Domestic Ventilation & Hazardous Areas in Buildings

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Hazardous areas context and project aims

- IGEM/SR/25 defines a hazardous area as: “An area in which explosive gas/air mixtures are, or may be expected to be, in quantities such as to require special precautions for the construction, installation and use of electrical apparatus or other sources of ignition.”
- Domestic properties (typically 98-99% of connections) are not covered by DSEAR, but related standards can be used as a reference point, especially for calculating leak rates.
- BS 6891 details the requirements of a gas installation in a domestic setting, e.g. separation distances between services.
- A literature review was conducted examining hazardous areas for domestic and small commercial installations (gas pressure <25mbar) for natural gas and hydrogen.
- The aim was to determine whether conversion of UK gas network to hydrogen would affect existing zoning classification and distances.

Failures within a domestic environment

- Domestic pipework operates at <25 mbar – this means the internal pressure is not high enough to cause spontaneous pipe failure.
- Failure is usually due to (GS(M)R reportable incidents 2016-2022):
  - Defects in the pipe wall e.g. mechanical interference including third party, or corrosion
  - Defects in fittings and seals e.g. weeping fitting/valve
- BS 6891 details the requirements of a gas installation in a domestic setting, e.g. separation distances between services.
  - If these distances are not maintained, incidents can occur e.g. a pipe and cable rub together.
- Incidents can also occur if cable meter tails interact with gas meter flexibles.
- Domestic dwellings tend to be occupied (unlike large commercial sites) therefore odorisation is very effective at detecting gas escapes.

Hazardous areas conclusions

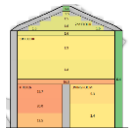
In a domestic setting:

- Methods of failure in a domestic setting will not change if the pipework carries hydrogen instead of natural gas.
- BS 6891 requirements for installation and separation distances still apply.
- Changing the distance won't help if the damage is caused by a third party.
- Meter flexibles should be pre-wrapped to prevent corrosion, and this is included in PAS4441.

Domestic Ventilation

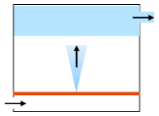
Asses current building regulations on ventilation

Acquire air leakage rates of occupied homes



Investigate previous experimental domestic hydrogen releases

Development of gas accumulation model



Modelling hydrogen accumulation in homes

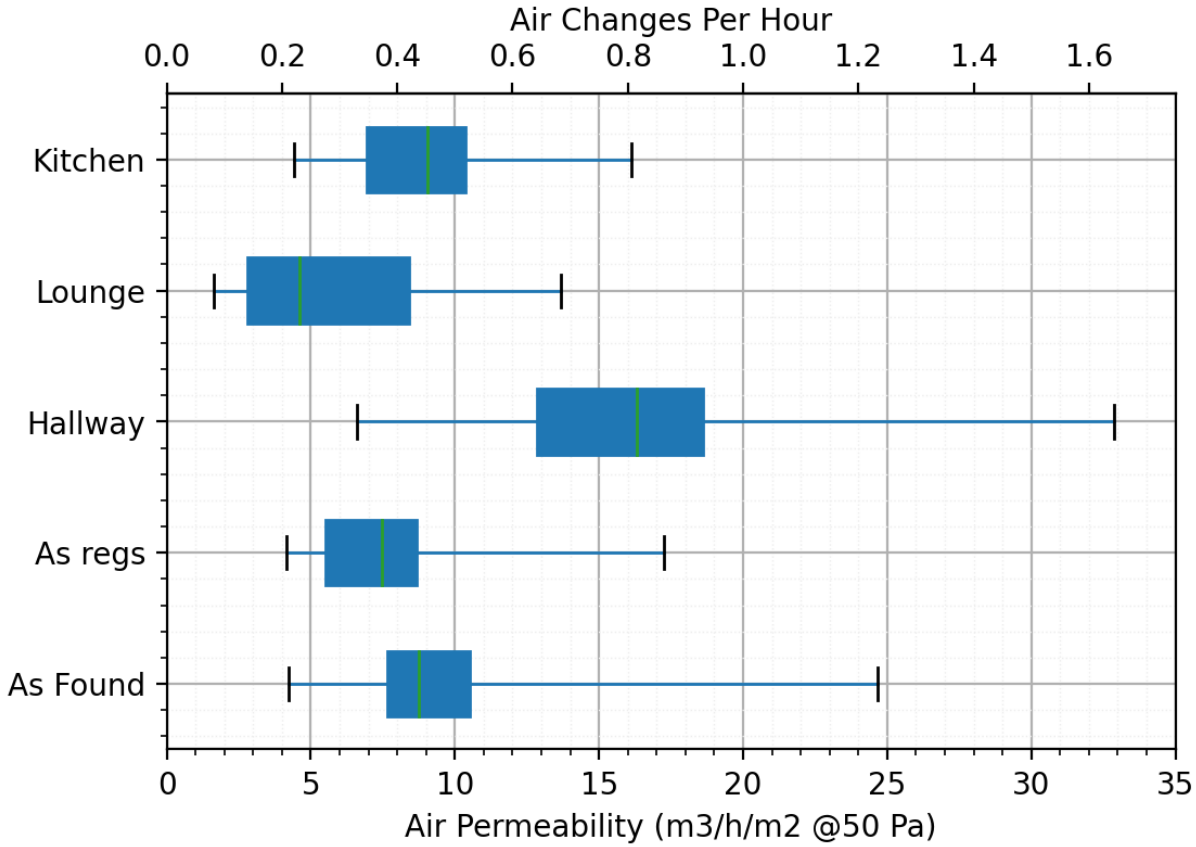
Produce draft appliance location procedures

Air permeability tests of 24 properties

A range (broadly reflective of UK housing stock)

Findings:

- Whole House - As found (vents open) typically only very slightly leakier than regs (vents sealed).
- Most ventilation comes from air leakage not purpose-built ventilation.
- Hallways found to be leaky.
- Kitchens comparable with whole house (often slightly leakier).
- Lounges found to be very tight in places with more variation than kitchens.

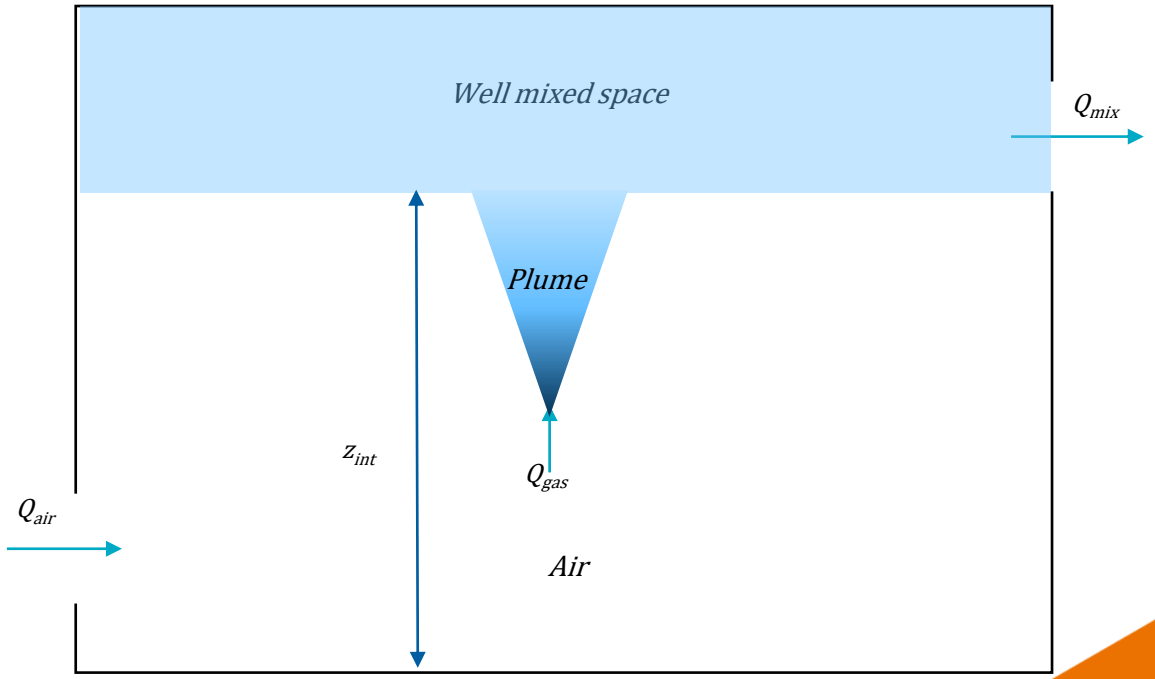


Modelling

Development of gas accumulation model:

- The properties (and rooms) tested under the Pipework project modelled as enclosures with two vents
- The vent sizes were calculated from the measured air permeability.
- The model was validated against experimental data from HyHouse and Hy4Heat Projects.
- All rooms/spaces modelled with doors closed (worst case)

Two-Vent Plume Model (chosen model)



Modelling

- Pipework project Findings - majority of faults below 0.25 mm^2
- These do not cause concern

DSEAR Classifications

- Normal Leak
- Adverse Leak

Within current standards the gas industry does not anticipate leaks larger than the above

Property	0.025mm2 0.016m3/h			0.25mm2 0.16m3/h			2.5mm2 1.65m3/h			9.1mm2 6m3/h		
	Kitchen	Lounge	Hall	Kitchen	Lounge	Hall	Kitchen	Lounge	Hall	Kitchen	Lounge	Hall
1	0.10	0.17	0.06	0.85	1.37	0.44	5.36	8.18	2.73	13.30	19.27	6.86
2	0.16	0.18	0.07	1.24	1.50	0.51	7.28	9.25	2.84	17.37	21.57	6.82
3	0.07	0.08	0.04	0.63	0.69	0.32	4.18	4.51	1.99	10.78	11.50	5.05
4			0.04			0.31			2.05			5.29
5	0.05	0.16	0.04	0.46	1.34	0.35	3.29	8.26	2.34	8.86	19.50	6.03
6	0.11	0.27	0.06	0.89	2.06	0.49	5.50	11.51	3.07	13.59	25.97	7.71
7	0.14	0.21	0.08	1.07	1.62	0.60	6.33	9.29	3.53	15.37	21.55	8.66
8	0.10	0.12	0.07	0.80	0.98	0.55	5.04	5.89	3.24	12.61	14.45	8.00
9	0.10	0.17	0.06	0.84	1.34	0.44	5.26	7.87	2.67	13.07	18.59	6.69
10	0.05	0.06	0.06	0.48	0.50	0.46	3.48	3.52	2.77	9.27	9.36	6.87
11	0.14	0.19	0.11	1.08	1.44	0.91	6.41	8.15	5.86	15.54	19.19	14.72
12	0.06	0.11	0.03	0.54	0.87	0.24	3.79	5.41	1.64	9.92	13.41	4.34
13	0.11	0.06	0.03	0.86	0.50	0.28	5.33	3.54	2.07	13.24	9.39	5.63
14	0.10	0.07	0.04	0.82	0.56	0.32	5.13	3.85	2.19	12.79	10.06	5.76
15	0.15	0.11	0.06	1.13	0.85	0.45	6.62	5.27	2.79	15.95	13.12	7.05
16	0.07	0.07	0.03	0.57	0.60	0.22	3.86	4.06	1.45	10.08	10.51	3.71
17	0.11	0.20	0.07	0.87	1.59	0.51	5.41	9.36	3.06	13.41	21.65	7.57
18	0.08	0.15	0.05	0.69	1.22	0.41	4.52	7.23	2.63	11.51	17.28	6.71
19	0.05	0.20	0.04	0.45	1.57	0.33	3.25	9.01	2.20	8.78	20.94	5.67
20	0.07	0.00	0.06	0.63		0.48	4.35		3.03	11.16		7.64
21	0.08	0.09	0.04	0.70	0.73	0.34	4.57	4.76	2.30	11.61	12.01	6.00
22			0.03			0.29			2.54			7.76
23	0.09		0.12	0.75		0.86	4.81		4.88	12.12		11.67
24			0.03			0.25			2.11			6.03

Range	Format
0 - 2%	0.00
2 - 4%	2.06
4 - 8%	5.77
8 - 16%	11.19
16 - 23%	20.7271
> 23 %	31.9891

Single story

Open plan, very airtight, small space

WALES&WEST UTILITIES

Modelling

Likely trip point SMART meter EFV

Trip point mechanical EFV

These are clearly high concentrations BUT :

- They are worst case - modelled with the door closed so the concentrations in the rest property will be low.
- The inventory of the whole property is much lower than without an EFV
- They are extremely rare.

27.3mm2			36.3mm2		
18m3/h			24m3/h		
Kitchen	Lounge	Hall	Kitchen	Lounge	Hall
28.44	38.45	15.01	34.40	45.38	18.36
35.28	42.15	14.32	42.02	49.36	17.27
24.08	25.27	11.19	29.61	30.93	13.73
		11.91			14.68
20.74	38.84	13.57	25.99	45.89	16.74
28.96	48.92	16.85	34.99	56.67	20.56
31.99	42.11	18.43	38.35	49.32	22.32
27.22	30.38	17.15	33.13	36.58	20.82
28.03	37.31	14.58	33.95	44.22	17.78
21.49	21.60	14.86	26.75	26.86	18.07
32.18	38.33	31.87	38.58	45.33	38.69
22.60	28.65	10.04	27.98	34.66	12.48
28.28	21.68	13.37	34.34	27.00	16.74
27.54	22.78	13.20	33.52	28.15	16.38
32.99	28.14	15.47	39.46	34.08	18.91
22.87	23.61	8.33	28.26	29.07	10.26
28.65	42.27	16.31	34.64	49.61	19.84
25.28	35.19	14.92	30.93	41.89	18.32
20.60	41.13	12.77	25.75	48.38	15.73
24.71		16.72	30.27		20.45
25.54	26.17	13.65	31.24	31.99	16.89
		20.74			26.75
26.42		24.08	32.17		28.87
		14.63			18.39

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WALES&WEST UTILITIES

Findings

- Detection

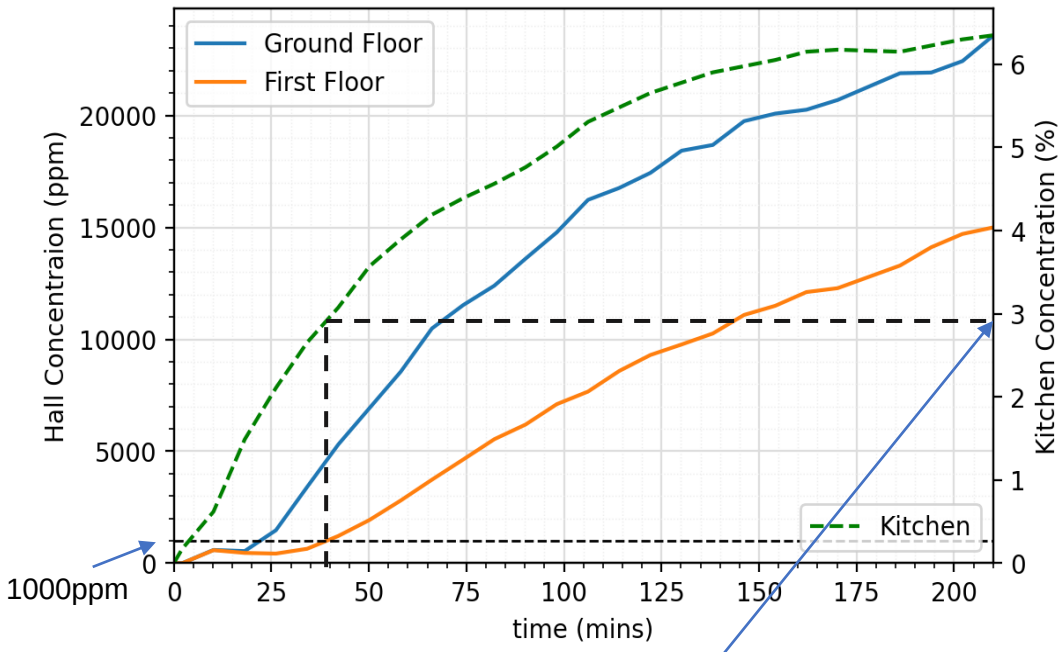
- Previous experimental data indicates hydrogen leaks readily detected in adjoining space.

- If one alarm at top of hall/central location:
  - Majority of leaks detected before explosive atmosphere in room of leak (large leaks to be investigated)
  - Centrality increases likelihood of alerting occupants

- One alarm sufficient for majority of properties

- For more complex properties, more alarms may need consideration

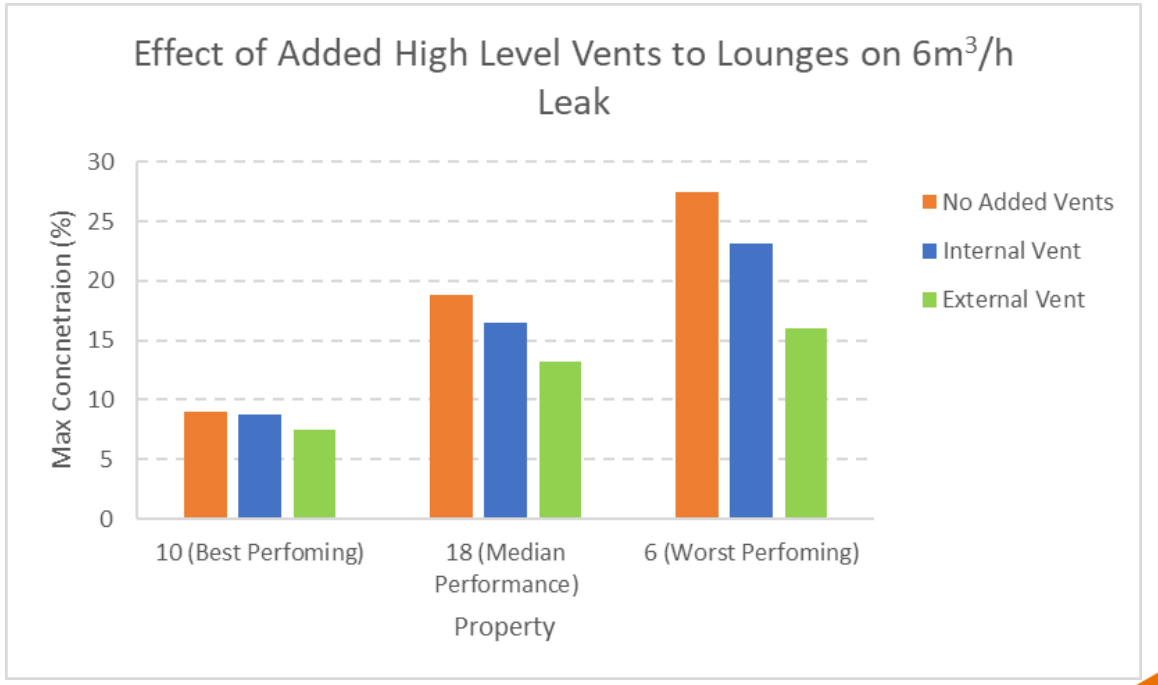
2.2 m^3/h hydrogen leak in Kitchen at SpadeAdam



Less than 3% in kitchen when 1000ppm at top of first floor

Findings

- Added Ventilation
- Effect of adding vents just below ceiling level
  - Internal vent to hallway
  - External vent
- Again, worst performing property sees largest improvement.
- External vent produces largest decrease but:
  - External vents increase heat loss and increase likelihood of being blocked
  - Internal vents increase detection time of leak in the rest of the property



WALES&WEST UTILITIES

Recommendations and Conclusions

Hallways (ventilated central spaces) (0.7-0.9ACH)

- Found to be well ventilated.
- If unable to locate meter externally, meters can be in hallways (within a suitable cupboard, 125cm2 vents top & bottom) or other very well-ventilated spaces (garages, out houses, etc.).
- It is also suggested that hallways (or another central location) are the most suitable location for an audible alarm.

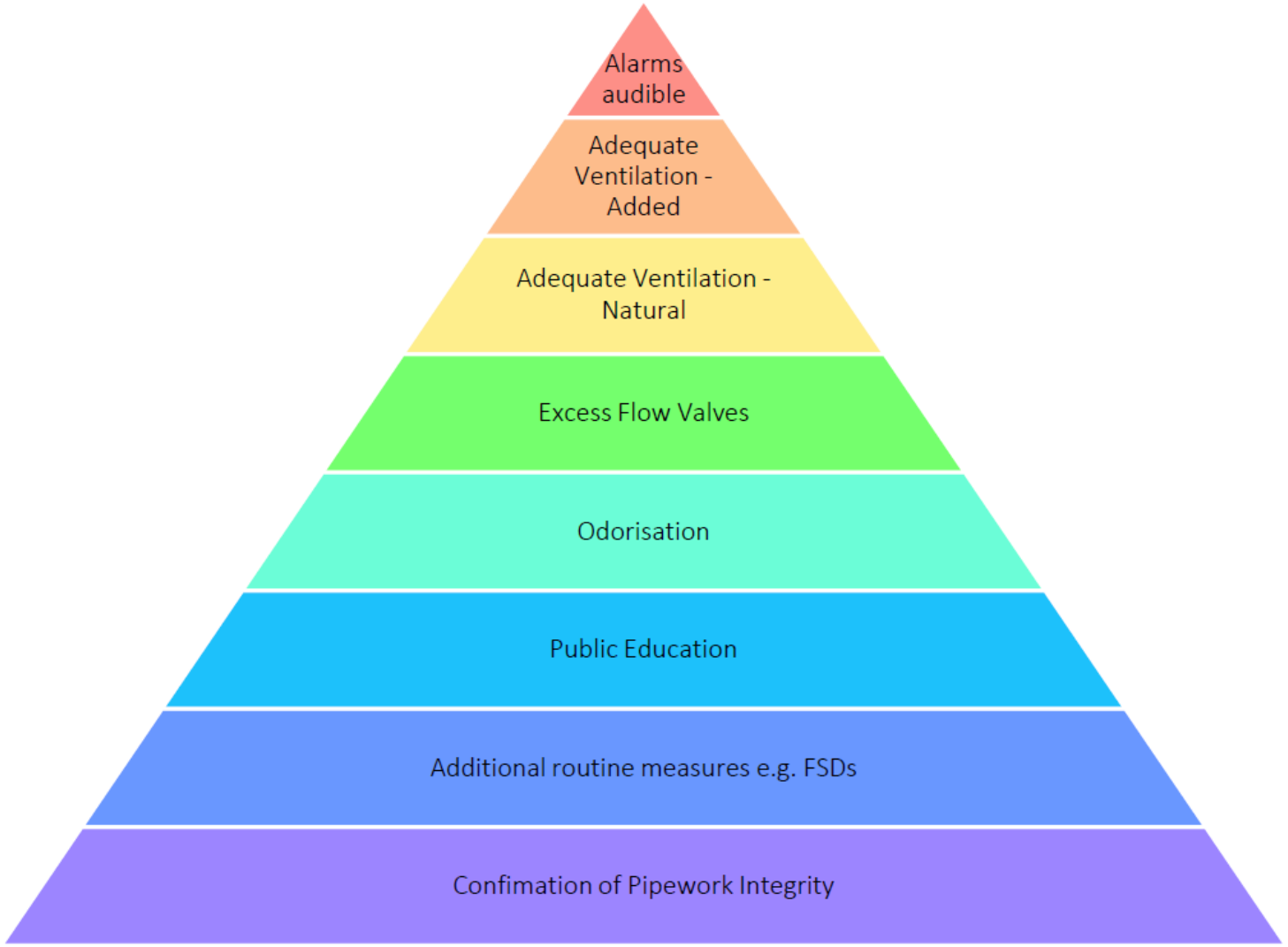
Kitchens (0.3-0.5ACH)

- Suitable for boilers and other hydrogen appliances such as hobs and gas fires.
- Should be compliant with ADF namely an extract fan, not for the mechanical extract rate, but to add natural ventilation when not operating.

Living rooms (single doored habitable rooms) (0.1-0.5ACH)

- Produced far more varied results than the other spaces tested.
- Boilers should not be installed in single doored rooms without additional risk reducing measures
- Gas fires suitable with the recommendation of additional risk reduction measures where ACH are lower.

Recommendations and Conclusions



Thank You

Questions?