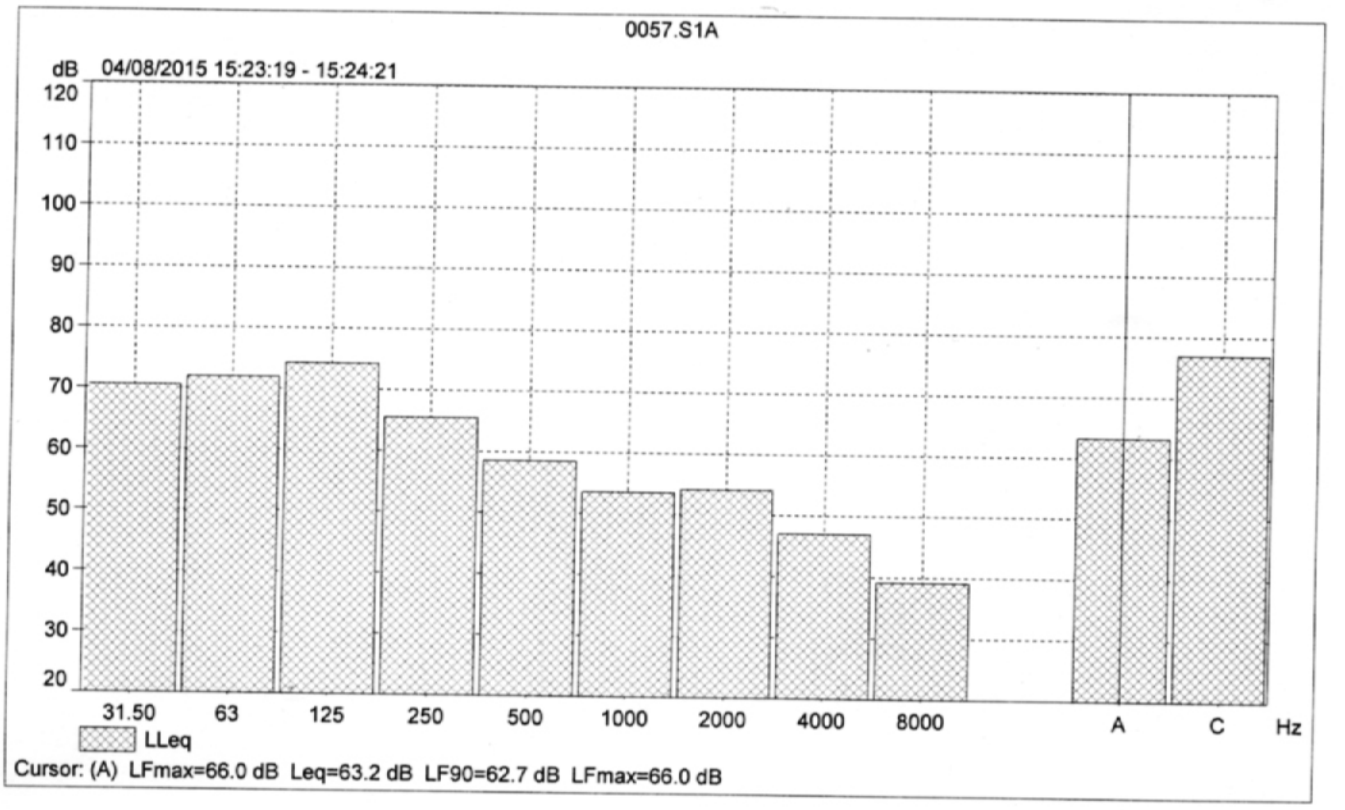

Octave frequency spectrum of noise measured at 1m from plant, main kitchen fan motor and flue, on flat roof.

73 Grays Inn Road , Holborn, London WC1

4th August 2015

Sound level 63 dBA LAeq. 1 min.

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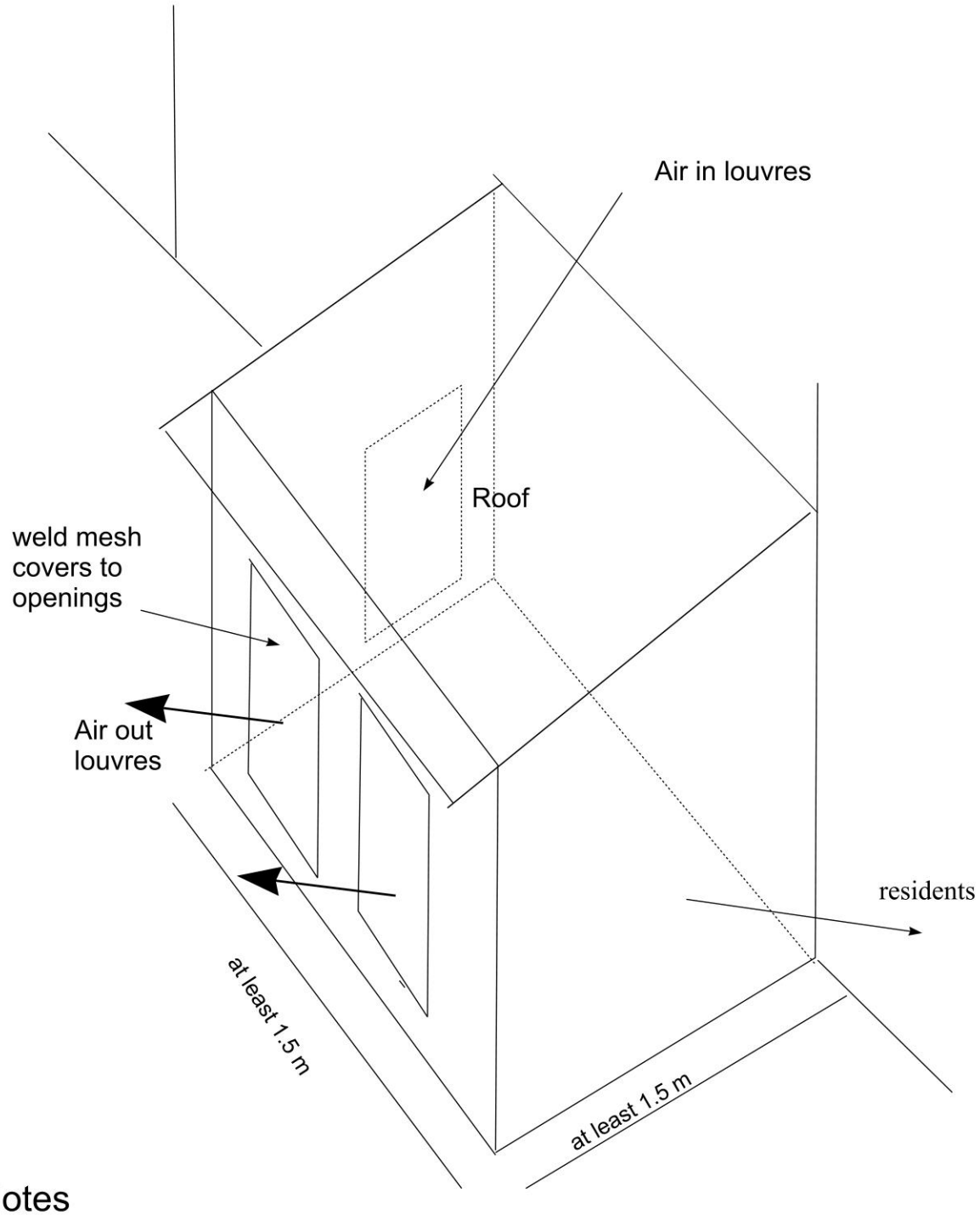

Notes

1 Allow plenty of space around units to prevent over heating

2 Make louvre sections as big and as wide as possible, with 100mm air flow gap between louvres, (see acoustic louvre chevron section sketch).

3 Allow access for maintenance, at front.

4. Auxilliary fans may be needed to assist outgoing air flow internally if enclosures are too small to prevent overheating.

Acoustic enclosure with chevron louvres, general layout sketch.

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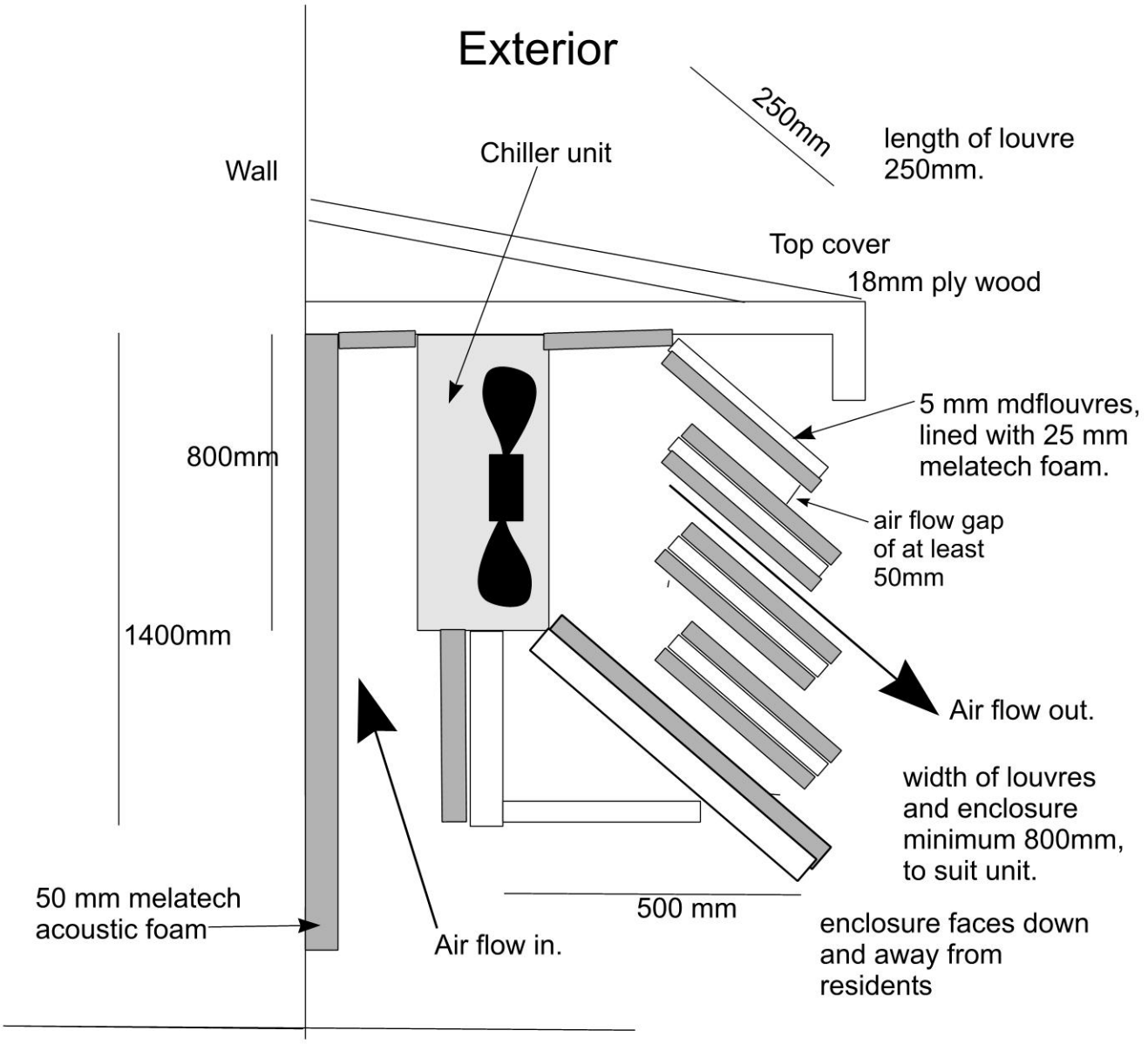

Cross section elevation side view.

Notes

1 This is nominaly a side view, but the same principle holds for plan view; keep the outside opening pointing away from nearest residents, either downwards or sideways, and also for floor mounted units. In some cases the top cover may not be necessary, just a front baffle; refer to report.

2 Tops and sides are required to complete the enclosure so that only one face is open.

3 Use 18 mm plywood and line all inside surfaces with 25 mm melatech acoustic foam (available from Hodgson and hodgson); which is particularly effective

4 Seal all edges and gaps with mastic; make outside weatherproof.

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

Chiller condensor unit, louvred acoustic enclosure

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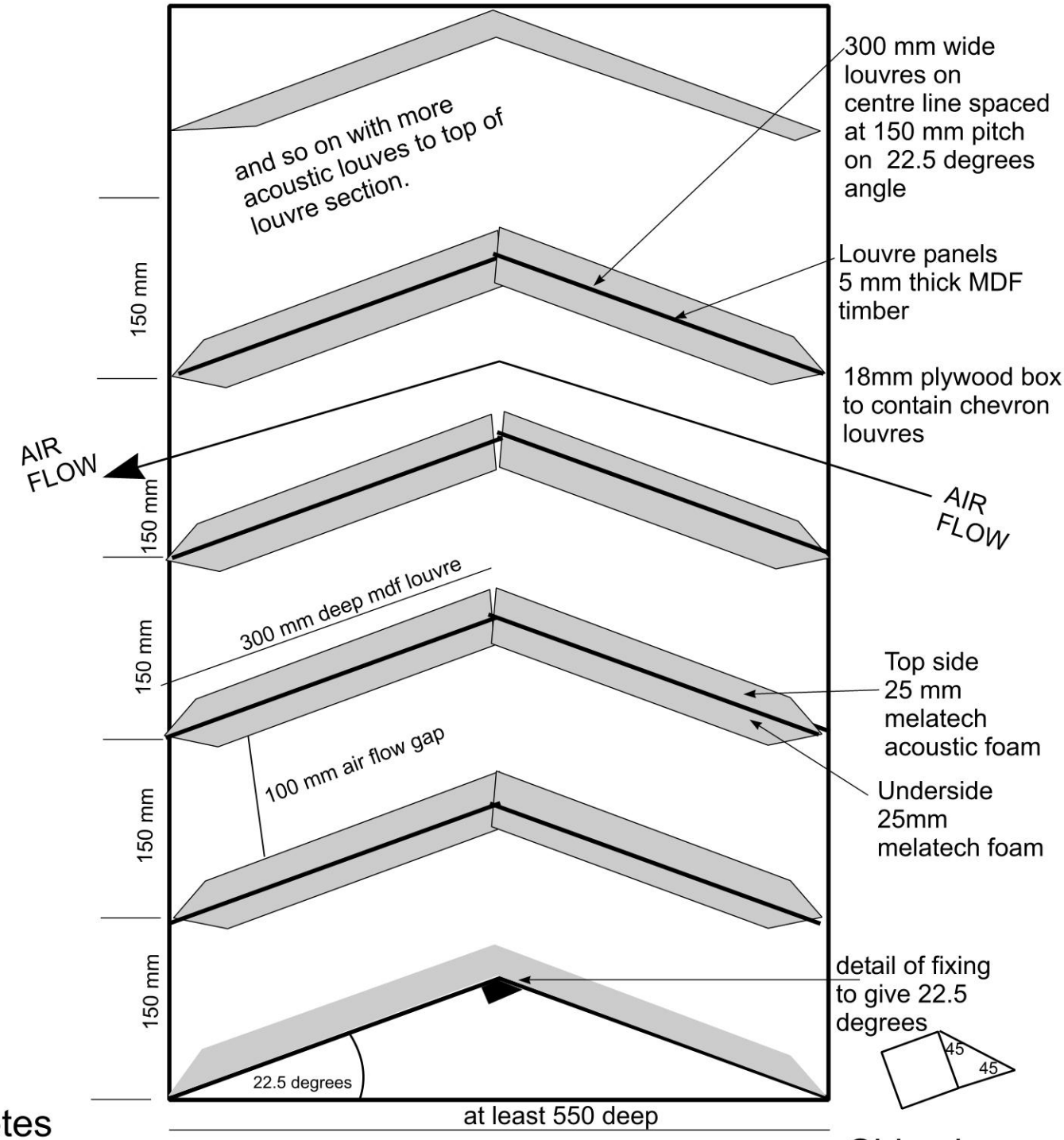

Side view

Notes

1 Acoustic louvre section , height and width to suit front size of plant, at least 550 mm deep, with sides , top, and bottom etc in 18mm plywood .

2 Acoustic louvres, 300 deep of 5 mm mdf , lined on both sides with 25 mm plain AM Melatech acoustic foam (available from Hodgsons, or, (for extract only, 30 mm RW3 rockwool), to allow a 100mm air flow gap. Allow some space from edge of louvres to start of plant.

3 Louvres spaced at 150mm pitch at 22.5 degree angle, (set fixing at centre of 18mm square, with 18mm quarter section of 45 degrees in timber length to give 22.5 degrees angle).

4 Chamfer foam at edge of louvres with sharp knife to increase smooth air flow.

5 Chevron sections may be linked together as advised in report.

Acoustic louvre 22.5 chevron, 550 mm in enclosure for ducts and fans, ventilation systems.

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July 2015