

Measuring Air Leakage in Commercial & Multi-Family Buildings

Denali Jones
Retrotec



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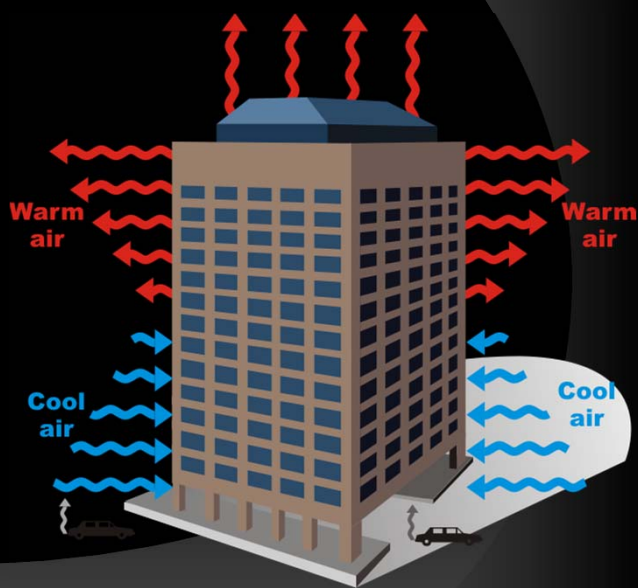
Stack Pressure + Holes = Leaks



Stack Effect

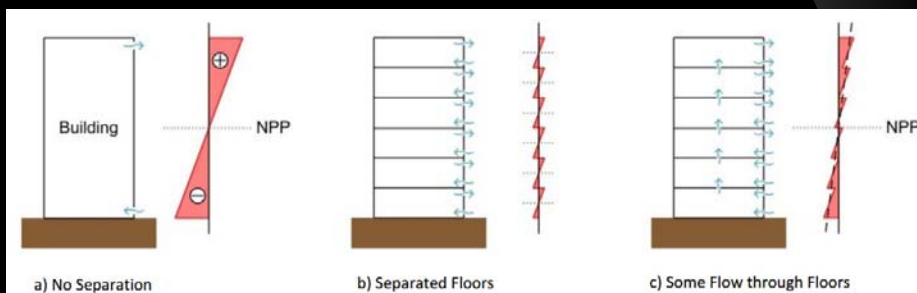
Warm air rising

Cold air falling



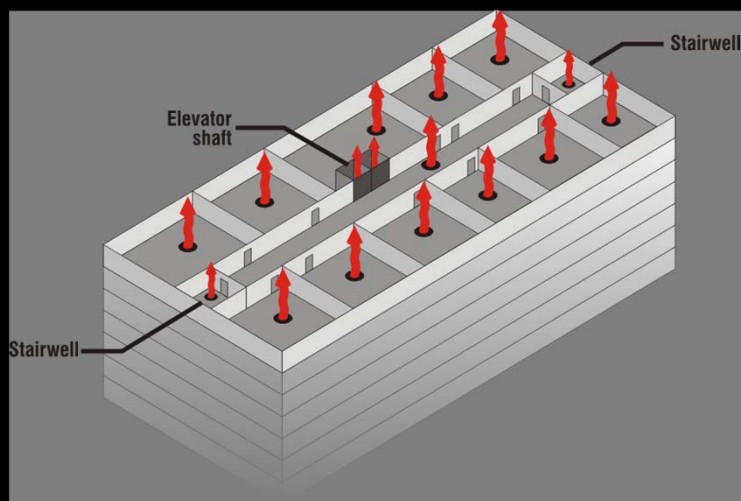
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Separation of floors reduces stack



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Primary Boundaries for cold climates



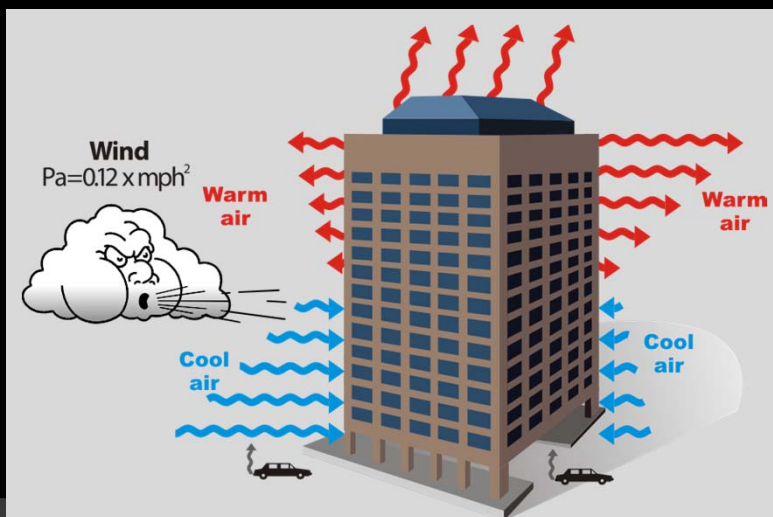
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14 windows open at -25 C

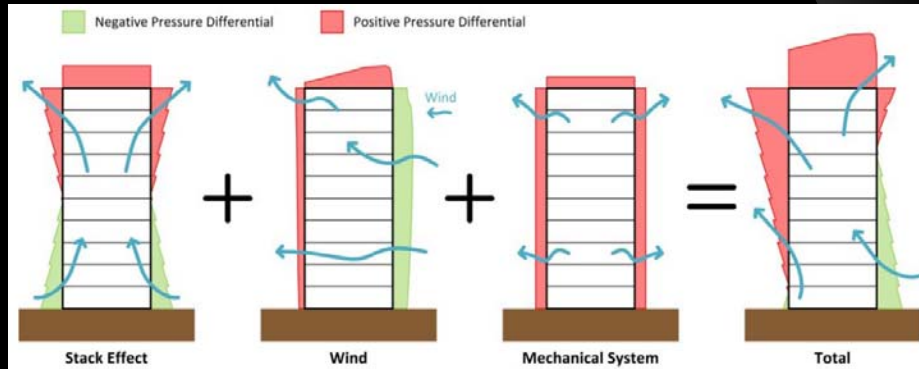
inset shows open window



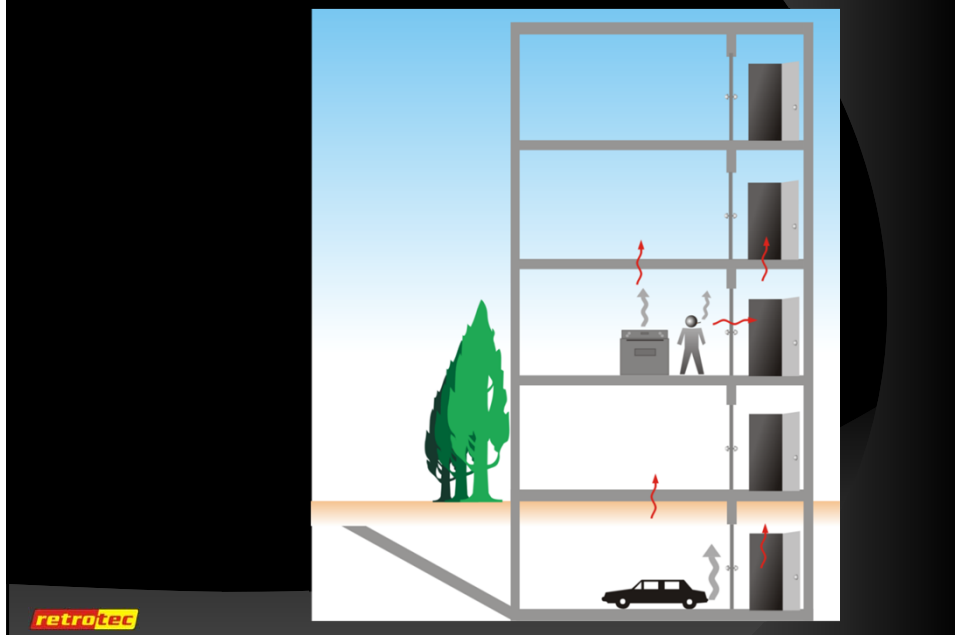
Stack Pressure + Wind Pressure + Holes = Bigger Leak



Adding all driving forces



Real problems



Smoke safety is affected by floor to floor leakage

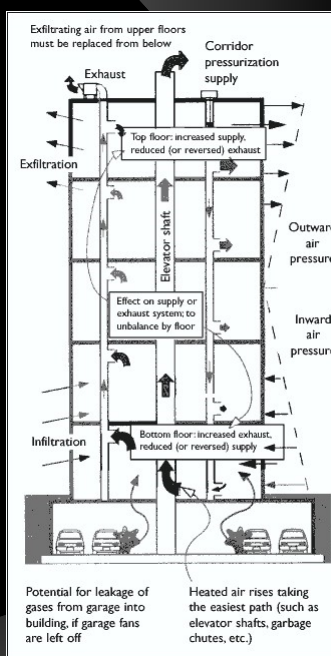


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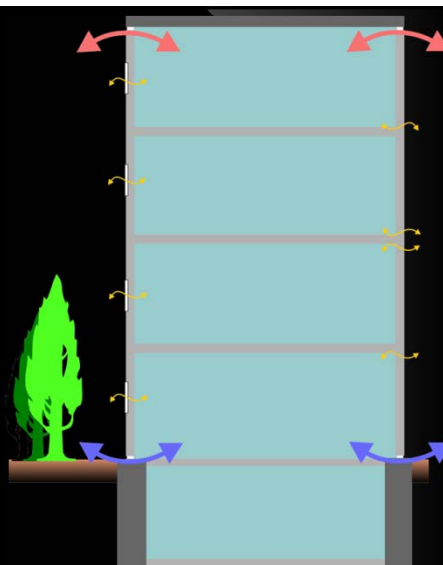
Hallway mechanicals cannot keep up with flow requirements



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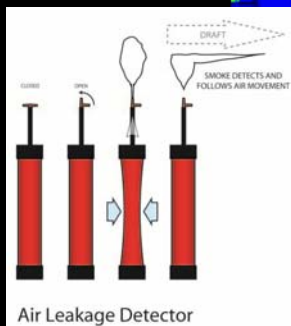
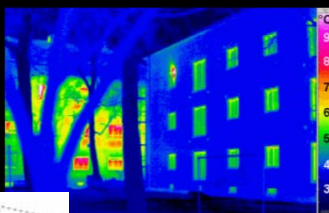


Most important leakage at top and bottom

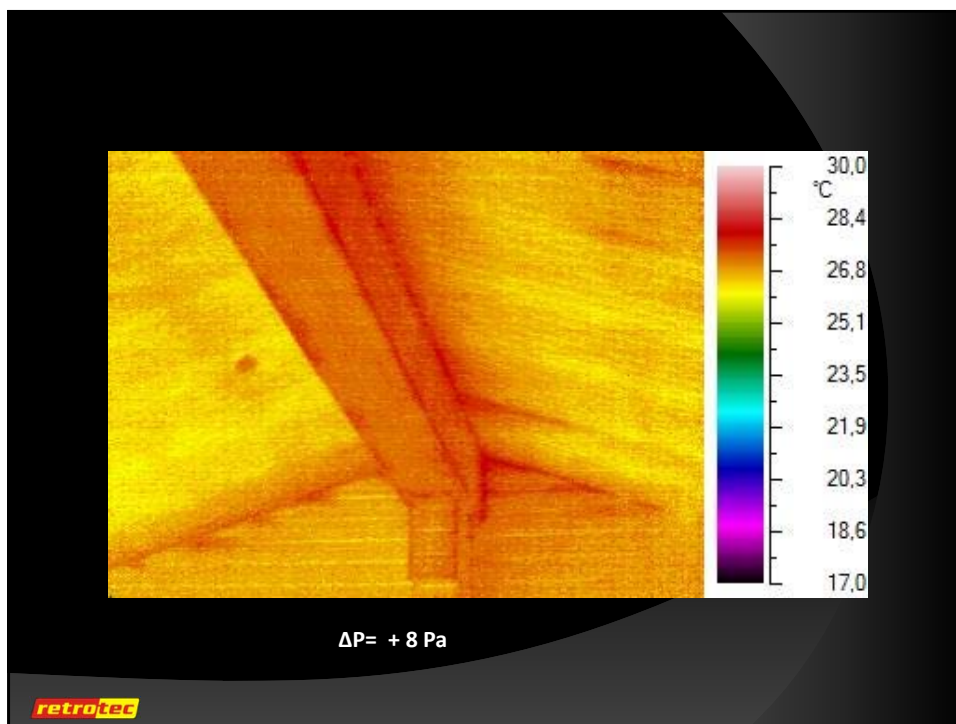


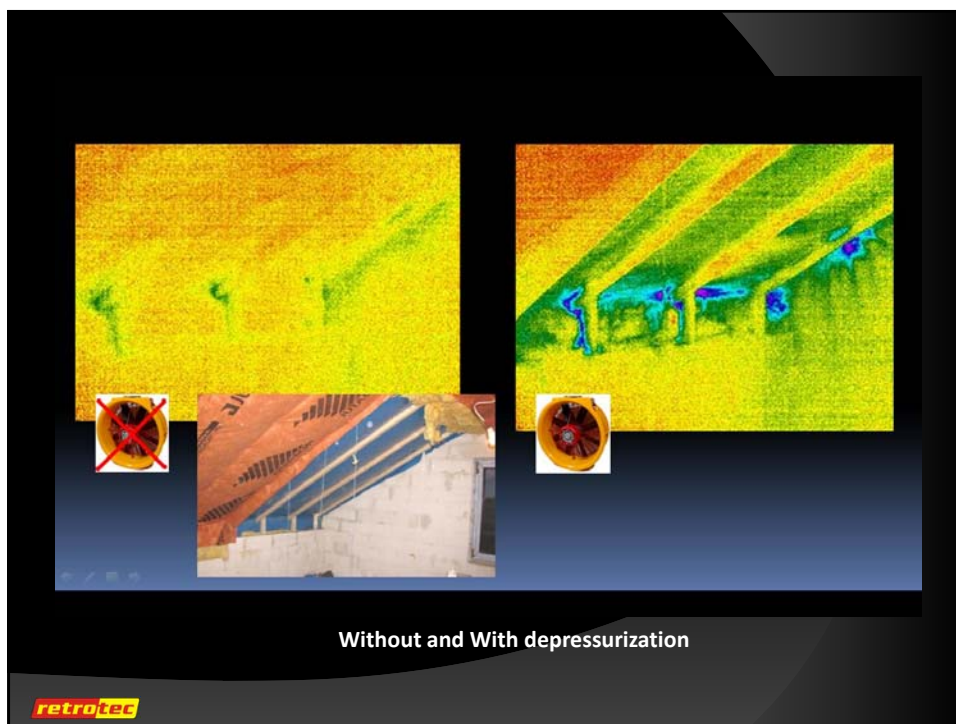
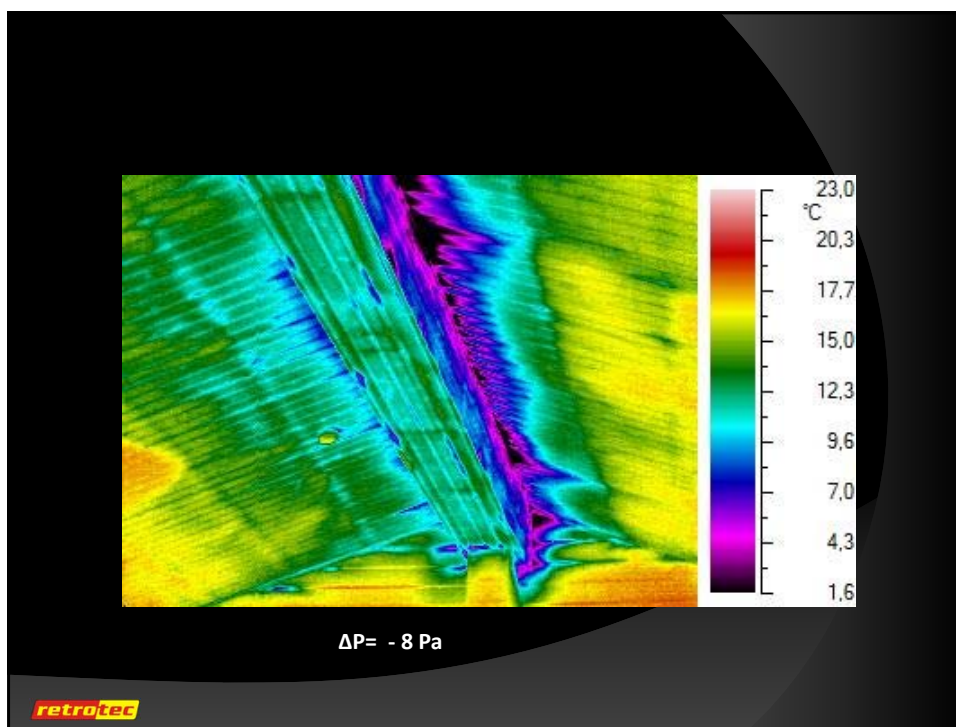
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Smoke and IR identify air leakage paths



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What components of buildings can be measured?

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USACE pass/fail for new construction

“shall pass ...0.25 CFM/sq ft ...at 75 Pa ...”

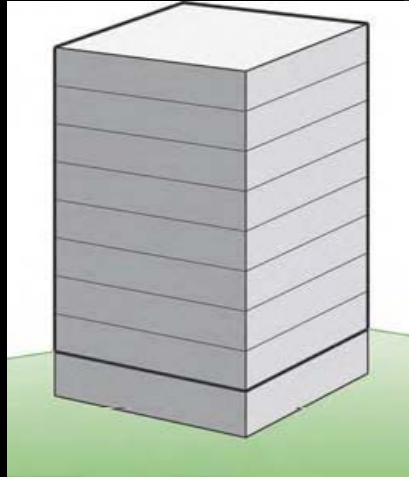
=1.0 L/s-m² at 50Pa



US Army Corps
of Engineers®
Engineer Research and
Development Center

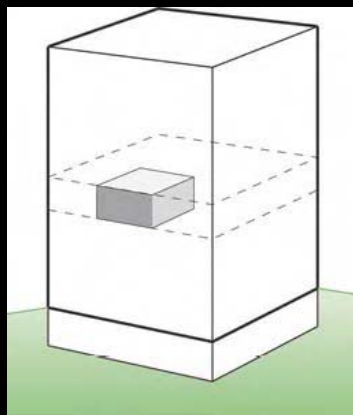
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Whole building envelopes can be measured



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Individual apartments can be measured



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Hallways can be measured



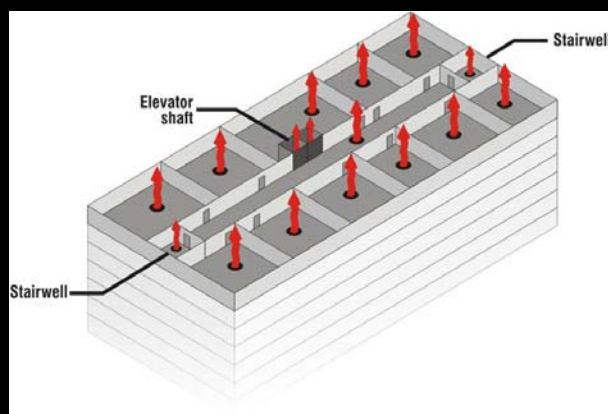
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Stairwells can be measured



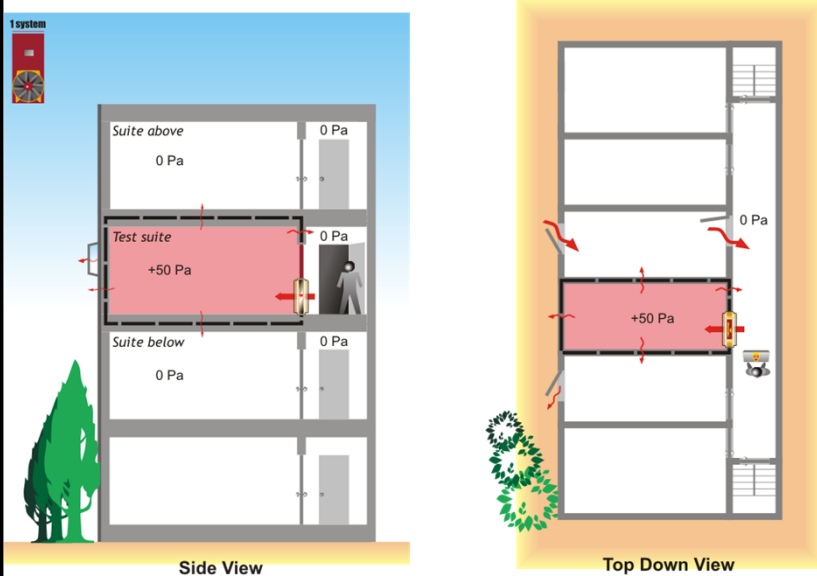
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Floor to floor leakage can be measured



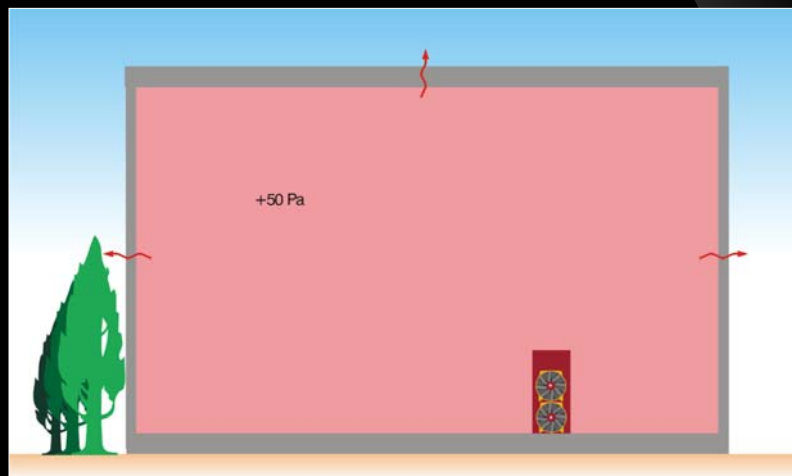
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Total Unit Leakage - All 6 Sides, 1 Door Fan



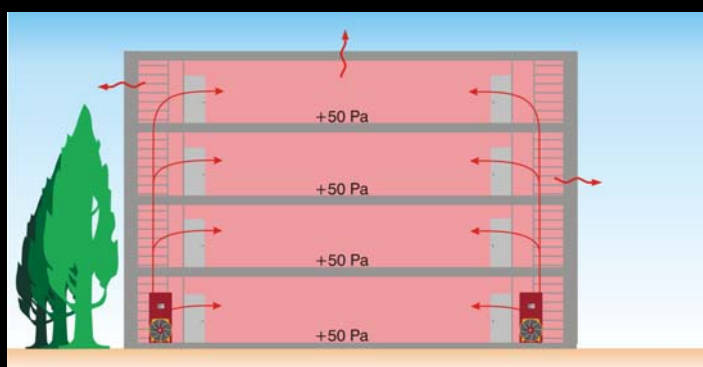
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Measure Entire Envelope

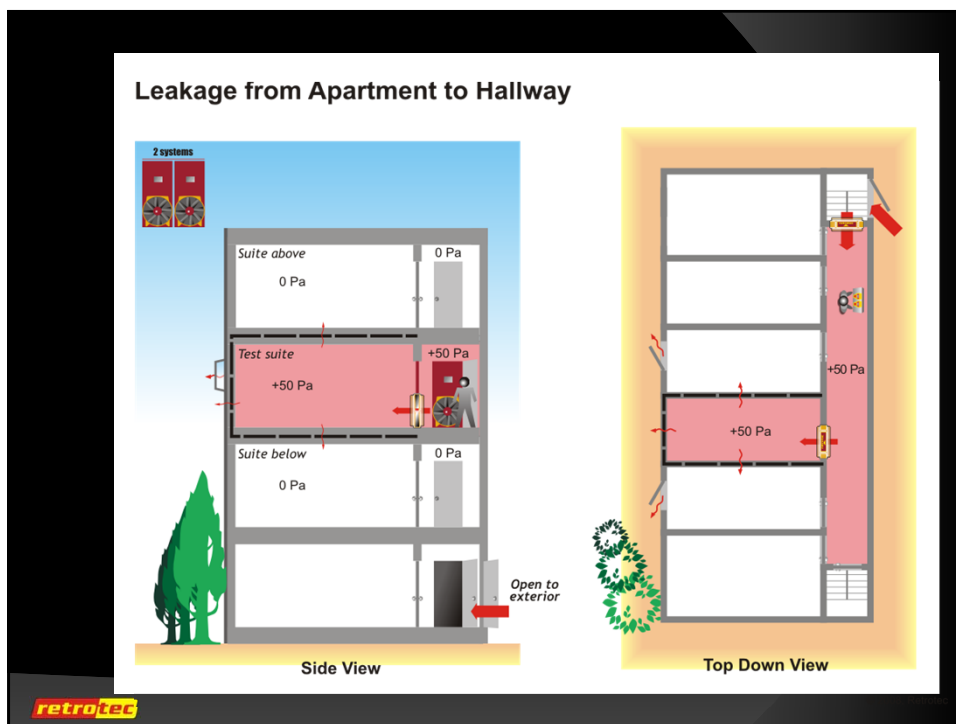
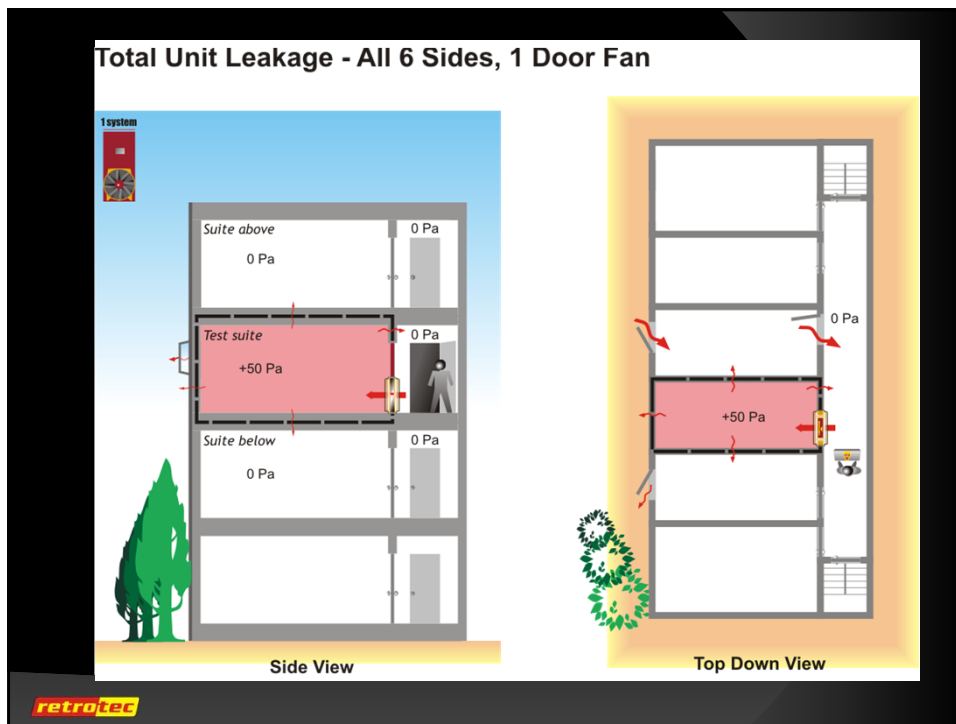


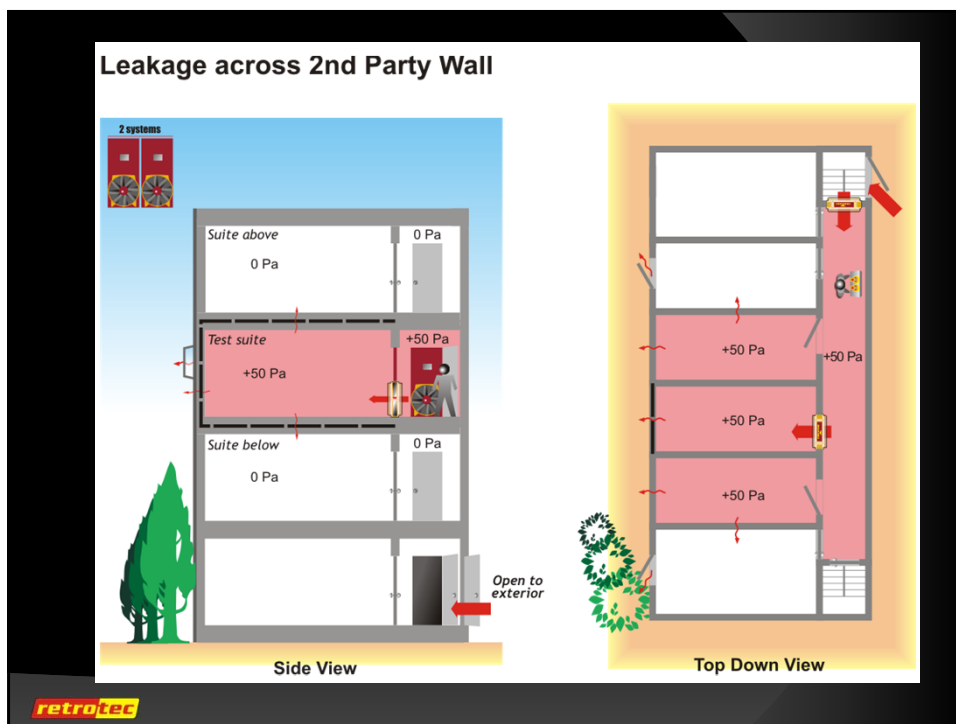
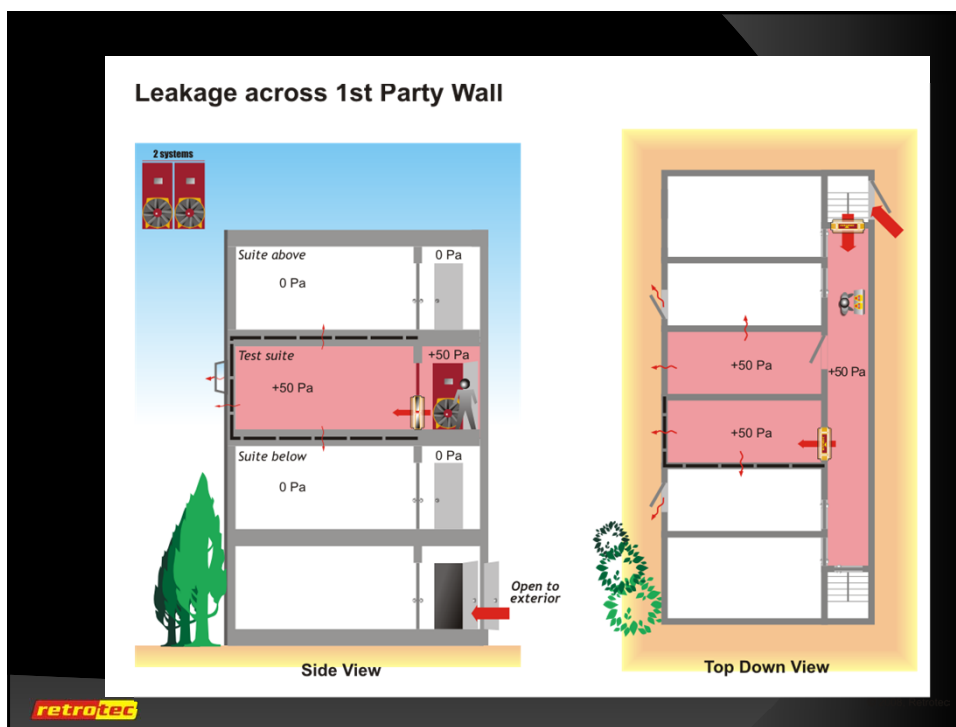
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Measure Entire Envelope



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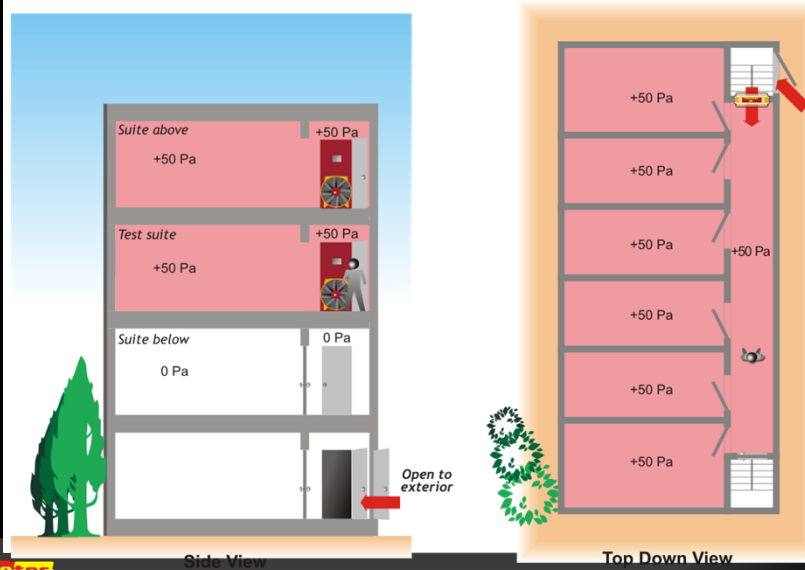


Slab leakage – total floor leakage



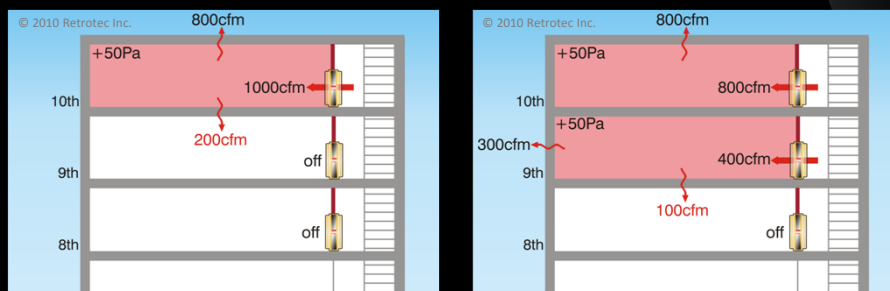
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Pressurizing the Floor Above



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Floor to floor leakage can be measured



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Standard Test Method - large building



Canada
CGSB 149.10



UK
TS-L1/TS-L2



Europe
EN13829



USA
USACE Air Leakage Protocol



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Results expressed in many ways

Standard	ASTM	CGSB	EN13829 ATTMA	USACE	LEED	IECC
Origin	USA	Canada	Europe	USA WA State	North America	
Results	EfLA ₄ ACH ₅₀ CFM ₅₀	EqLA ₁₀ ACH ₅₀	m ³ /h ₅₀ /m ² m ³ /h ₄ /m ² ACH ₅₀	CFM ₇₅ /ft ²	EfLA ₄ /100 ft ²	ACH ₅₀ CFM ₂₅ /100 ft ²

Suggest using only:

ACH50

EqLA 50/Floor area x 1,000,000

- Unitless
- Always whole number
- Calibrate against holes of known sizes
- Always reference results to 50 Pa

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Case Study - Germany



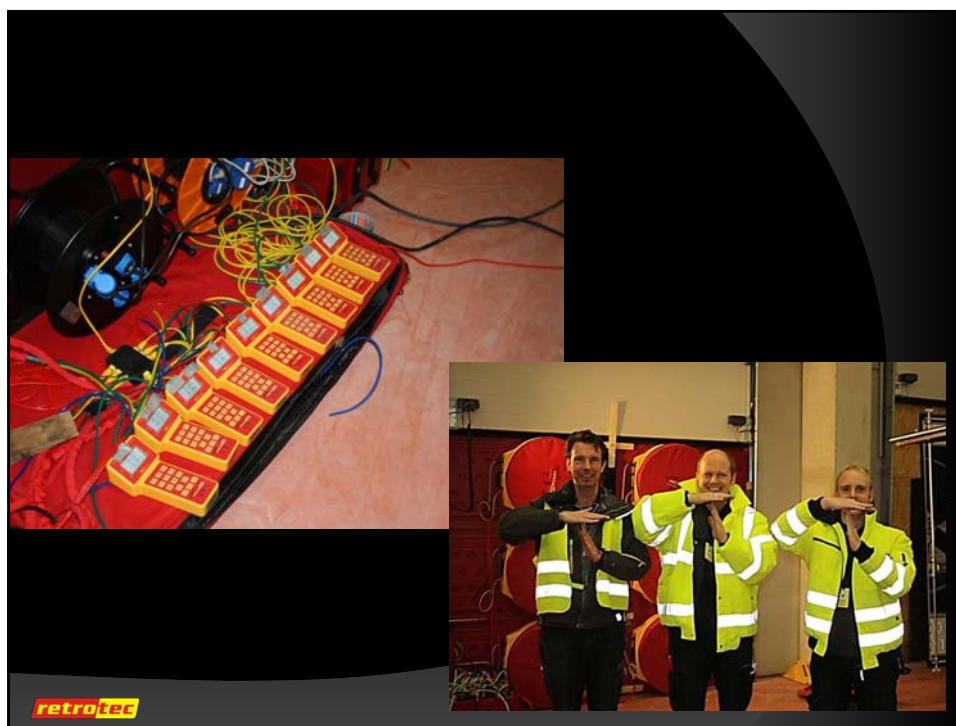
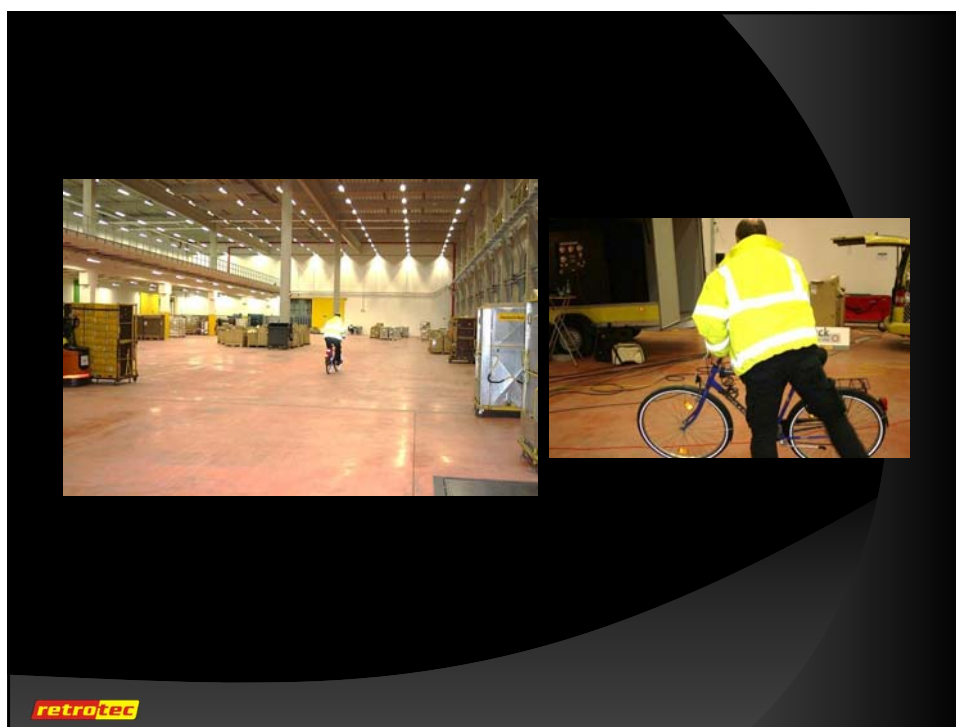
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15,000,000 cubic feet



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Building Air Leakage Test
In compliance with European Norm EN13829
Retrotec Software, version 6.0.0.27 License# Free Beta Version

Building Address: 1425 West 4th Ave - 10th Fl Vancouver, BC Canada V6Z 1Y1

Start date: 2013-1-31 Start time: 09:17

Point	Static pressure (Pa)	Building gauge pressure (Pa)	Air flow (m³/h)	Air flow (m³/h)
1	113.1	133.8	187.5	217.2
2	113.1	133.8	187.5	217.2
3	113.1	133.8	187.5	217.2
4	113.1	133.8	187.5	217.2
5	113.1	133.8	187.5	217.2
6	113.1	133.8	187.5	217.2
7	113.1	133.8	187.5	217.2
8	113.1	133.8	187.5	217.2
9	113.1	133.8	187.5	217.2
10	113.1	133.8	187.5	217.2
11	113.1	133.8	187.5	217.2
12	113.1	133.8	187.5	217.2
13	113.1	133.8	187.5	217.2
14	113.1	133.8	187.5	217.2
15	113.1	133.8	187.5	217.2
16	113.1	133.8	187.5	217.2
17	113.1	133.8	187.5	217.2
18	113.1	133.8	187.5	217.2
19	113.1	133.8	187.5	217.2
20	113.1	133.8	187.5	217.2
21	113.1	133.8	187.5	217.2
22	113.1	133.8	187.5	217.2
23	113.1	133.8	187.5	217.2
24	113.1	133.8	187.5	217.2
25	113.1	133.8	187.5	217.2
26	113.1	133.8	187.5	217.2
27	113.1	133.8	187.5	217.2
28	113.1	133.8	187.5	217.2
29	113.1	133.8	187.5	217.2
30	113.1	133.8	187.5	217.2
31	113.1	133.8	187.5	217.2
32	113.1	133.8	187.5	217.2
33	113.1	133.8	187.5	217.2
34	113.1	133.8	187.5	217.2
35	113.1	133.8	187.5	217.2
36	113.1	133.8	187.5	217.2
37	113.1	133.8	187.5	217.2
38	113.1	133.8	187.5	217.2
39	113.1	133.8	187.5	217.2
40	113.1	133.8	187.5	217.2
41	113.1	133.8	187.5	217.2
42	113.1	133.8	187.5	217.2
43	113.1	133.8	187.5	217.2
44	113.1	133.8	187.5	217.2
45	113.1	133.8	187.5	217.2
46	113.1	133.8	187.5	217.2
47	113.1	133.8	187.5	217.2
48	113.1	133.8	187.5	217.2
49	113.1	133.8	187.5	217.2
50	113.1	133.8	187.5	217.2
51	113.1	133.8	187.5	217.2
52	113.1	133.8	187.5	217.2
53	113.1	133.8	187.5	217.2
54	113.1	133.8	187.5	217.2
55	113.1	133.8	187.5	217.2
56	113.1	133.8	187.5	217.2
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78	113.1	133.8	187.5	217.2
79	113.1	133.8	187.5	217.2
80	113.1	133.8	187.5	217.2
81	113.1	133.8	187.5	217.2
82	113.1	133.8	187.5	217.2
83	113.1	133.8	187.5	217.2
84	113.1	133.8	187.5	217.2
85	113.1	133.8	187.5	217.2
86	113.1	133.8	187.5	217.2
87	113.1	133.8	187.5	217.2
88	113.1	133.8	187.5	217.2
89	113.1	133.8	187.5	217.2
90	113.1	133.8	187.5	217.2
91	113.1	133.8	187.5	217.2
92	113.1	133.8	187.5	217.2
93	113.1	133.8	187.5	217.2
94	113.1	133.8	187.5	217.2
95	113.1	133.8	187.5	217.2
96	113.1	133.8	187.5	217.2
97	113.1	133.8	187.5	217.2
98	113.1	133.8	187.5	217.2
99	113.1	133.8	187.5	217.2
100	113.1	133.8	187.5	217.2

AutoTest
1 DM2 gauge found. Gauge #201653 on Retrotec DU200, Range Low.

Static Bias Pressure (Pre) graph: Pressure (Pa) vs Readings (0-120). Values are stable around 0 Pa.

Building gauge pressure graph: Pressure (Pa) vs Readings (0-240). Shows a linear increase from ~10 Pa to ~40 Pa.

Static Bias Pressure (Post) graph: Pressure (Pa) vs Readings (0-120). Values are stable around 0 Pa.

Building Gauge Pressure vs. Flow Pressure graph: Flow (m³/h) vs Pressure (Pa). Shows a linear relationship from ~10 Pa at 0 m³/h to ~40 Pa at 100 m³/h.

Building Static pressure gauge: 0 Pa.

Flow (m³/h) gauge: 0 m³/h.

Buttons: Start Test, Stop Test, Change Range, Clear data.

Status: Auto test completed.

Instructions: Cover fans before taking bias readings? [] Yes [X] No

Previous step: Step 2: Flow pressure at 12 points, -15 Pa, -20 Pa, 25 Pa, -30 Pa, -35 Pa, -40 Pa, -45 Pa, -50 Pa, -55 Pa, -60 Pa, -65 Pa, -70 Pa, each point collected for 20 seconds (minimum 20 readings).

Current step: Step 3: Bias Pressure. 12 points, averaged from data collected over 10 seconds (minimum 10 readings).

Next step: Step 4: Flow pressure at 12 points, -15 Pa, -20 Pa, 25 Pa, -30 Pa, -35 Pa, -40 Pa, -45 Pa, -50 Pa, -55 Pa, -60 Pa, -65 Pa, -70 Pa, each point collected for 20 seconds (minimum 20 readings).

Footer: 1 DM2 gauge found. Gauge #201653 on Retrotec DU200, Range Low. Gauges ready. Click start when ready to start autotest.

Automatic vs. manual data collection

Start date: 2010-05-02 Start time: 19:37 Get Time Pressurization set © 2010 Retrotec Inc.

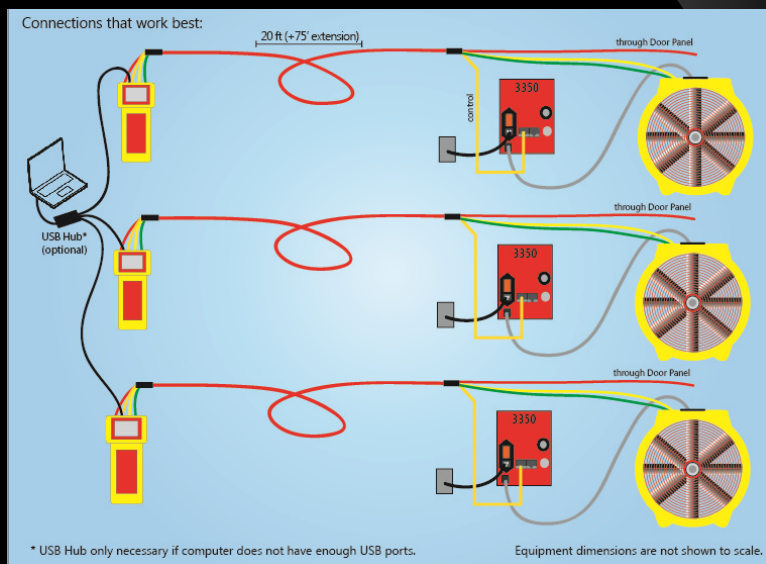
Average wind speed: 8 mph Direction: WN Operator station: Inside Temperature: 75 indoors 87 outdoors

Blow pressure, inPa (Pa)	-777	1,093	1,227	649	81	1,129	1,223	801	841	1,284	871	1,011
#1 Building gauge pressure (Pa)	25.1	28.9	33.9	38.0	43.0	47.0	52.0	55.6	60.9	65.0	69.9	75.1
#2 Building pressure variation (Pa)	2.1%	2.4%	2.3%	2%	1.9%	2.1%	2.3%	2.1%	-3%	6%	-1%	-1%
#3 Building pressure variation (Pa)	3%	3.1%	3.3%	3%	2.8%	3%	2.9%	2.8%	1.4%	1.5%	1.2%	1.3%
#4 Building pressure variation (Pa)	2.8%	2.5%	2.7%	2.1%	1.7%	2.1%	2.2%	1.8%	1.8%	2%	1.8%	1.7%
#5 Building pressure variation (Pa)	-1.4%	-1.1%	-7%	-8%	-9%	-8%	-7%	-1%	-3%	-2.7%	-3.1%	-3%
#6 Building pressure variation (Pa)	-3%	-3%	-2%	-1%	-1%	-1%	-1%	-1%	-2.8%	-2.3%	-2.4%	-2.8%
Door Fan 1	88.9	109.2	131.2	152.7	167.6	189.8	212.8	237.0				
Door Fan 2	75.9	93.6	116.9	136.8	160.7	181.5	206.5	227.1				
Door Fan 3	91.1	108.3	114.1	115.3	174.8	194.8	217.6	227.7				
Door Fan 4	98.4	114.5	138.1	138.1	188.1	200.0	224.0	242.2				
Door Fan 5	71.6	89.3	111.7	129.7	152.2	171.2	196.0	213.4	115.6	126.4	140.4	155.5
Door Fan 6	82.5	107.7	128.3	161.0	193.9	222.2	262.4	309.0				
Door Fan 7									88.8	74.3	80.5	88.2
Door Fan 8									62.9	68.2	77.2	84.1
Door Fan 9									63.1	68.0	75.1	82.4
Door Fan 10									105.6	118.5	111.4	148.7
Door Fan 11									70.7	77.5	85.5	93.5
Blow pressure, inPa (Pa)	-206	-224	-345	-018	-018	-17	-149	-234	-112	-236	-129	-381
Temperature, °F (°C)												

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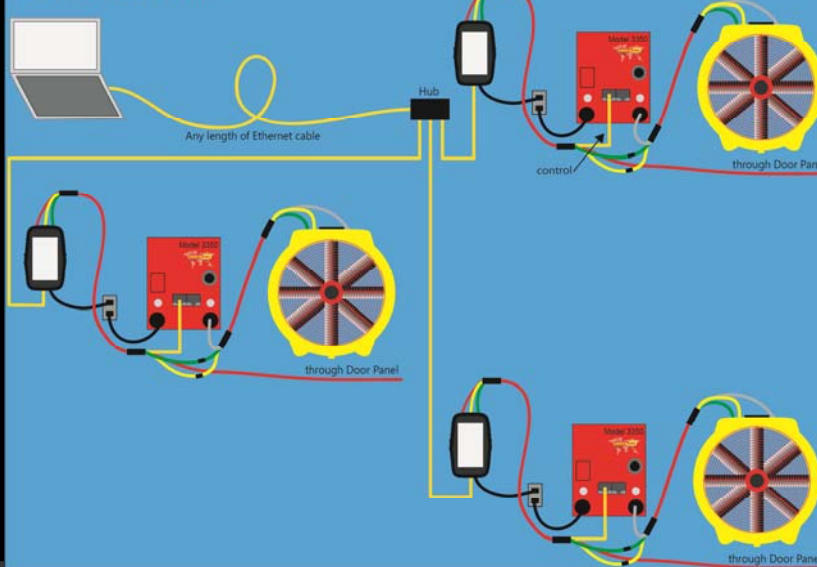


Lots of cable & tubing



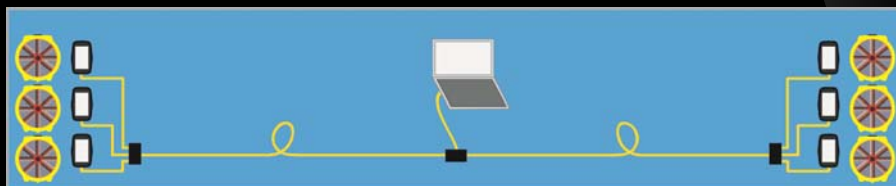
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Connections that work best:

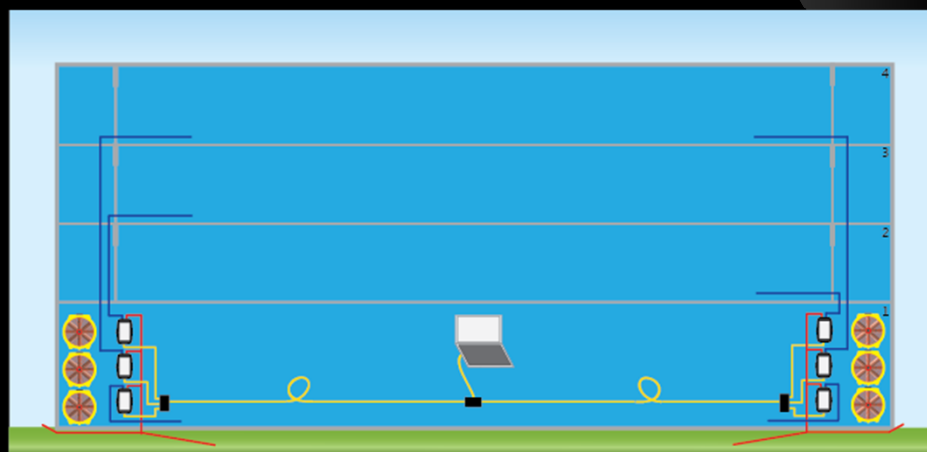


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Easier connections



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Conclusions

- Virtually any component of a building can be tested
- Running tubing and speed control cables long distances is cumbersome
- New technology eases setup & allows testers to take advantage of existing networks
- Software is needed for large tests with many fans

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**Questions?
Comments?
Angry rants?**

**Denali Jones
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