# Rogiet School – Natural ventilation

MACH Acoustics inspirational acoustics

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# Introduction

This report presents MACH Acoustics approach to the design of a naturally ventilated school sandwiched between the M4, the M48 and an intercity train line.

The aim of this report is to highlight MACH Acoustics innovative approach to the design of an attenuated, vented façade and the use of cross ventilation to corridors. The design of these systems is based upon a test rig developed by MACH Acoustics.

This report is formed by combining both MACH Acoustics ventilation Scheme Design and Detailed Design Reports.

**Project Architects - White Design**

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# Introduction

Roget Primary School is located on the border between Wales and England. The proposed site is situated between the M4 and the M48. In addition, the intercity railway between Swansea and London runs close to the school.

From a detailed noise survey undertaken on the 16th January 08, it can be shown that measured environmental noise levels peaked at 65 dBA between 8am and 11am, levels decreased to 50 dBA post 11am.

A key design goal for the school is natural ventilation, this report therefore provides a range of design solutions. The purpose of this document is therefore to present the ventilation strategy for Rogiet School and the acoustic requirements of this scheme.


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# BB93 Requirements

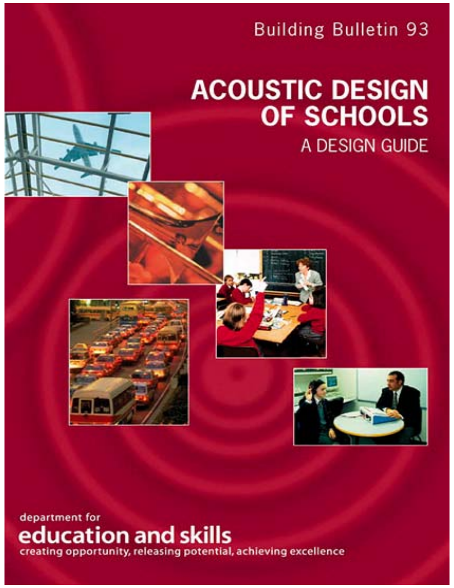
BB93 requirements for classrooms, small group rooms, music rooms and the Hall

- 8L/s/Person allows maximum internal noise levels of 40 dB(A).
- 3L/s/Person allows maximum internal noise levels of 35 dB(A).

The figure over leaf provides BB93's required background noise levels for different spaces within the proposed school.

The figure over leaf provides BB93 background noise requirements at ventilation rates of 3L/s/Person.

Note, zones with blue text and not highlighted with a white background, are non mandatory, therefore figures are advisory only.

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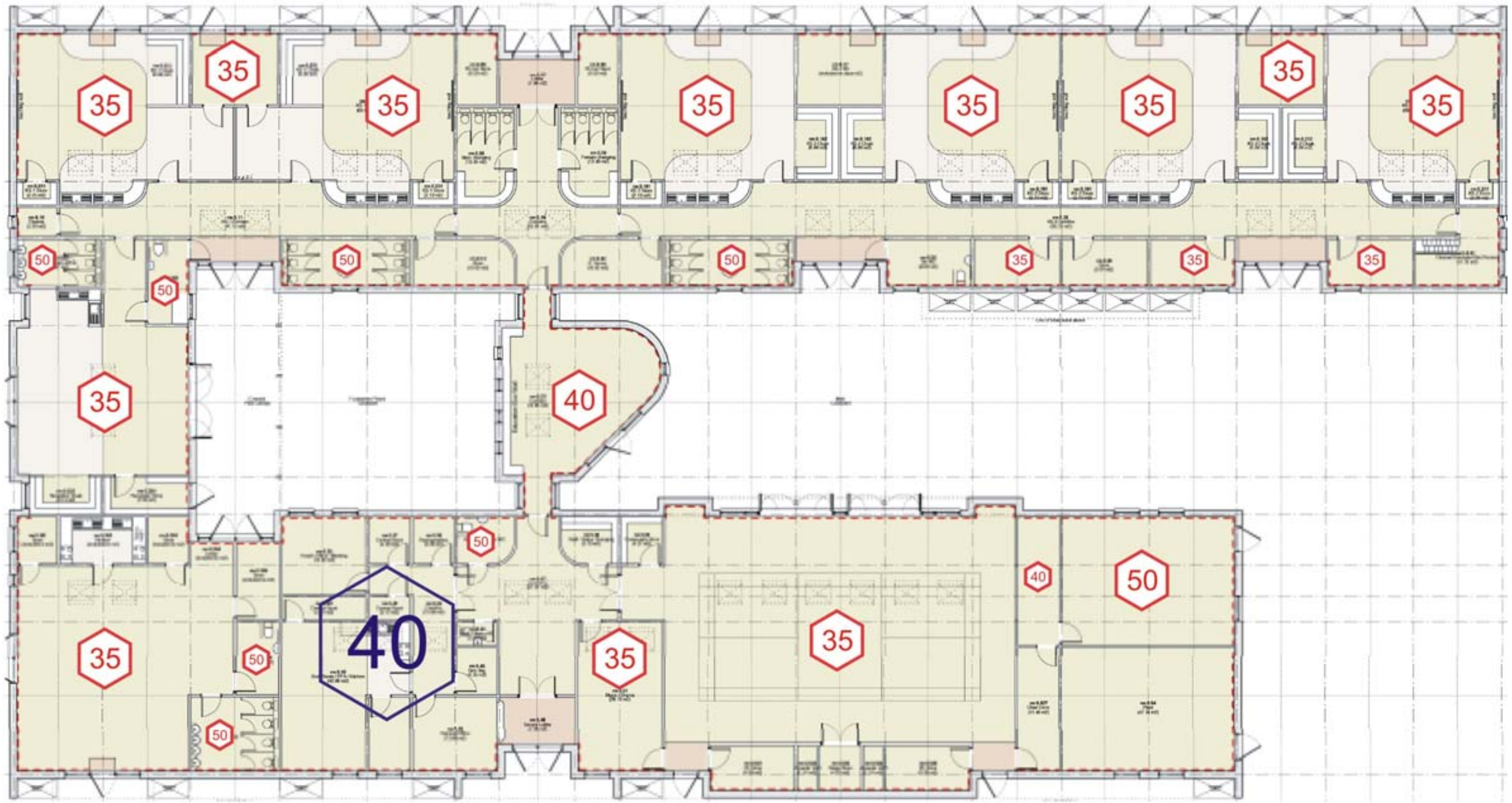
# BB93 Background Noise Requirements




All levels specified in dB(A) $L_{Aeq}$,

5 dB can be added to all levels when ventilation rates are increased to 8l/s/person

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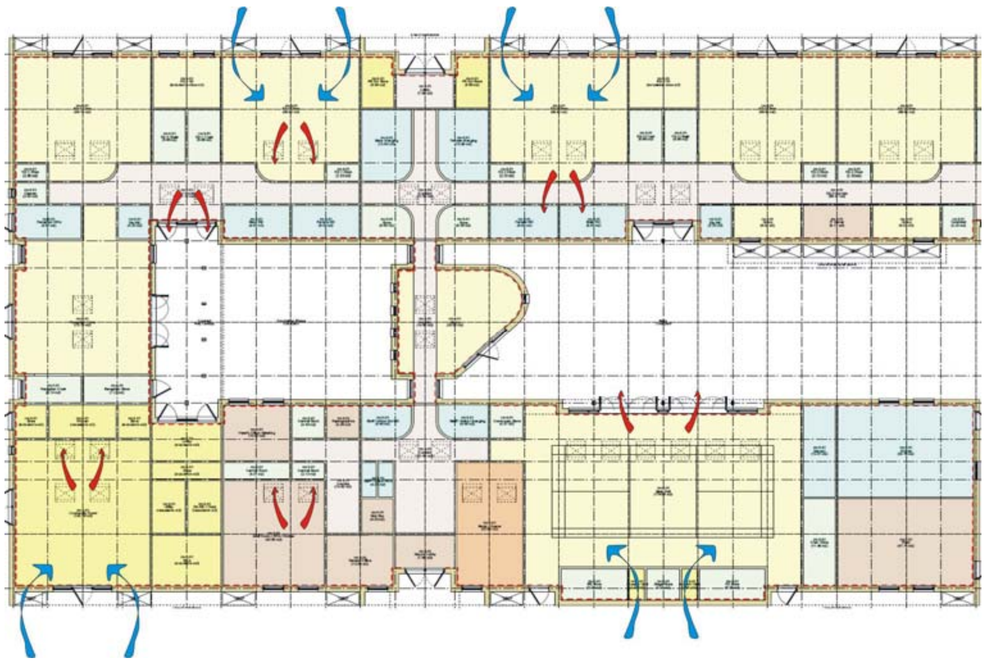
# Ventilating Rogiet

The figure to the right shows the basic ventilation strategy as provided by McCann's.

MACH Acoustics approach has been to work though the ventilation scheme as a team. From here, detailed designs have been developed.

One of the Key Design Requirements is the free area of both the air supply and extract points. This information is presented within the attenuator schedules given below.



INLET OULET

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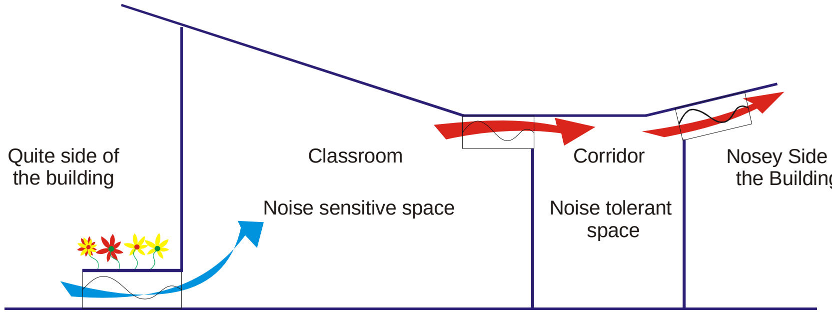
# Ventilation Scheme

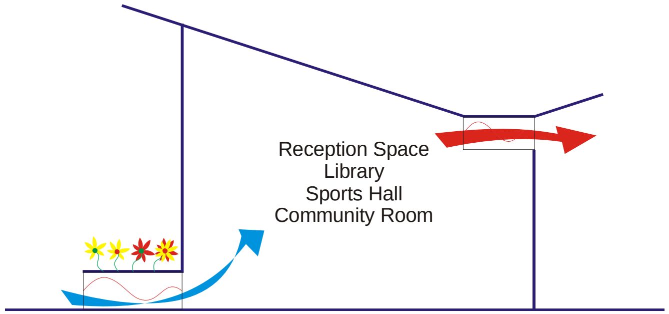
Simplistically, two ventilation schemes have been used within this development.

**Classroom** – Classrooms to the north facing façade are on the quieter side of the development.  In this location, planters, sand pits and water butts are used to hide attenuators controlling the ingress of noise to classrooms.

Cross ventilation is then achieved by means of attenuators within bulk heads above a cloakroom area.

**Other Teaching Spaces** – The same/similar attenuated opening are used on other spaces.  Due to the layout of the building, cross ventilation is achieved across most spaces other than classrooms.

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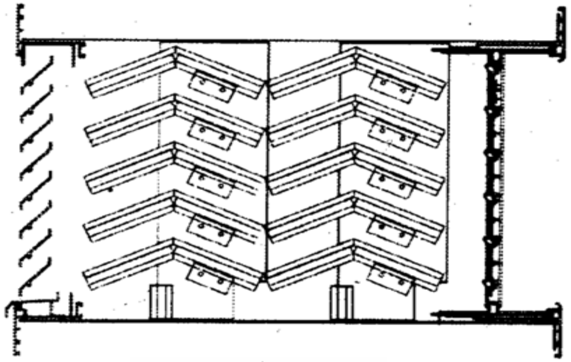
# Design Option

As part of the design process, several design options where reviewed, from passivent attenuated openings, acoustics louvers, attenuated wind catchers, acoustics screens etc.

Even though these systems offered good levels of sound reduction, BB93 internal levels could not be met.  Additionally, these systems did not provide sufficient architectural design flexibility.

The solution to this issue has been to design a simple, inexpensive bespoke system.  Here, a range of design options where reviewed, from vertical fins between classrooms, attenuation within the roof void, attenuators located under the slab etc.

passivent



$D_{new}$ (dB) = 26

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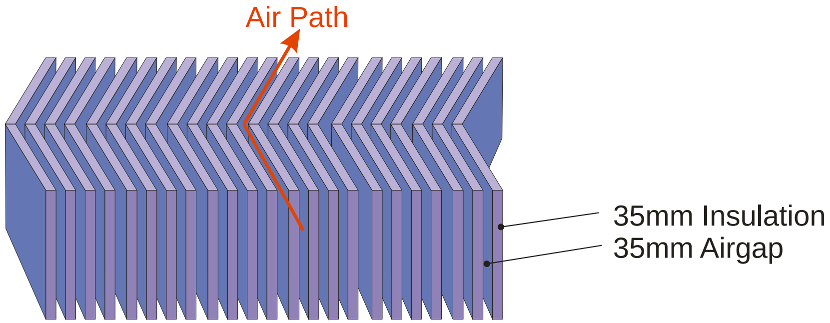
# Bespoke Attenuator

MACH Acoustics therefore developed a range of high performance natural ventilation attenuators. These attenuators where designed using a test rig complying with BS EN ISO 7235:2003 ‘Acoustics – Laboratory measurement procedures for ducted silencers and air-terminal units - Insertion loss, flow noise and total pressure loss’

The proposed schematic design of the air inlet attenuator is provided below.




Dimensions - 2m length, 600mm deep and 600mm high

MACH Acoustics Test Rig EN ISO 7235 :2003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# Cross Ventilation to Corridors

Cross ventilation has already been successfully used within previous MACH Acoustic designs.

BB93 requires that these vents achieve 39 dB $D_{ne,w}$. Based upon MACH Acoustics recently published paper 'An overview of on site test results of classroom corridor walls, including the effects of doors, glazing and ventilators, post BB93', it can be shown that this figure can be reduced to 34 dB $D_{ne,w}$, with no detriment to the performance of the separating wall. MACH Acoustics therefore used BB93 'Alternative performance standards' to achieve a change in the design targets for this school.

Once again, MACH Acoustics attenuator test rig was used to design a set of natural vent cross talk attenuators.


Cross Ventilation from a classroom


Cross Ventilation to a circulation spaces

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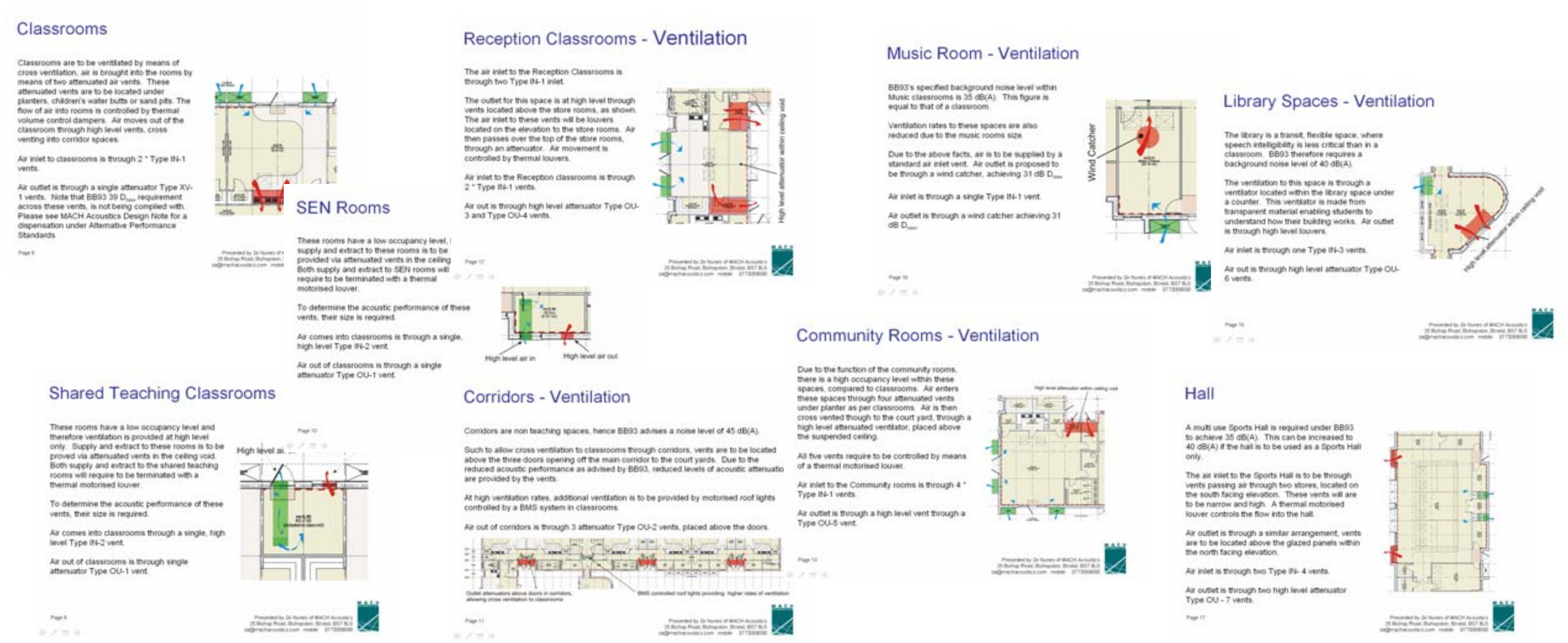
# Classrooms

Once the acoustic performance requirement had been established  a summary page for all teaching spaces was provided.  This page contained a summary of the ventilation scheme, The type of attenuator used per teaching space and basic sizes.





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# Attenuator Schedules

To supplement the teaching spaces summary two schedules where provided. The first indicated the classrooms and their associated attenuators, the free area of these attenuators as provided by McCanns, and whether a thermal damper was required in combination with the attenuator

The second schedule once again provided the free area and the required insertion loss for each attenuator type

| | Inlet | | | | | Outlet | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Inlet Attenuator type | No of units | VCD Required | Free Area | Size W H | Outlet Attenuator Type | No of units | VCD | Free Area | Size W H |
| Classrooms | In – 1 | 2 | Y | 0.36 $m^2$ | 1473 mm 530 mm | Xv – 1 | 1 | N | 0.375 $m^2$ | 3000 mm 250 mm |
| Group Rooms | In – 2 | 1 | Y | TBA | TBA | Ou – 1 | 1 | Y | TBA | TBA |
| SEN Room | In – 2 | 1 | Y | TBA | TBA | Ou - 1 | 1 | Y | TBA | TBA |
| Corridor | - | | | | | Ou – 2 | 1 | Y | TBA | TBA |
| Reception | In – 1 | 2 | Y | 0.36 $m^2$ | 1473 mm 530 mm | Ou – 3 Ou – 4 | | | | |
| Community Room | In – 1 | 4 | Y | 0.36 $m^2$ | 1473 mm 530 mm | Ou – 5 | | | | |
| Office Accommodation | By Others | | | | | | | | | |
| Library | In – 3 | 1 | Y | 0.27 $m^2$ | TBA | Ou – 6 | | | | |
| Music | In – 1 | 1 | Y | 0.36 $m^2$ | 1473 mm 530 mm | | | | | |
| Hall | In – 4 | 2 | Y | 0.44 $m^2$ | 1000 mm 880 mm | Ou - 7 | | | | |

| Type | Free Air | Attenuator Insertion loss measured to BS EN ISO 7235:2003 | | | | | |
|---|---|---|---|---|---|---|---|
| | | 125 Hz | 250 Hz | 500 Hz | 1K Hz | 2K Hz | 4K Hz |
| IN – 1 | 0.36 $m^2$ | 1 dB | 2 dB | 12 dB | 20 dB | 15 dB | 15 dB |
| IN -2 | TBA | TBA | TBA | TBA | TBA | TBA | TBA |
| IN - 3 | TBA | TBA | TBA | TBA | TBA | TBA | TBA |
| IN – 4 | 0.4 $m^2$ | 4 dB | 7 dB | 23 dB | 32 dB | 30 dB | 35 dB |
| Wind Catcher | TBA | $D_{new}$ 31 dB | | | | | |
| XV – 1 | 0.39 $m^2$ | 3 dB | 7 dB | 22 dB | 30 dB | 30 dB | 30 dB |
| OU – 1 | TBA | TBA | TBA | TBA | TBA | TBA | TBA |
| OU – 2 | TBA | TBA | TBA | TBA | TBA | TBA | TBA |
| OU – 3 | 0.28 $m^2$ | 2 dB | 5 dB | 20 dB | 30 dB | 28 dB | 25 dB |
| OU – 4 | 0.28 $m^2$ | 2 dB | 5 dB | 20 dB | 30 dB | 28 dB | 25 dB |
| OU – 5 | 0.72 $m^2$ | 2 dB | 5 dB | 20 dB | 30 dB | 28 dB | 25 dB |
| OU – 6 | 0.39 $m^2$ | 1 dB | 2 dB | 9 dB | 17 dB | 12 dB | 12 dB |
| OU - 7 | 0.4 $m^2$ | 4 dB | 7 dB | 23 dB | 32 dB | 30 dB | 35 dB |

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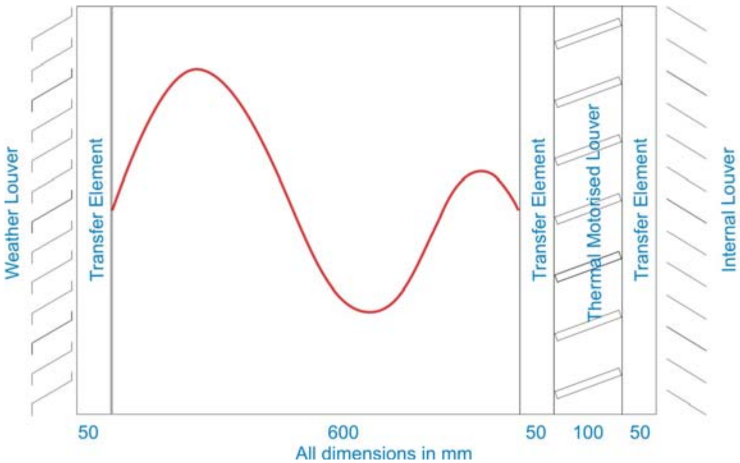
# Vent Schematic

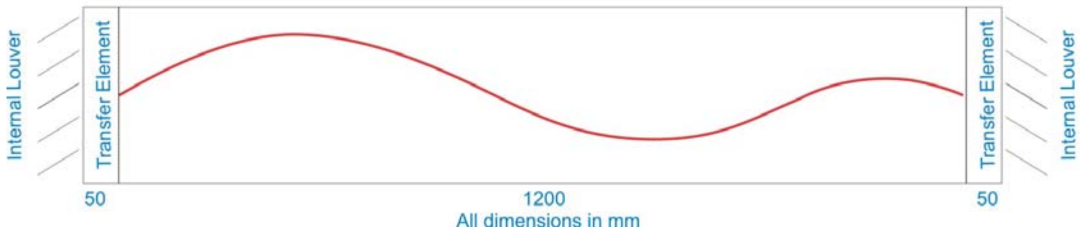
As a conclusion, a basic schematic of each of the attenuators was drawn.  Note, not all attenuators are provided below

Indicative detail – not to scale




**Type In-1**
Supply to Most Teaching Spaces

Cross Section
1473mm (w) By 530 mm (h)




**Type XT-1**
Cross Vents to Classrooms

Cross Section
3000mm (w) By 250 mm (h)

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# Classroom Noise Break-In Calculations

| | Calculated Noise Ingress | | 125 | 250 | 500 | 1000 | 2000 | 4000 | A |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Noise levels | | 55.7 | 52.1 | 55.6 | 62.4 | 54.5 | 43.3 | 63.7 |
| | Shading | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| | 3dB Safety | 3 dB | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| | Noise Level at Façade | | 58.7 | 55.1 | 58.6 | 65.4 | 57.5 | 46.3 | 66.7 |
| | Calculation of enviromental noise break-in | | | | | | | | |
| | L2 = L0 - R + 10*log(S/A) + 3dB (Freefield version) | | | | | | | | |
| | Calculated A = 0.16V/RT | | | | | | | | |
| | Volume = | 240 m3 | | | | | | | |
| | RT | 0.6 | | | | | | | |
| | Absorption | 65.2 | | | | | | | |
| | 10log A | | 18.1 | 18.1 | 18.1 | 18.1 | 18.1 | 18.1 | |
| | 10logS | | 15.8 | 15.8 | 15.8 | 15.8 | 15.8 | 15.8 | |
| | 10logS/A | | -2.4 | -2.4 | -2.4 | -2.4 | -2.4 | -2.4 | |
| | **FAÇADE Elements** | | | | | | | | |
| | **Façade Area** | 37.8 m2 | | | | | | | |
| 1 | Glazing Area, S | 10.5 m2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | |
| 31 | Double glazed 6/12/6 | | 20 | 19 | 29 | 38 | 36 | 45 | |
| | | | 0.0100 | 0.0126 | 0.0013 | 0.0002 | 0.0003 | 0.0000 | |
| | Predicted noise level in building from glazing | | 33.8 | 31.2 | 24.7 | 22.5 | 16.6 | -3.6 | 27.9 |
| 2 | Solid Façade | 27 m2 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | |
| | From INSUL | | 33 | 46 | 54 | 59 | 58 | 58 | |
| | | | 0.0005 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | |
| | Predicted noise level through solid façade | | 24.8 | 8.2 | 3.7 | 5.5 | -1.4 | -12.6 | 11.5 |
| 3 | Air Inlet Vent | | 7 | 10 | 14 | 15 | 11 | 10 | |
| | Attenuation Required | 0.70 m2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| | | | 2 | 3.8 | 13.1 | 16.8 | 16.8 | 15.3 | |
| | | | 0.6310 | 0.4169 | 0.0490 | 0.0209 | 0.0209 | 0.0295 | |
| | Predicted noise level through vent+B81 | | 40.0 | 34.6 | 28.8 | 31.9 | 24.0 | 14.3 | 34.7 |
| 4 | Chimney e14 | Ao/S | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | |
| | Dne | | 20.5 | 26.8 | 34.9 | 38.1 | 37.9 | 42.7 | |
| | | | 0.0090 | 0.0021 | 0.0003 | 0.0002 | 0.0002 | 0.0001 | |
| | Predicted noise level through trickle vent ` | Lff-Dne+10log(A0/A)+K | 33.1 | 23.2 | 18.6 | 22.1 | 14.4 | -1.6 | 25.0 |
| | Combined Noise Levels (1+2+3) | | 41.7 | 36.4 | 30.5 | 32.8 | 25.1 | 14.5 | 35.9 |
| | **Target dB(A) Level** | | | | | | | | 35.9 |
| | | | | | | | | | Pass |

| | Calculated Noise Ingress | | 125 | 250 | 500 | 1000 | 2000 | 4000 | A |
|---|---|---|---|---|---|---|---|---|---|
| | Measured Noise levels | | 55.7 | 52.1 | 55.6 | 62.4 | 54.5 | 43.3 | 63.7 |
| | Shading | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| | 3dB Safety | 3 dB | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | |
| | Noise Level at Façade | | 58.7 | 55.1 | 58.6 | 65.4 | 57.5 | 46.3 | 66.7 |
| | Calculation of enviromental noise break-in | | | | | | | | |
| | L2 = L0 - R + 10*log(S/A) + 3dB (Freefield version) | | | | | | | | |
| | Calculated A = 0.16V/RT | | | | | | | | |
| | Volume = | 240 m3 | | | | | | | |
| | RT | 0.6 | | | | | | | |
| | Absorption | 65.2 | | | | | | | |
| | 10log A | | 18.1 | 18.1 | 18.1 | 18.1 | 18.1 | 18.1 | |
| | 10logS | | 15.8 | 15.8 | 15.8 | 15.8 | 15.8 | 15.8 | |
| | 10logS/A | | -2.4 | -2.4 | -2.4 | -2.4 | -2.4 | -2.4 | |
| | **FAÇADE Elements** | | | | | | | | |
| | **Façade Area** | 37.8 m2 | | | | | | | |
| 1 | Glazing Area, S | 10.5 m2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | |
| 31 | Double glazed 6/12/6 | | 20 | 19 | 29 | 38 | 36 | 45 | |
| | | | 0.0100 | 0.0126 | 0.0013 | 0.0002 | 0.0003 | 0.0000 | |
| | Predicted noise level in building from glazing | | 33.8 | 31.2 | 24.7 | 22.5 | 16.6 | -3.6 | 27.9 |
| 2 | Solid Façade | 27 m2 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | |
| | From INSUL | | 33 | 46 | 54 | 59 | 58 | 58 | |
| | | | 0.0005 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | |
| | Predicted noise level through solid façade | | 24.8 | 8.2 | 3.7 | 5.5 | -1.4 | -12.6 | 11.5 |
| 3 | Air Inlet Vent | | 7 | 10 | 14 | 15 | 11 | 10 | |
| | Attenuation Required | 0.70 m2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| | | | 2 | 3.8 | 13.1 | 16.8 | 16.8 | 15.3 | |
| | | | 0.6310 | 0.4169 | 0.0490 | 0.0209 | 0.0209 | 0.0295 | |
| | Predicted noise level through vent+B81 | | 40.0 | 34.6 | 28.8 | 31.9 | 24.0 | 14.3 | 34.7 |
| 4 | Chimney e14 | Ao/S | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | |
| | Dne | | 21.6 | 19.8 | 21.1 | 23.5 | 26.8 | 32.8 | |
| | | | 0.0069 | 0.0105 | 0.0077 | 0.0044 | 0.0021 | 0.0005 | |
| | Predicted noise level through trickle vent ` | Lff-Dne+10log(A0/A)+K | 32.0 | 30.2 | 32.3 | 36.7 | 25.5 | 8.4 | 37.9 |
| | Combined Noise Levels (1+2+3) | | 41.5 | 37.2 | 34.4 | 38.1 | 28.2 | 15.4 | 39.9 |
| | **Target dB(A) Level** | | | | | | | | 39.9 |
| | | | | | | | | | Pass |

All noise break in calculations are based upon a standard calculation to BS8233

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