Exploring Pressure Differentials in Residential and Commercial Buildings

Radon and Vapor Intrusion

Pressure Differential

A comparison measurement made between to ports of a device.

Has various scales depending on the value.

For our purposes expressed as inches of water column or pascals



Where to Measure

Find Value For X

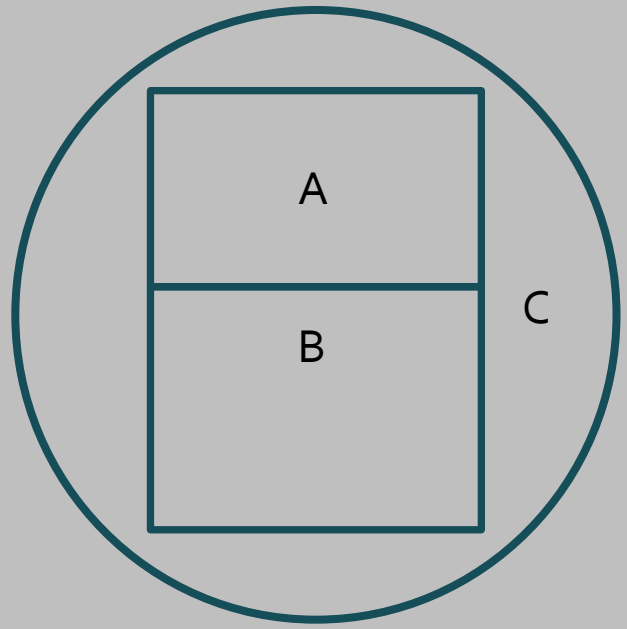
- Sub-Slab to Indoor
- Sub Slab to Outdoor
- Indoor to Outdoor

Basics

There must be a force acting on one at least one port of the device to register a differential.

There must be a barrier between the two ports to register a pressure differential.

The permeability of the barrier impacts the result.



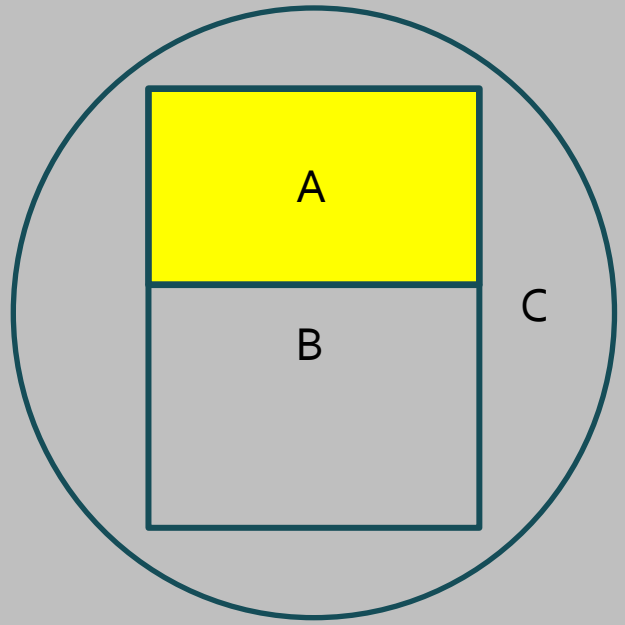
If no force is expressed on A, B or C there is no differential

Basics

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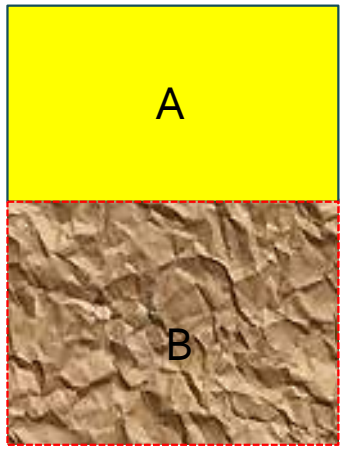
If a force is expressed on A and the barriers are non-permeable then A- B and A-C will register that differential as the same value and B-C will register none.

Basics

There must be a force acting on one at least one port of the device to register a differential.

There must be a barrier between the two ports to register a pressure differential.

The permeability of the barrier impacts the result.



If a force is expressed on A and the barrier of A-B is permeable and C has no barrier then A- C will register the value of the force. Then A-B and B-C will have different values based on the permeability of B

Driving Forces

Residential

- Stack Effect
  - Temperature Driven
- Appliances
- Wind
- Weather
- Tide, Geology & Other

Commercial

- HVAC
  - Exhaust Vent, Air Handlers
- Equipment
  - Process Equipment
- Wind
- Stack Effect
- Weather
- Tide, Geology & Other

Radon vs Vapor Intrusion

Radon

- Primary Goal is to achieve a reduction in radon as measured in an indoor sample.
- While creating a pressure differential is used to mitigate radon it can be targeted using sub slab radon measurements to achieve the goal.

Vapor Intrusion

- Primary goal is to achieve a pressure differential value (as determined by others) from the indoor to the Sub-Slab
- This performance goal is completely pressure differential data driven.

Residential vs Commercial

Residential

- Pressure differentials tend to be minimal as the primary driver is Stack Effect and has fewer variables.
- Small footprint is easier to diagnose.

Commercial

- Pressure differentials tend to be greater and have a much higher variability as they are driven primarily by HVAC, Processes and Procedures

Vapor Intrusion Large Building Case Study

- 750,000 sq ft manufacturing building upstate NY
- 5% Offices
- 5% R&D labs
- 65% Manufacturing
- 25% Warehouse

Background Data

- Indoor to Sub-Slab diagnostic background measurements varied from 1.5 Pa - 8 Pa (.006- .032 Inches WC) based on the proximity to process equipment.
  - Painting operations, Exhaust vents at workstations HVAC building make-up equipment.
- Indoor to outdoor diagnostic measurements varied from .5 Pa -8 Pa (.002- .032 Inches WC)
  - Indicates a very low permeability slab, likely resulting from multiple slabs combined and leveled to one uniform height with an epoxy floor coating.

Diagnostic Data

Suction Point # :	S-2				
Location / Description :	K7				
Soil Description	sandy with some clay				
Temperature :					
Outdoor to Indoor	0.032				
	Distance (	**Backgrour**	**Series 1**	**Max**	
Airflow Yield (cfm)		+.032	<5	7	
Applied Vacuum ("w.c.)			20	44	
SSP 1 (1' from applied)			1.3	3	Differential
TP-13	10		0.148		0.18
TP-14	20		0.043		0.075
TP-15	30		BG		0.032
TP-16	10		0.214		0.246
TP-17	20		0.061		0.093
TP-18	30		0.0019		0.034
TP-9	10		0.081		0.113
TP-8	20		0.074		0.106
TP-7	30		+.013		0.019

This data set illustrates the importance of background measurements in the sub-slab and background measurements indoor to outdoor

Without that knowledge the projected ROI would have been 20'(1200 sq ft) however once corrected for both background measurements and the indication of a non permeable slab the projected ROI was 35' (3675 sq ft) an area 3 times larger

Vapor Intrusion Large Building Case Study

We were asked to find a solution for replacing 4 15 HP blowers and redesign the distribution of vacuum.

Systems and monitoring located in isolated building.

- 1 .1 Million Sq ft Distribution Center
- 5% Offices
- 5% R&D labs
- 10% Manufacturing
- 80% Warehouse

Diagnostic Data Blowers Off

Table 2 – Pressure Differential with All Blowers Off	
VMP#	*Measured Pressure Differential ("w.c.)*
1	+ 0.051
2	+ 0.007
3	0.063
4	0.029
5	0.000
6	0.004
7	0.000
8	0.010
10	0.008

VMP 3 and VMP 4 Both have significant negative pressure differentials.

Both are below the portion of the building used to print labels which has a negative pressure to the building of .110 inches WC

The reference port was not in the Printing Lab or these measurements would have been positive .051 Inches WC and .081 Inches WC

Negative

Diagnostic Data Blowers Suction points Isolated

Baseline Data

Table 2 – Pressure Differential with All Blowers Off	
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8	0.010
10	0.008

The Data demonstrates the additive value when measured from a neutral reference. Data brings into discussion of the performance criteria of Sub-Slab to Indoor Measurements

Table 6 – Zone 1 Only Individual SPs Open (all others closed)								
VMP#	*Baseline*	*SP1*	*SP2*	*SP3*	*SP4*	*SP5*	*SP6*	*SP7*
1	+ 0.051	0.000	0.001	+ 0.020		0.067	+ 0.015	+ 0.011
2	+ 0.007	+ 0.019	+ 0.006	0.615		0.075	0.046	0.014
3	0.063	0.148	0.190	0.155	N/A	0.225	0.460	0.272
4	0.029	+ 0.024	+ 0.030	+ 0.036		0.045	0.011	0.021
5	0.000	0.008	+ 0.003	+ 0.003		+ 0.004	+ 0.001	0.003

Conclusion

- Pressure differential measurements are critical in evaluating buildings for SSDS
- Pressure differential is the criteria for success in Vapor Intrusion
- The performance criteria for Vapor Intrusion Systems is more complicated then previously thought.