Tipperary
Fire & Rescue Service

Ventilation in Dwellings

Review of TGD F 2019 & Supp. Guidance

Opening

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Comhairle Contae Thiobraid Árann
Tipperary County Council

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Q & A

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Agenda

- Background
- Building Physics
- Regulations & Guidance Documents
- Main Types of Systems
- Common Defects
- NSAI Validation of Ventilation Systems
- Conclusions

Comhairle Contae Thiobraid Árann
Tipperary County Council

Part 1 – Background & Regulations

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Assistant Chief Fire Officer
Tipperary Fire & Rescue Service

Tipperary Consolidated Guidance TGD B Vol. 2 2017

This diagrammatic guidance document has been put together to assist owners, builders and designers with regards to fire safety provisions in the 5 most common dwelling house types:

- Bungalow
- Dormer Bungalow
- Two Storey
- Dormer Two Storey
- Three Storey

The guidance within this document is not exhaustive, reference should be made to Technical Guidance Document B (Fire Safety) Volume 2-Dwelling Houses 2017 and the Supplementary Guidance to TGD B (Fire Safety) Volume 2 - Dwelling Houses 2017, to ensure full compliance with Part B of the Building Regulations. Responsibility for ensuring full compliance with the Building Regulations remains with the Owner, Builder and Designer of the works. You are advised to review your design to ensure compliance with all Parts of the Building Regulations.

For Modern Methods of Construction refer to Manufacturer's Test Data and Agrément Certification to ensure compliance with Part B of Building Regulations.

Technical Guidance Document B- Fire Safety - Volume 2 Dwelling Houses

Recording of Webinar - Review of TGD B Vol. 2 and Supp. Guidance

Webinar slides PART 1- TGD B Vol. 2 and Supp. Guidance review

Webinar slides PART 2- TGD B Vol. 2 and Supp. Guidance review

https://www.tipperarycoco.ie/emergency-services/fire-safety-and-prevention-initiatives/tipperary-consolidated-guidance-tgd-b-vol

Construction Sector

Rialtas na hÉireann
Government of Ireland

Project Ireland 2040

BUILD 2022:
Construction Sector Performance and Capacity

gov.ie/2040 July 2022

159,300 construction sector employees

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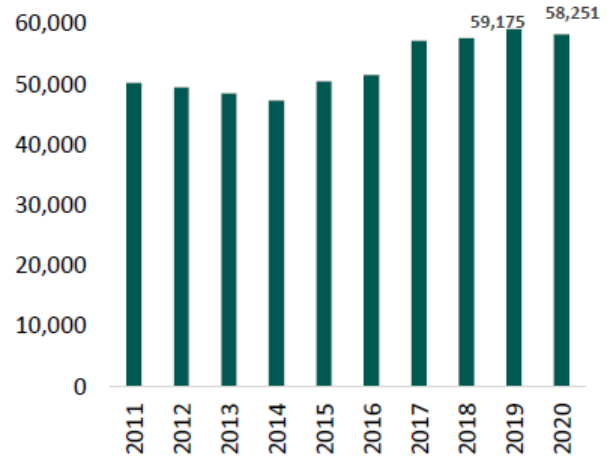
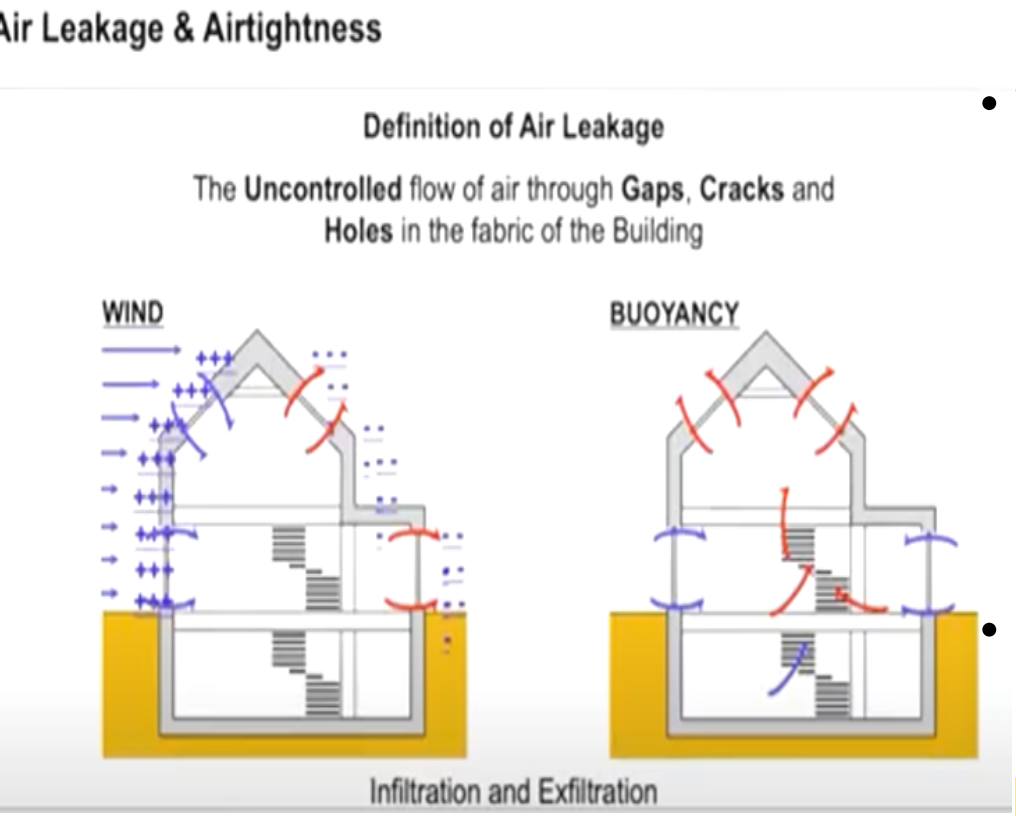
Figure 5.11: Number of Construction Enterprises



1970's or earlier

Heat sources range (solid fuel cooker) and open fire with chimneys,
Wooden ground floors, air bricks/ vents in walls, single glazing in wooden frame, no air tight junctions AND LPG gas Superser or 2 bar electric heaters… NO RADON barrier

Uncontrolled air movements



- **The buoyancy (or stack) effect** Warm air inside a building in winter is less dense than cold air outside and, like a hot air balloon, will tend to rise. This has the effect of sucking in cold air from outside into the rooms and out chminey

- **Wind pressure on building** Wind pressure will attempt to force air in through gaps in the walls on the windward side of the building and out again on the leeward side

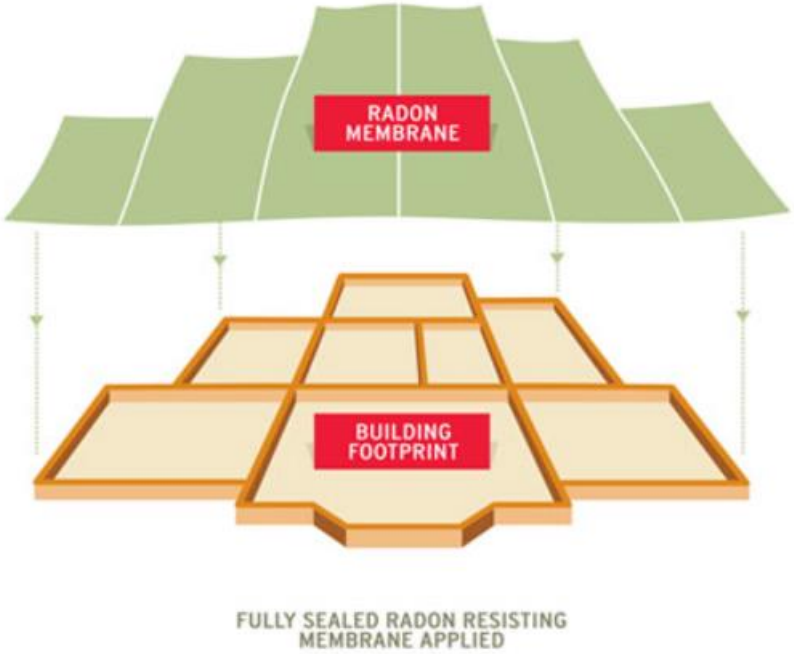
Airtightness Advantages:

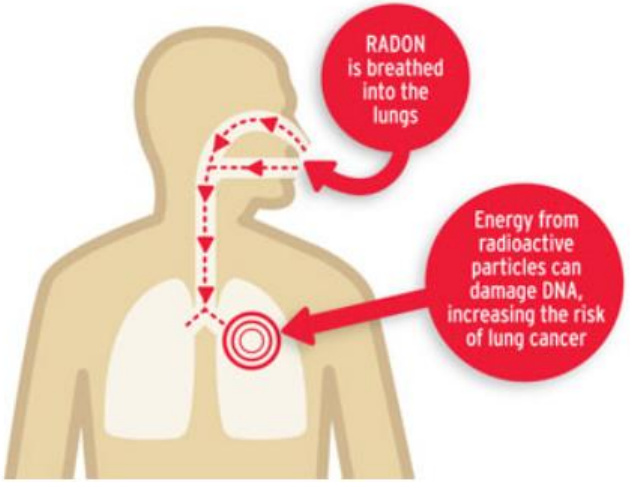
- **Up to 2002 no mention of airtightness regulations**

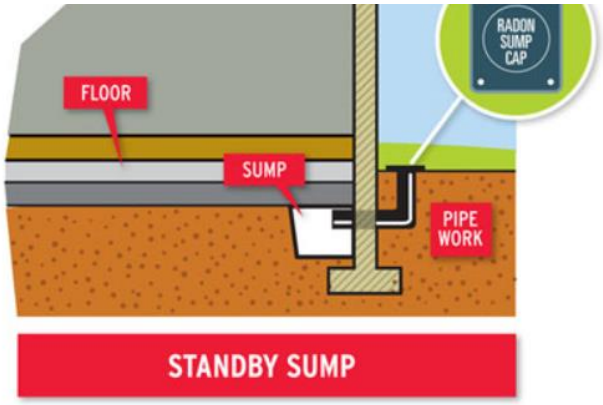
- prevention of moisture related building damage (timber frame)
- prevention of drafts and cold feet
- prevention of high heat losses due to infiltration
- improvement of sound insulation
- improved indoor air quality (e.g. prevention of pollution with radon from the ground

Radon Barrier

56% of the total radiation we are exposed in Ireland is from radon.
About 350 cases/year of lung cancer in Ireland linked to radon.

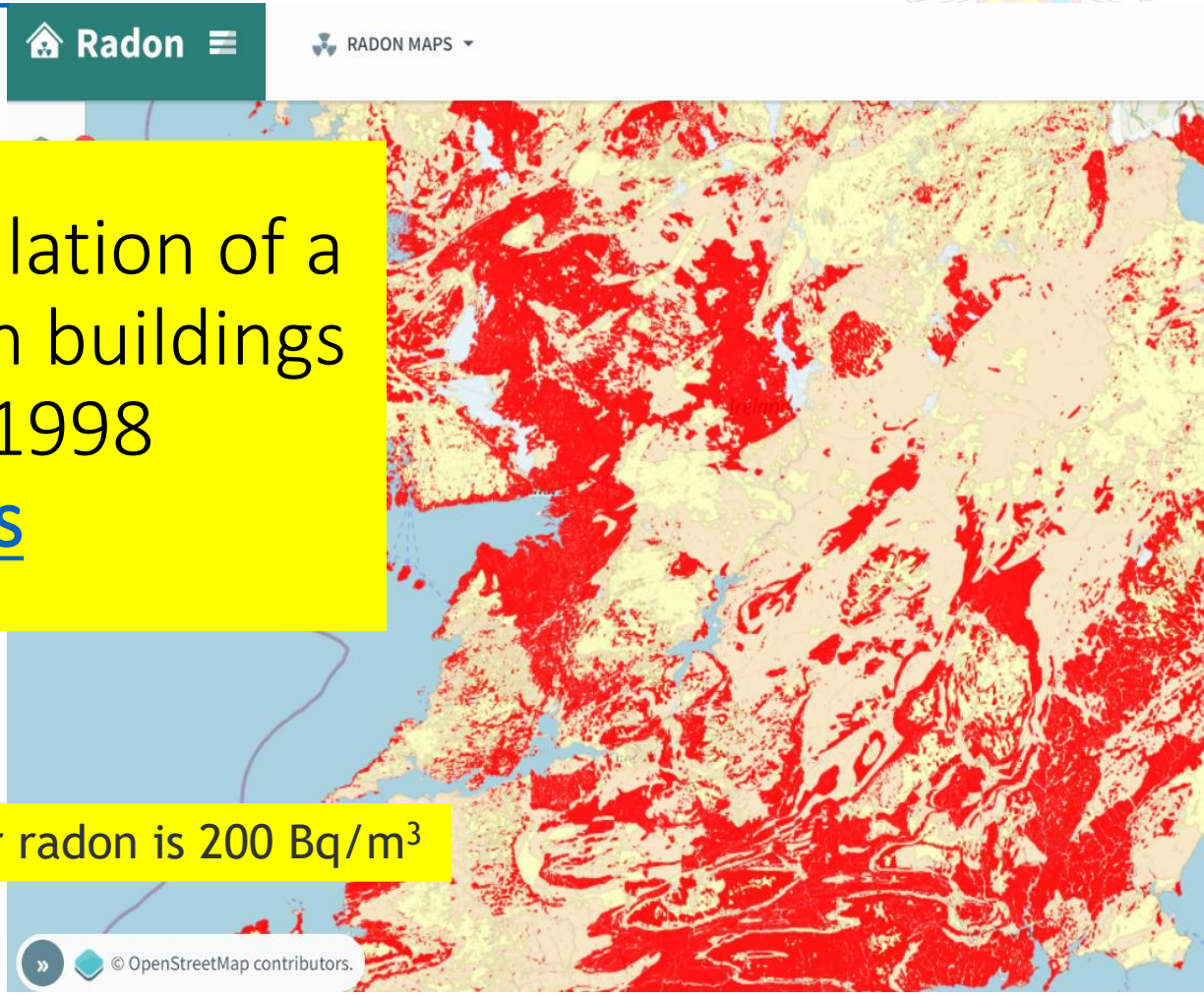






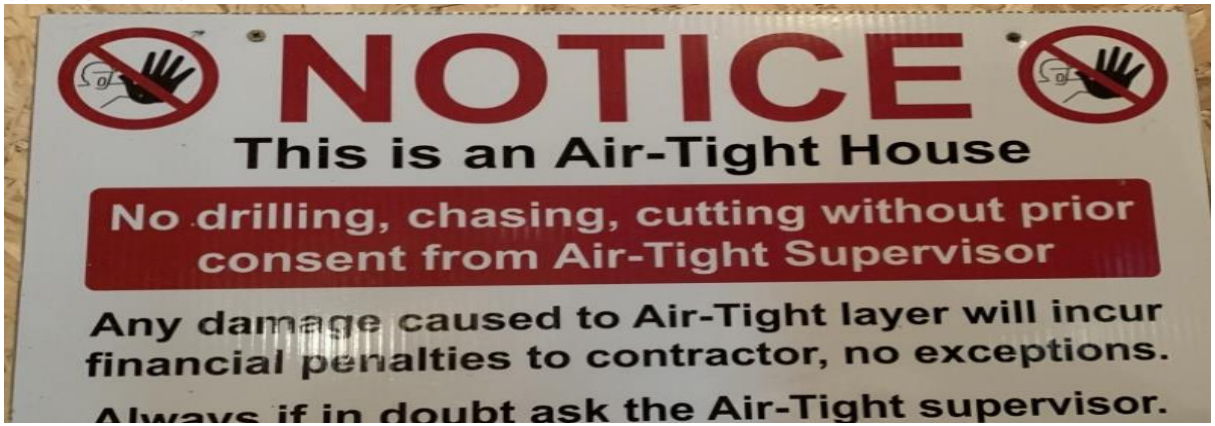
High Radon Areas

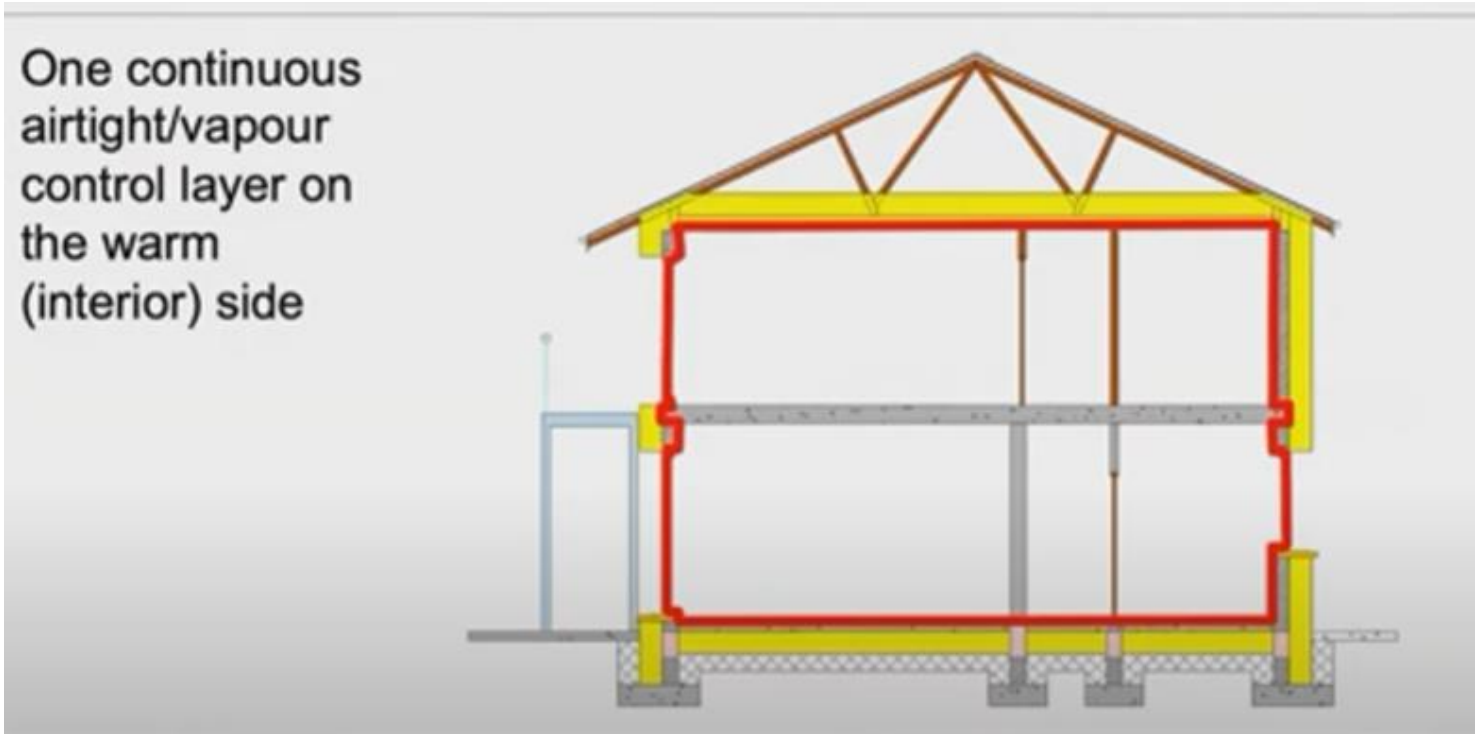
Regs requires installation of a radon membrane in buildings built since 1st July 1998 in High Radon Areas

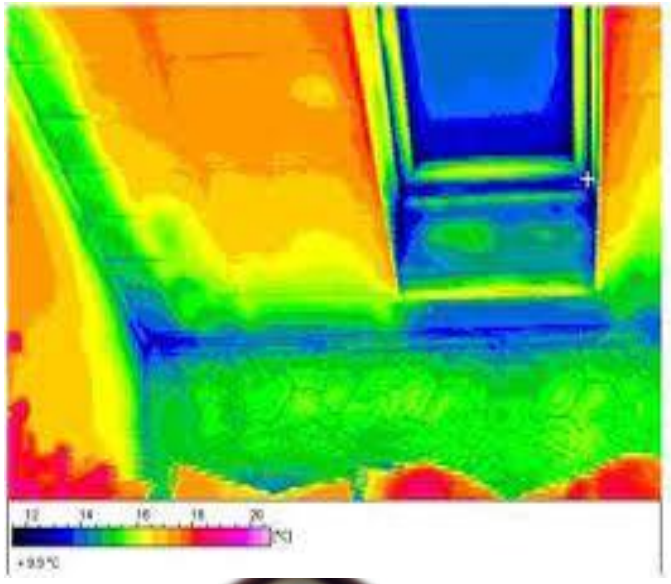


Housing reference level for radon is 200 Bq/m^3

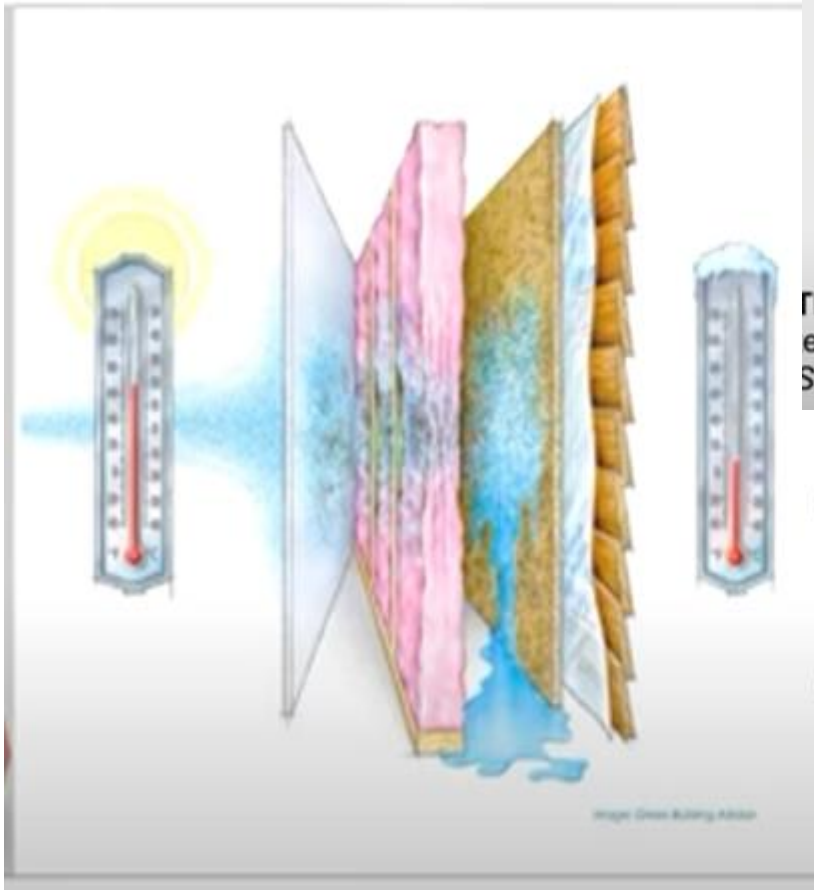
https://www.epa.ie/environment-and-you/radon/radon-map/#d.en.70996Ground

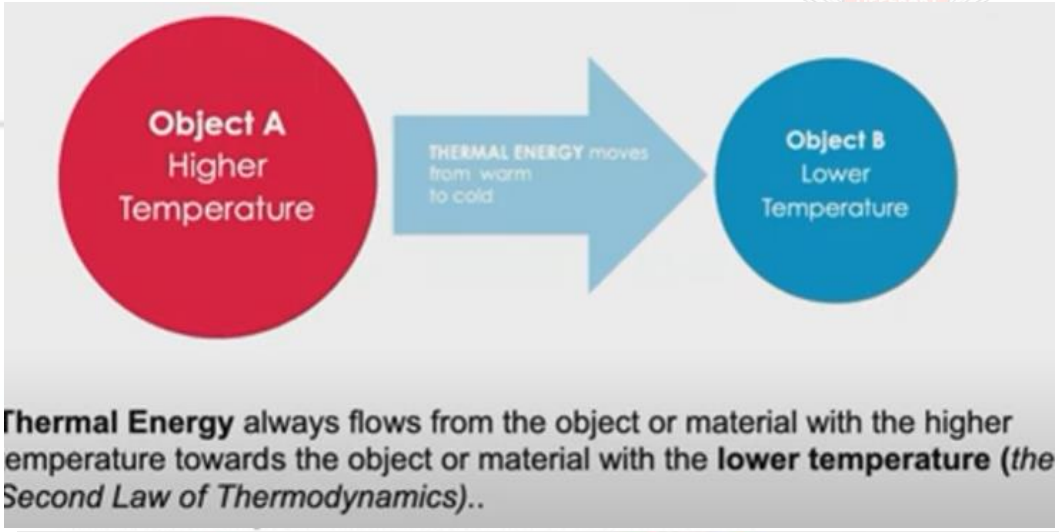

NOTICE
This is an Air-Tight House
No drilling, chasing, cutting without prior consent from Air-Tight Supervisor
Any damage caused to Air-Tight layer will incur financial penalties to contractor, no exceptions.
Always if in doubt ask the Air-Tight supervisor.


One continuous airtight/vapour control layer on the warm (interior) side

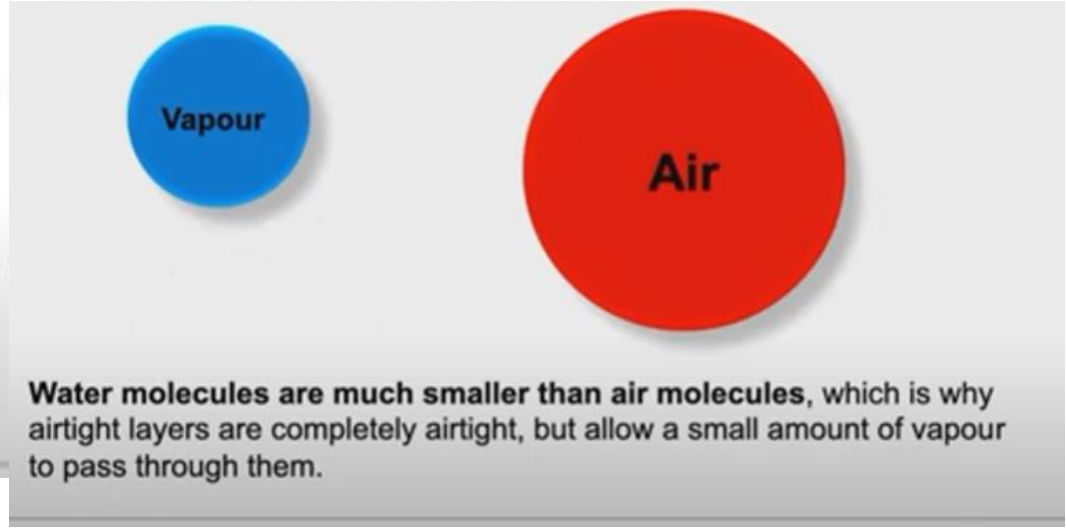


Interstitial Condensation





Thermal Energy always flows from the object or material with the higher emperature towards the object or material with the **lower temperature** (*the Second Law of Thermodynamics*)..



Water molecules are much smaller than air molecules, which is why airtight layers are completely airtight, but allow a small amount of vapour to pass through them.

1 mm wide cut a 1 m long will allow 300 mls moisture a day to move from house into the cavity.

Timber frame systems - long term condensation ? mould growth and ? structural issues.

Air tightness Test

- Measurement Name q50
- Measurement is based on Square metres of external envelope area
- Unit of Measurement m3/(hr.m2)
- **Max limit = 5 m3/m2.hr**
- **Under 3 m3/m2.hr = Mech ventilation**

Ventilation

- An air change rate is the number of times every hour that new air from outside enters a room and is mixed and exchanged with old air from inside.

- Why is this important?
- If your air change rate is too high, you're losing air that you're paying to heat.
- If the rate is too low, your air is becoming stale and stagnant, which can also lead to a buildup of humidity, toxins, viruses, pathogens, and carbon dioxide.

Moisture

- 1kg a day of water vapour per person from respiration and sweating
- 0.5-1kg a day per person from showers
- 0.25kg a day dishwashing
- 0.24kg a day / meal from cooking
- 3kg a load of washing (assuming its' dried inside, and would have been dried inside regardless)

- For example, a five person household puts about 10 litres of water into the air every day

Poor Ventilation Consequences

How proper ventilation can clear condensation for good

Streaming windows? Water on walls? Musty damp odours? Mould and damp patches?

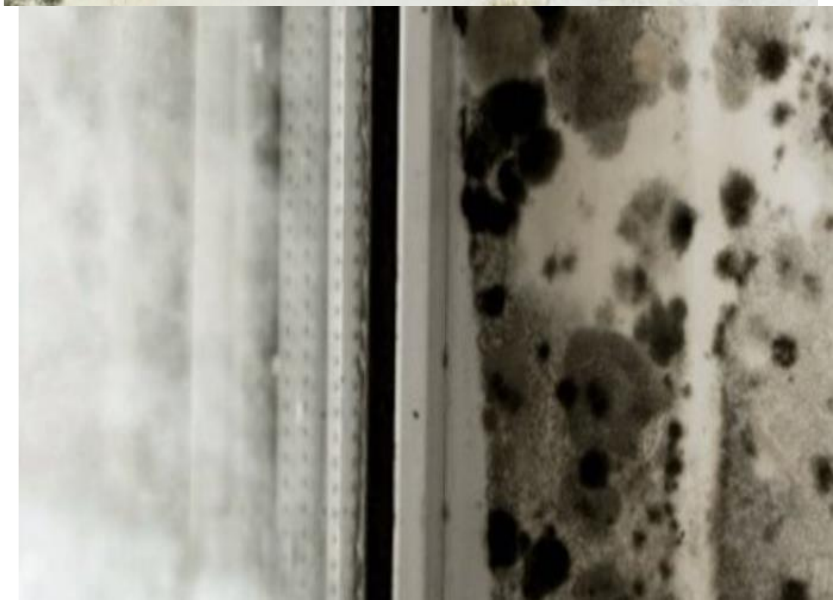
Why live with damp when we can solve it?

Musty smells? Cold damp walls? Condensation around windows? Discoloured walls? Deteriorating plaster and paint?

Permanently banish mould with effective ventilation

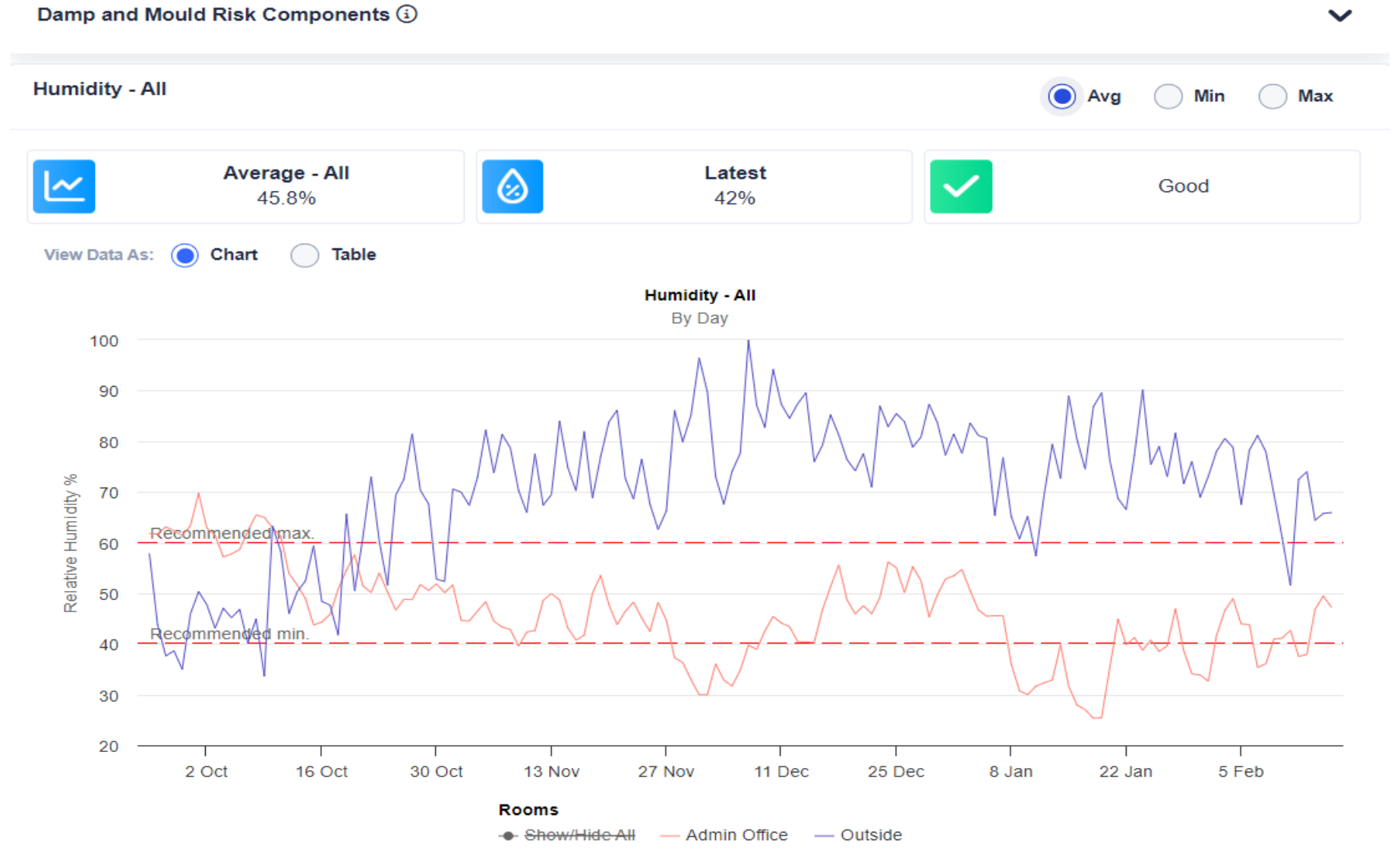
Black, green or white mould? Musty smells? Condensation issues? Damp patches? Mould around windows, on furniture, mattresses, walls floors, ceilings and doors?

You won't solve the problem with bleach and household cleaners. Mould will keep coming back unless you deal with the root cause. What's more it can also affect your health and immune system, causing headaches, breathing difficulties, nausea, fatigue and even trigger respiratory problems and asthma.



CO2 – Temperature – Humidity sensor (WIFI)

Ventilation Performance Measurement



The Law

- Building Control Acts 1990 to 2014
  - Building Regulations 1997 (as amended)
    - Part F (Ventilation) of the Second Schedule to the Building Regulations

Means of ventilation	F1	Adequate and effective means of ventilation shall be provided for people in buildings. This shall be achieved by: (a) limiting the moisture content of the air within the building so that it does not contribute to condensation and mould growth, and (b) limiting the concentration of harmful pollutants in the air within the building.

- What's "Adequate"?
- Applies to New builds, Extensions and Retrofits


Building Regulations
Technical Guidance Document L 2021
Conservation of Fuel and Energy - Dwellings


Ventilation
F
Building Regulations 2019
Technical Guidance Document


Installation and Commissioning of Ventilation Systems for Dwellings - Achieving Compliance with Part F 2019

Acceptable Construction Details (ACDs) are intended to **help the construction industry achieve the performance standards** in the Technical Guidance Document (TGD) to Part L of the Building Regulations - Conservation of Fuel and Energy - Dwellings.

The 2021 edition of the ACDs updates drawings to take account of internal insulation which was previously provided for in text of 2011 ACDs and some editorial updates. **It does not change the thermal performance** of the details from the 2011 edition.

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Tipperary County Council

Part 2 – Technical Advice

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Main Types of Systems

- Continuous Mechanical Extract Ventilation (cMEV) <5m³/h.m²
- Mechanical Ventilation with Heat Recovery (MVHR) <5m³/h.m²
- Natural Ventilation with Intermittent Extract Ventilation 3m³/h.m² - 5m³/h.m²

Diagram 1a: Continuous Mechanical Extract Ventilation - House

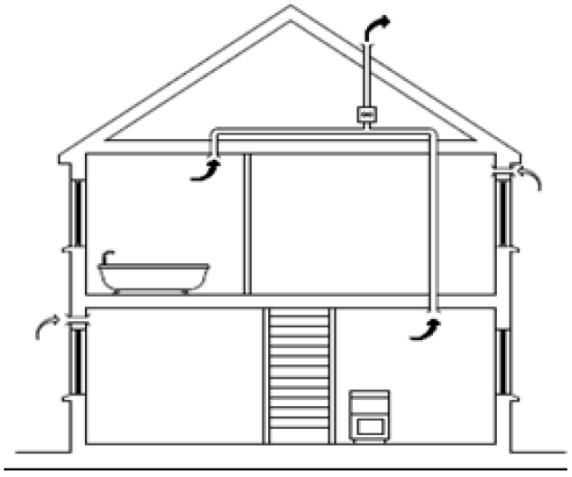


Diagram 2a: Mechanical ventilation with heat recovery – House

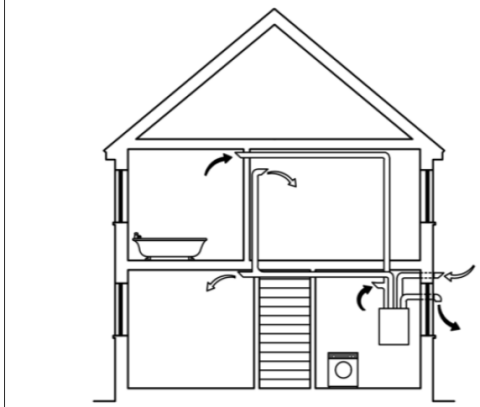
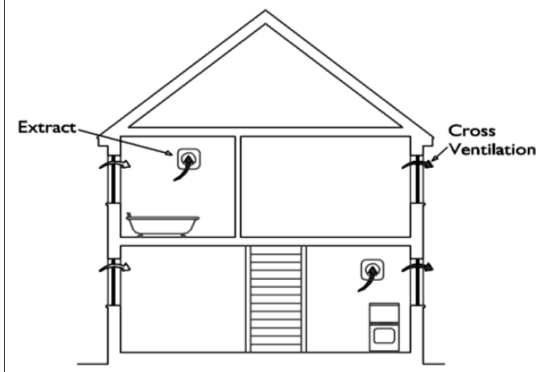


Diagram 2c: Natural Ventilation with intermittent fans mechanical extract - House



Main Types of Systems

- Continuous Mechanical Extract Ventilation (cMEV)

- Central extraction unit pulling moisture laden air from wet rooms

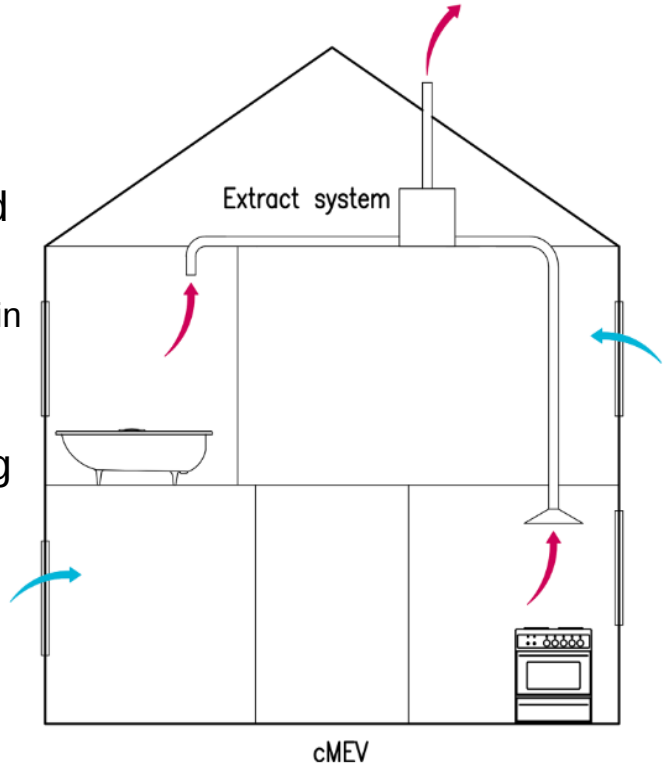
- Extract system introduces negative pressure

- Replacement air from humidity controlled inlets* or background ventilators**
  - Inlets should be approx. 2m high and located away from door into room in order to achieve a sufficient rate of air transfer

- Downside to CMEV: heated air is being extracted from dwelling

*humidity controlled inlets form part of a Demand Controlled Ventilation system (DCV) – designed by a specialist.

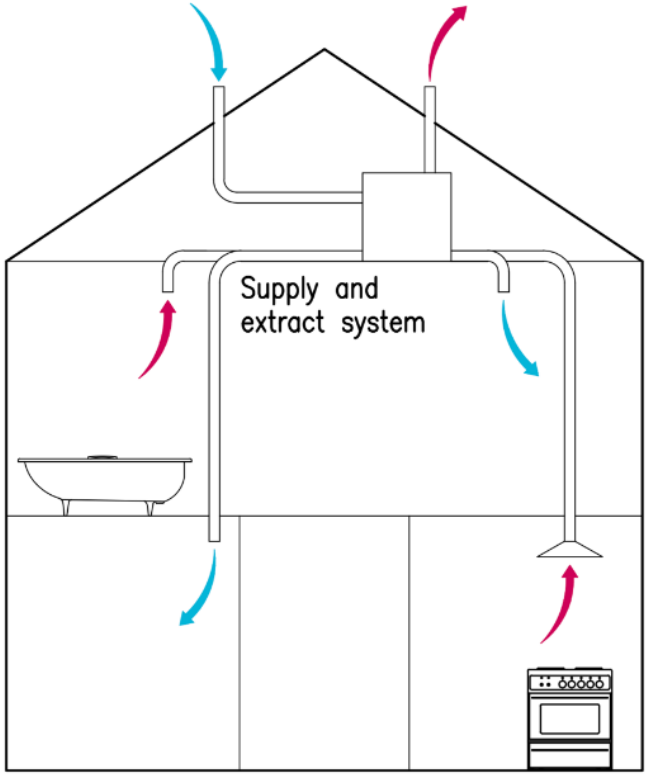
** background ventilators to achieve a minimum equivalent area of 2,500mm² in each room (except wet rooms)



Main Types of Systems

- Mechanical Ventilation with Heat Recovery (MVHR)

- Extracted air from wet rooms ran through heat exchanger
- Outside air passed through heat exchanger - “pre-heating”
- Can recover up to 95% of heat
- Intake and Exhaust terminals should be located on same façade to reduce wind pressure interference but they should also be spaced far enough part to avoid short-circuiting.
- Downside: significant number of duct runs to insulate and airtight

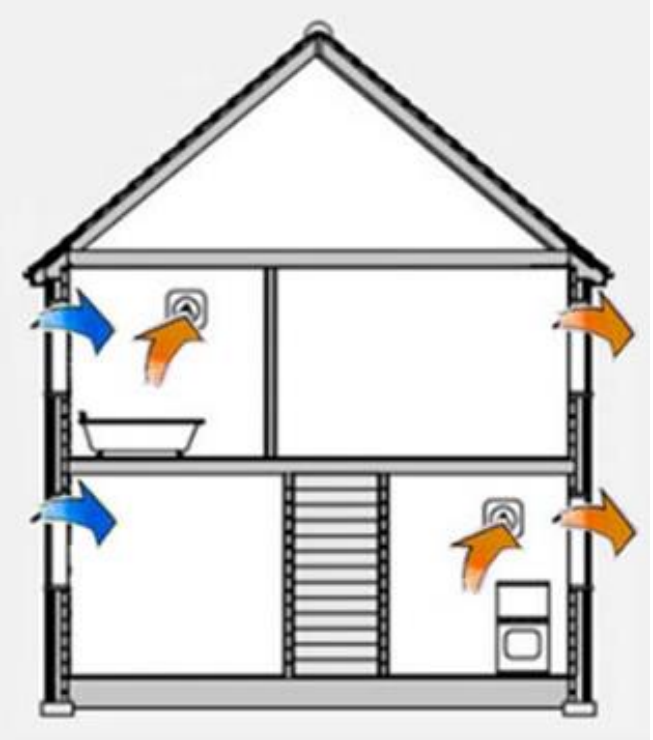


MVHR

Main Types of Systems

- Natural Ventilation with specific Extract Ventilation

- Exploits pressure differences created by wind or temperature,
- Vent opes act as either inlets or outlets depending on wind speed, direction and air temperature,
- Local extract fans provided to wet rooms
- Downside: effectiveness varies wildly depending on exposure of the dwelling and weather conditions



Ventilation Rates

- **Natural Ventilation**

Table 3: Basic ventilation provision using background ventilators and specific provision for extract and purge ventilation for 5m3/hr/m2> air permeability > 3m3/hr/m2

Room or Space	General Ventilation Minimum equivalent area of background ventilator[a] (mm^2)	Extract ventilation Extract fan[b] - Minimum intermittent extract rate (l/s)[h]	Purge ventilation Opening window or external door - Minimum provision[g]
Habitable Room	*7000[c,f]*	-	*1/20th of room floor area*
Kitchen	*3500[c,d,f]*	*60l/s generally 30l/s if immediately adjacent to cooker (e.g. cooker-hood not recirculating)*	*Window opening section (no size requirement)[d]*
Utility Room	*3500 [c,d]*	*30 l/s*	*Window opening section (no size requirement)[d]*
Bathroom	*3500 [c,d]*	*15 l/s*	*Window opening section (no size requirement)[d]*
Sanitary Accommodation (no bath or shower)	*3500 [c,d]*	*6 l/s[e]*	*Window opening section (no size requirement)[d]*

Notes:

(a) See paragraph 1.2.4.1 re: total equivalent area for all background ventilators.

(b) See paragraphs 1.2.4.9 and 1.2.4.10 re alternative of passive stack ventilation or continuous room ventilation with heat recovery.

(c) See paragraph 1.2.4.12 re the extent and location of background ventilation where there is only a single exposed façade and cross-ventilation is not possible.

(d) See paragraph 1.2.4.3 re ventilation provision where the provision of background ventilation and purge ventilation is not possible, e.g. when there is no external wall.

(e) As an alternative, the opening window section provided for purge ventilation may also be relied on for extract ventilation.

(f) See paragraphs 1.2.4.13 to 1.2.4.15 re: provision for ventilation of habitable rooms through other rooms or into courtyards.

(g) Opening window or external door minimum provisions given in this table are for ventilation purposes. Other requirements apply to the provision of openings for windows or external doors for example escape in case of a fire. Refer to Part B / TGD B for further guidance.

(h) The performance flowrates for Intermittent extract fans should be tested in accordance with I.S. EN 13141-4:2011, Cooker Hood performance flowrates should be measured in accordance with I.S. EN 13141-3:2017.

Ventilation Rates

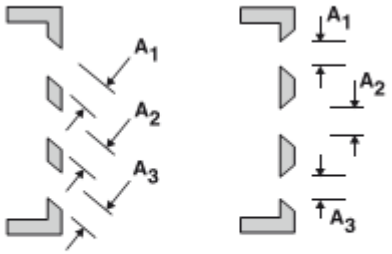
- **Natural Ventilation**

- Paragraph 1.2.4.1 of TGD F 2019:

- *"The minimum total equivalent area of background ventilators providing general ventilation should be **42,000mm² + 7,000mm² for every 10m² above 70m²***

the areas specified should be increased by 25% where free area of ventilators is used instead of equivalent area"

Free Area



(b) Measuring the free area of components on site
Free area = $A_1 + A_2 + A_3$

Equivalent Area

Ventilation Rates

- **Natural Ventilation**

- Local extract rates
  - 60l/s for kitchen (30l/s if cooker hood – non-recirculating)
  - 30l/s for utility
  - 15l/s for bathroom
  - 6l/s for WC

- Not all fans are equal! – Calculations required

Most fans sold with specs for extraction rates in m^3/hr

1l/s = 3.6m^3/hr

Example:
Extractor fan achieves 54m^3/hr (15l/s)
Bathroom measures 2.5m x 2m x 2.4m(high) = 12m^3
6-10 ACH recommended for bathrooms
6 ACH x 12m^3 = 72m^3/hr 10 ACH x 12m^3 = 120m^3/hr

while 54m^3/hr is the minimum, it may not effectively remove steam from the bathroom depending on size…..

Ventilation Rates

- **MEV and MVHR General Ventilation Rate:**

DCV may not achieve these rates....certification required to prove equivalency

Method 1: 5l/s + 4l/s per person

or

Method 2: 0.3l/s per m² internal floor area

Whichever is greater = required general ventilation rate

EXAMPLE:

Method 1: 3 Bed Semi-D (2 double beds and 1 single) = 5 persons

5l/s + (4l/s x 5 persons) = 25l/s

Method 2: 3 Bed Semi-D = 120m²

0.3l/s x 120m² = 36l/s

36l/s is the required general ventilation rate

Ventilation Rates

- **MEV and MVHR Boost Ventilation Rate:**

Table 1: Centralized continuous mechanical extract ventilation systems: minimum boost extract rates[1]	
Wet rooms	**Minimum extract rate (l/s)**
Kitchen	13[2]
Utility room	8
Bathroom	8
Sanitary accommodation (no bath or shower)	6[3]

Notes:

1 The above are minimum boost extract rates and may need to be increased to achieve the general ventilation rate.

2. Excludes cooker hood extract.

3. As an alternative, an opening window provided for purge ventilation may be relied on for extract.

The system should be able to provide a capacity of at least:

- 25% over the calculated general ventilation rate in 1.2.2.2, and

- the overall minimum extract boost rate.

Example calculations are given in Appendix 1.

Table 2: MVHR Systems: Minimum boost extract rates	
Wet rooms	**Minimum extract rate (l/s)**
Kitchen	13
Utility room	8
Bathroom	8
Sanitary accommodation (no bath or shower)	6[1]

Notes:
1. As an alternative, an opening window provided for purge ventilation may be relied on for extract.

The system should be able to provide a capacity of at least:

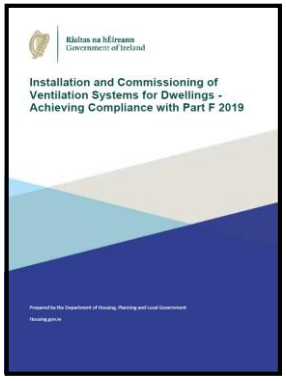
- 25% over the calculated general ventilation rate in 1.2.3.2, and

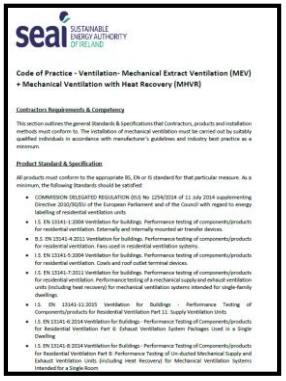
- the overall minimum extract boost rate.

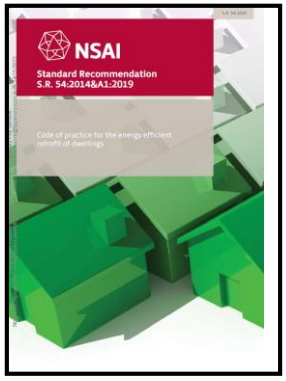
Example calculations are given in Appendix 1.

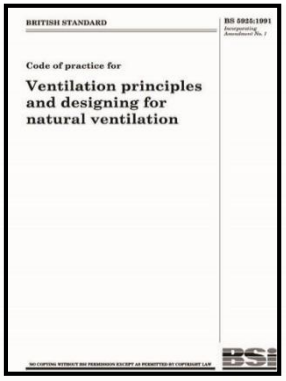
Guidance Available

- Technical Guidance Document F 2019
- Installation and Commissioning of Ventilation Systems for Dwellings – Achieving Compliance with Part F 2019
- SEAI CoP for MEV and MHVR
- S.R. 54 – CoP: Methodology for Energy Efficient Retrofit of Existing Dwellings
- BS 5925 – CoP for ventilation principles and designing for natural ventilation
- BS 5250 – CoP for control of condensation in buildings



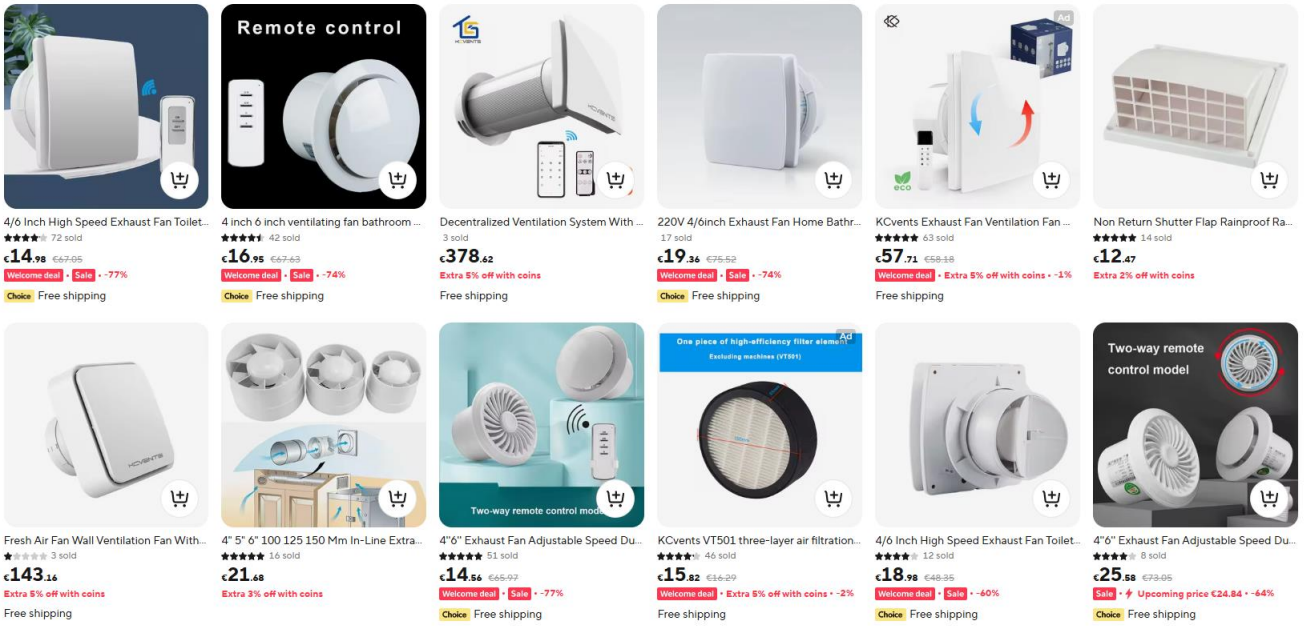






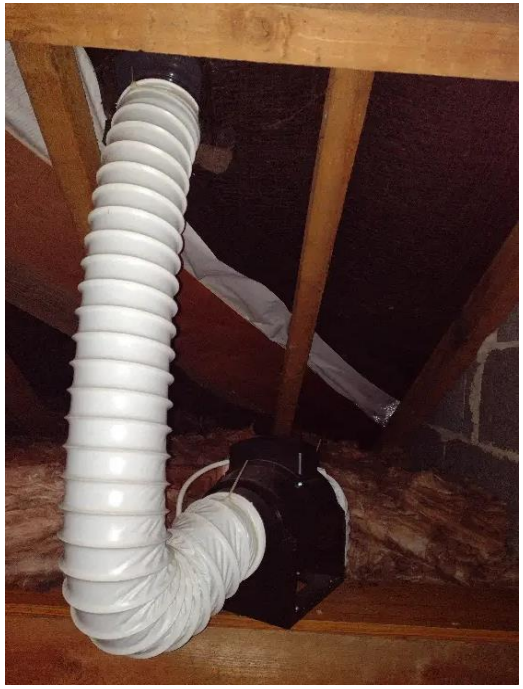
Common Non-Compliances

- Non conforming ventilation products used
  - Any ventilation product used must conform to I.S. EN 13141
    - I.S. EN 13141 Parts 1 to 11 cover the performance testing of components / products for residential ventilation



Common Non-Compliances

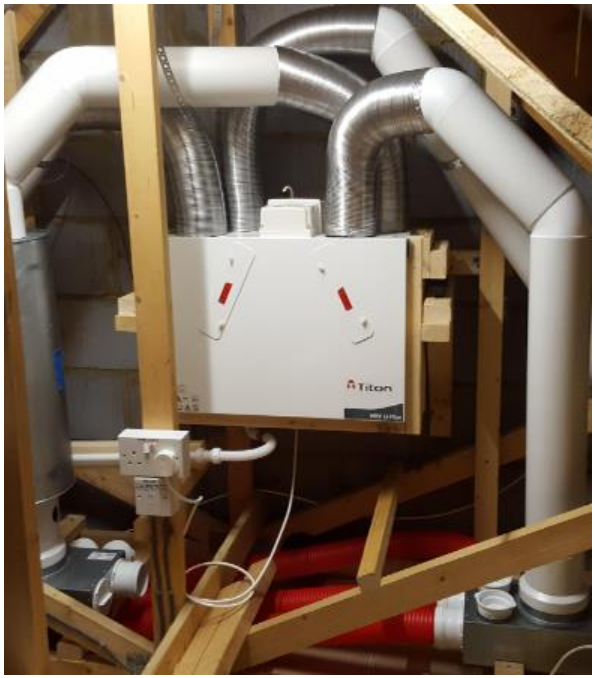
- Excessive flexible ducting runs from local extract fan
  - Axial fans – max. run of 1.5m
  - Centrifugal fans – max. run of 6m
  - Ducting should also be insulated! – minimum of 25mm @ 0.04W/mK



Common Non-Compliances

- Poorly installed ductwork
  - Peaks and troughs – minimum supports every 750mm (check with manufacturer)
  - Outside thermal envelope – if laid on top of insulation layer – must be adequately insulated ducts
  - Poor jointing between ducts – joints must be airtight (taped and sealed)

Poor Practice



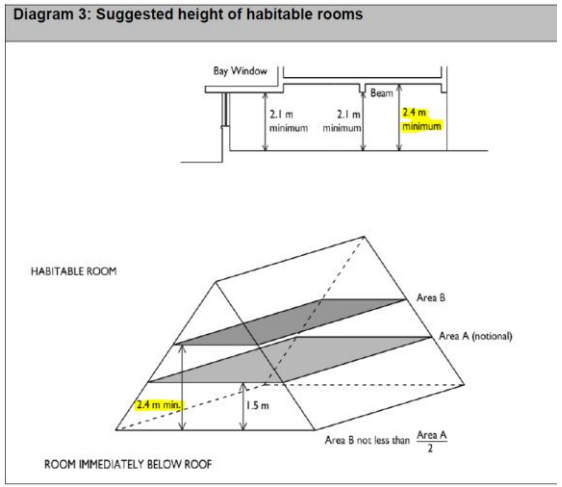
Good Practice

Common Non-Compliances

- Natural ventilation used with air-tightness results of <3m³.hr.m²
  - Serious design failure
  - Will result in the building not being adequately ventilated
    - Could lead to significant condensation and mould growth
  - Requires significant and costly retrofit measures;
    - Retrofit a full system cMEV or MVHR – difficulty with duct runs (reworks)
    - Retrofit a decentralised MVHR system (dMVHR) – individual units can be costly

Common Non-Compliances

- Natural ventilation used with ceiling heights below 2.4m
  - Typically found in loft conversions
  - Will result in rooms not being adequately ventilated and overheating
    - Could lead to condensation and mould growth
  - Calculations will be required in line to BS 5925 and BS 5250 to determine required ventilation rate and compliance measures
    - Remember minimum headroom's for safety and accessibility….



Common Non-Compliances

- Mechanical ventilation system commissioning timing
  - The commissioning of the ventilation system should be avoided when building works are ongoing (i.e internal joinery)





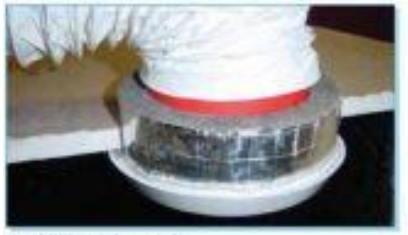

Common Non-Compliances

- Central unit in attic space
  - "out of sight….out of mind.."

- Suitable for Cold Atmosphere?
- Maintenance Access?
- Filter Replacement?

Common Non-Compliances

- Fire rated diffuser not installed (with metal web joist floor)
  - All penetrations through plasterboard must be fire-stopped
  - Floor to achieve:
    - **RE30 I15** for 2 storey home
    - **REI30** for 3 storey home



Vent FIREFLY 100 Sleeve in Situ

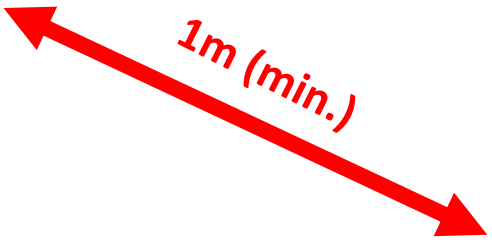
Fan FIREFLY 100 with Flat Ducting

Vent FIREFLY 100 Sleeve Prior to Installation

Common Non-Compliances

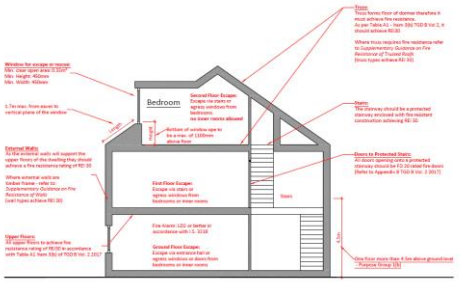
- Location of inlets / outlets to detectors
  - Smoke / heat detectors should be at least **1m** from supply or extract air diffusers

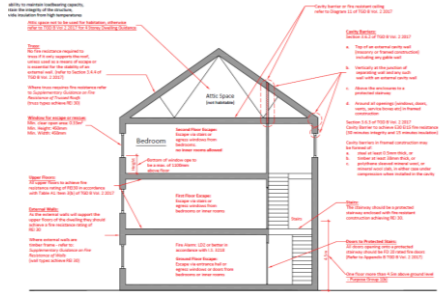
I.S. 3218:2024



Common Non-Compliances

- No gap under door
  - 10mm gap required under doors to facilitate adequate cross ventilation between spaces
- If floor finish is not fitted – owner of works must be consulted on possible finishes
- What about fire doors? (3 storey and over)

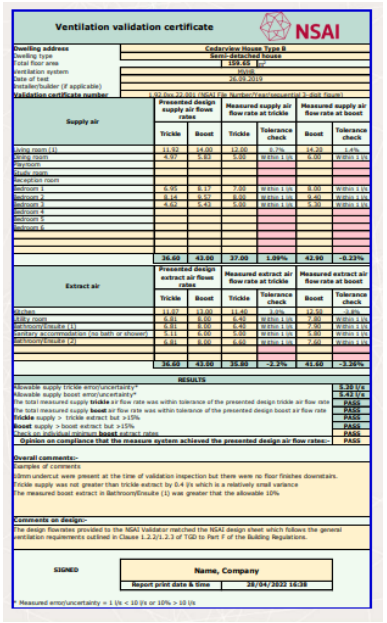




Common Non-Compliances

- Ventilation system not validated by third party
  - TGD F 2019 – Section 1.2.1.10 NSAI Ventilation Validation Scheme
  - **Must be submitted with CCC for all housing in Tipperary**

I.S. EN 14134:2019, *Ventilation for buildings - Performance testing and installation checks of residential ventilation systems*



Ventilation validation certificate

NSAI

Dwelling address	Cedarview House Type B
Dwelling type	Semi-detached house
Total floor area	154.69 m²
Ventilation system	MVHR
Date of test	26.09.2019
Installer/builder (if applicable)	
Validation certificate number	1.03 Dev 22-001 (NSAI Cert Number/Year/sequential 3-digit figure)

Supply air	Presented design supply air flow rates		Measured supply air flow rate at trickle		Measured supply air flow rate at boost	
	Trickle	Boost	Trickle	Tolerance check	Boost	Tolerance check
Living room (1)	11.92	14.00	12.00	0.7%	14.20	1.4%
Dining room	4.97	6.83	5.00	Within ± 10 l/s	6.80	Within ± 10 l/s
Playroom						
Study room						
Reception room						
Bedroom 1	6.95	8.17	7.00	Within ± 10 l/s	8.00	Within ± 10 l/s
Bedroom 2	8.14	9.57	8.00	Within ± 10 l/s	9.40	Within ± 10 l/s
Bedroom 3	4.62	5.43	5.00	Within ± 10 l/s	6.30	Within ± 10 l/s
Bedroom 4						
Bedroom 5						
Bedroom 6						
	36.60	43.00	37.00	1.09%	42.90	-0.23%

Extract air	Presented design extract air flow rates		Measured extract air flow rate at trickle		Measured extract air flow rate at boost	
	Trickle	Boost	Trickle	Tolerance check	Boost	Tolerance check
Kitchen	11.07	13.00	11.40	1.0%	12.50	-1.8%
Utility room	6.81	8.00	6.40	Within ± 10 l/s	7.80	Within ± 10 l/s
Bathroom/Ensuite (1)	6.81	8.00	6.40	Within ± 10 l/s	7.90	Within ± 10 l/s
Sanitary accommodation (no bath or shower)	5.11	6.00	5.00	Within ± 10 l/s	5.80	Within ± 10 l/s
Bathroom/Ensuite (2)	6.81	8.00	6.60	Within ± 10 l/s	7.00	Within ± 10 l/s
	36.60	43.00	35.80	-2.2%	41.40	-3.26%

RESULTS	
Allowable supply trickle error/uncertainty*	5.39 l/s
Allowable supply boost error/uncertainty*	9.43 l/s
The total measured supply **trickle** air flow rate was within tolerance of the presented design trickle air flow rate	PASS
The total measured supply **boost** air flow rate was within tolerance of the presented design boost air flow rate	PASS
Trickle supply > trickle extract but >15%	PASS
Boost supply > boost extract but >15%	PASS
Check on individual minimum **boost** extract rates	PASS
Opinion on compliance that the measure system achieved the presented design air flow rates:-	PASS

Overall comments:-
Samples of comments
10mm undercut were present at the time of validation inspection but there were no floor finishes downstairs.
Trickle supply was not greater than trickle extract by 0.4 l/s which is a relatively small variance
The measured boost extract in Bathroom/Ensuite (1) was greater that the allowable 10%.

Comments on design:-
The design flowrates provided to the NSAI Validator matched the NSAI design sheet which follows the general ventilation requirements outlined in Clause 1.2.2/1.2.3 of TGD to Part F of the Building Regulations.

SIGNED

Name, Company	
Report print date & time	28/04/2022 14:38

* Measured error/uncertainty = 1 l/s < 10 l/s or 10% > 10 l/s

Conclusions

- Ventilation should be a key priority of designers – particularly for homes achieving greater levels of airtightness ($<3 m^3/hr.m^2$)
- Not all systems are created equally – proposals for natural ventilation should be approached with caution.
- Critical analysis of proposed ventilation design required at early stage
- Good guidance docs available – also consult with the Building Control Authority where you are unsure
- Be aware of the common non-compliances
- Ventilation installation is not a “D.I.Y” job – specialist knowledge and installation is required

Comhairle Contae Thiobraid Árann
Tipperary County Council

Questions?

Martin Moore C. Build E MCABE (Reg. Building Surveyor)
Assistant Chief Fire Officer
Tipperary Fire & Rescue Service