Overheating: Approved Document O

Building regulation in England setting standards for overheating in new residential buildings.

apexacoustics

H|M HILSON MORAN

INKLING

CIBSE
Building Simulation Group

CIBSE Building Simulation Awards

Extension announced earlier this week!

Winners will be announced at an event as part of the **Build2Perform** programme, **29th November**

October 2022

M	T	W	T	F	S	N
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

Overheating: Approved Document O – Speakers

Susie Diamond
Inkling

Ben Abel
Hilson Moran

Jack Harvie-Clark
Apex Acoustics

About Inkling

- Building Physics Consultancy
  - Susie Diamond
  - Claire Das Bhaumik
- Services
  - Design stage overheating risk assessments for all building types now including Part O reports
  - Thermal performance and TM54 analyses
  - NABERS modelling and Independent Design Review (IDR) services
  - Advanced HVAC modelling
  - Part L2A compliance modelling and advice
  - Research
- www.inklingllp.com

Part O

- Came into force June 15th 2022 (with some transitional arrangements)

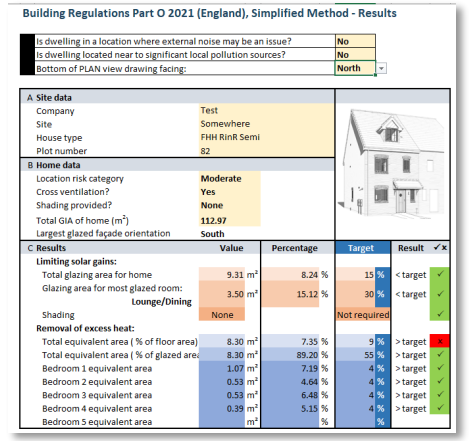
June 2022

M	T	W	T	F
		1	2	3
6	7	8	9	10
13	14	15	16	17
20	21	22	23	24
27	28	29	30	

- Applies to all new homes including care homes, boarding schools and student accommodation
- Aimed at reducing overheating risk

Two routes to compliance

- Simplified method
  - Quicker and easier
  - More prescriptive
  - Focus on glazing areas and free areas



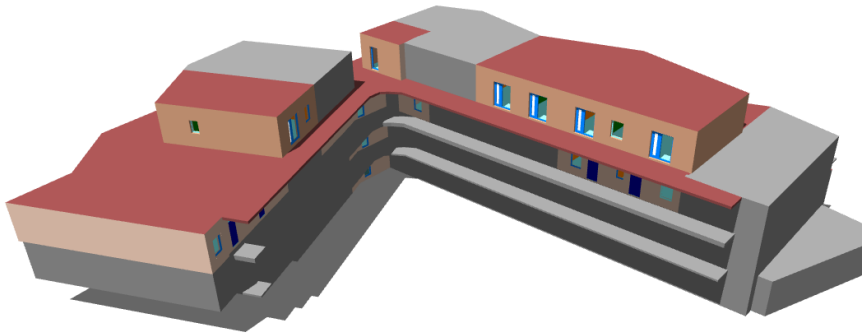
Building Regulations Part O 2021 (England), Simplified Method - Results

Is dwelling in a location where external noise may be an issue?	No
Is dwelling located near to significant local pollution sources?	No
Bottom of PLAN view drawing facing:	North

A Site data	
Company	Test
Site	Somewhere
House type	FHH RinR Semi
Plot number	82
B Home data	
Location risk category	Moderate
Cross ventilation?	Yes
Shading provided?	None
Total GIA of home (m^2)	112.97
Largest glazed façade orientation	South

C Results	Value	Percentage	Target	Result ✓×
Limiting solar gains:				
Total glazing area for home	9.31 m^2	8.24 %	15 %	< target ✓
Glazing area for most glazed room: Lounge/Dining	3.50 m^2	15.12 %	30 %	< target ✓
Shading	None		Not required	✓
Removal of excess heat:				
Total equivalent area (% of floor area)	8.30 m^2	7.35 %	9 %	> target ×
Total equivalent area (% of glazed area	8.30 m^2	89.20 %	55 %	> target ✓
Bedroom 1 equivalent area	1.07 m^2	7.19 %	4 %	> target ✓
Bedroom 2 equivalent area	0.53 m^2	4.64 %	4 %	> target ✓
Bedroom 3 equivalent area	0.53 m^2	6.48 %	4 %	> target ✓
Bedroom 4 equivalent area	0.39 m^2	5.15 %	4 %	> target ✓
Bedroom 5 equivalent area	m^2	%	%	

- Dynamic thermal modelling method
  - Follows CIBSE TM59
  - Needs specialist modelling software and experienced modeller
  - More flexibility
  - More location specific



Additional requirements - noise

- Noise limits set for bedrooms at night only

> **3.3** Windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits.
>
> a. 40dB $L_{Aeq,T}$, averaged over 8 hours (between 11pm and 7am).
>
> b. 55dB L_{AFmax}, more than 10 times a night (between 11pm and 7am).

- Many existing UK homes exceed these criteria
- Passive solutions are often still possible
- Mechanical ventilation/cooling solutions may be needed at night
- ANC/IOC Guide: association-of-noise-consultants.co.uk/demonstrating-compliance-with-the-noise-requirements-of-approved-document-o/

Additional requirements - security

- Windows relied upon for night-time ventilation must be secure
- Bedrooms on ground floors or that are easily accessible can be made secure with:
  - Fixed or lockable louvred shutters
  - Fixed or lockable grilles or railings




Additional requirements - protection from falling

Windows that open more than 100mm must also:

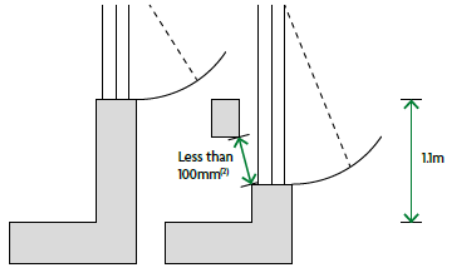
- Have handles that operate with a maximum reach outwards of 650mm from inside face of wall
- Sill heights or guarding >1100mm (acceptable build tolerance is +0 / - 100mm)

Guarding can include:

- Shutters with a child –proof lock
- Fixed guarding
- But should not allow children to easily climb it

Table 3.1 Guarding heights

Change in floor level between inside and outside	Guarding height[1]
Less than 600mm	See Approved Document K
More than 600mm	1.1m

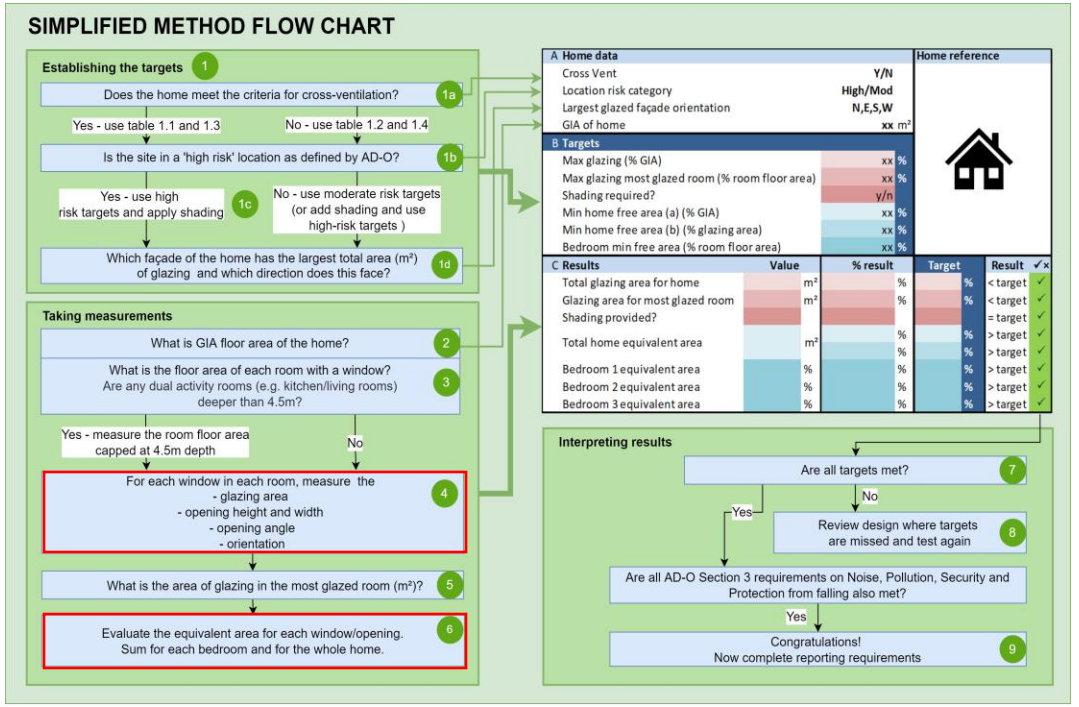


NOTES:

1. This approved document has increased levels of protection from falling compared to Approved Document K. Where applicable, the higher standard applies.
2. Guarding should be sized to prevent the passage of a 100mm sphere.

Simplified method

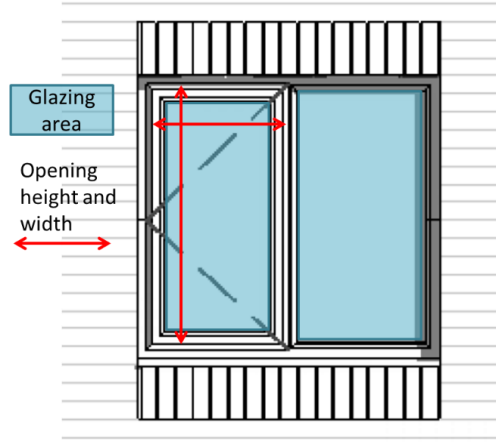
- Not ‘simple’
- All units must be assessed
- Two requirements
  - Maximum limits on glazing areas (plus shading in London)
  - Minimum limits of free areas
- These targets vary depending on
  - Location of the site
  - Presence of cross-ventilation
  - Orientation of most glazed facade
  - The floor area of the unit (GIA), bedrooms and most glazed room

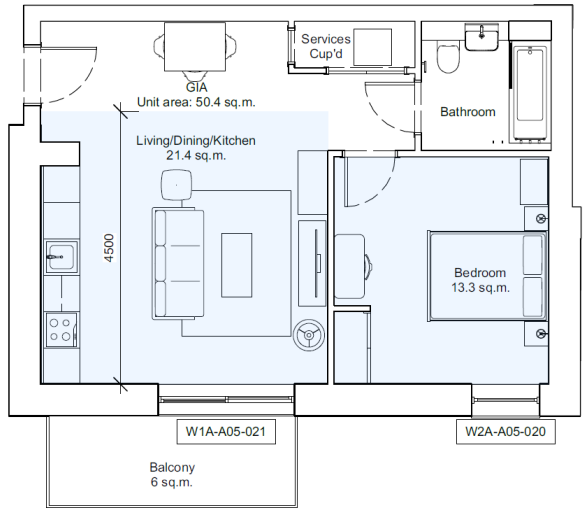


Simplified method

Detailed measurements needed for each unit & each window

- Glazed area (m²) for each window pane
- Width and height of each sash opening
- Any restrictors or opening limits
- Floor area for each room
- GIA of whole home
- Equivalent areas calculated by tool

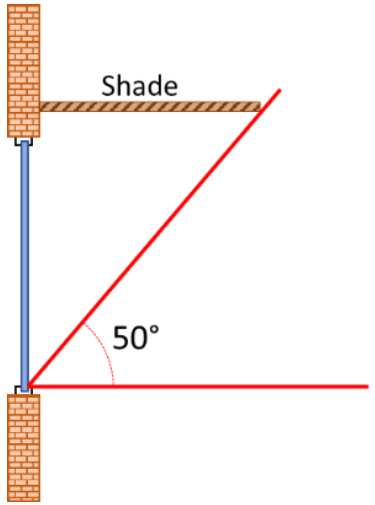




Simplified method

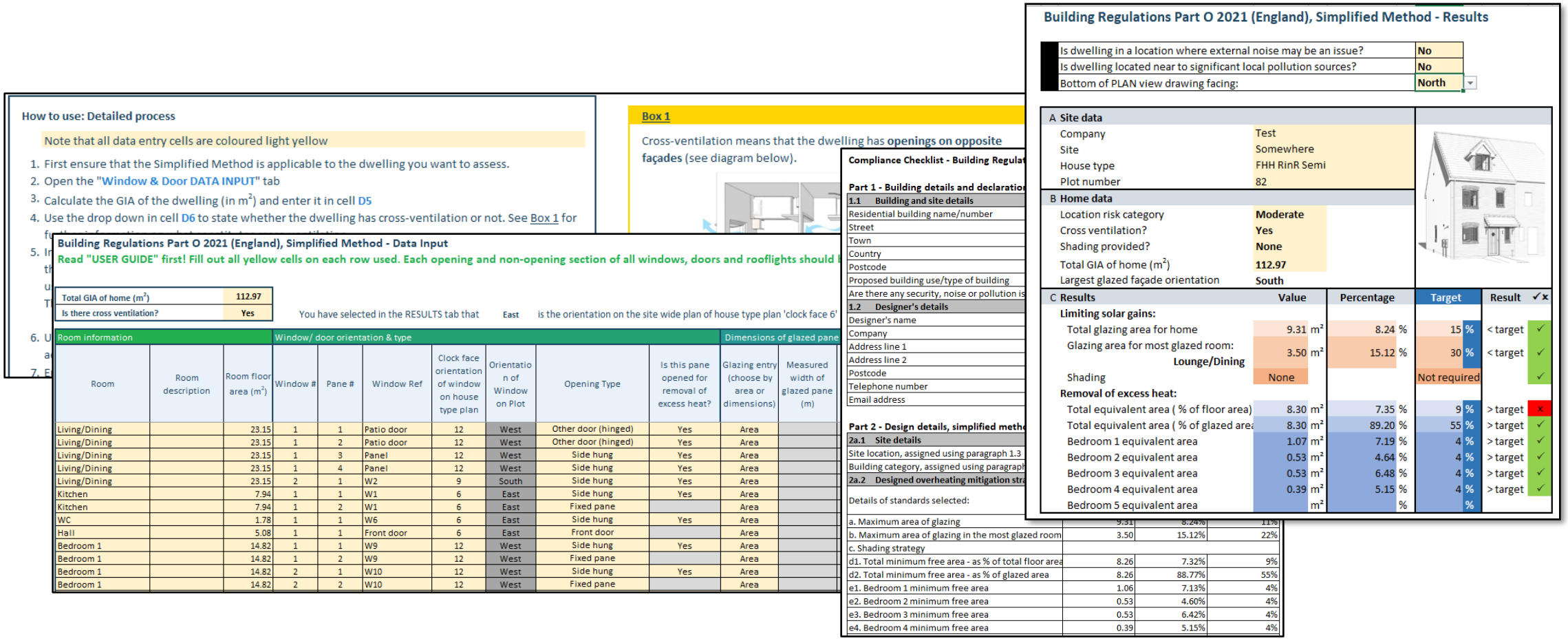
Shading

- Required in London
  - External shutters with means of ventilation
  - Glazing with low-g specification (<0.4) – centre-pane
  - Overhangs to south-facing facades
- Applies to all glazing orientated NE to NW via South



Simplified method – FHH spreadsheet

Available from the Future Homes Hub website futurehomes.org.uk/guidance



How to use: Detailed process

Note that all data entry cells are coloured light yellow

1. First ensure that the Simplified Method is applicable to the dwelling you want to assess.
2. Open the "Window & Door DATA INPUT" tab
3. Calculate the GIA of the dwelling (in m^2) and enter it in cell D5
4. Use the drop down in cell D6 to state whether the dwelling has cross-ventilation or not. See Box 1 for

Box 1

Cross-ventilation means that the dwelling has **openings on opposite façades** (see diagram below).

Building Regulations Part O 2021 (England), Simplified Method - Data Input

Read "USER GUIDE" first! Fill out all yellow cells on each row used. Each opening and non-opening section of all windows, doors and rooflights should

Total GIA of home (m^2)	112.97
Is there cross ventilation?	Yes

You have selected in the RESULTS tab that East is the orientation on the site wide plan of house type plan 'clock face 6'

Room information			Window/ door orientation & type							Dimensions of glazed pane	
Room	Room description	Room floor area (m^2)	Window #	Pane #	Window Ref	Clock face orientation of window on house type plan	Orientation of Window on Plot	Opening Type	Is this pane opened for removal of excess heat?	Glazing entry (choose by area or dimensions)	Measured width of glazed pane (m)
Living/Dining		23.15	1	1	Patio door	12	West	Other door (hinged)	Yes	Area	
Living/Dining		23.15	1	2	Patio door	12	West	Other door (hinged)	Yes	Area	
Living/Dining		23.15	1	3	Panel	12	West	Side hung	Yes	Area	
Living/Dining		23.15	1	4	Panel	12	West	Side hung	Yes	Area	
Living/Dining		23.15	2	1	W2	9	South	Side hung	Yes	Area	
Kitchen		7.94	1	1	W1	6	East	Side hung	Yes	Area	
Kitchen		7.94	1	2	W1	6	East	Fixed pane		Area	
WC		1.78	1	1	W6	6	East	Side hung	Yes	Area	
Hall		5.08	1	1	Front door	6	East	Front door		Area	
Bedroom 1		14.82	1	1	W9	12	West	Side hung	Yes	Area	
Bedroom 1		14.82	1	2	W9	12	West	Fixed pane		Area	
Bedroom 1		14.82	2	1	W10	12	West	Side hung	Yes	Area	
Bedroom 1		14.82	2	2	W10	12	West	Fixed pane		Area	

Compliance Checklist - Building Regulat

Part 1 - Building details and declaratio

1.1 Building and site details	
Residential building name/number	
Street	
Town	
Country	
Postcode	
Proposed building use/type of building	
Are there any security, noise or pollution is	
1.2 Designer's details	
Designer's name	
Company	
Address line 1	
Address line 2	
Postcode	
Telephone number	
Email address	

Part 2 - Design details, simplified meth

2a.1 Site details			
Site location, assigned using paragraph 1.3			
Building category, assigned using paragraph			
2a.2 Designed overheating mitigation str			
Details of standards selected:			
a. Maximum area of glazing	9.31	8.24%	11%
b. Maximum area of glazing in the most glazed room	3.50	15.12%	22%
c. Shading strategy			
d1. Total minimum free area - as % of total floor area	8.26	7.32%	9%
d2. Total minimum free area - as % of glazed area	8.26	88.77%	55%
e1. Bedroom 1 minimum free area	1.06	7.13%	4%
e2. Bedroom 2 minimum free area	0.53	4.60%	4%
e3. Bedroom 3 minimum free area	0.53	6.42%	4%
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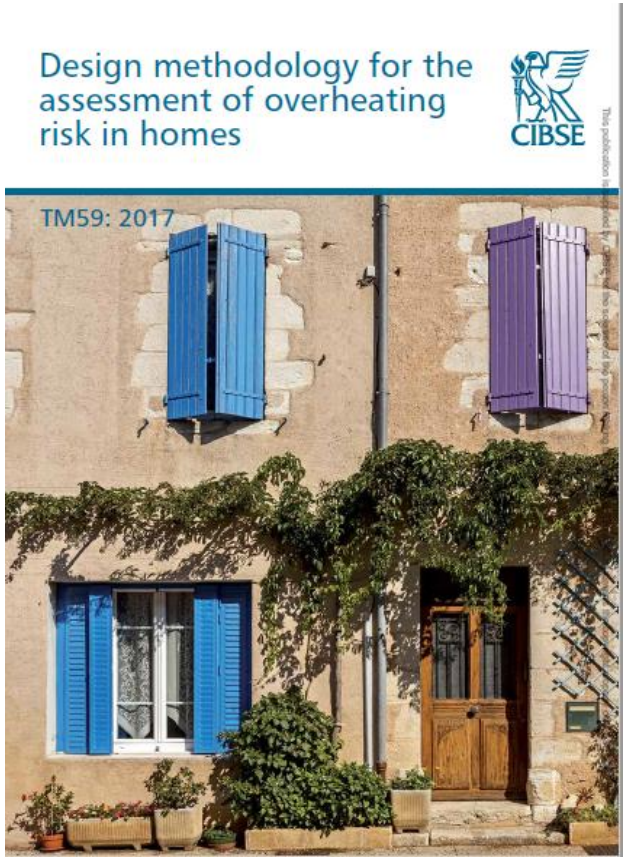
Dynamic Thermal Modelling method

- Assess sample set of units
- Based on CIBSE TM59 (two criteria)
- Results for each occupied room
- Modeller should provide commentary on spaces that don't pass

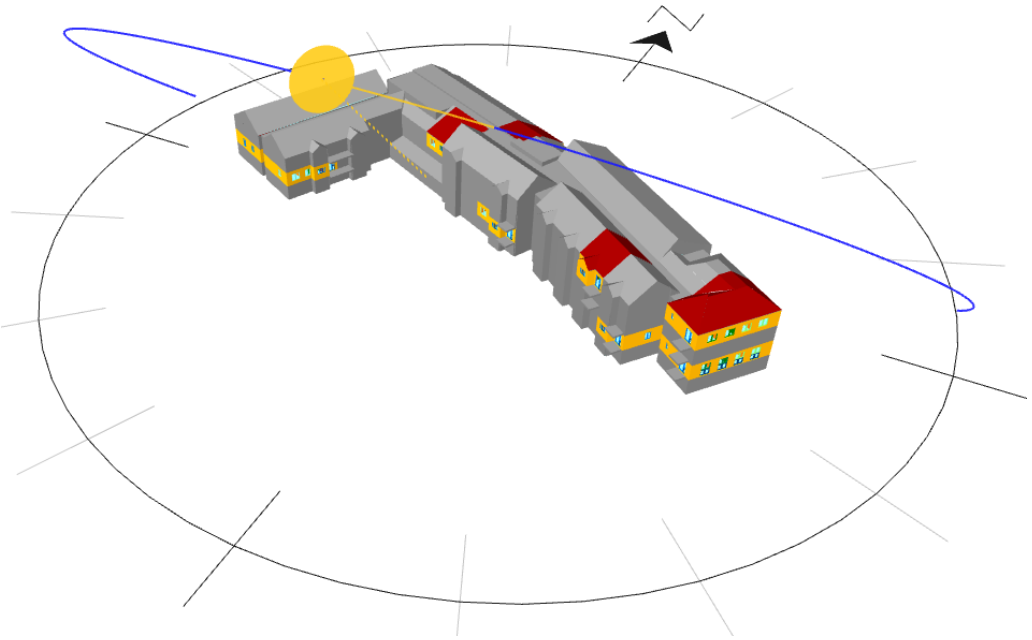
Zone Name	Occupied Summer Hours	Max. Exceedable Hours	Criterion 1: #Hours Exceeding Comfort Range	Max Exceedable Night Hours	Criterion 2: Number of Night Hours Exceeding 26 °C for Bedrooms.	Result
A_Bedroom	3672	110	58	32	74	Fail
A_Kitchen	1989	59	22	N/A	N/A	Pass
A_Living	1989	59	23	N/A	N/A	Pass
B_Bedroom 1	3672	110	18	32	42	Fail
B_Bedroom 2	3672	110	21	32	63	Fail
B_LKD	1989	59	24	N/A	N/A	Pass



Dynamic Thermal Modelling method

Selecting a sample of units

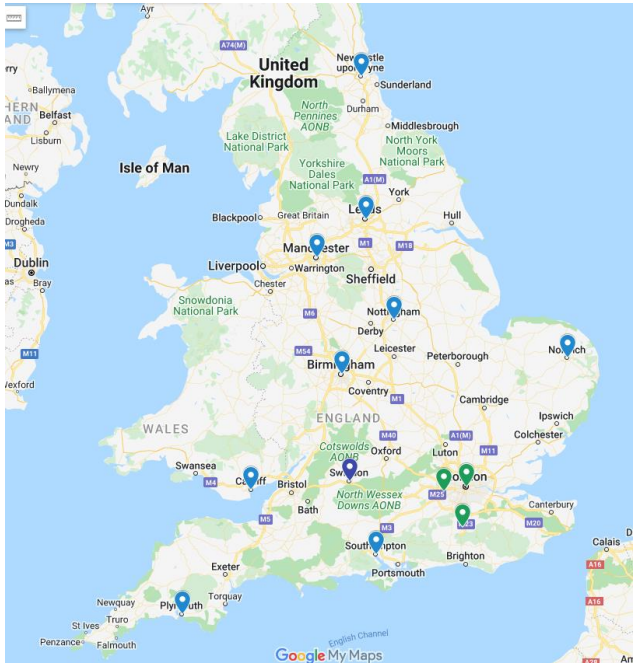
- Units with highest risk of overheating
- Most solar exposure (glazing area vs shading, orientation)
- Lowest free areas or greatest constraints to opening windows
- Covering all unit types
- Attention to ground floor (security)
- GHA one page tool helpful for informing choice



Dynamic Thermal Modelling method

Weather data

- Local to site
- CIBSE 2020s High emissions, 50th %ile DSY1



Natural ventilation

- Reflects weather, window design and cross-ventilatic potential

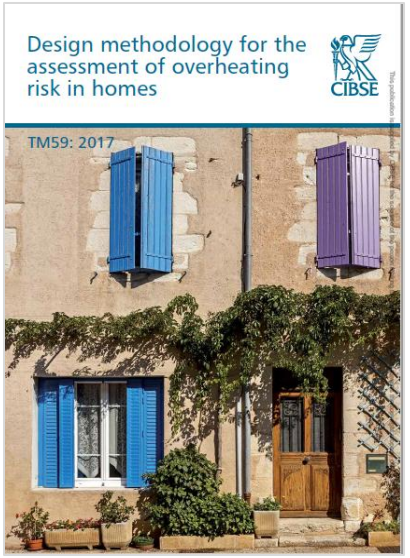
More Design Options

- Ceiling fans
- External shading devices
- Mechanical ventilation and/or cooling

Dynamic Thermal Modelling method

Differences to original TM59

- Small changes to how window openings are modelled:
  - Daytime openings gradual from Tin 22-26°C
  - Bedroom windows open all night if bedroom>23°C at 11pm
- **No internal blinds or curtains!**



Reporting requirements

A compliance checklist must be completed for building control

- FHH template for simplified method results
- Detailed modelling report required under dynamic modelling method

Compliance Checklist - Building Regulations Part O (England), Simplified Method

Part 1 - Building details and declarations

1.1 Building and site details	
Residential building name/number	
Street	
Town	
Country	
Postcode	
Proposed building use/type of building	
Are there any security, noise or pollution issues?	
1.2 Designer's details	
Designer's name	
Company	
Address line 1	
Address line 2	
Postcode	
Telephone number	
Email address	

Part 2 - Design details, simplified method

2a.1 Site details			
Site location, assigned using paragraph 1.3	Moderate Risk		
Building category, assigned using paragraph 1.4			
2a.2 Designed overheating mitigation strategy			
Details of standards selected:	This dwelling		Target
	m^2	%	%
a. Maximum area of glazing	9.31	8.24%	11%
b. Maximum area of glazing in the most glazed room	3.50	15.12%	22%
c. Shading strategy			
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Which method?

Simplified

- Cheaper to assess
- No specialist software needed
- No experienced modeller needed
- All units must be assessed

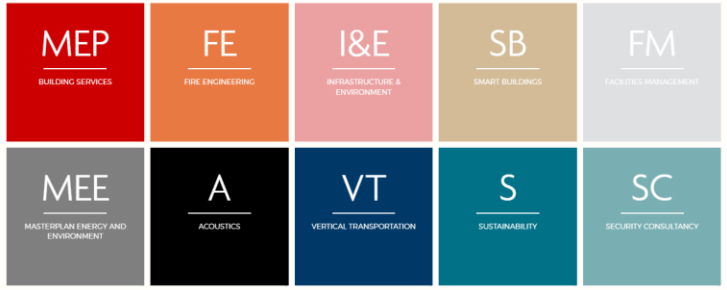
Dynamic thermal modelling

- More design flexibility
- Choice of weather file to match site location
- Smaller sample of units assessed
- Easier to pass?

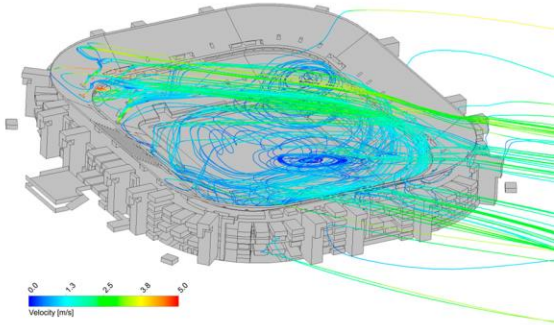
Resources

- GHA One-page early design tool for:
  - Existing homes
  - Retrofit
- CIBSE TM59
- Future Homes Hub Guidance
- ANC/IOA Guidance on noise
- DLUHC FAQs
- Inkling blogs!

About Hilson Moran



- Multi-disciplinary engineering practice
- Building physics modelling specialist
- Thermal modelling
- Computation Fluid Dynamics
- Embodied Carbon
- Daylight/sunlight
- Acoustics
- Air quality



Definitions vary

Part O

Effective area

The area through which air flows after the resistance of airflow has been taken into account.

Equivalent area

A measure of the aerodynamic performance of an opening. It is the area of a sharp-edged circular orifice through which air would pass at the same volume flow rate, under an identical applied pressure difference, as through the opening under consideration

Free area

The geometric open area of a ventilation opening. This area assumes a clear sharp-edged orifice that would have a Coefficient of discharge (Cd) of 0.62.

Part F

Effective area

Not defined

Equivalent area

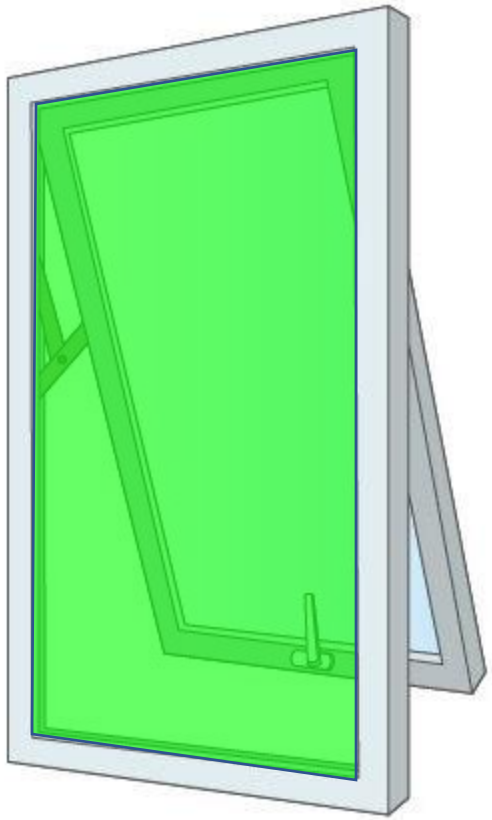
A measure of the aerodynamic performance of a ventilator. It is the area of a sharp-edged circular orifice through which air would pass at the same volume flow rate, under an identical applied pressure difference, as through the opening under consideration.

Free area

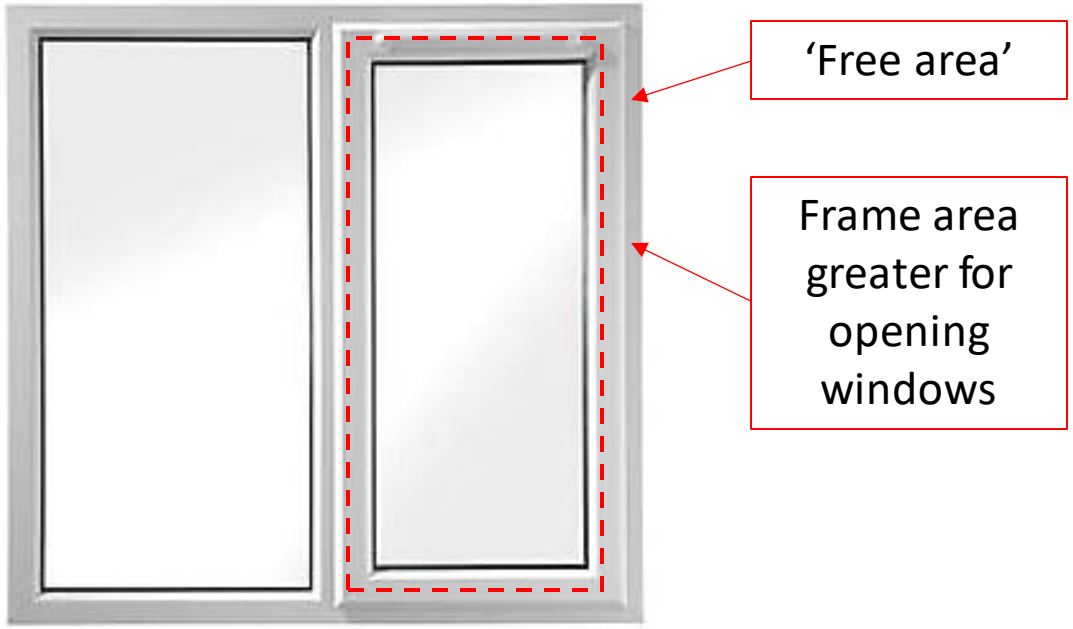
The geometric open area of a ventilator

Window opening terminology

Free area A_F

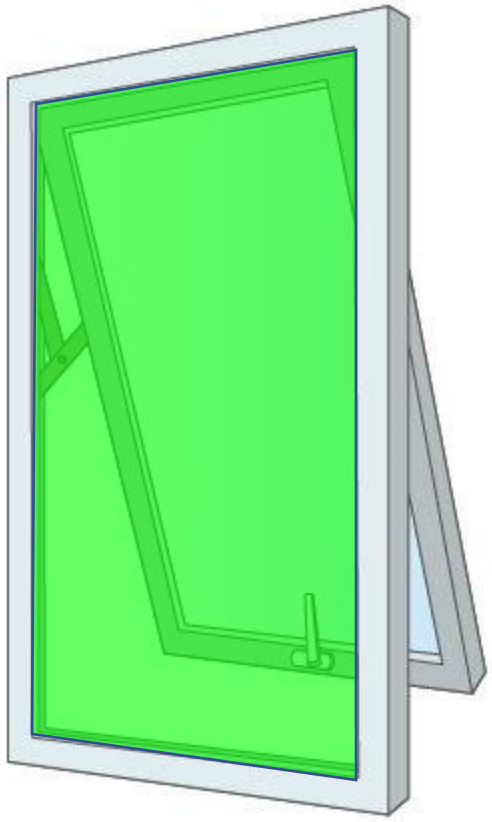


- Commonly defined as ‘the minimum unobstructed area perpendicular to the flow’
- Cross sectional area of the window opening
- Can be difficult to measure
- Be careful how opening window is defined in the model



Window opening terminology

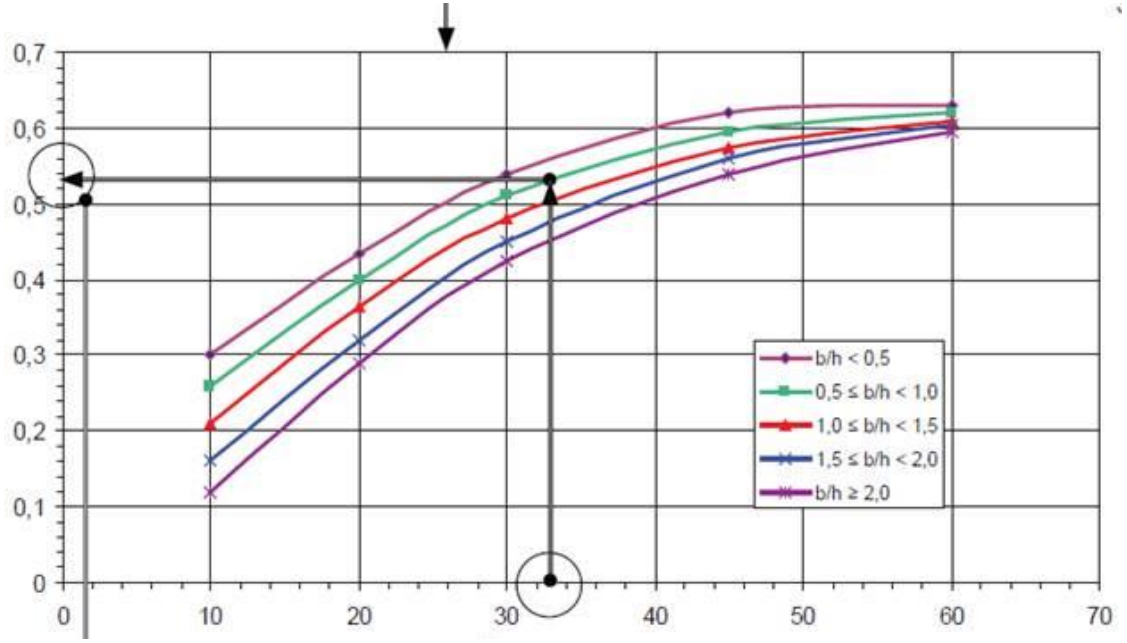
Window Effective Area A_{eff}



$$A_{eff} = A_f \times C_d$$

Coefficient of discharge Cd :

- Geometry dependent
- Dependent on open angle
- Derived by experimentation



Window opening terminology

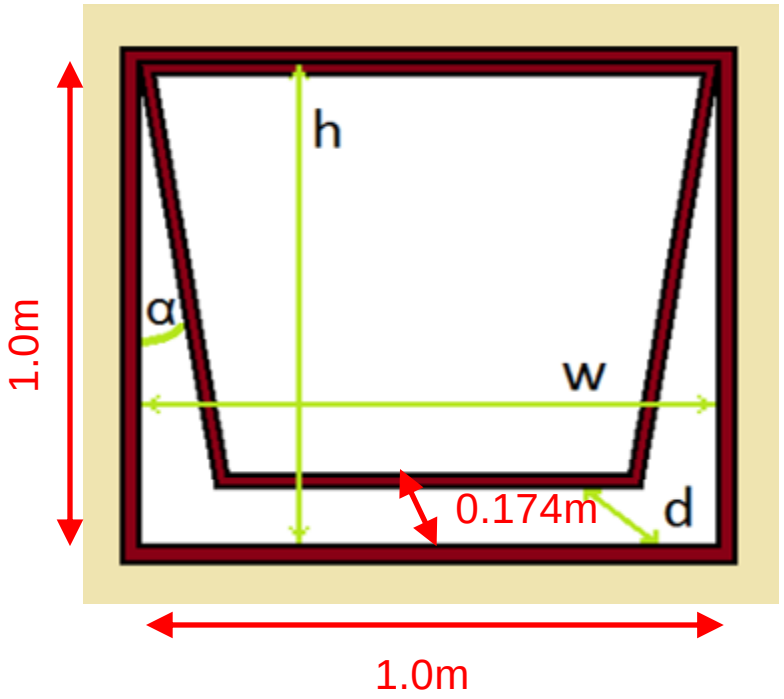
Equivalent Area A_{eq}

- Describes convoluted airflow pathways as equivalent to a circular orifice of *x*m^2
- Air flowing through a circular orifice is still restricted by the orifice discharge coefficient

$$A_{eff} = A_{eq} C_{d_o}$$
$$A_{eff} = 0.61\, A_{eq}$$

$$A_{eq} = \frac{C_d A_f}{C_{d_o}} = \frac{A_{eff}}{C_{d_o}}$$

Data Entry



WINDOW DISCHARGE COEFFICIENT CALCULATOR		
Window width, w (also b)	1.000	m
Window height, h	1.000	m
Opening angle, α	10	°
Length ratio, b/h	1	-
Gradient, M	0.040	-
Maximum Discharge Coefficient, C_{dmax}	0.563	-
Stroke length, d	0.174	m
Orifice Discharge Coefficient, C_{d0}	0.62	-
Equivalent area, A_{eq}	0.302	m^2
Effective area, A_{eff}	0.187	m^2
Free area, A_{free}	**1.000**	**m^2**
Discharge coefficient, C_d	**0.19**	**-**

Free Area = 1.0m²

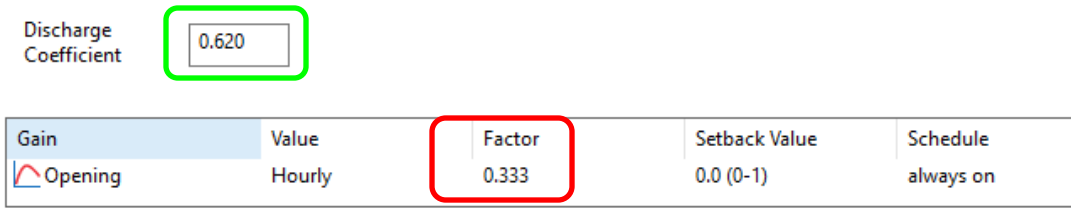
Discharge Coefficient = 0.19

[Building Bulletin 101: calculation tools - GOV.UK (www.gov.uk)]

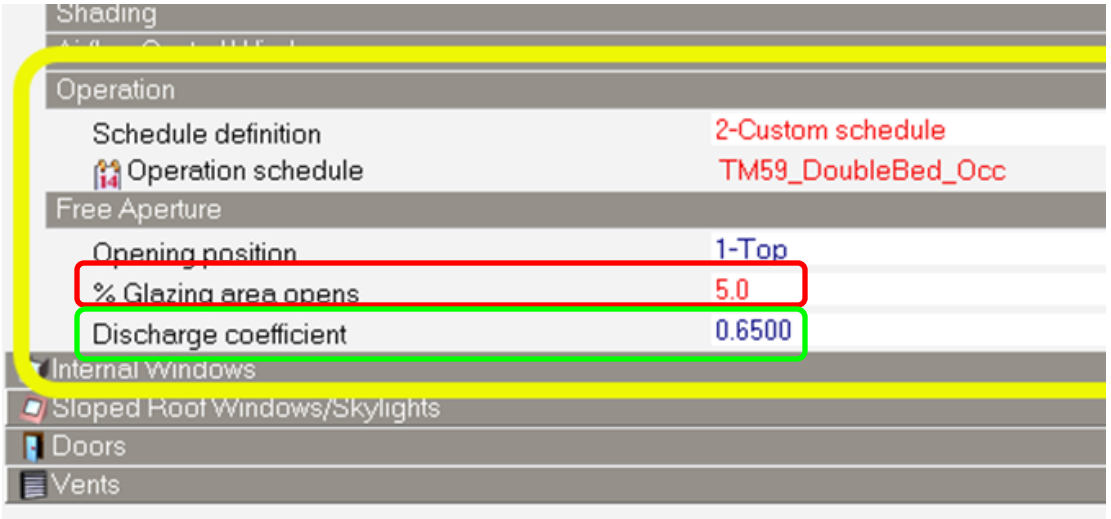
New calculation tool coming soon, but will need approval!

Data Entry – Modelling Tools

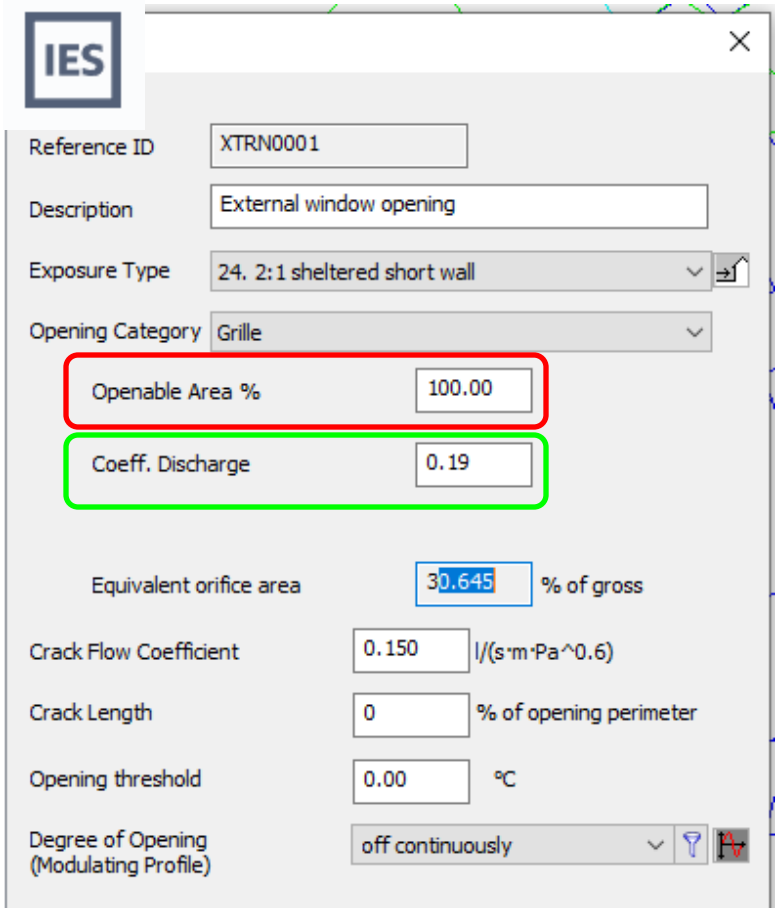
EDSL Tas



DesignBuilder



IES



Window opening research - SEAM

Contents lists available at ScienceDirect

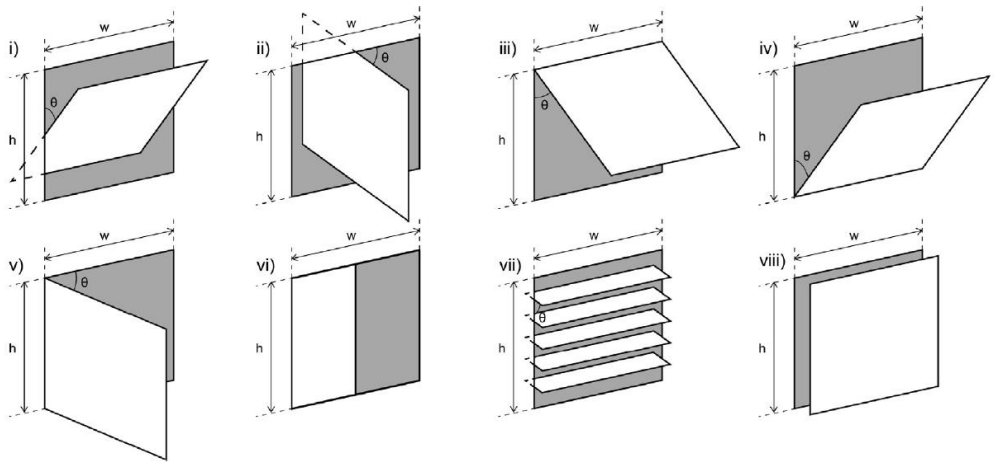
Energy & Buildings

journal homepage: www.elsevier.com/locate/enb

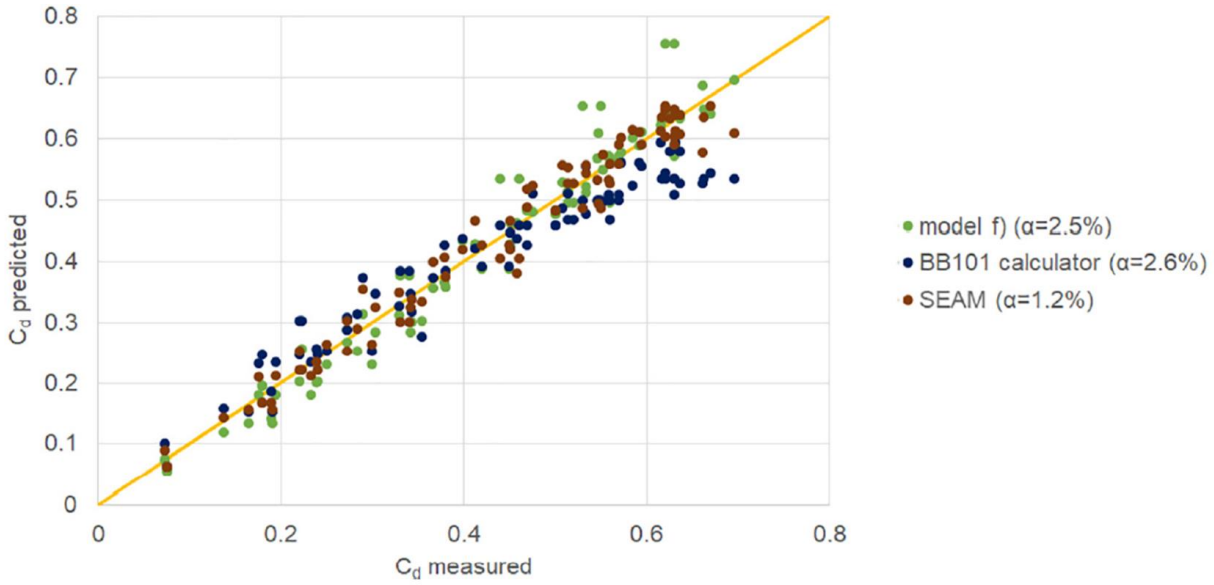
What we think we know about the aerodynamic performance of windows

Patrick Sharpe [a], Benjamin Jones [a,*], Robin Wilson [a], Christopher Iddon [b]

[a] Department of Architecture and Built Environment, University of Nottingham, Nottingham, UK
[b] Chartered Institution of Building Services Engineers Natural Ventilation Special Interest Group, 222 Balham High Road, London, UK



Statistical Effective Area Model - SEAM



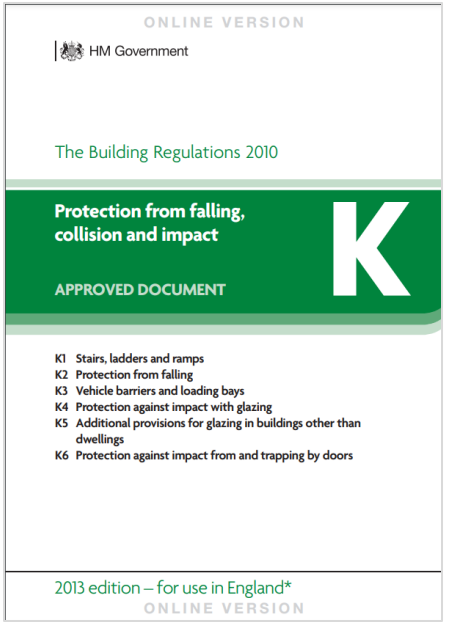
Maximum reach

AD-O says *"Window handles on windows that open outwards are not more than 650mm from the inside face of the wall when the window is at its maximum openable angle."*

Modelling should not assume any window opens wider than 650mm (even on ground floor, and even if it physically can be opened wider).

FHH spreadsheet does this calc for you – see **'Calculations'** tab for calculated discharge coefficient including this limit

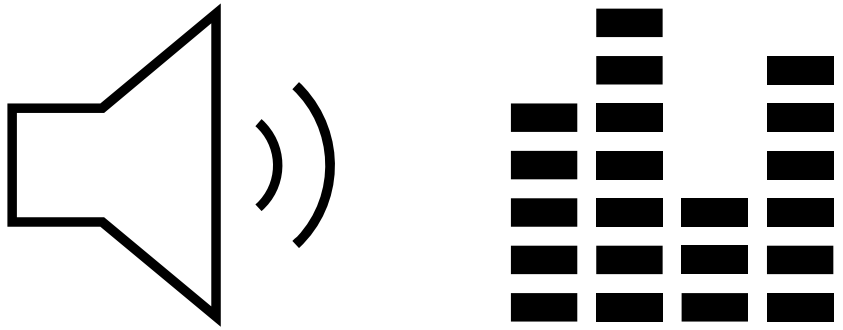
Measure and include 'Distance [a] from inside wall to window frame (mm)' in data entry for each window.



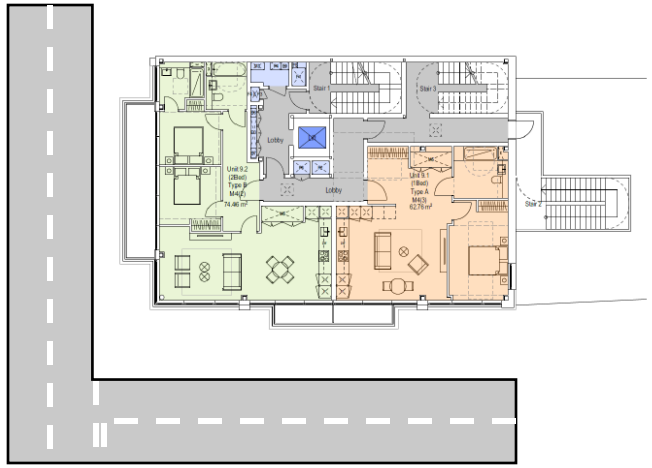
Stroke length, d	Discharge coefficient, Cd	Effective area, Aeff	Equivalent area, Aeq
0.484	0.382	0.382	0.615

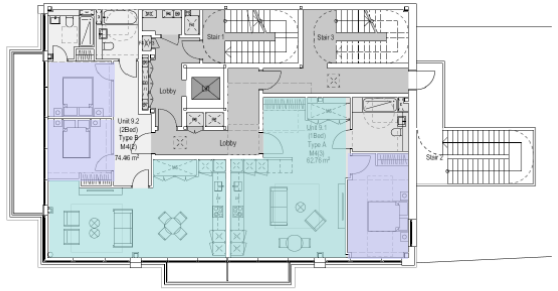
Noise exceedance

- Limit on night-time openings only (unless additional planning constraint)
- Acoustic report should outline affected facades and degree of exceedance
- Plan site to reduce or eliminate bedrooms from affected facades
- Work through hierarchy of potential solutions
  - Passive solutions
  - Augmented bedroom mechanical ventilation (quietly)
  - Comfort cooling (last resort)

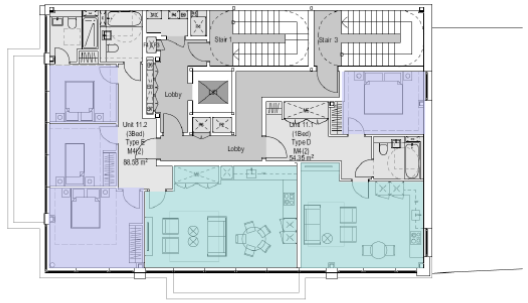


Site Planning

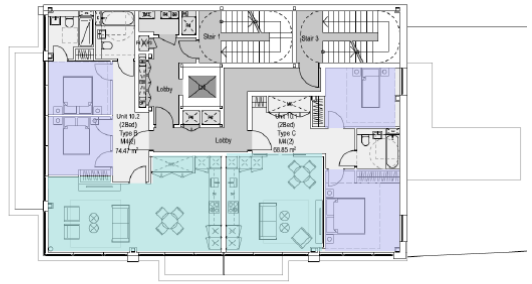




Proposed Ninth Floor



Proposed Eleventh Floor



Proposed Tenth Floor

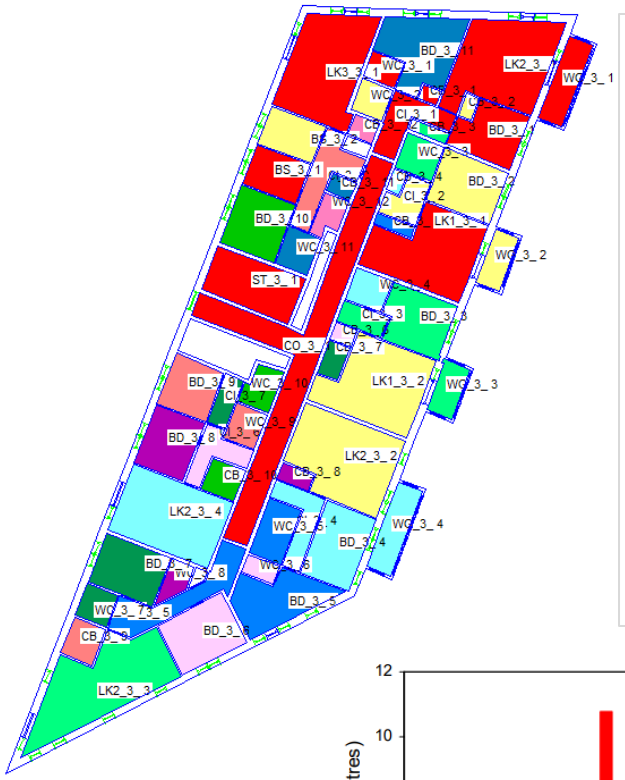
Iteration	Free ventilation area	Bedrooms meeting the criteria	Living rooms/Kitchens meeting the criteria
1	0.2	3/11	3/6
2	0.4	11/11	5/6
3	0.6	11/11	6/6

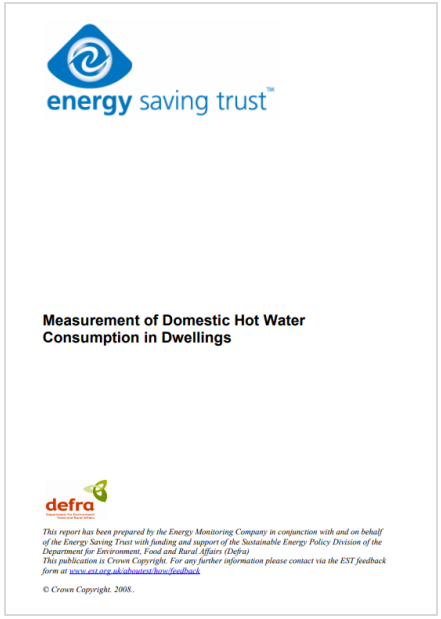
Operable windows

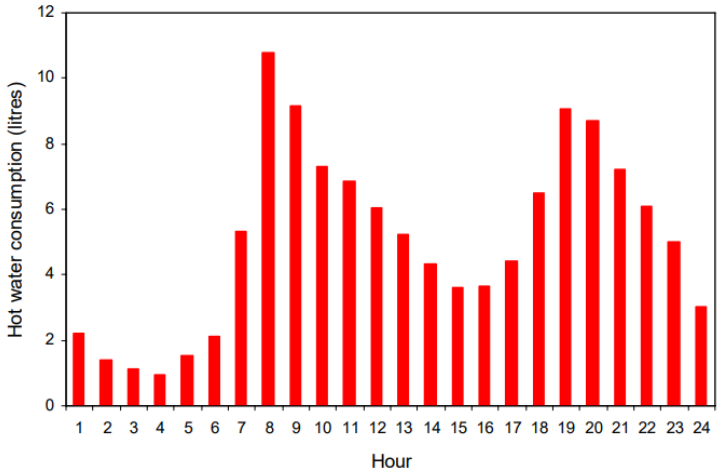
Glazing element thermal performance
U-Value 1
G-value 0.35

Opaque elements thermal performance (Minimum values for SAP compliance)
Wall U-Value 0.1
Roof U-value 0.1

Comfort Cooling

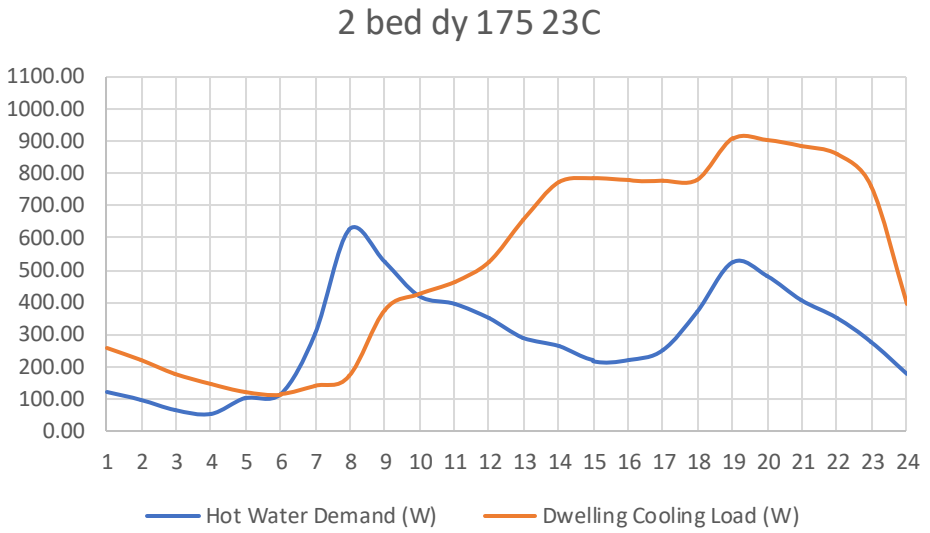


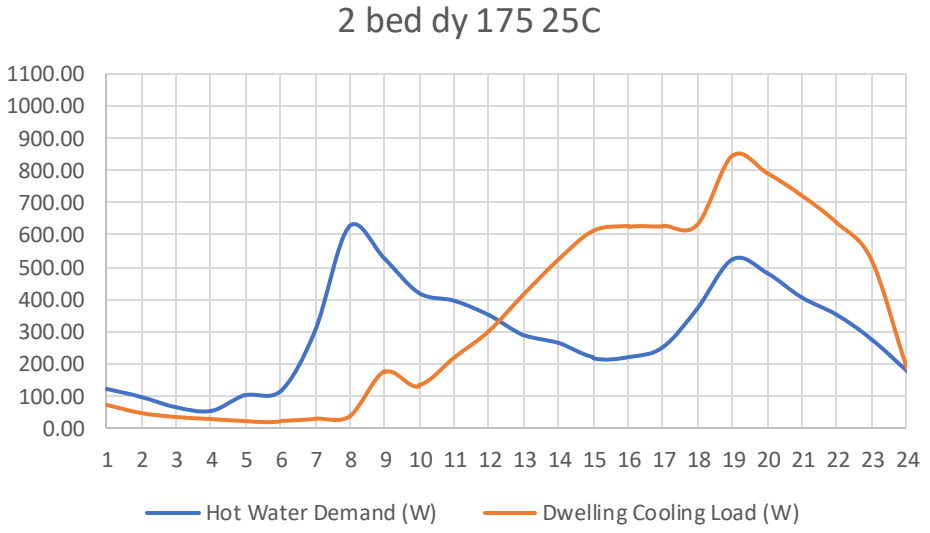




TM59 internal gains not suitable for cooling loads

Passive test first





About Apex Acoustics

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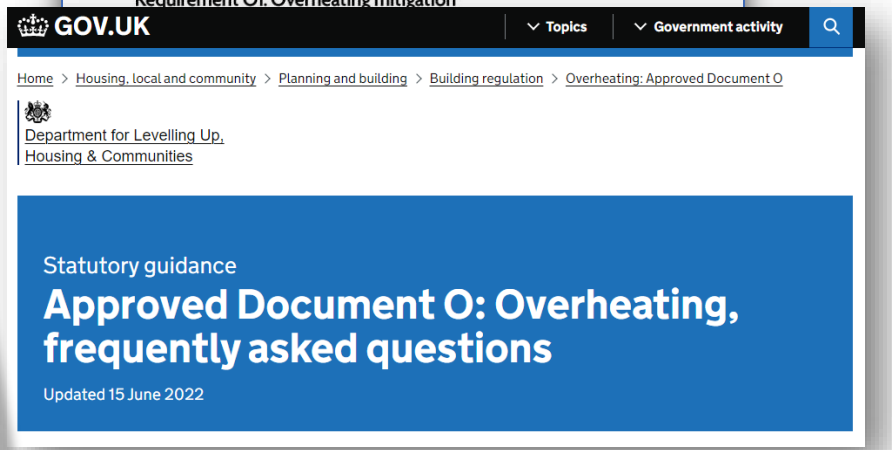
https://www.apexacoustics.co.uk/noise-constraints-in-approved-doc-o-overheating-part-1/

@apex_acoustics

Approved Doc O - interpretation



Noise constraints

Noise

3.2 In locations where external noise may be an issue (for example, where the local planning authority considered external noise to be an issue at the planning stage), the overheating mitigation strategy should take account of the likelihood that windows will be closed during sleeping hours (11pm to 7am).

3.3 Windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits.

a. 40dB $L_{Aeq,T}$, averaged over 8 hours (between 11pm and 7am).

b. 55dB L_{AFmax}, more than 10 times a night (between 11pm and 7am).

“Minimum *Free Area*” = Minimum *Equivalent Area*

D

ONLINE VERSION

Appendix D: Calculating equivalent area

D2 The equivalent area of a window can be calculated using one of the following.

a. The discharge coefficient calculator, available online at: https://www.gov.uk/government/publications/classvent-and-classcool-school-ventilation-design-tool.

b. Tables D1 to D9.

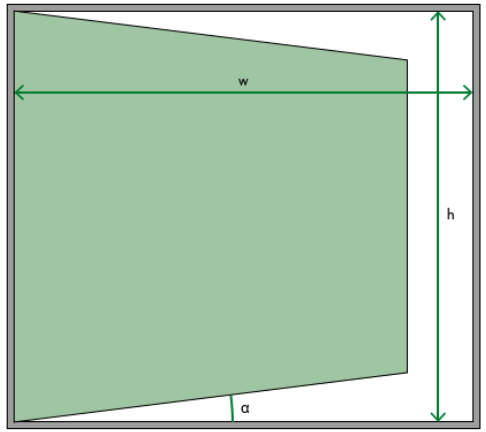
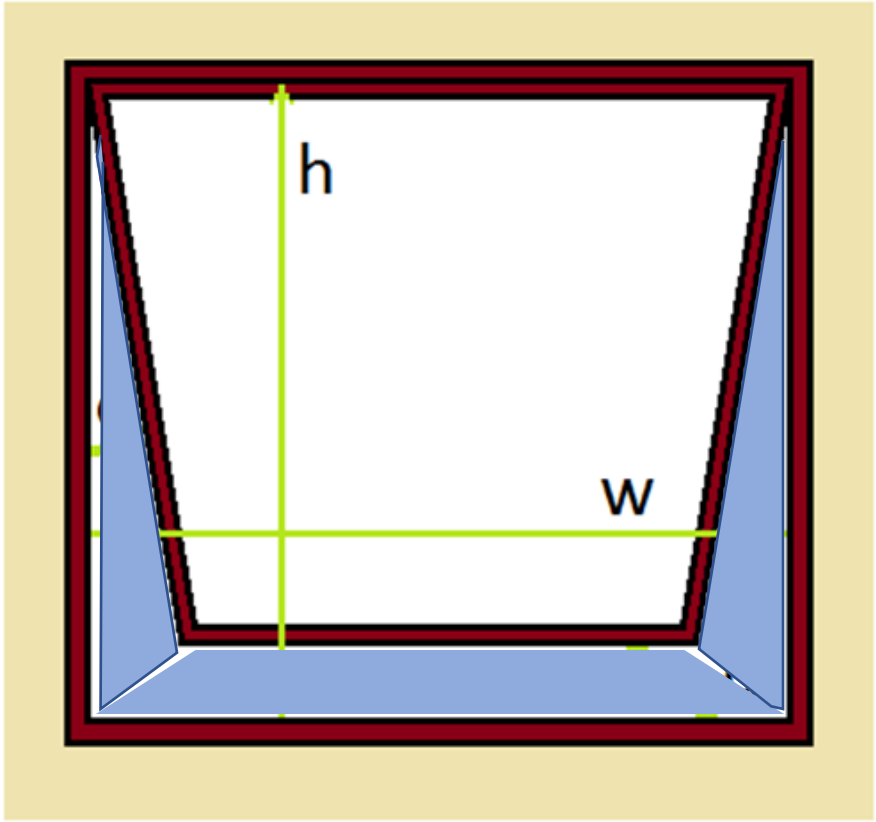


Diagram D1 Side hung window illustration with table references

Acoustics AD-O Guide Appendix A – Acoustic model for open area

- Open area?
- “Free area” as used in AD-O = Equivalent Area
- ***Acoustic open area***



Acoustics AD-O Guide Appendix A – Acoustic model for open area

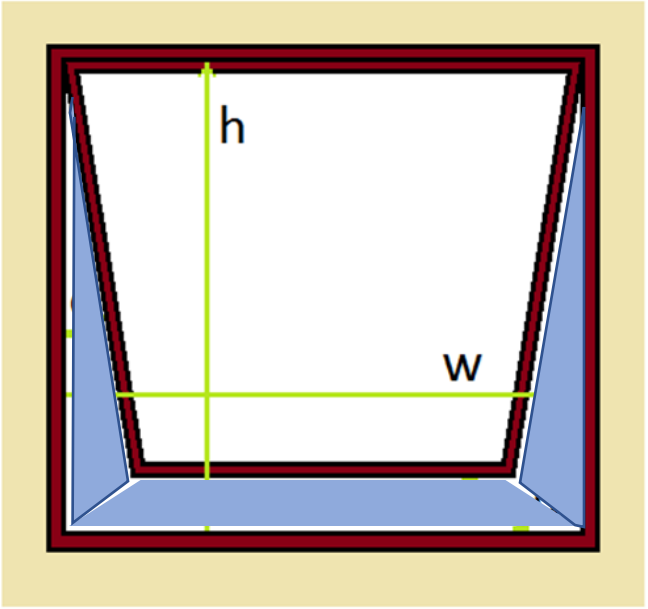
- BS EN 12354-3

$$D_{n,e} = -10\lg\left(\frac{S_{open}}{A_o}\right) \quad \text{(D.1)}$$

where

S_{open} is the area of the opening, in square metres.

A_0 is the reference equivalent sound absorption area, in square metres for dwellings given as 10 m².



$$L_2 = L_{1,ff} - R + 10\log\left(\frac{ST}{V}\right) + 11$$

Acoustics AD-O Guide – Threshold sound levels for Simplified Method

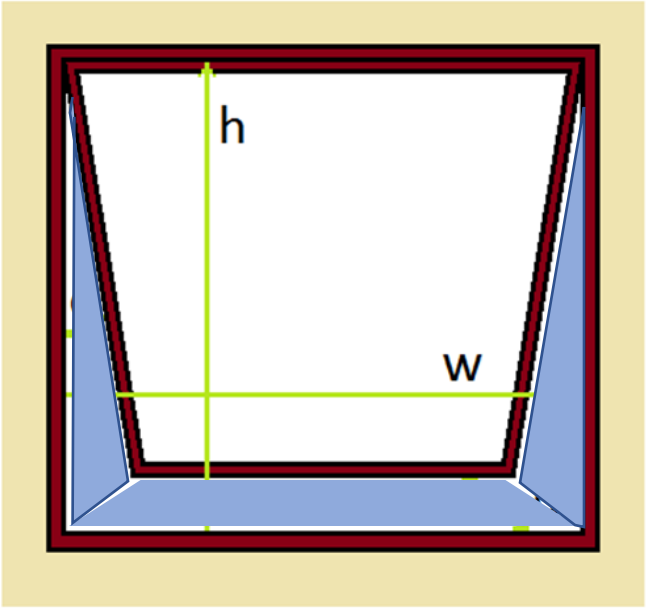
- BS EN 12354-3

$$D_{n,e} = -10 \lg\left(\frac{S_{open}}{A_o}\right) \qquad (D.1)$$

where

S_{open} is the area of the opening, in square metres.

A_0 is the reference equivalent sound absorption area, in square metres for dwellings given as 10 m².

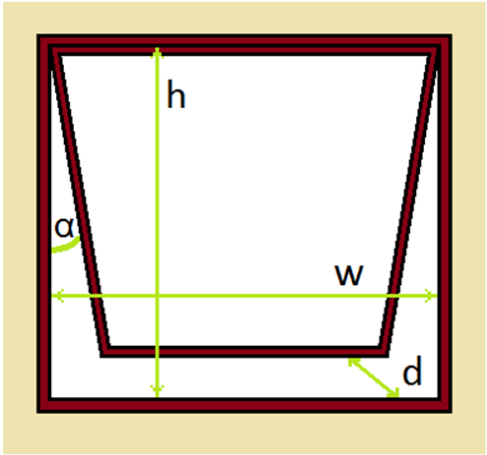


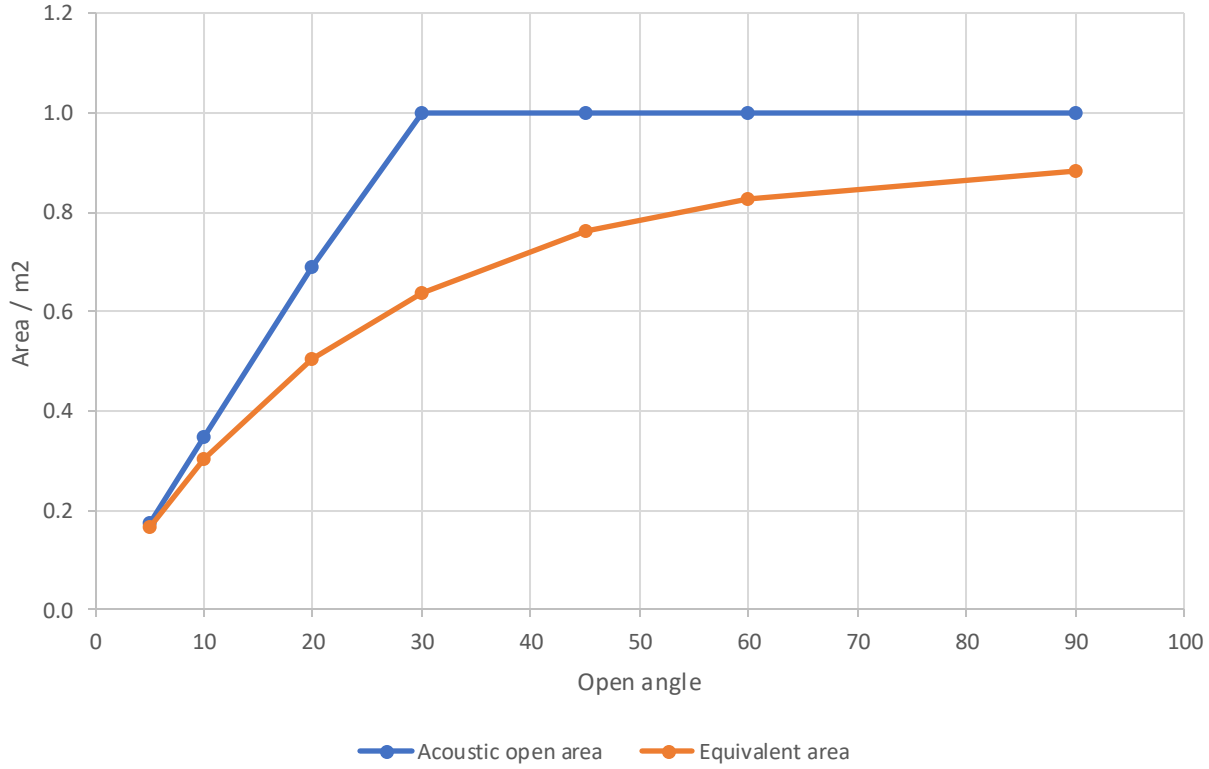
- Window (w *h) ≈ 5 % of floor area
- Assume 2.4 m ceiling height, 0.5 sec reverberation time

$$\boldsymbol{L_{1,ff} - L_2 = 9\ dB}$$

Acoustics AD-O Guide Appendix A – Acoustic model for open area

- Open area?
- “Free area” as used in AD-O = Equivalent Area
- Acoustic open area





Approximate façade noise level limits – Simplified Method

Moderate risk locations

- 49 dB $L_{Aeq,\ T}$
- 64 dB $L_{AF,max}$

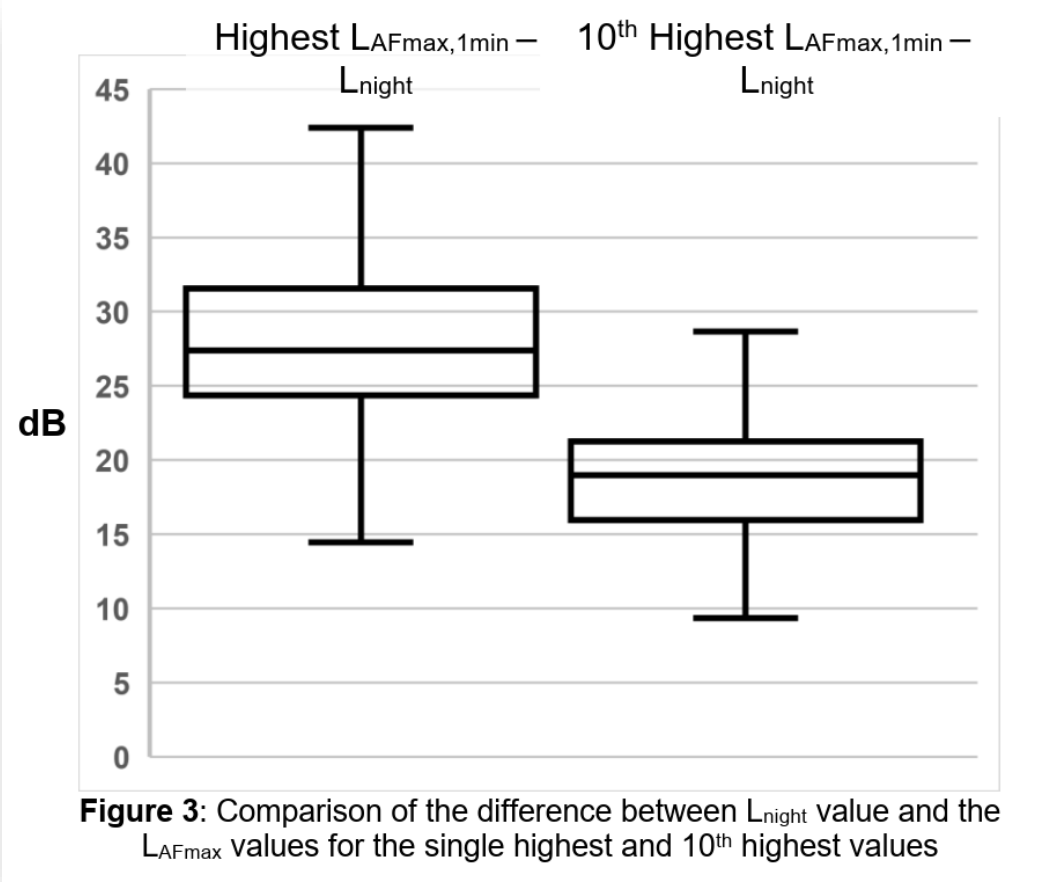
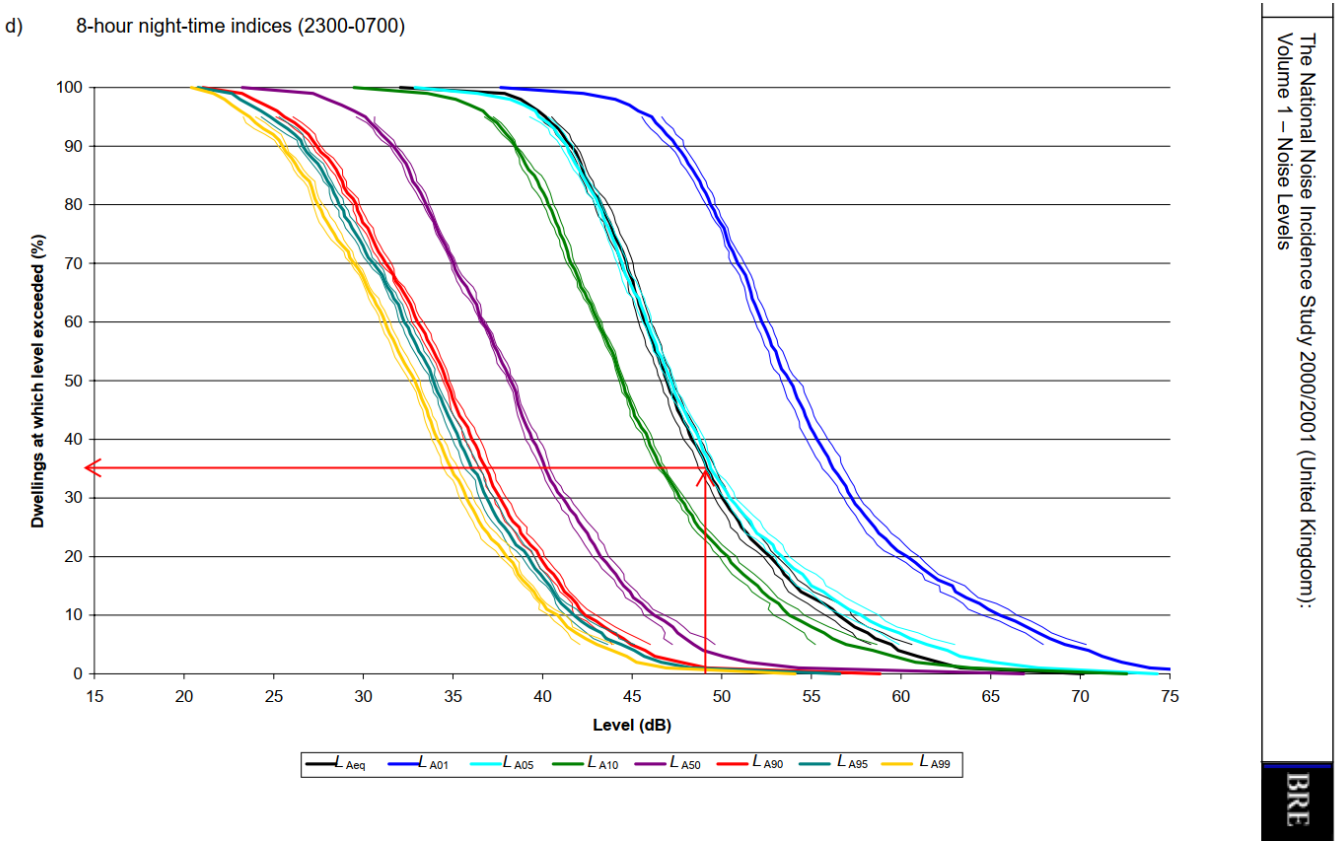


Figure 3: Comparison of the difference between L_{night} value and the L_{AFmax} values for the single highest and 10th highest values

Empirical relationship between L_{night} and L_{AMAX}. N Conlan, W Wei, J Harvie-Clark, Proc IOA 2021

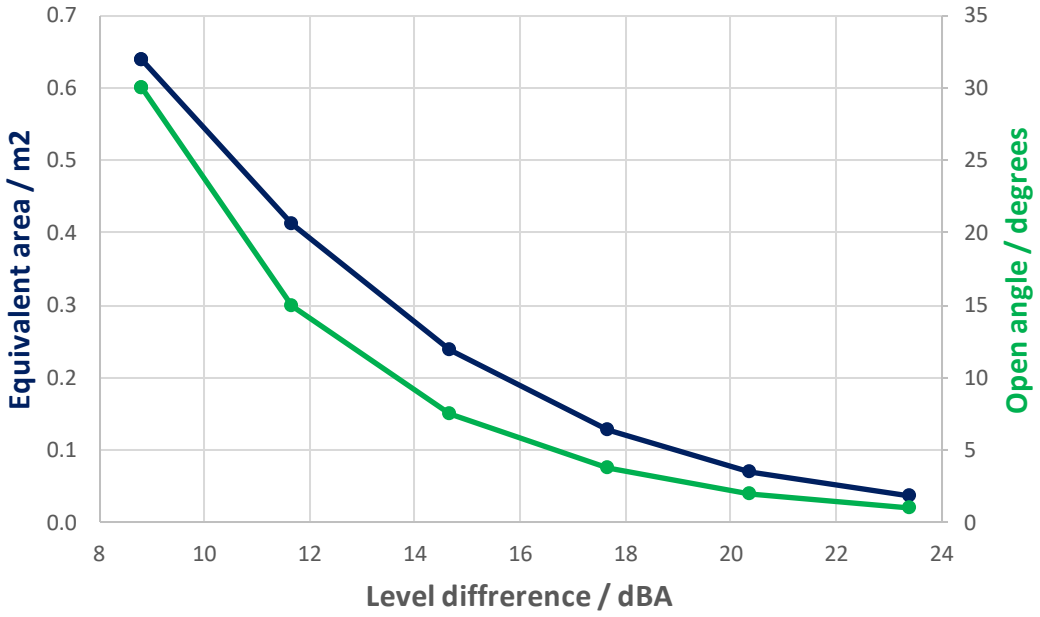
Extent of noise constraint

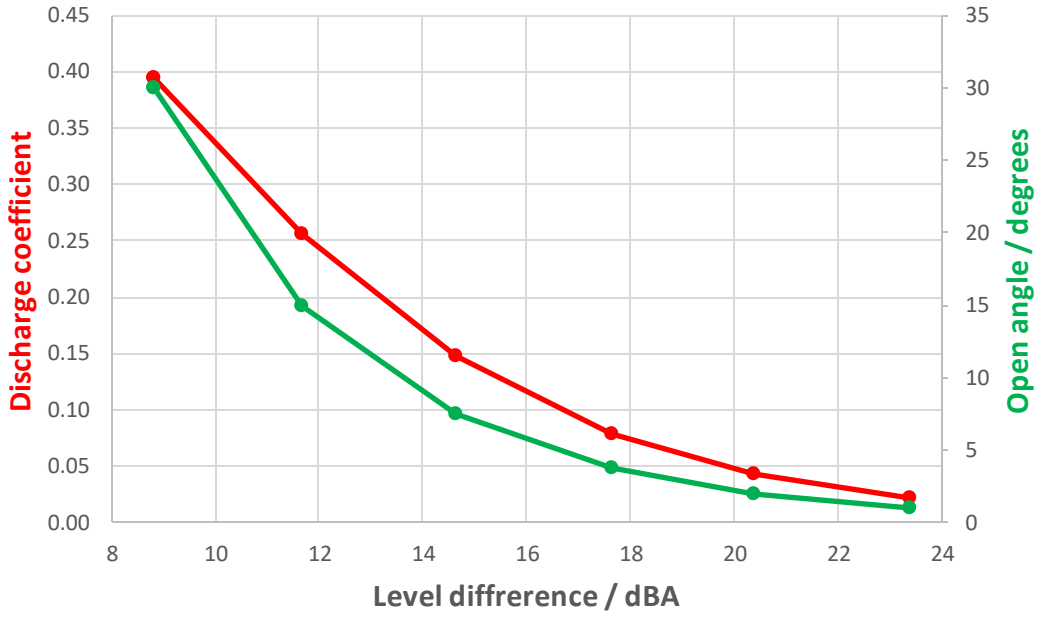
> 30 % of properties exceed Simplified Method limit!

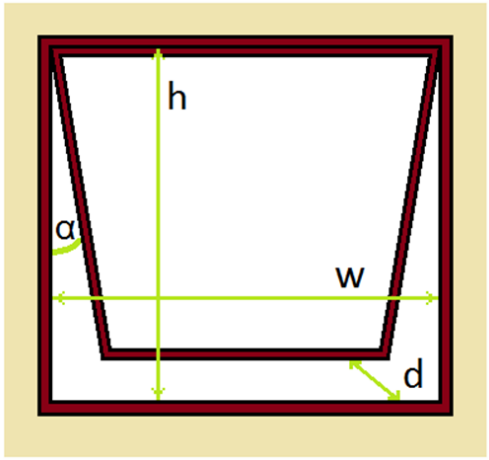


[The National Noise Incidence Study 2000 / 2001 Vol 1 – Noise levels](), BRE for DEFRA

*Sound level difference - example 20m² room, window 1*1m*

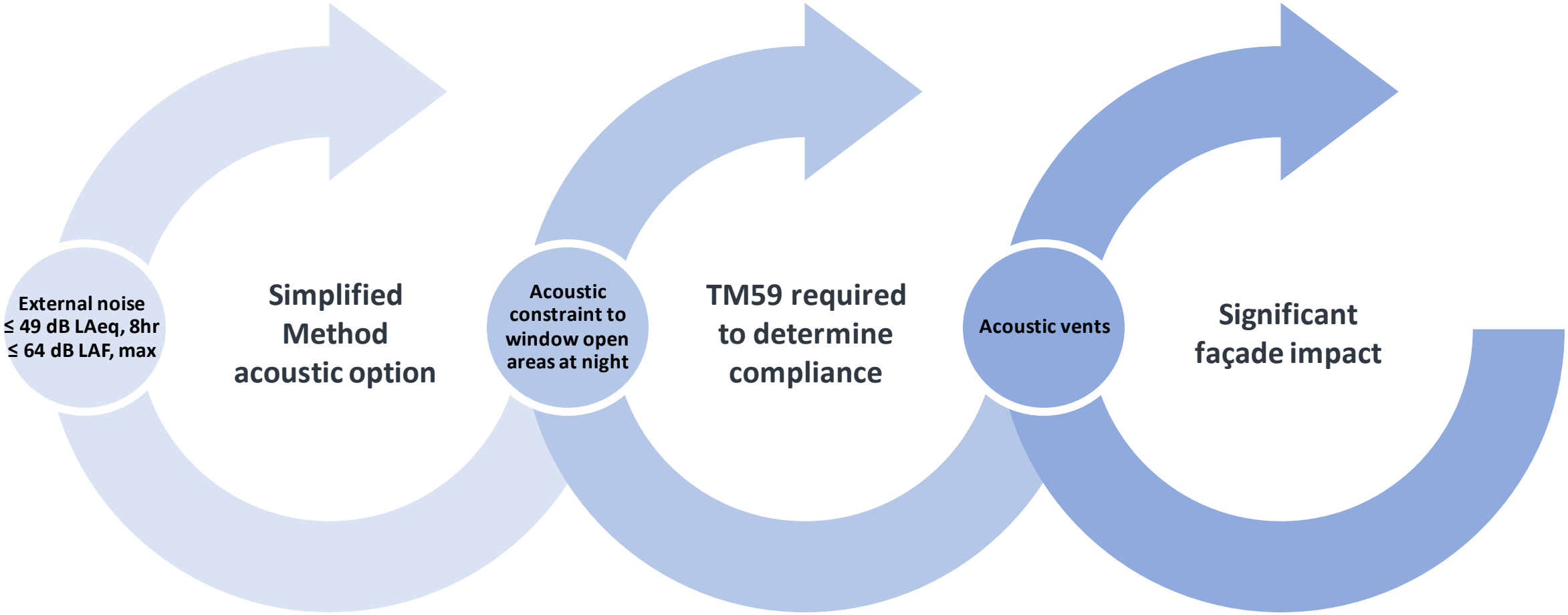




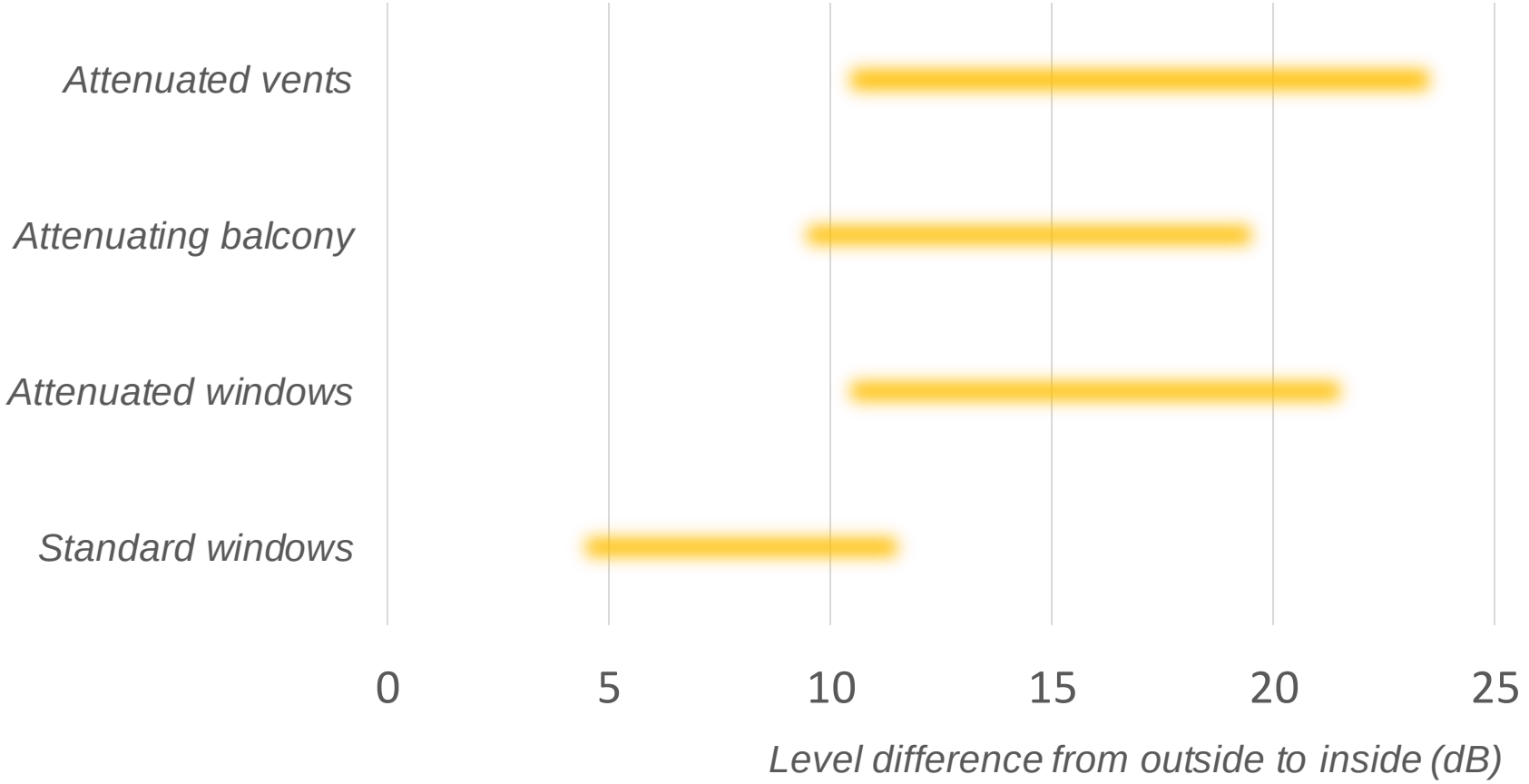


Sound level difference, outside to inside / dBA

Hierarchical considerations for AD-O compliance – Natural ventilation

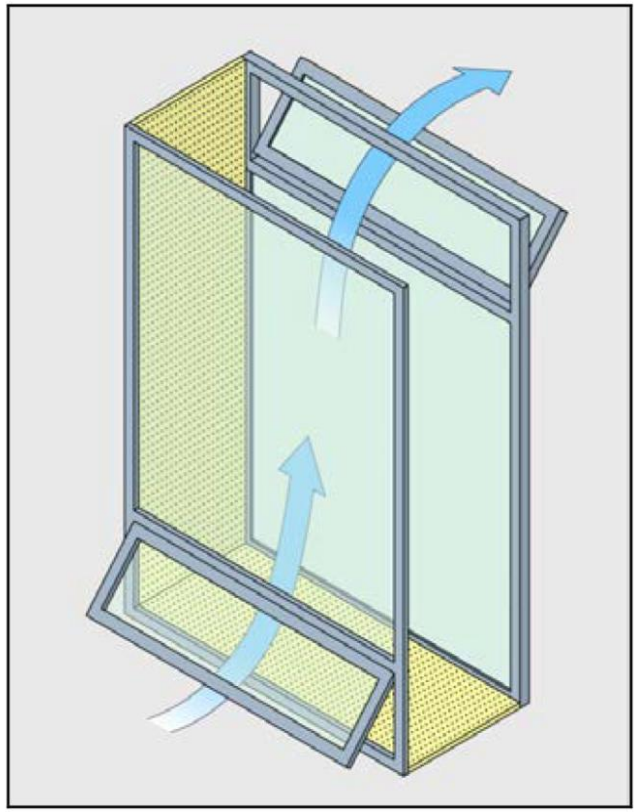


Passive attenuated options

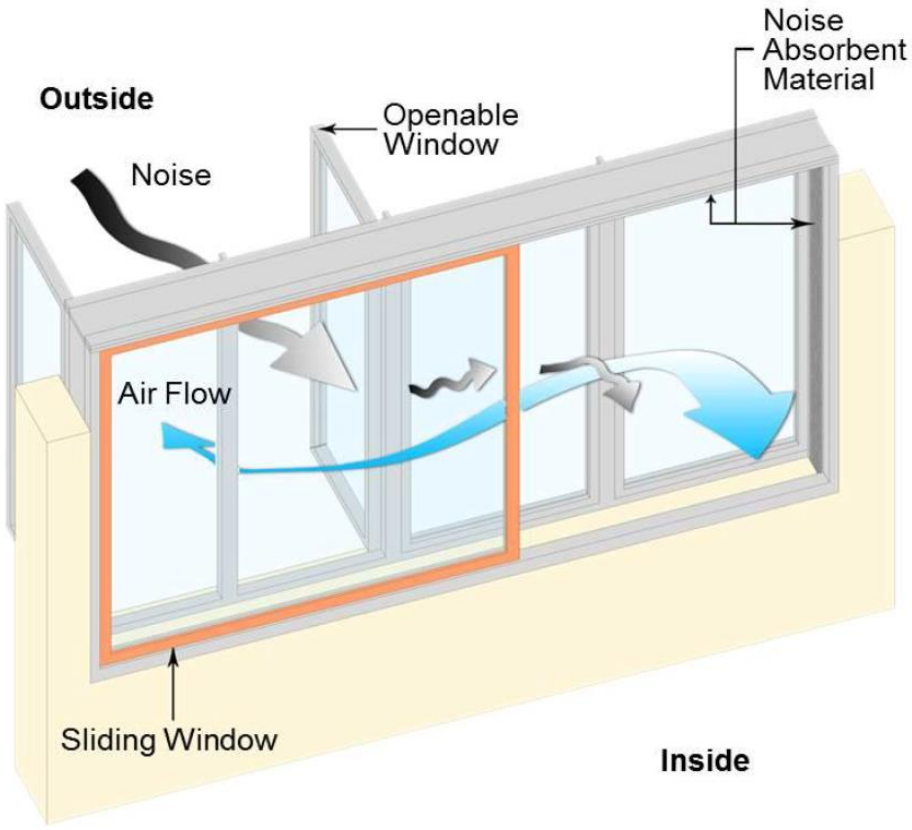


www.apexacoustics.co.uk/attenuated-passive-ventilation-options/

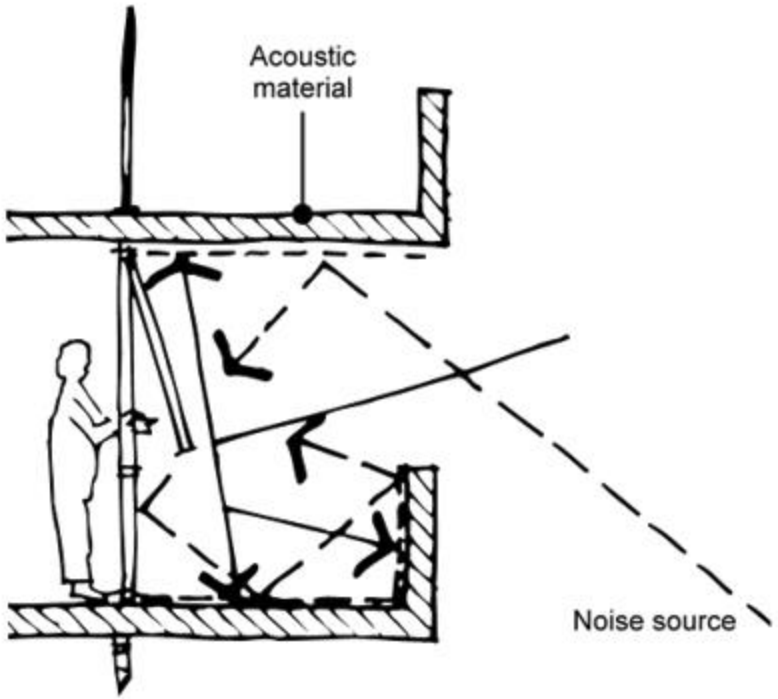
Examples of attenuated windows – unlikely to work alone

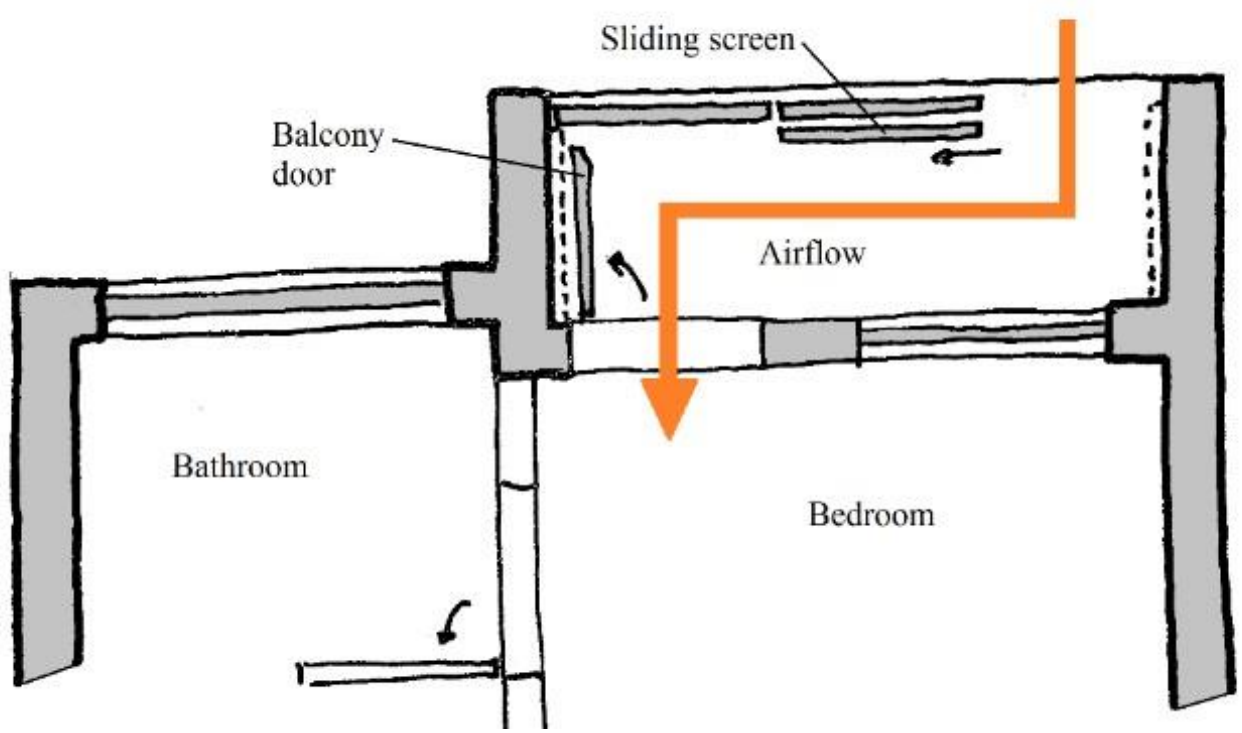


Examples of attenuated windows



Examples of attenuating balconies



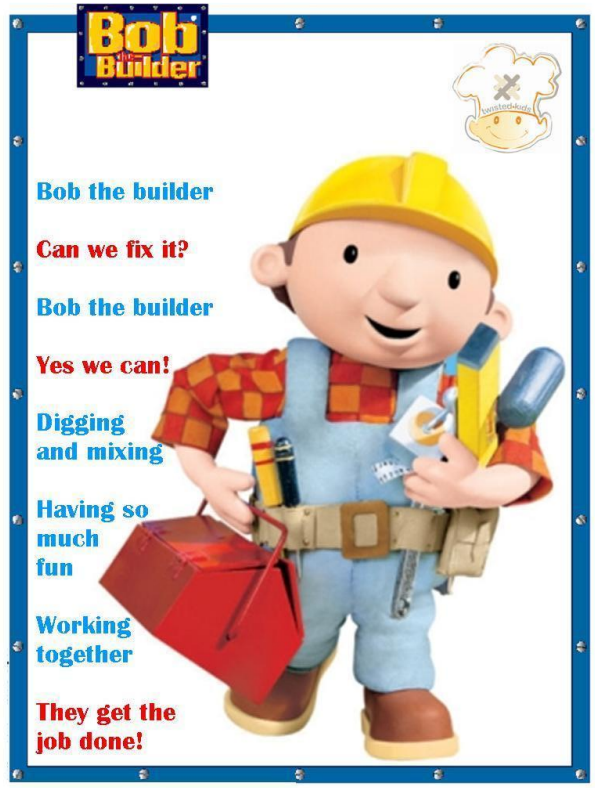


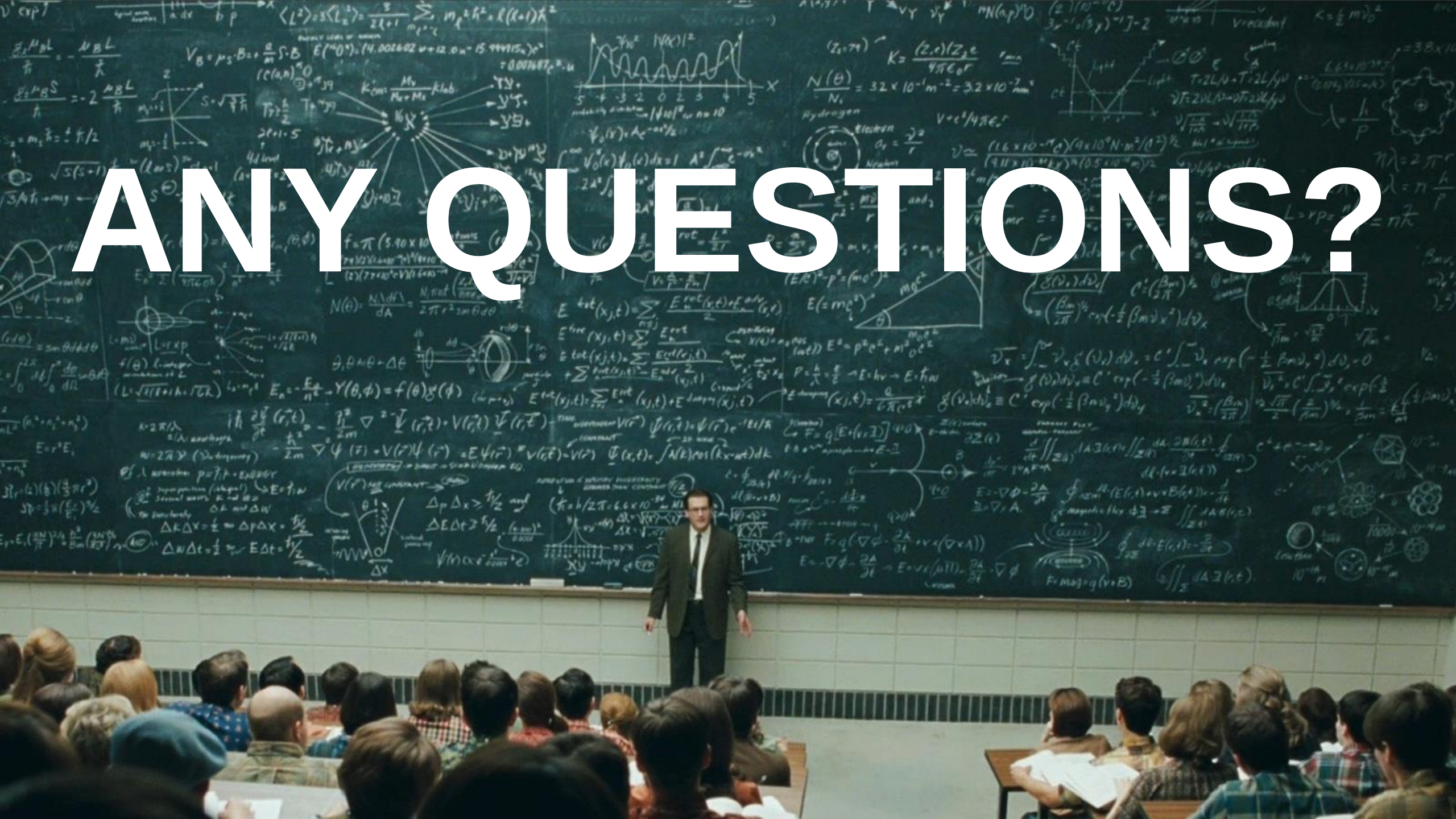
Examples of attenuated vents

Ventilative cooling in noisy environments: practical options for the UK Proc. IOA Vol 42 Pt. 1 2020

Conclusions

- Environmental noise significant constraint to use of opening windows for compliance with AD-O
- Toolbox of options and approaches required
- Strong collaboration between disciplines:
  - **Consistent description of façade opening for acoustics and thermal modelling**
- Pre-planning assessment vital




ANY QUESTIONS?