

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

Rogiet 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.



BB93 Requirements

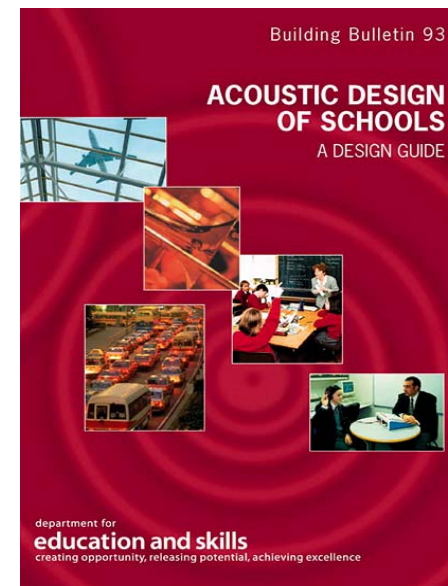
BB93 requirements for classrooms, small group rooms, music rooms and the Hall

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

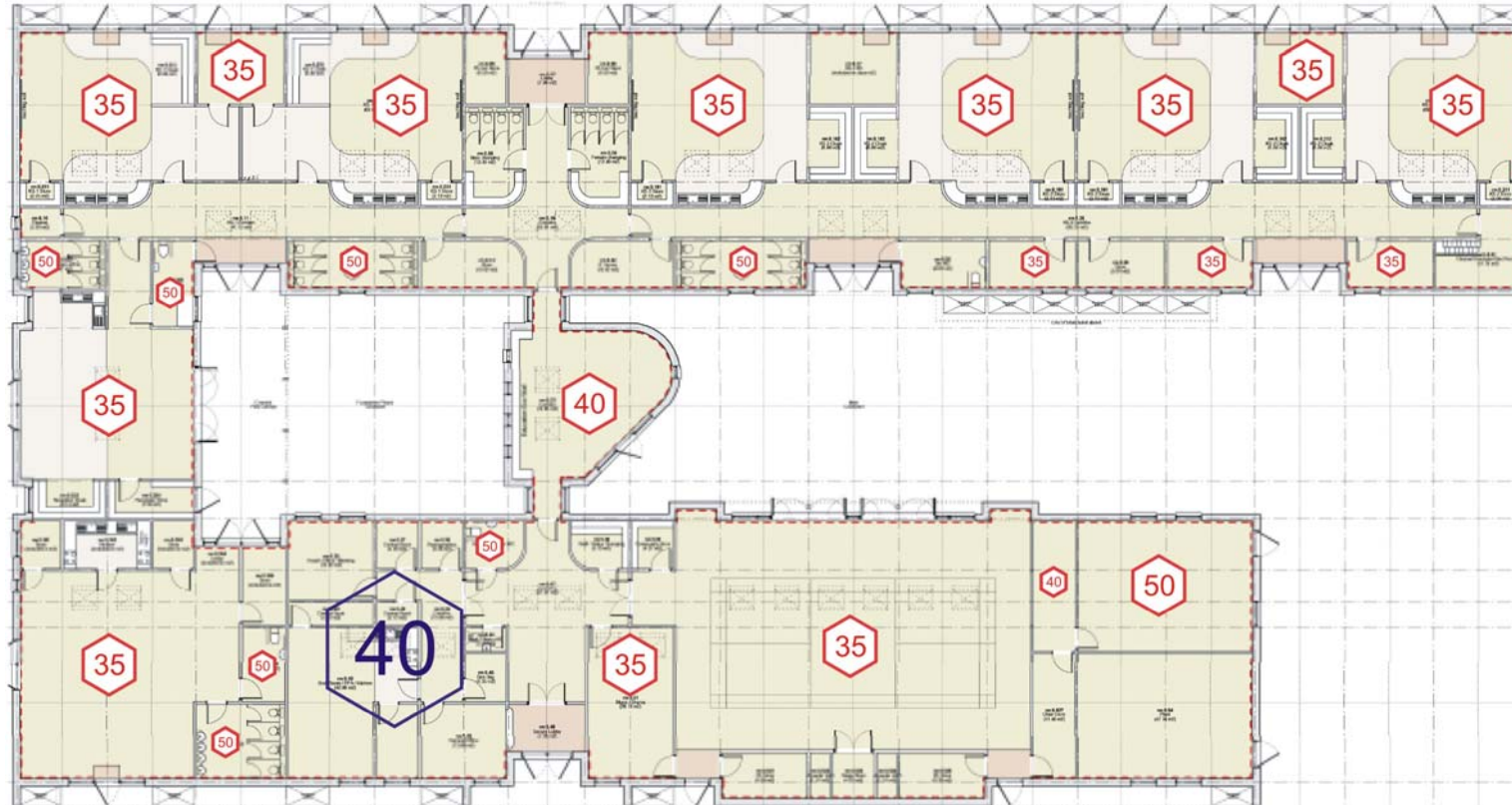
The figure over leaf provides BB93's required background noise levels for different spaces within the proposed school.

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.



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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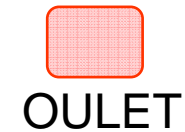
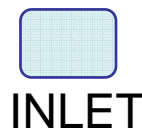
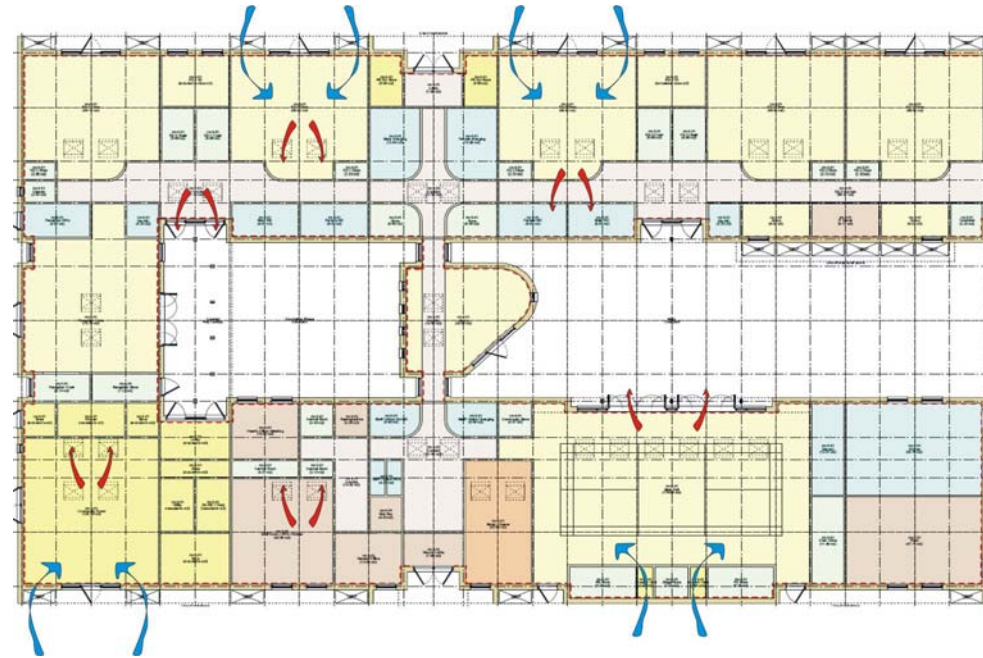


Ventilating Rogiet

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

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

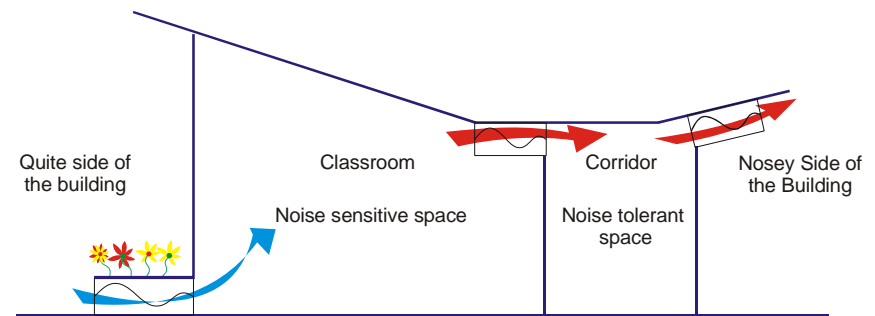
One of the Key Design Requirements is the free area of both the air supply and extract points. This information is presented within the attenuator schedules given below.



Ventilation Scheme

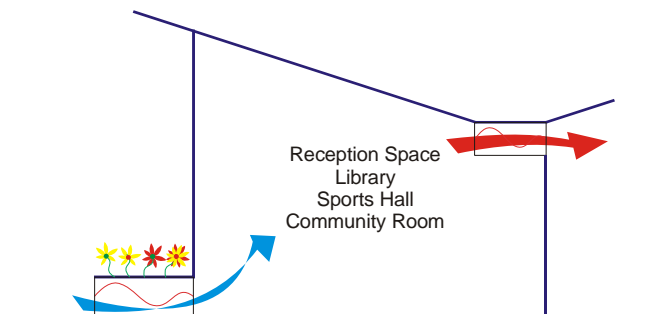
Simplistically, two ventilation schemes have been used within this development.

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.



Design Option

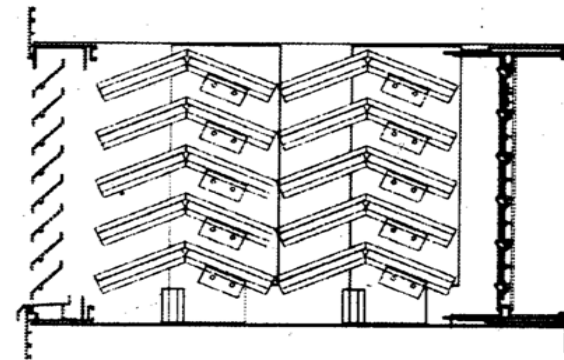
As part of the design process, several design options were reviewed, from passive attenuated openings, acoustics louvers, attenuated wind catchers, acoustics screens etc.

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 were reviewed, from vertical fins between classrooms, attenuation within the roof void, attenuators located under the slab etc.



passivent

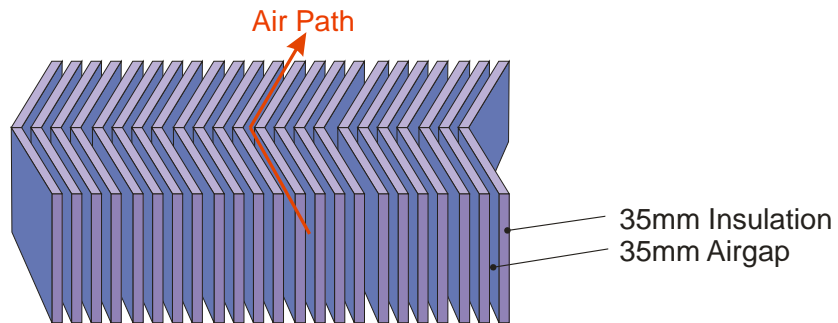


D_{new} (dB) = 26

Bespoke Attenuator

MACH Acoustics therefore developed a range of high performance natural ventilation attenuators. These attenuators were 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

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MACH Acoustics Test Rig EN ISO 7235 :2003



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

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.

Classrooms

Classrooms are to be ventilated by means of cross ventilation, air is brought into the rooms by means of two attenuated air vents. These attenuated vents are to be located under planters, children's water baths or sand pits. The flow of air into rooms is controlled by thermal volume control dampers. Air moves out of the classroom through high level vents, cross venting into corridor spaces.

Air inlet to classrooms is through 2" Type IN-1 vents.

Air outlet is through a single attenuator Type XV-1 vents. Note that BB93 39 D_{max} requirement across these vents, is not being complied with. Please see MACH Acoustics Design Note for a dispensation under Alternative Performance Standards.



SEN Rooms

These rooms have a low occupancy level, supply and extract to these rooms is to be provided via attenuated vents in the ceiling. Both supply and extract to SEN rooms will require to be terminated with a thermal motorised louvre.

To determine the acoustic performance of these vents, their size is required.

Air comes into classrooms through a single, high level Type IN-2 vent.

Air out of classrooms is through a single attenuator Type OU-1 vent.

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Shared Teaching Classrooms

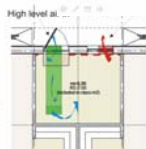
These rooms have a low occupancy level and therefore ventilation is provided at high level only. Supply and extract to these rooms is to be provided via attenuated vents in the ceiling void. Both supply and extract to the shared teaching rooms will require to be terminated with a thermal motorised louvre.

To determine the acoustic performance of these vents, their size is required.

Air comes into classrooms through a single, high level Type IN-2 vent.

Air out of classrooms is through single attenuator Type OU-1 vent.

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Reception Classrooms - Ventilation

The air inlet to the Reception Classrooms is through two Type IN-1 inlet.

The outlet for this space is at high level through vents located above the store rooms, as shown. The air inlet to these vents will be louvers located on the elevation to the store rooms. Air then passes over the top of the store rooms, through an attenuator. Air movement is controlled by thermal louvers.

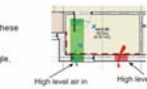
Air inlet to the Reception classrooms is through 2" Type IN-1 vents.

Air out is through high level attenuator Type OU-3 and Type OU-4 vents.



High level attenuator within ceiling void

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Corridors - Ventilation

Corridors are non teaching spaces, hence BB93 advises a noise level of 45 dB(A).

Such to allow cross ventilation to classrooms through corridors, vents are to be located above the three doors opening off the main corridor to the court yards. Due to the reduced acoustic performance as advised by BB93, reduced levels of acoustic attenuators are provided by the vents.

At high ventilation rates, additional ventilation is to be provided by motorised roof lights controlled by a BMS system in classrooms.

Air out of corridors is through 3 attenuator Type OU-2 vents, placed above the doors.



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Music Room - Ventilation

BB93's specified background noise level within Music classrooms is 35 dB(A). This figure is equal to that of a classroom.

Ventilation rates to these spaces are also reduced due to the music rooms size.

Due to the above facts, air is to be supplied by a standard air inlet vent. Air outlet is proposed to be through a wind catcher, achieving 31 dB D_{max}.

Air inlet is through a single Type IN-1 vent.

Air outlet is through a wind catcher achieving 31 dB D_{max}.



Wind Catcher

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Community Rooms - Ventilation

Due to the function of the community rooms, there is a high occupancy level within these spaces, compared to classrooms. Air enters these spaces through four attenuated vents under planter as per classrooms. Air is then cross vented through to the court yard, through a high level attenuated ventilator, placed above the suspended ceiling.

All five vents require to be controlled by means of a thermal motorised louvre.

Air inlet to the Community rooms is through 4" Type IN-1 vents.

Air outlet is through a high level vent through a Type OU-5 vent.



High level attenuator within ceiling void

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Hall

A multi use Sports Hall is required under BB93 to achieve 35 dB(A). This can be increased to 40 dB(A) if the hall is to be used as a Sports Hall only.

The air inlet to the Sports Hall is to be through vents passing air through two stores, located on the south facing elevation. These vents will also be narrow and high. A thermal motorised louvre controls the flow into the hall.

Air outlet is through a similar arrangement, vents are to be located above the glazed panels within the north facing elevation.

Air inlet is through two Type IN-4 vents.

Air outlet is through two high level attenuator Type OU-7 vents.

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High level attenuator within ceiling void

Library Spaces - Ventilation

The library is a transit, flexible space, where speech intelligibility is less critical than in a classroom. BB93 therefore requires a background noise level of 40 dB(A).

The ventilation to this space is through a ventilator located within the library space under a counter. This ventilator is made from transparent material enabling students to understand how their building works. Air outlet is through high level louvers.

Air inlet is through one Type IN-3 vents.

Air out is through high level attenuator Type OU-6 vents.



High level attenuator within ceiling void

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Attenuator Schedules

To supplement the teaching spaces summary two schedules were 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

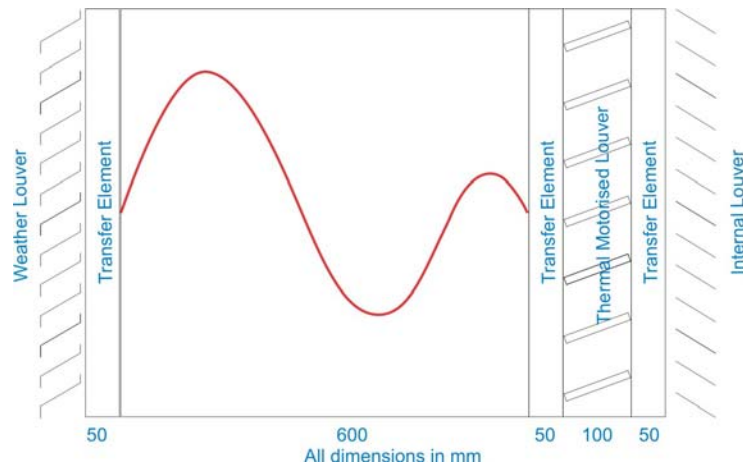
The second schedule once again provided the free area and the required insertion loss for each attenuator type

	Inlet					Outlet					Attenuator Insertion loss measured to BS EN ISO 7235:2003							
	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	Type	Free Air	125 Hz	250 Hz	500 Hz	1K Hz	2K Hz	4K Hz
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					IN - 1	0.36 m ²	1 dB	2 dB	12 dB	20 dB	15 dB	15 dB
Office Accommodation	By Others										IN - 2	TBA	TBA	TBA	TBA	TBA	TBA	TBA
Library	In - 3	1	Y	0.27 m ²	TBA	Ou - 6					IN - 3	TBA	TBA	TBA	TBA	TBA	TBA	TBA
Music	In - 1	1	Y	0.36 m ²	1473 mm 530 mm						IN - 4	0.4 m ²	4 dB	7 dB	23 dB	32 dB	30 dB	35 dB
Hall	In - 4	2	Y	0.44 m ²	1000 mm 880 mm	Ou - 7					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



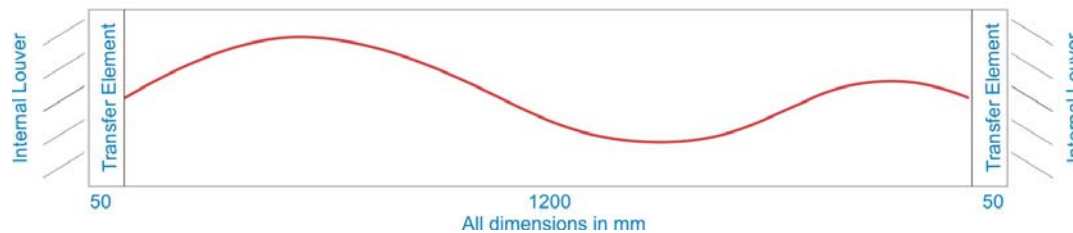
Vent Schematic

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



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)

Indicative detail – not to scale

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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 environmental 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	
317 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		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 environmental 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	
317 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		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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