

AABC Commissioning Group

AIA Provider Number: **50111116**



Pressure and Flow Diagnostic Applica Opportunities

Course Number: **CXENERGY1507**

Colin Genge, CEO, Retrotec

April 30, 2015



Learning Objectives

At the end of the this course, participants will be able to:

1. Understand how to test building enclosures using non-traditional methods to gain new insights into building performance characteristics.
2. Learn how pressure gauges and smoke puffers can provide information to uncover catastrophic problems that might otherwise be missed in a more detailed approach.
3. Understand how to use WiFi gauges in multiple locations to collect data, thereby reducing labor and increasing overall efficiency.
4. Learn what is required to perform fire suppression system containment, testing of pressurized stairwells and testing of false floor leakage.



How do WE SEE buildings

Air and water is free to go where it wants

- “ HVAC guy – air goes where my ducts go!
- “ Commissioning - why is it going there?
- “ TAB guy, I can measure where it's going
- “ IR guy, I can see where it's going
- “ Envelope guy – buildings are chimneys
- “ Compartmentation guy – not working for me at all

Clean Agent...

UK test every building

Vancouver leaky condo ...

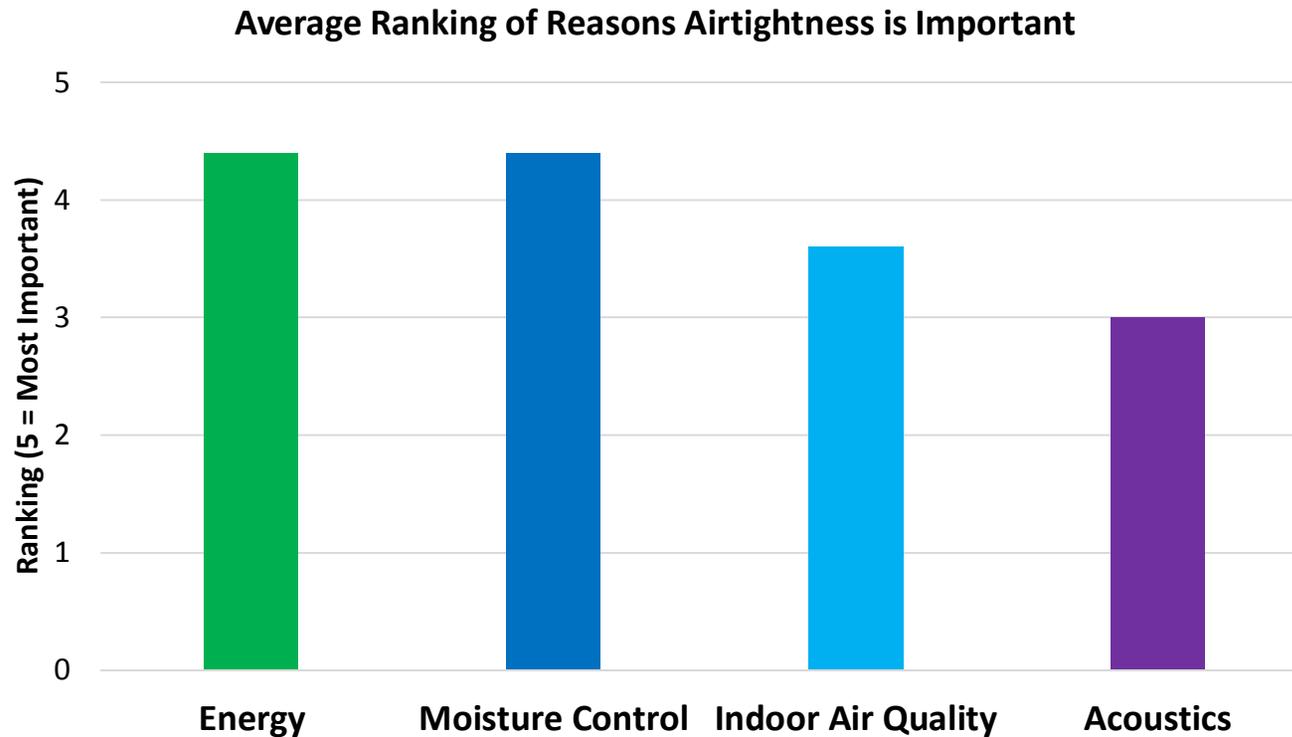


Recent study of airtightness of large buildings

(700+ buildings!)



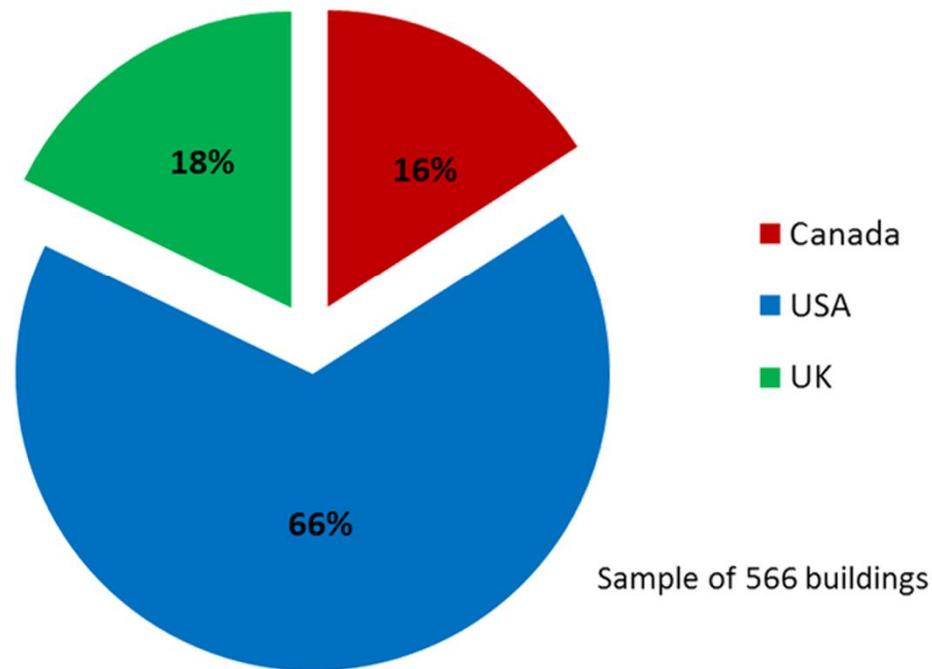
Reasons for Airtightness



BUT, IT'S RELATIVE...

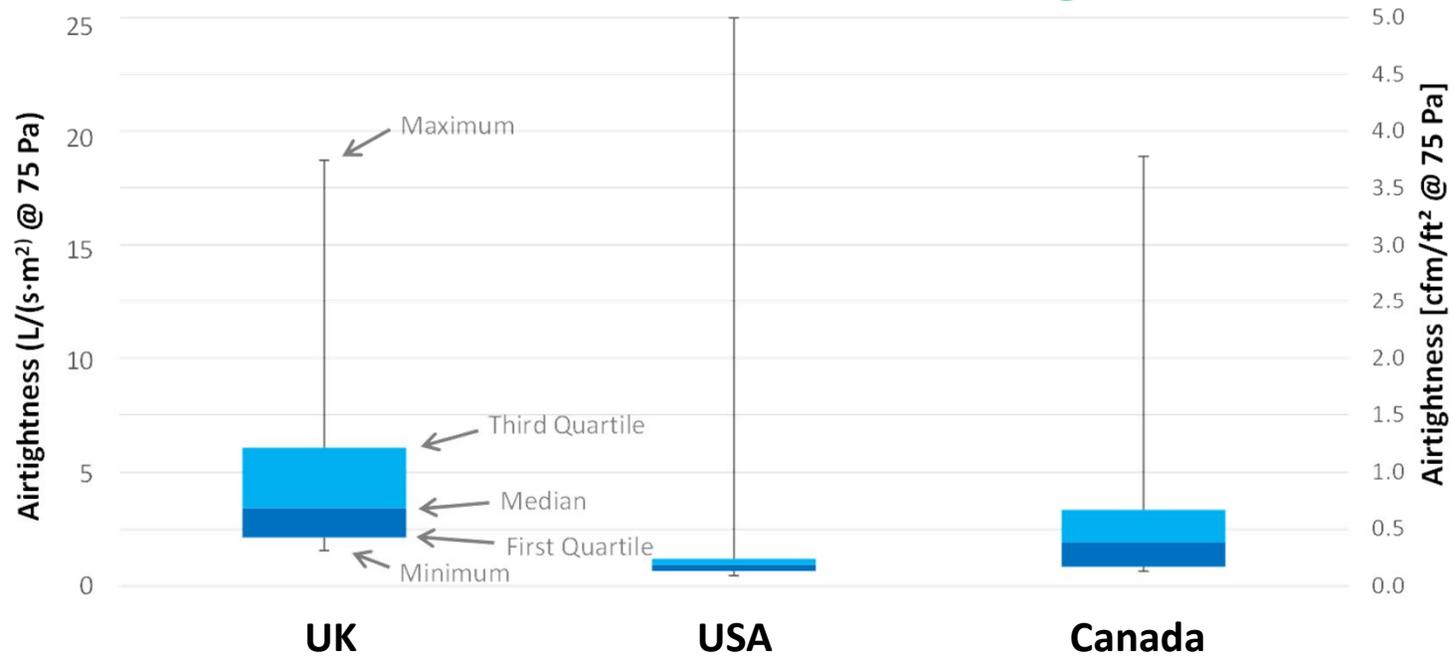
Database Population Characteristics

Location of Buildings in Database



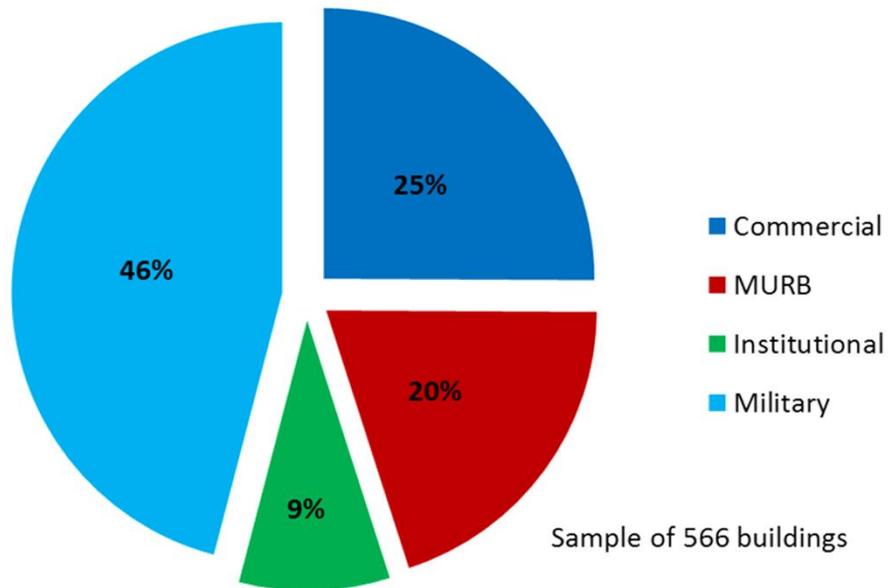
Airtightness of Buildings by Building Location

Looks like the USA is winning...



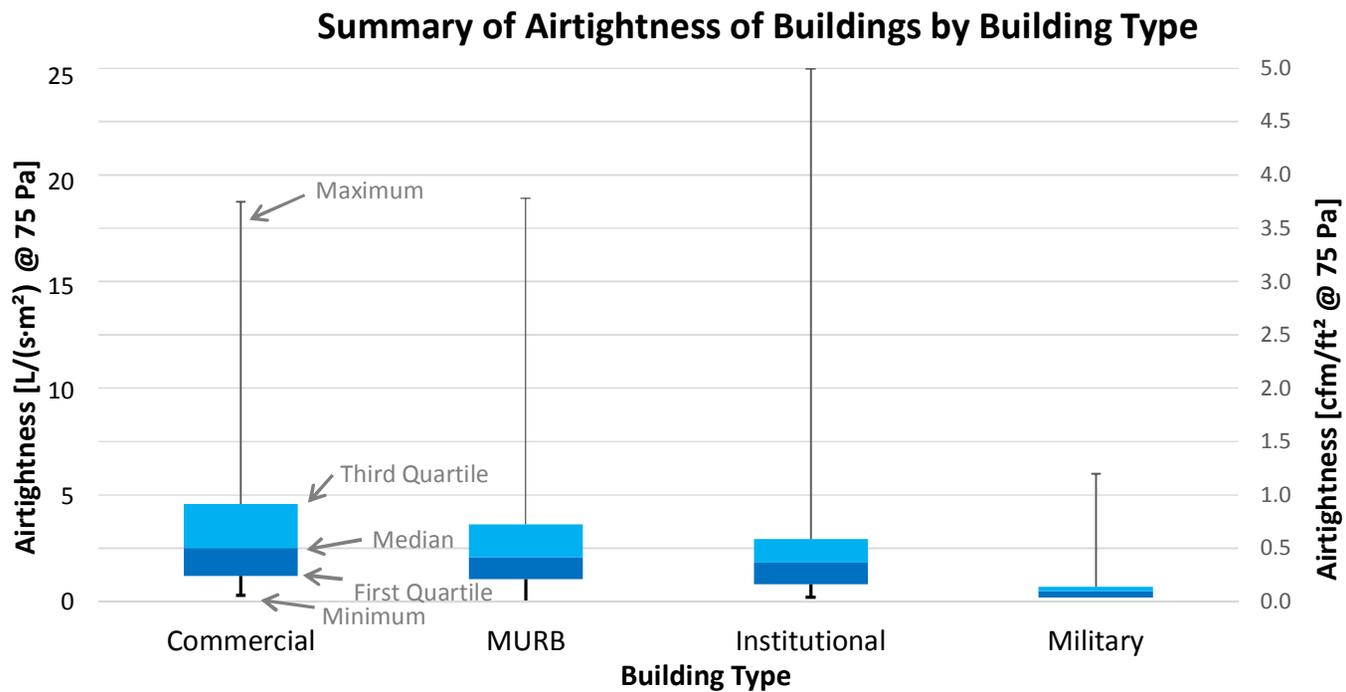
Database Population Characteristics

Types of Buildings in Database

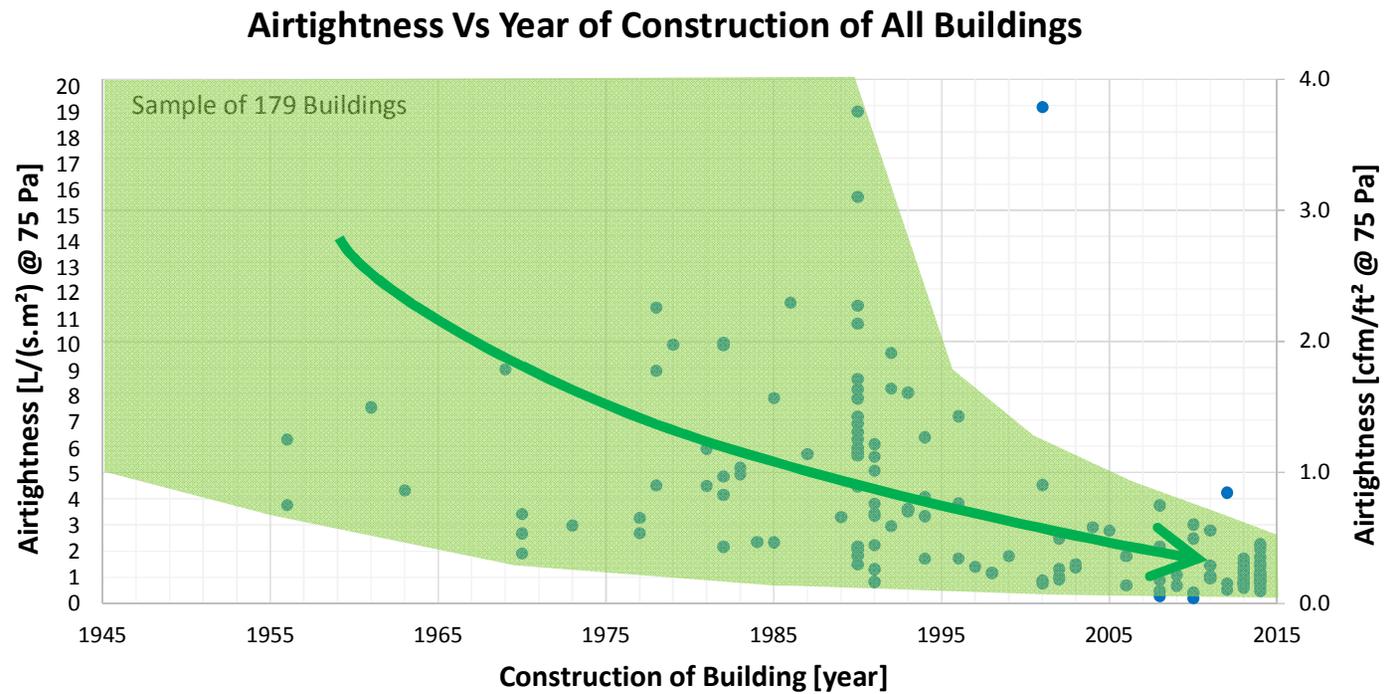


“ Lots of USACE buildings

Airtightness versus Building Type



Building Age vs Airtightness

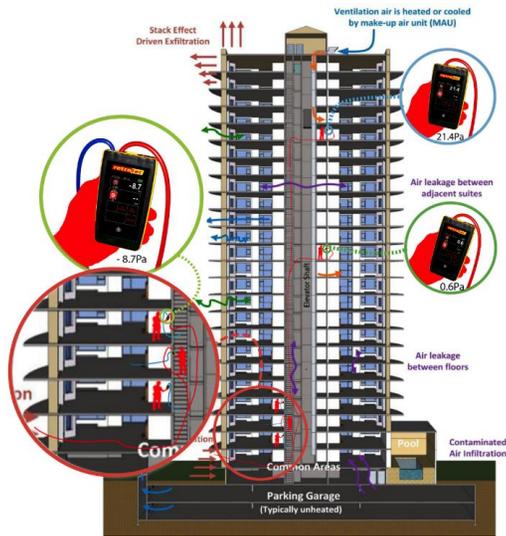


Guides & Manuals

www.Retrotec.com www.energyconservatory.com



Pressure Diagnostics



WiFi act as a free technician



New applications



1 Pressure Diagnostics

What tools do you have?

- “ Smoke
- “ Digital pressure gauges
- “ Blower door
- “ Flow Hood
- “ Duct tester
- “ IR

Pressure drivers

” HVAC - one way of seeing a building – intention

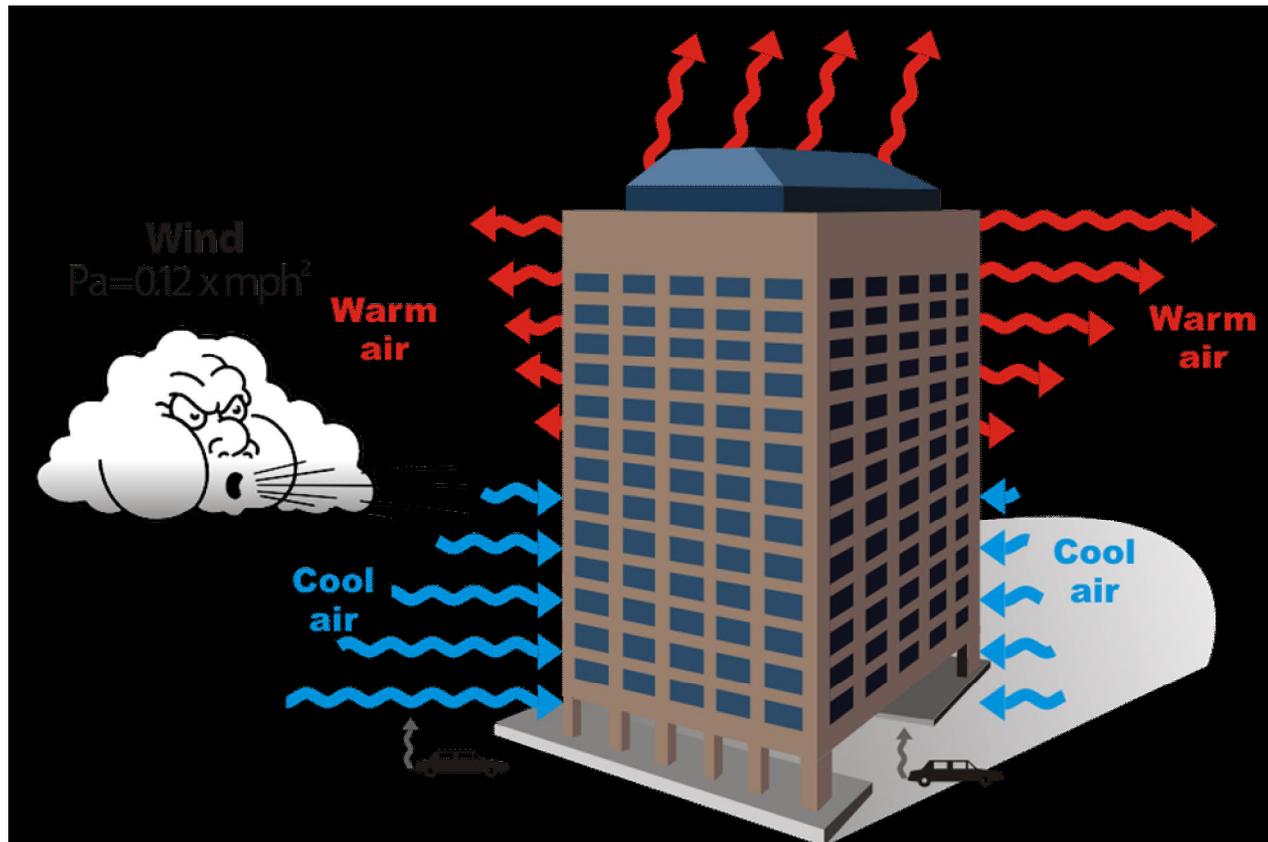
” Stack

” pressure is where the leaks aren't.

” Soda straw analogy

” Wind

Stack Pressure + Wind Pressure +
Holes = Bigger Leak



The Energy Conservatory

DG-700



Retrotec

DM-2



DM32



Qualify leaks

Find the leaks – with hand, smoke or infrared..
Another way of seeing the building

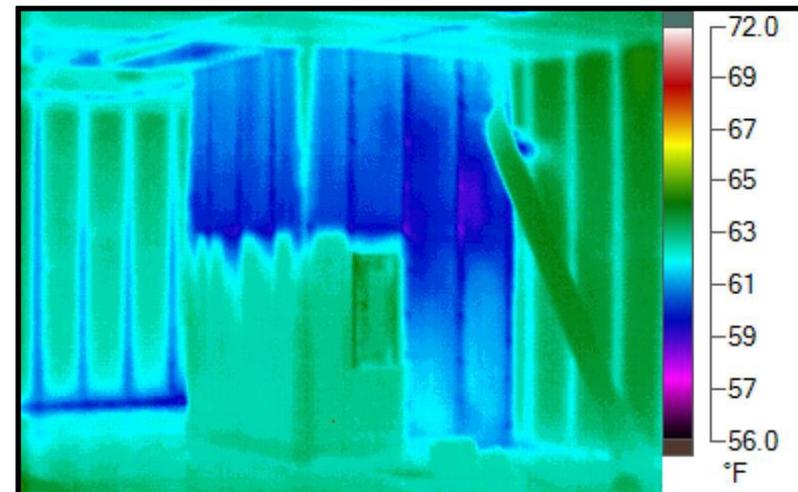
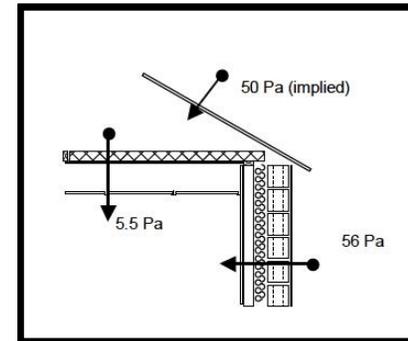
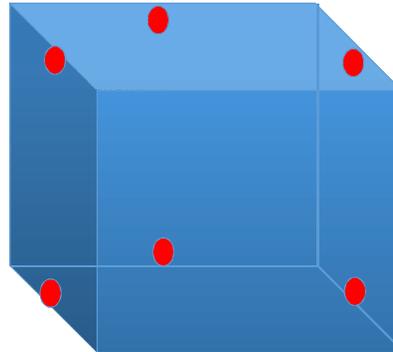


photo credit Phil Emory

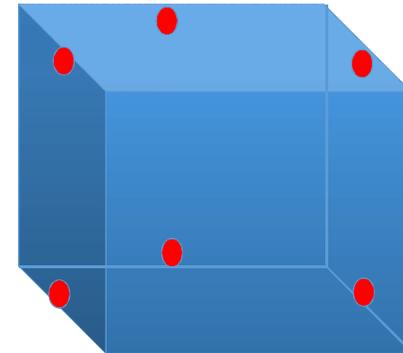
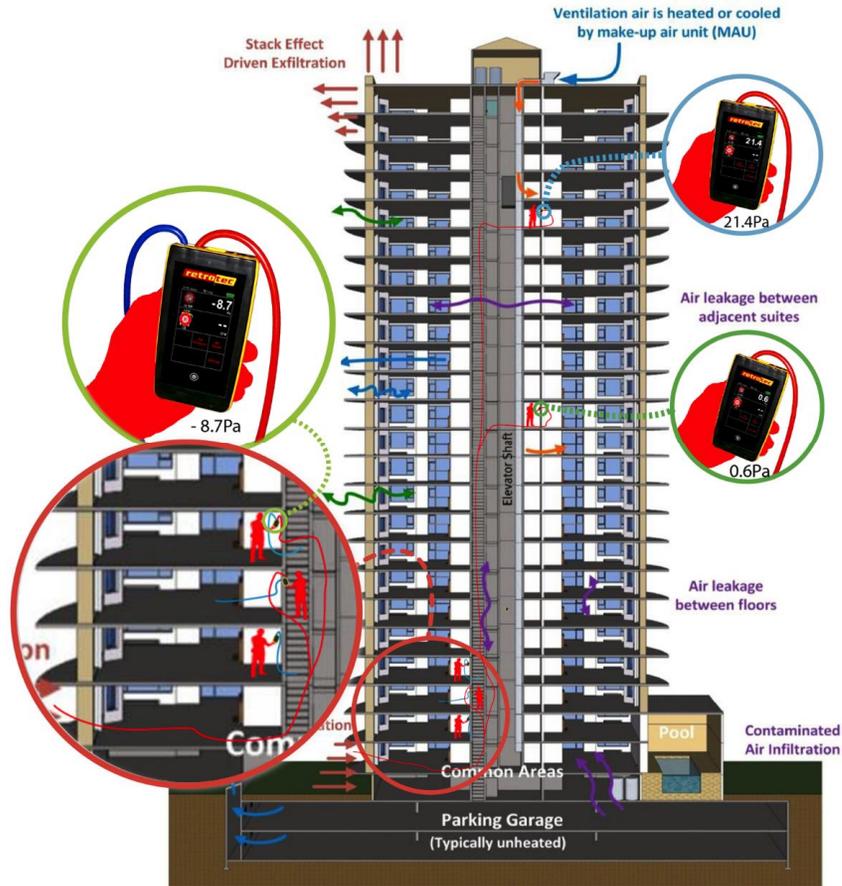
Diagnostics

Evaluate under ambient (natural) conditions.

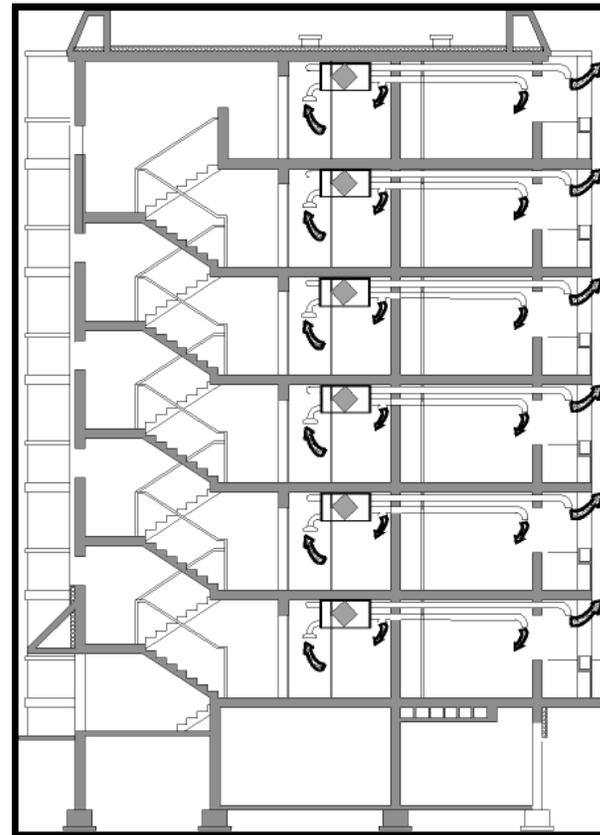
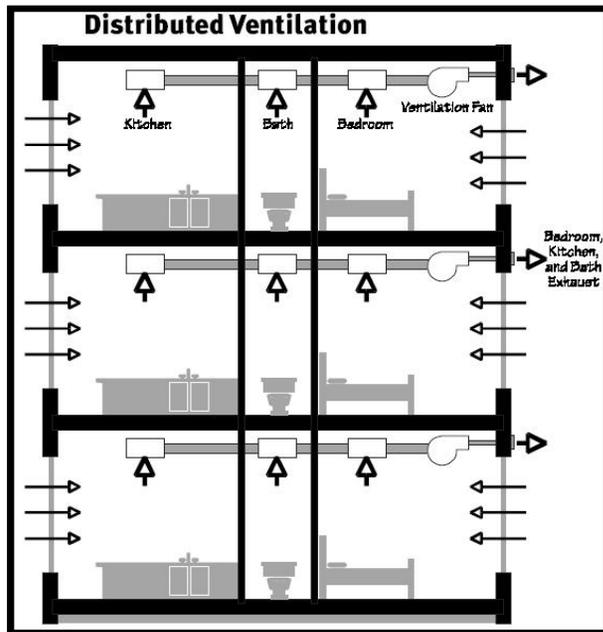
- Pressure boundary – Gauge REF = Exterior
- Zonal pressure map



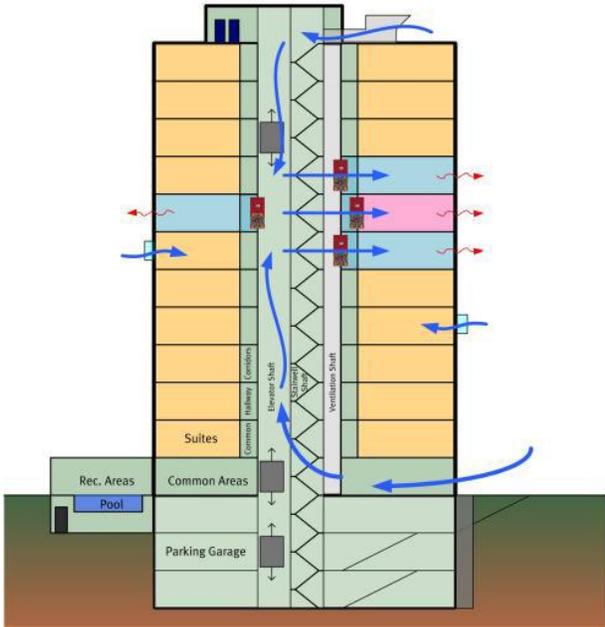
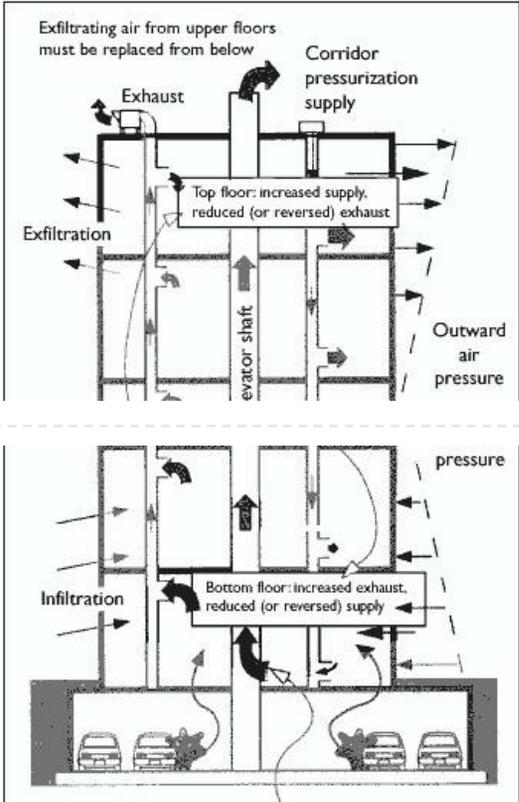
Diagnostics



Mechanical Pressures



Natural & Mechanical



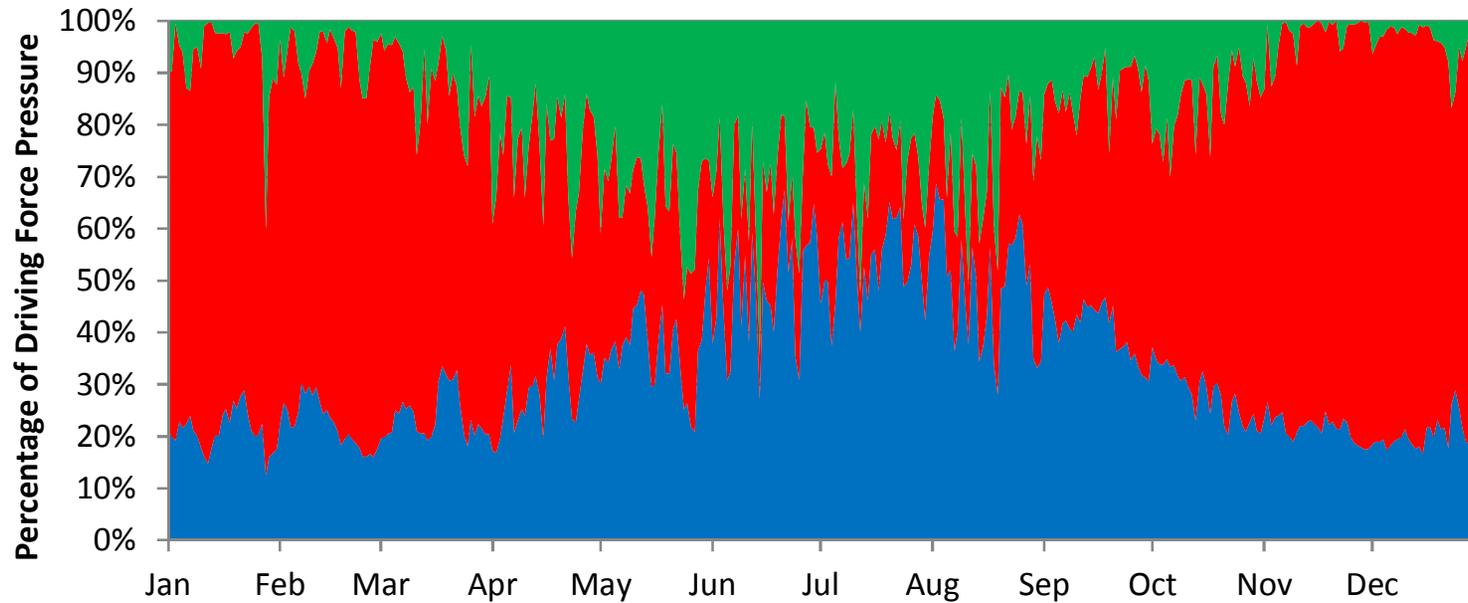
Relative Impact of Driving Forces

■ Wind

■ Stack Effect

■ Mechanical (10 Pa)

130 ft Tall Building in Fairbanks



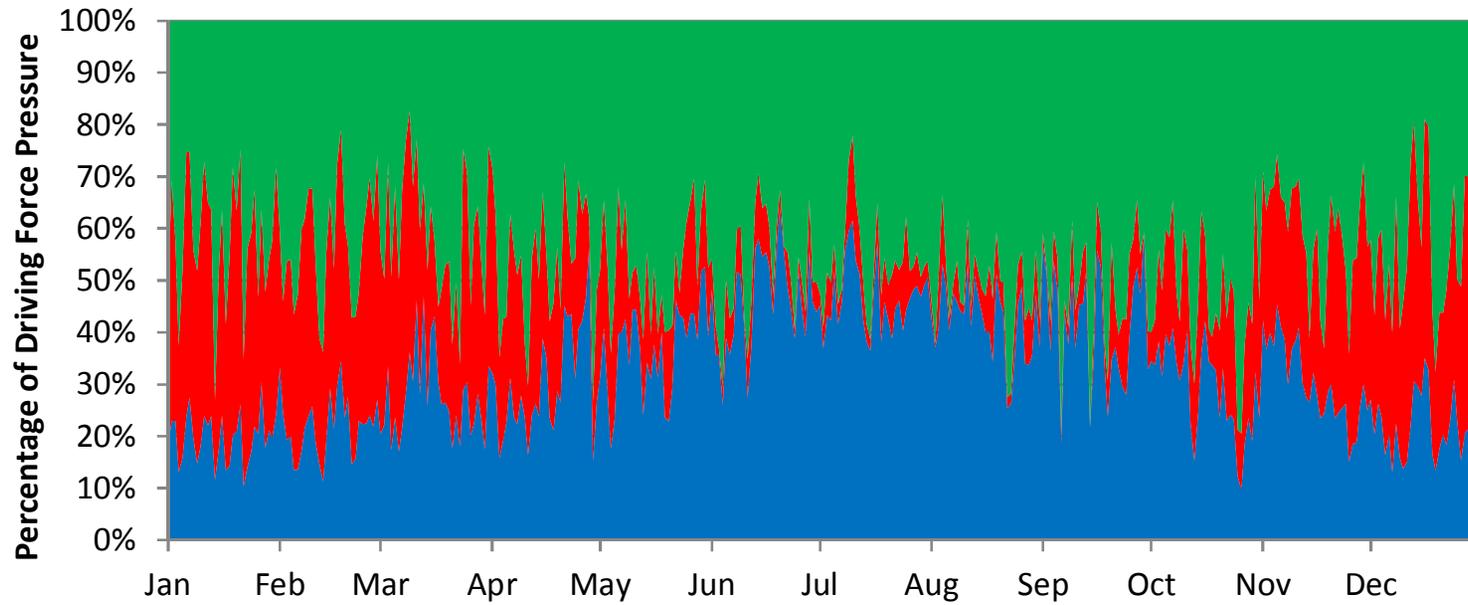
Relative Impact of Driving Forces

■ Wind

■ Stack Effect

■ Mechanical (10 Pa)

130 ft Tall Building in New York



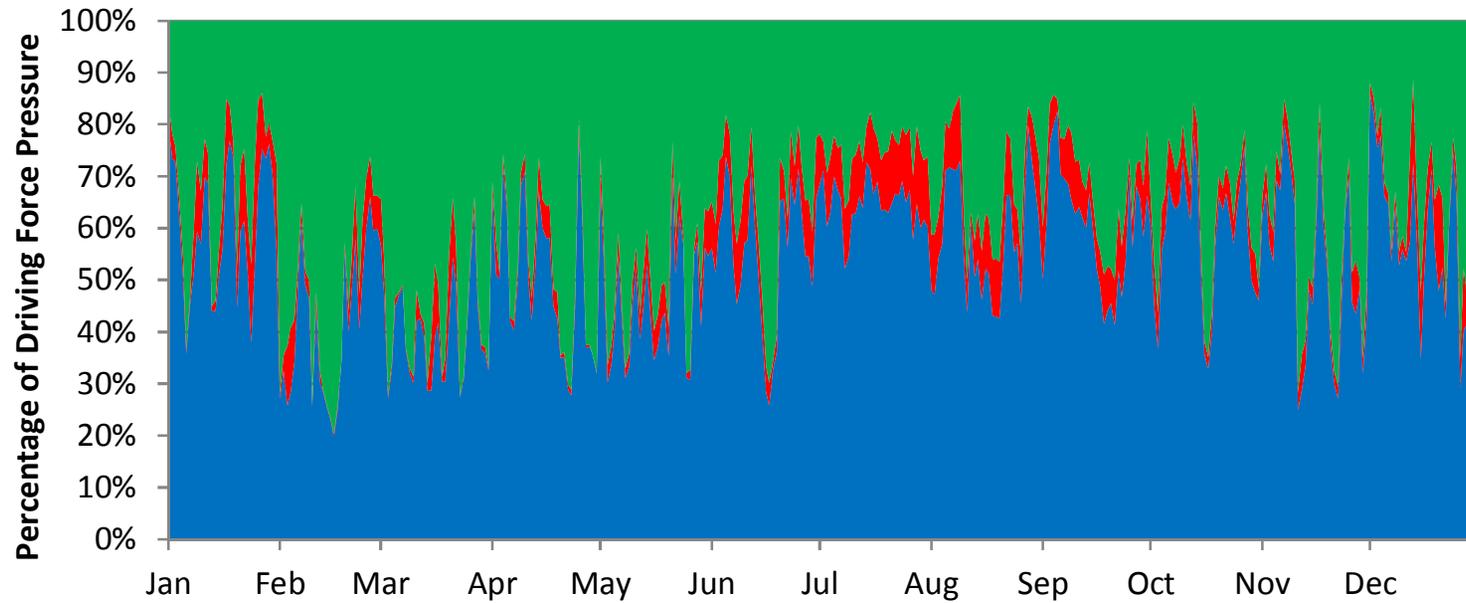
Relative Impact of Driving Forces

■ Wind

■ Stack Effect

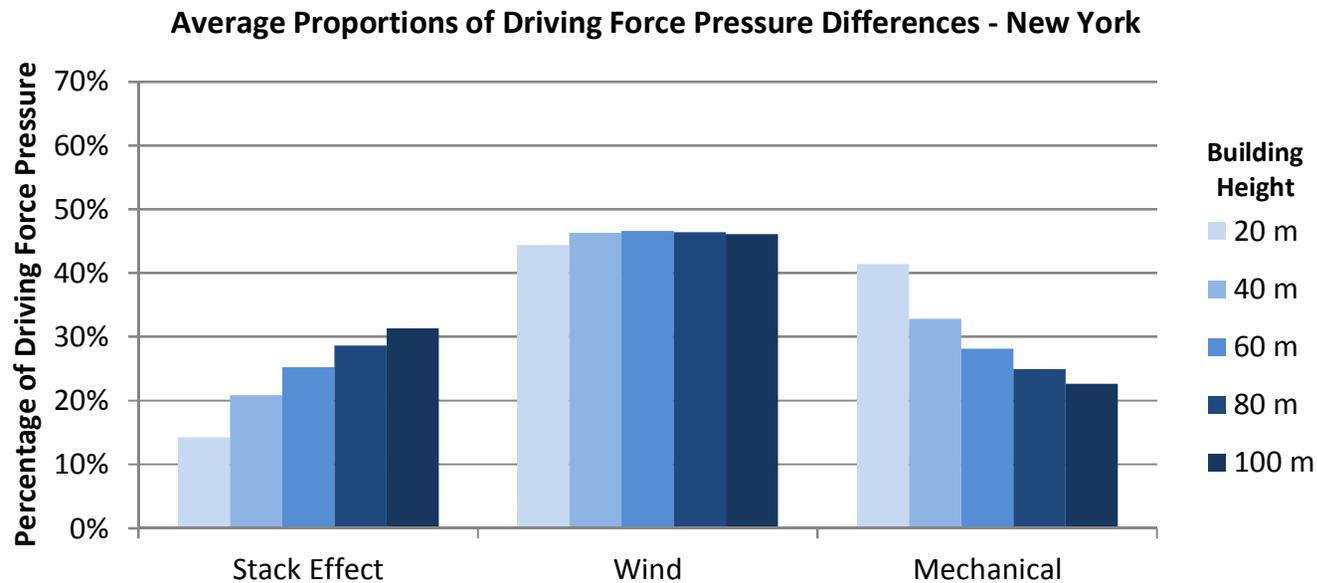
■ Mechanical (10 Pa)

130 ft Tall Building in Miami



Pressure Differences and Height

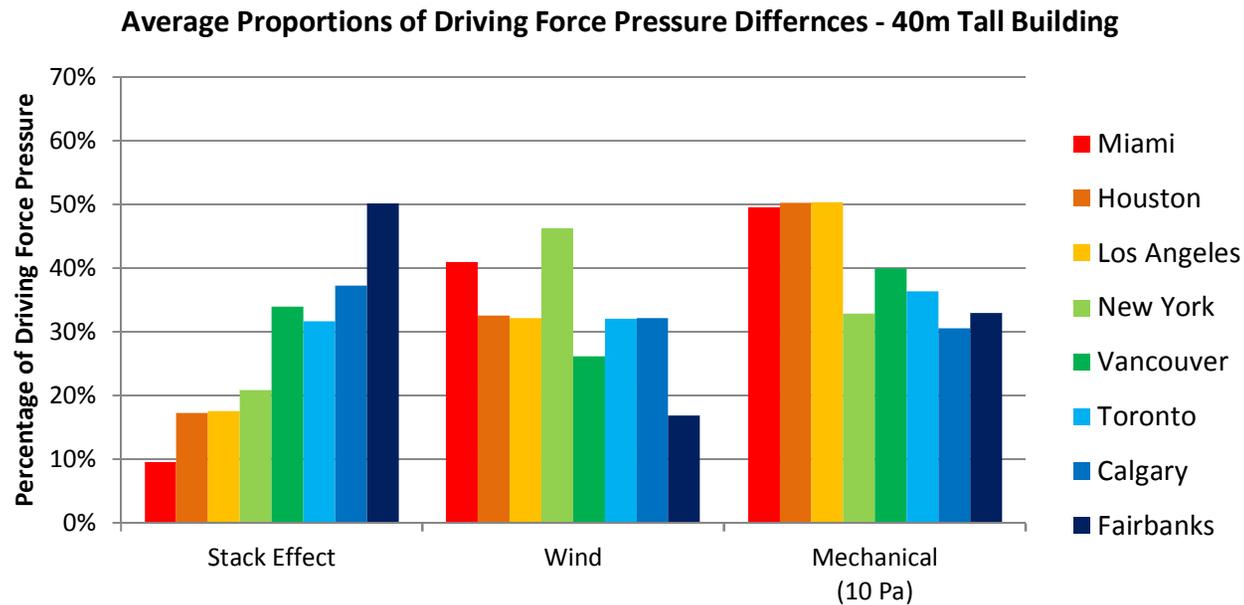
- ” Stack effect > with height
- ” mechanical < with height



Pressure Differences & Climate

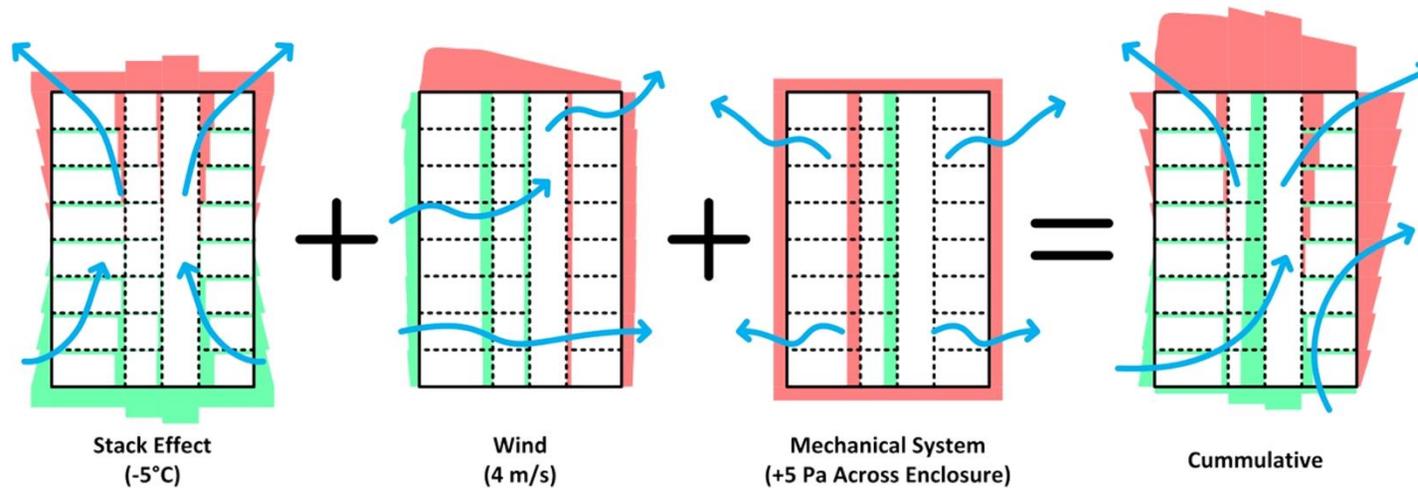
” Stack effect > in cold climates

” Wind > in warm climates



Pressure Differences - Summary

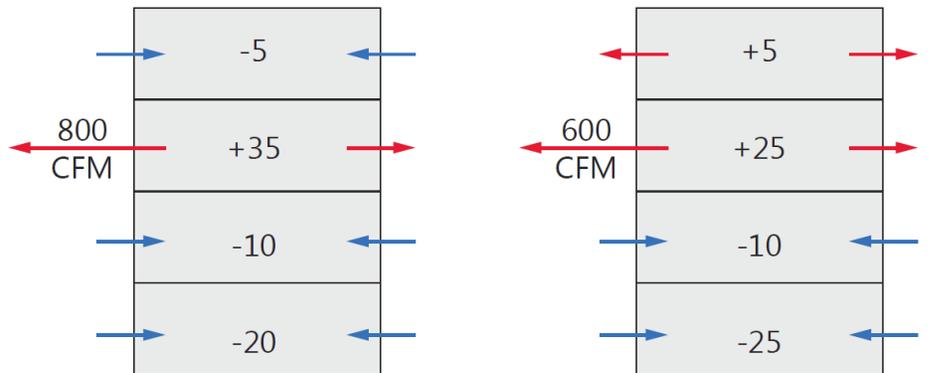
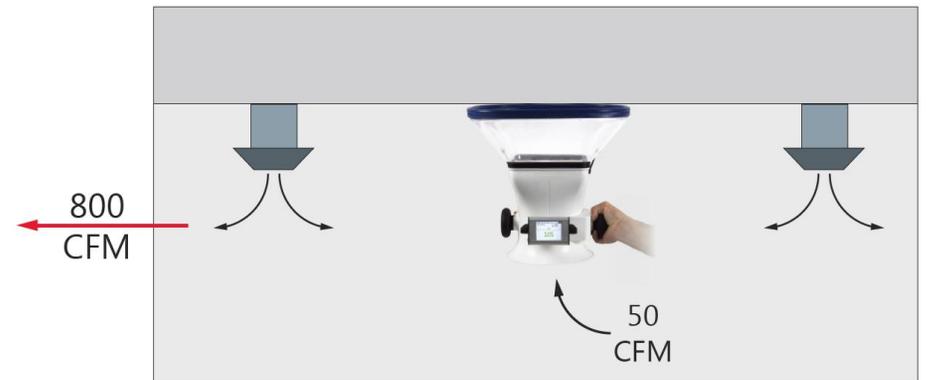
“ any one could dominate



Typical 4 story office with problems



HVAC imbalance- complaints for over 6 years



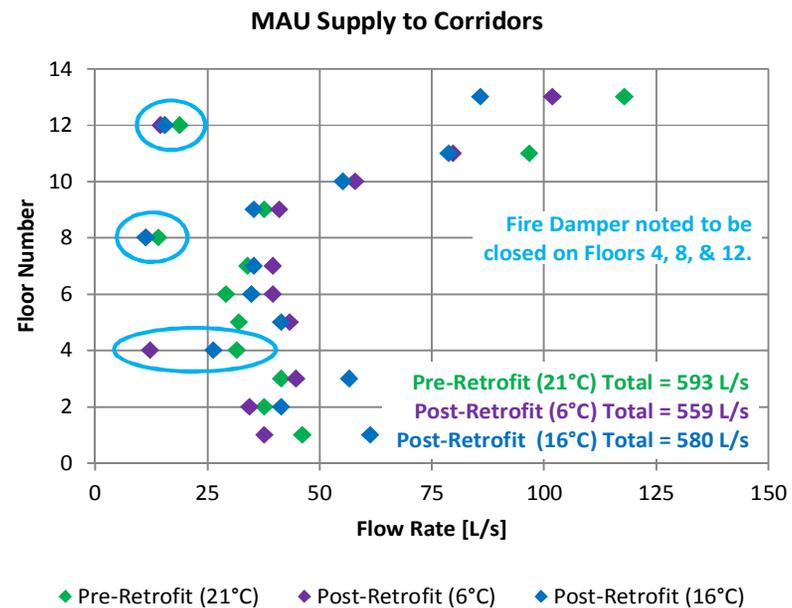
Powered Flow Hood



“The Belmont” – Ventilation to Corridors

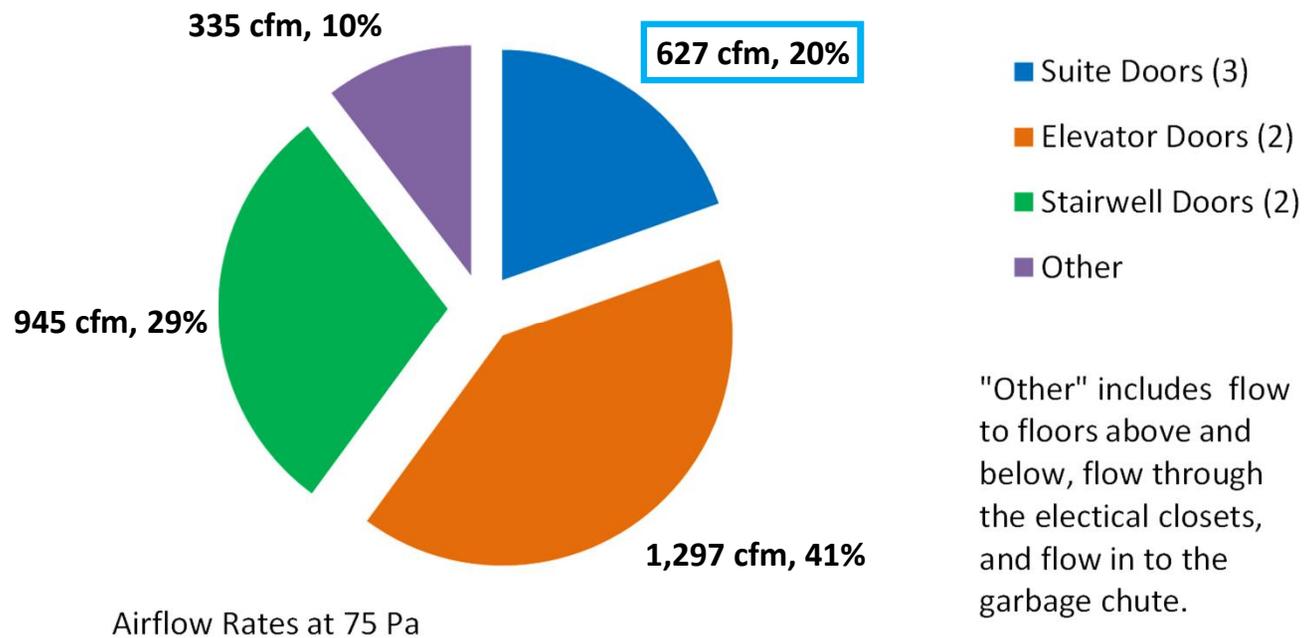
Maybe ventilation air isn't reaching the corridors?

” Only 40% of intake flow reaches the corridors directly



air isn't reaching the suites from the corridors?

“ Only 20% to the suites!



“The Belmont” – Ventilation Leakage

” 40% reaches the corridors
And, 20% of that air reaches the suites...

$$40\% \times 20\% = 8\%$$

” goes where it is supposed to!

Leakage of air along ventilation flow path is a major issue.

“The Belmont” – Bathroom Fan Operation

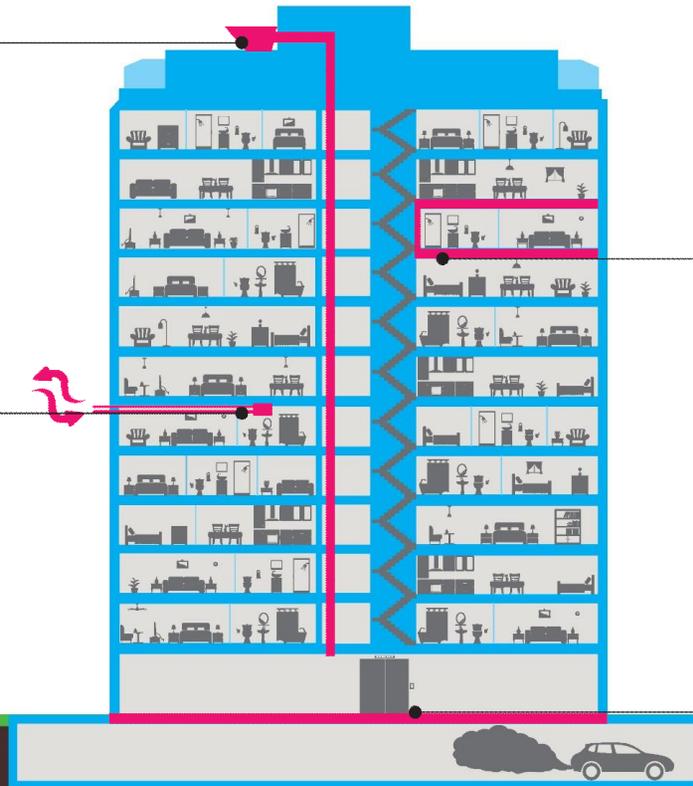
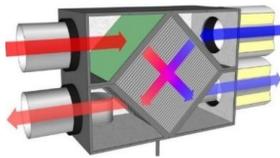
” Crushed or significantly obstructed ducts



“The Belmont” – Phase 2

Central Ventilation Size Reduced
Only ventilates corridors.

Heat Recovery Ventilators
Installed in Each Suite
Direct ventilation and
heat recovery.

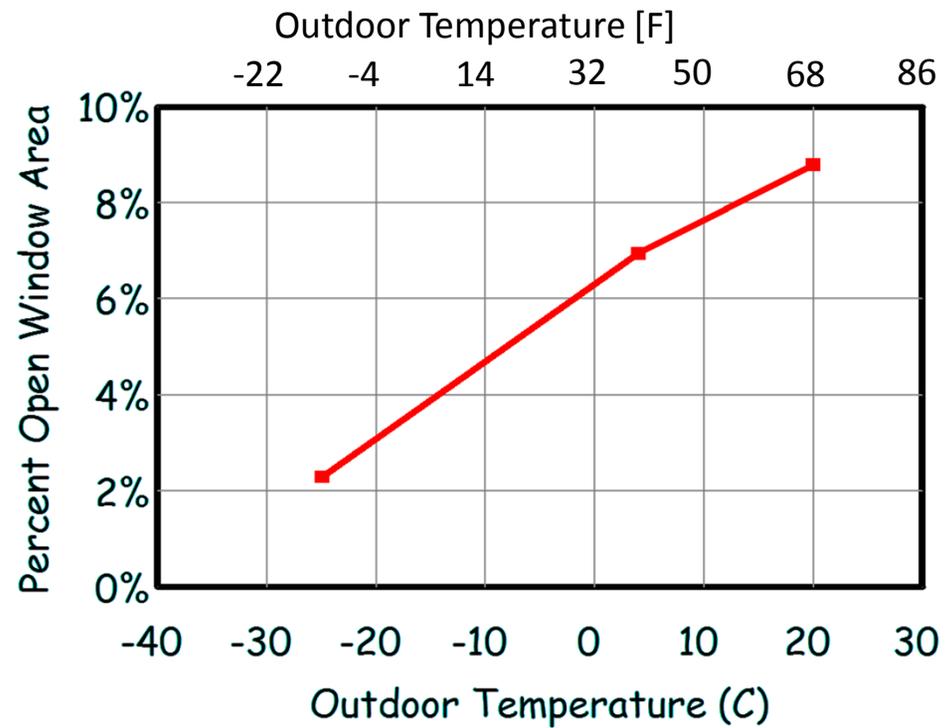


Air Sealing Between Suites
Reduced Internal transfer of
contaminates and energy.

Air Sealing Between Parking
Garage and Inside
Reduced infiltration of harmful
contaminates.

11% Additional Energy Savings & Improved Air Quality

Occupant Interaction - Windows



Source: CMHC, Gary Proskiw

14 windows open at -25 C

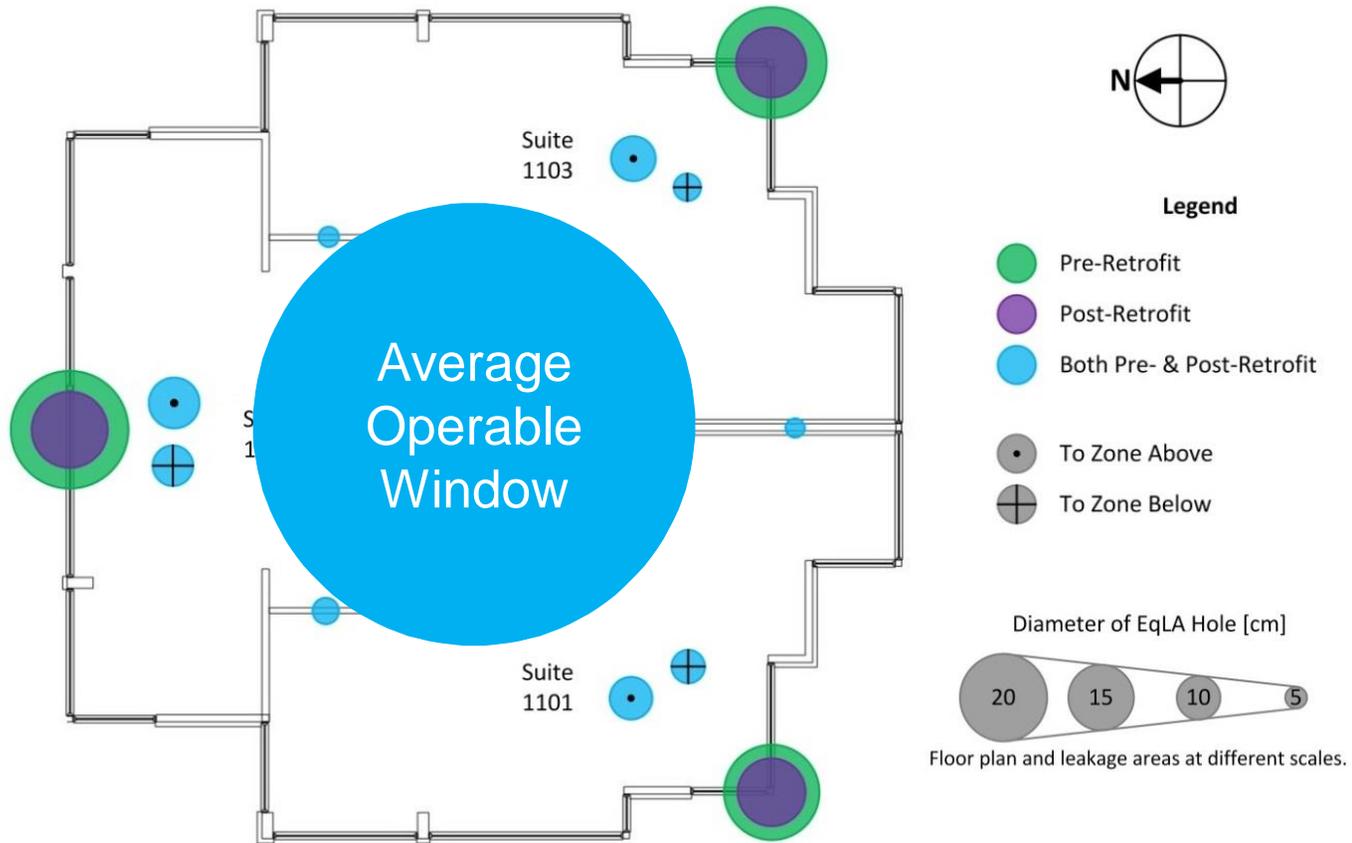
inset shows open window



Find the open window



Occupant Interaction - Windows



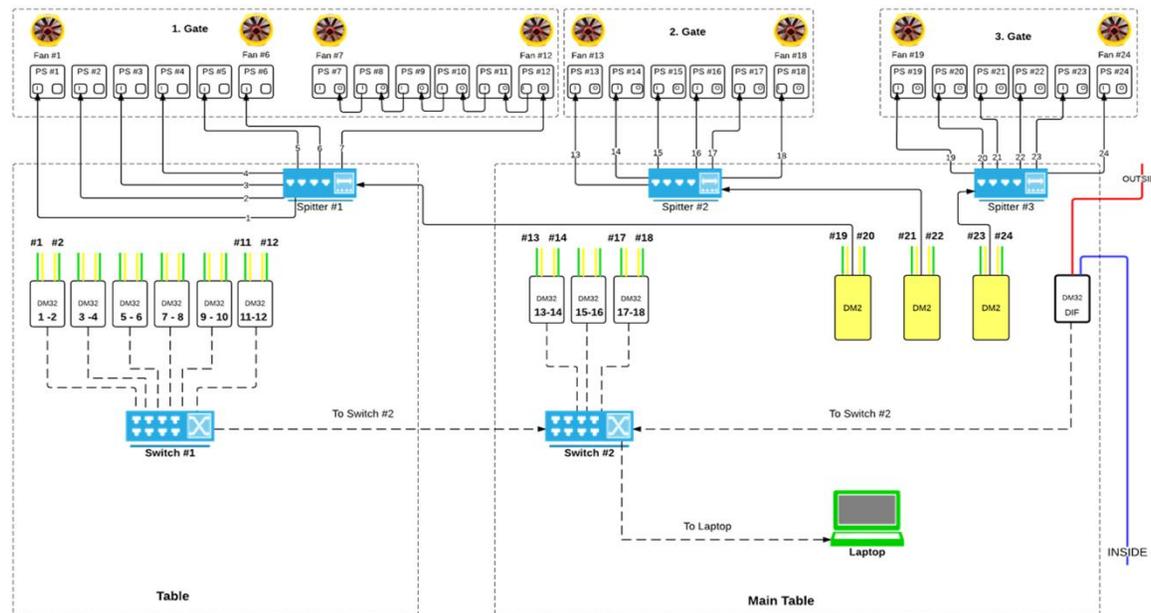
Multi-Fan Testing for Large Buildings and Multifamily buildings





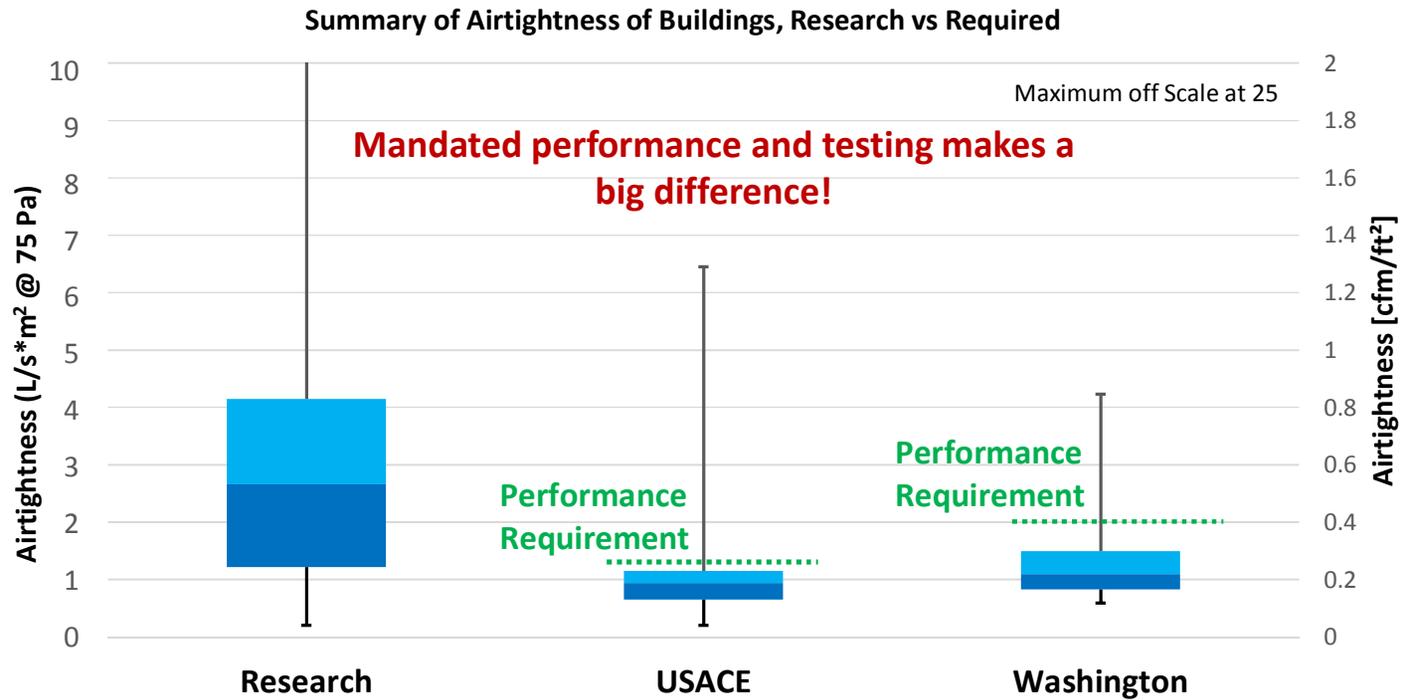
measurement scheme

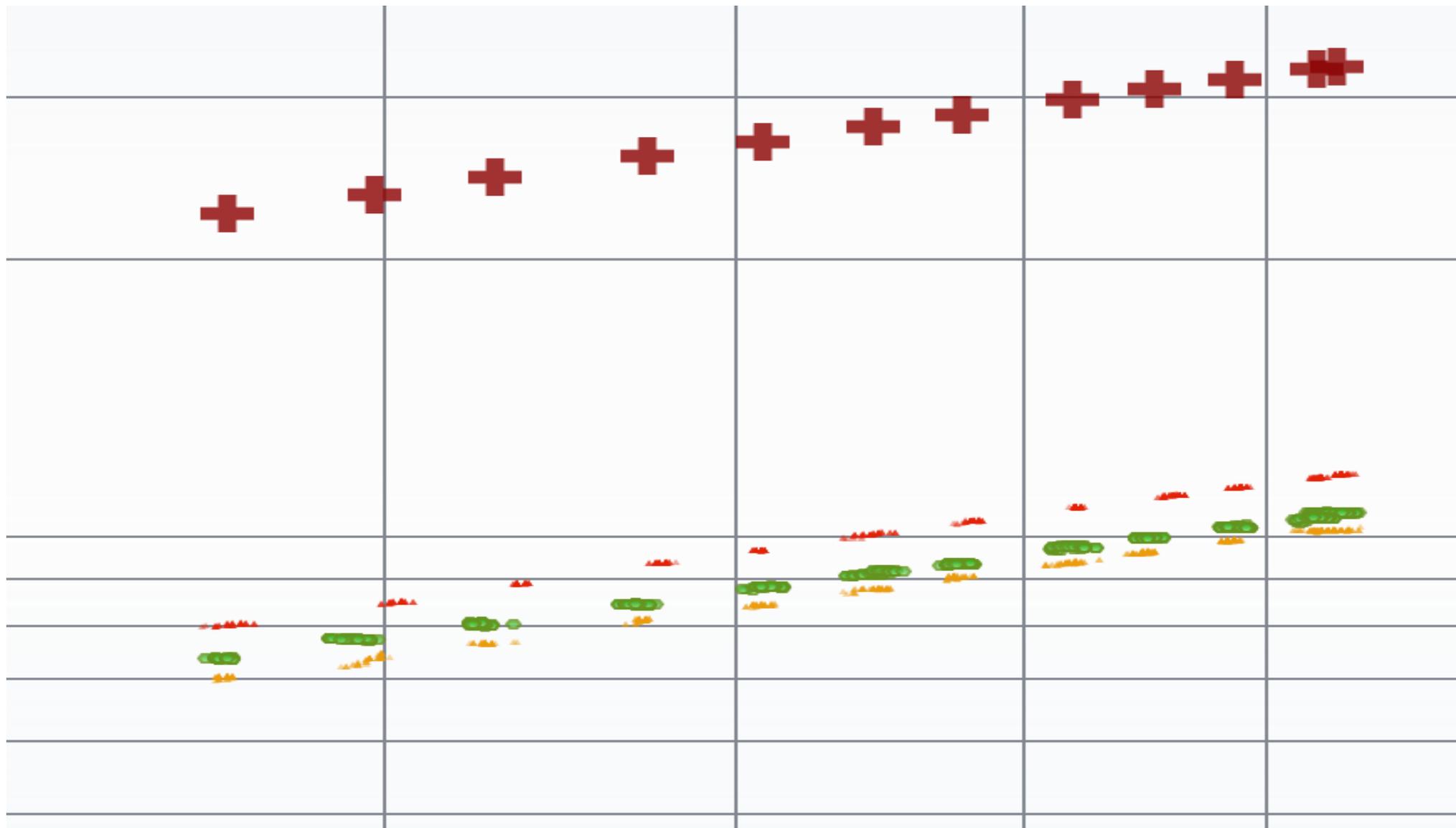
- semi-automatic test in both directions
- data collecting by FanTestic-24 software





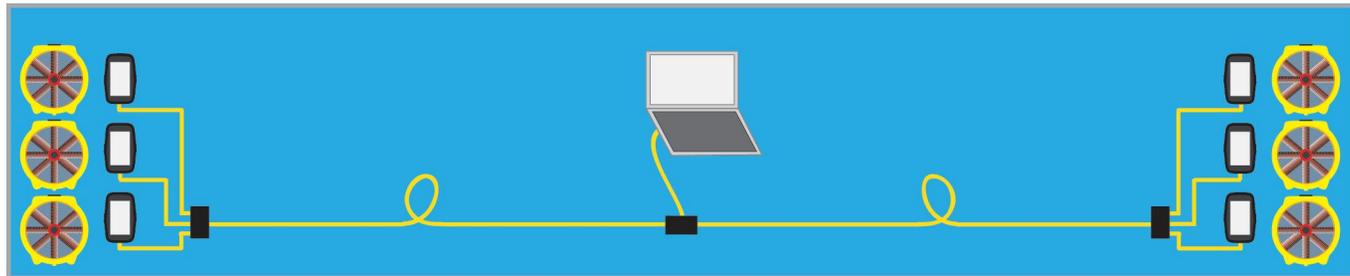
Reason for Testing vs Airtightness



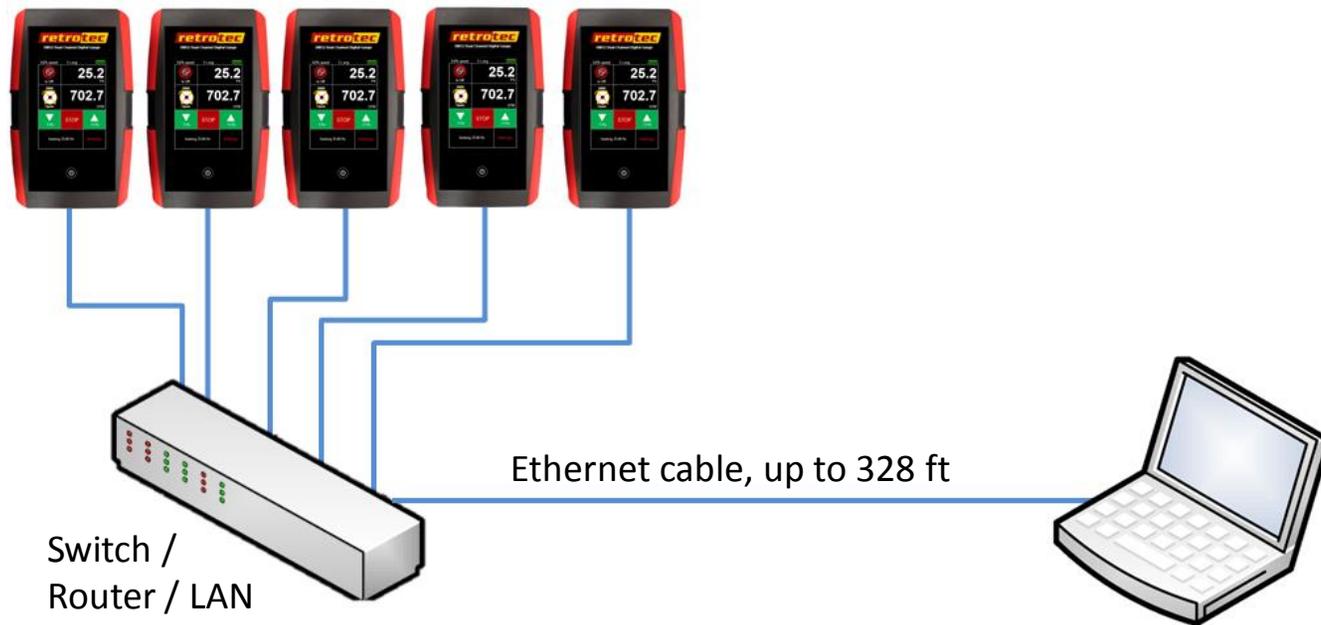


Ethernet cable extension

Up to 100 m or 328 feet each



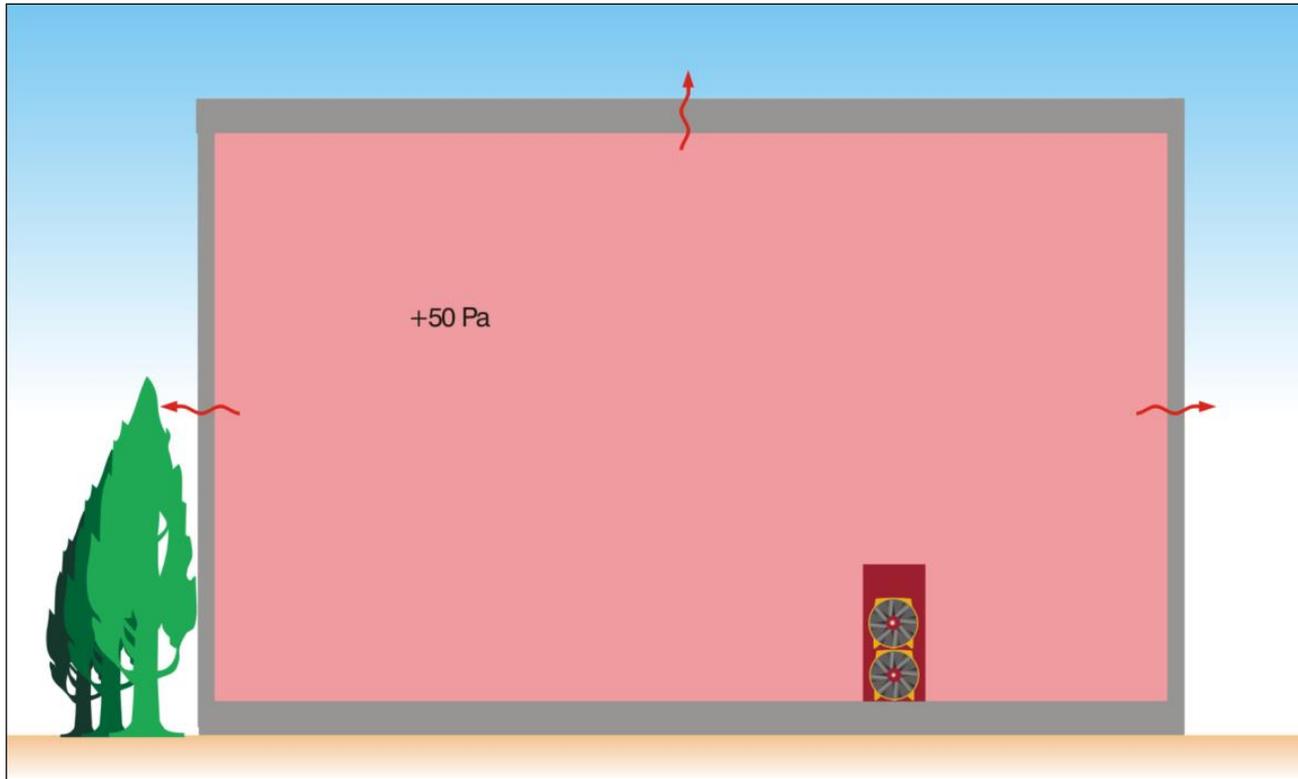
Via Ethernet cables



Testing 1 2 3



1



Test Method

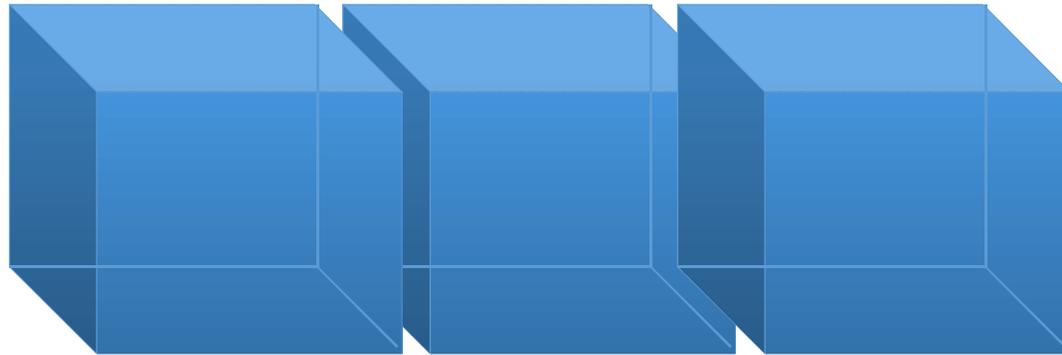
Single unit –need adjoining locations pressure opening.

Neutralization test – create pressure on adjoining side to determine leakage to that side

Multiple fans and multiple units simultaneously.

Neighbors

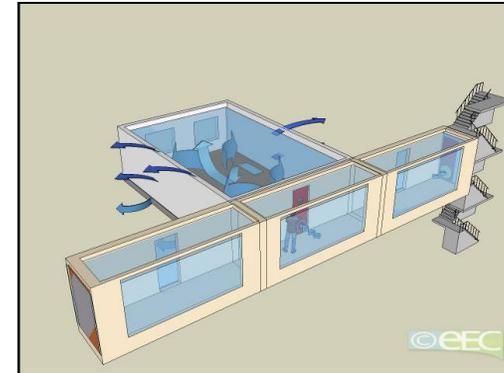
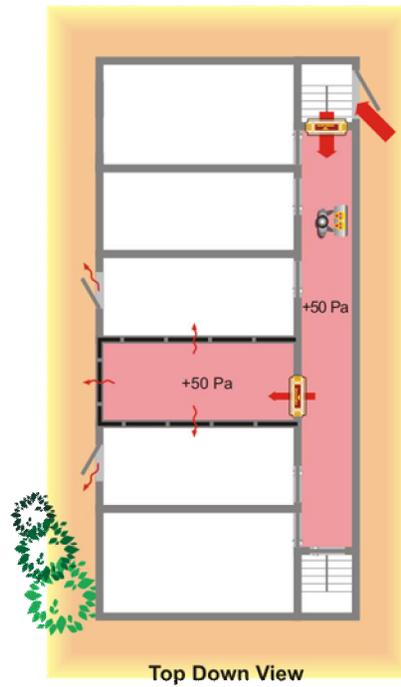
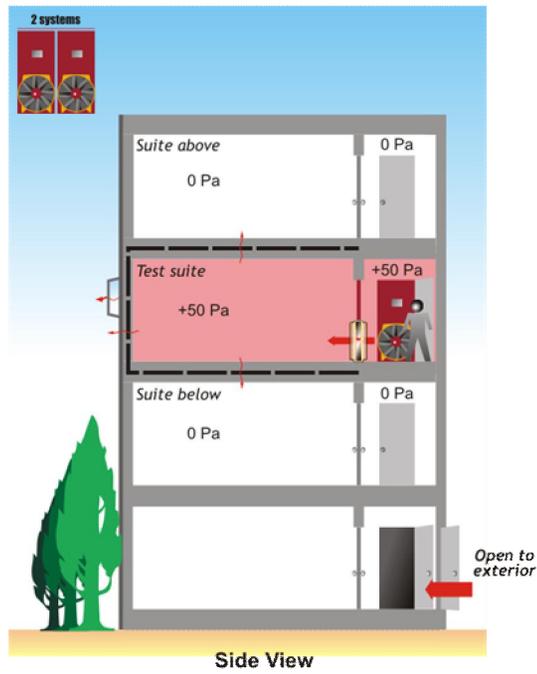
Isolating adjoining structures.



2

1100 CFM

Leakage from Apartment to Hallway

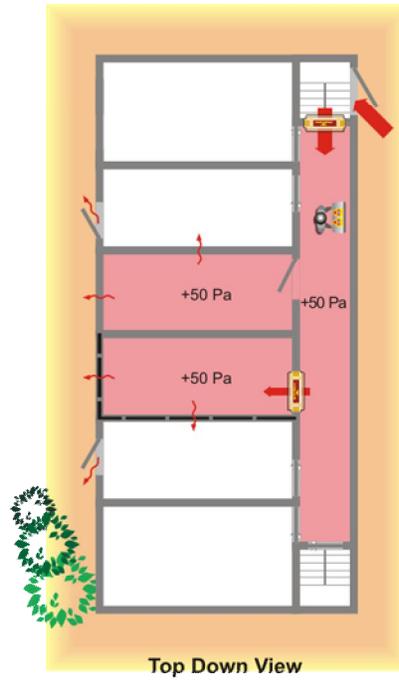
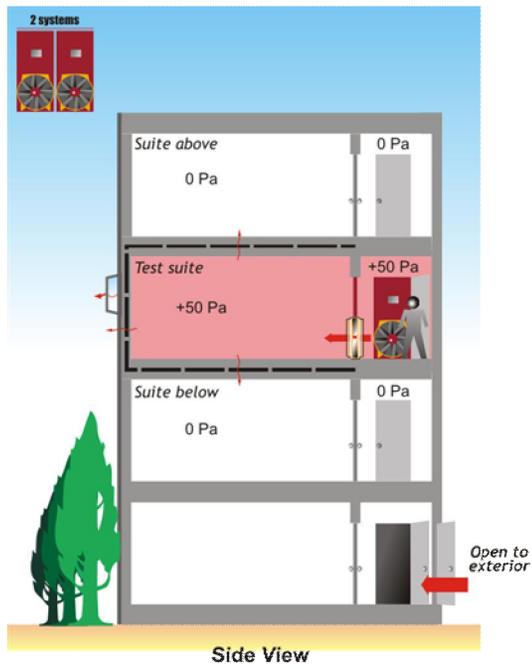


© 2008, Retrotec

3

900 CFM

Leakage across 1st Party Wall

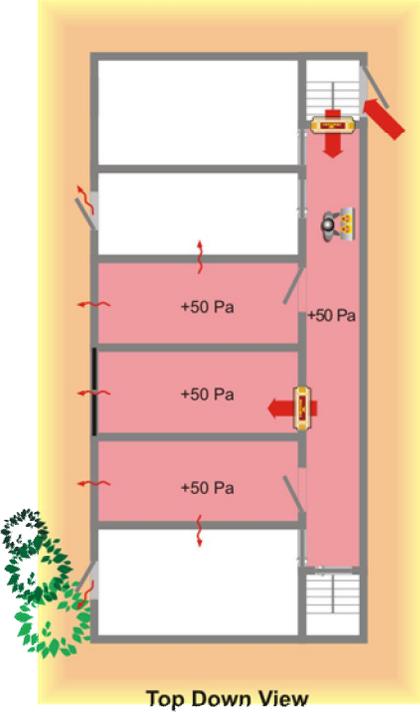
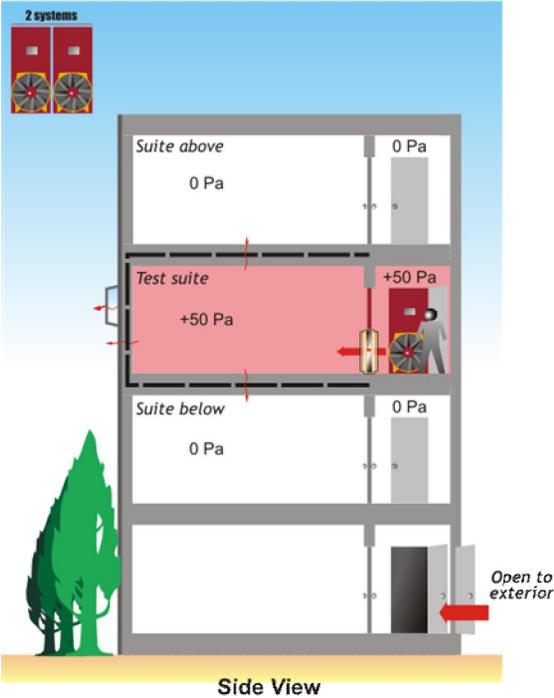


© 2008, Retrotec

4

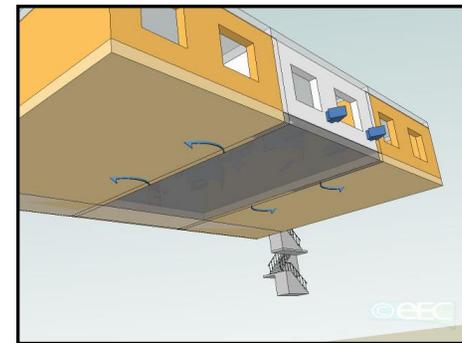
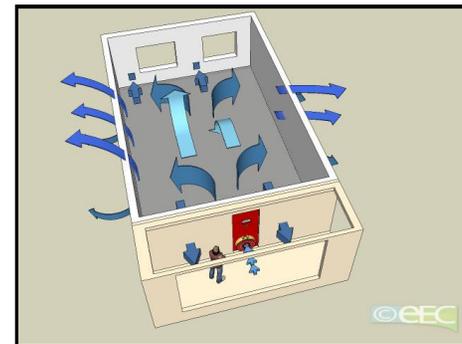
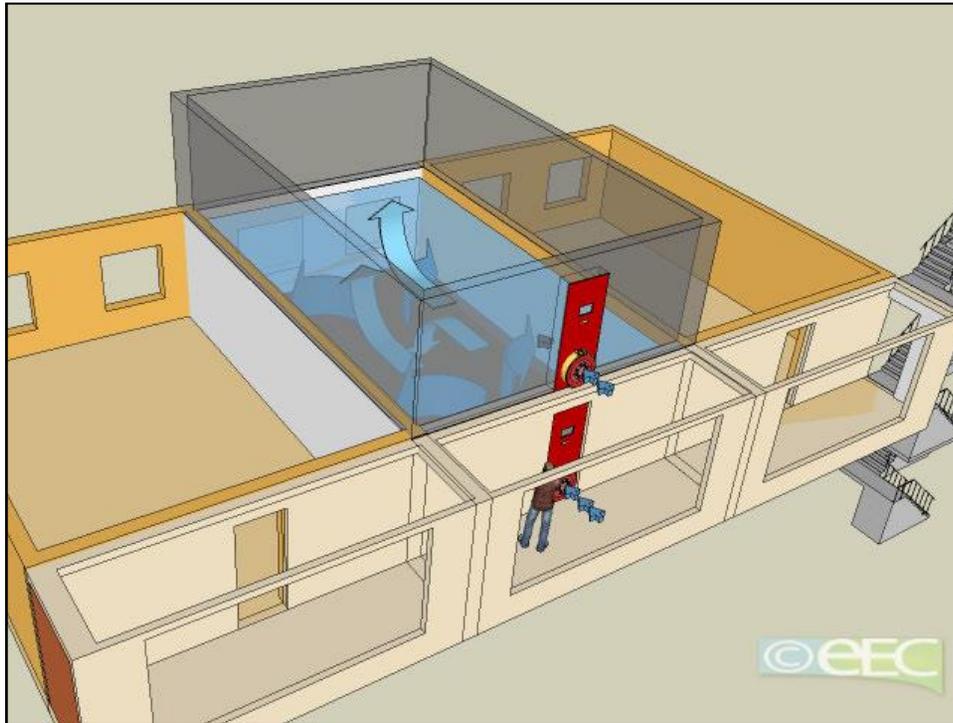
850 CFM

Leakage across 2nd Party Wall



5

750 CFM



'Mr. Watson, Come Here ...'

1876

Use technology to work smarter.

Use technology to work smarter.

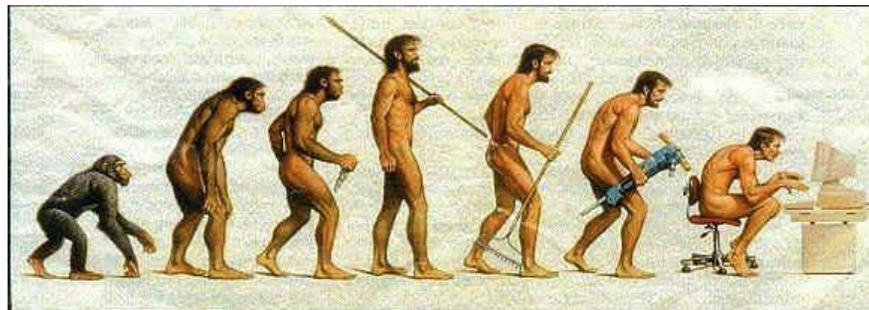


2007

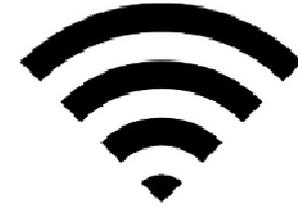


BYOD

Bring your own device.



2 WiFi Gauges – be in two places at once.



DM32 Smart Gauge Firmware update



USB 

Use technology to work smarter

simple as **On** & **Off**.



Commercial duct tester turned on and off remotely



Smartphone - tablet app



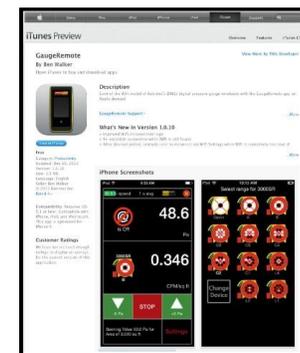
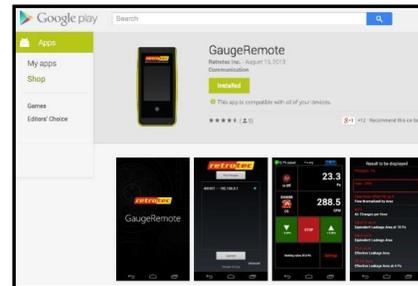
GaugeRemote App.



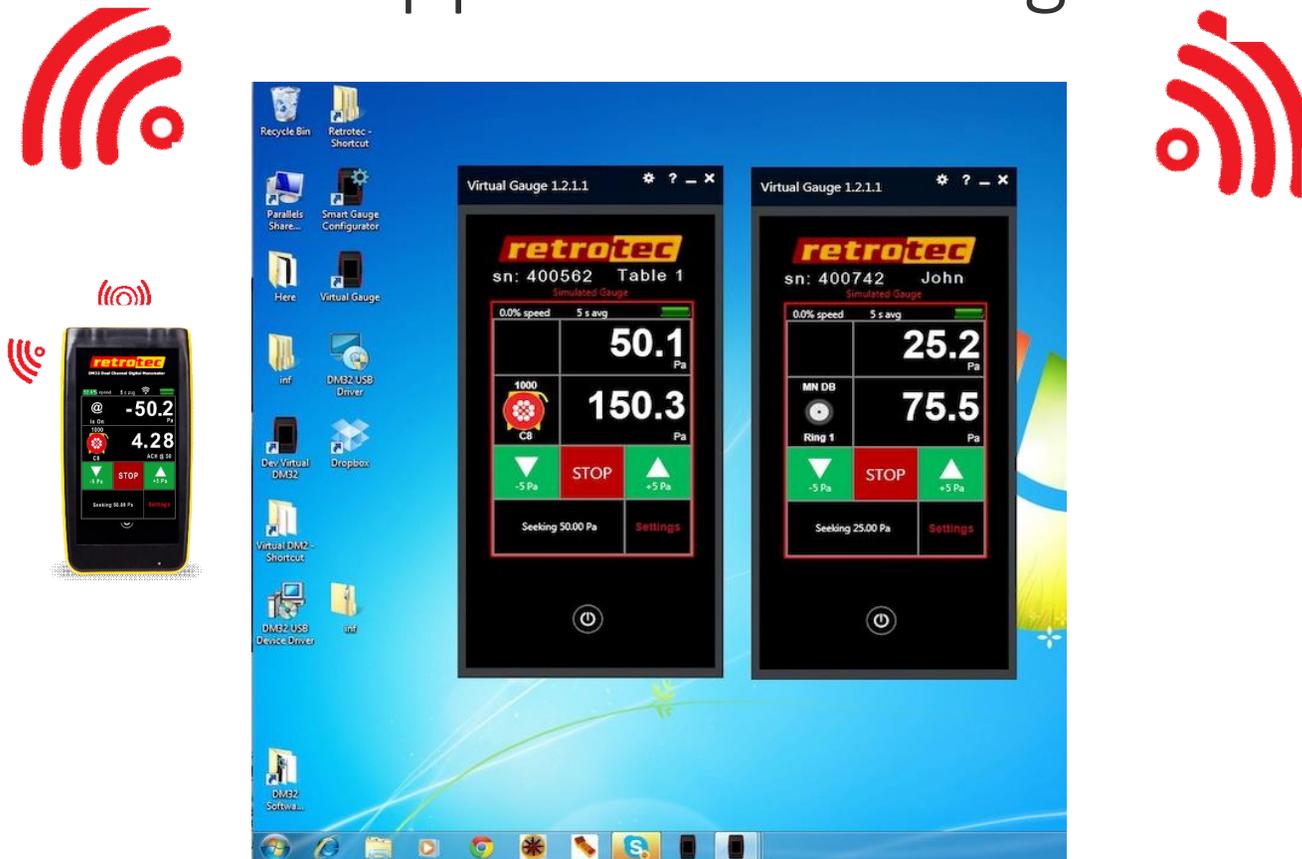
iOS Apple

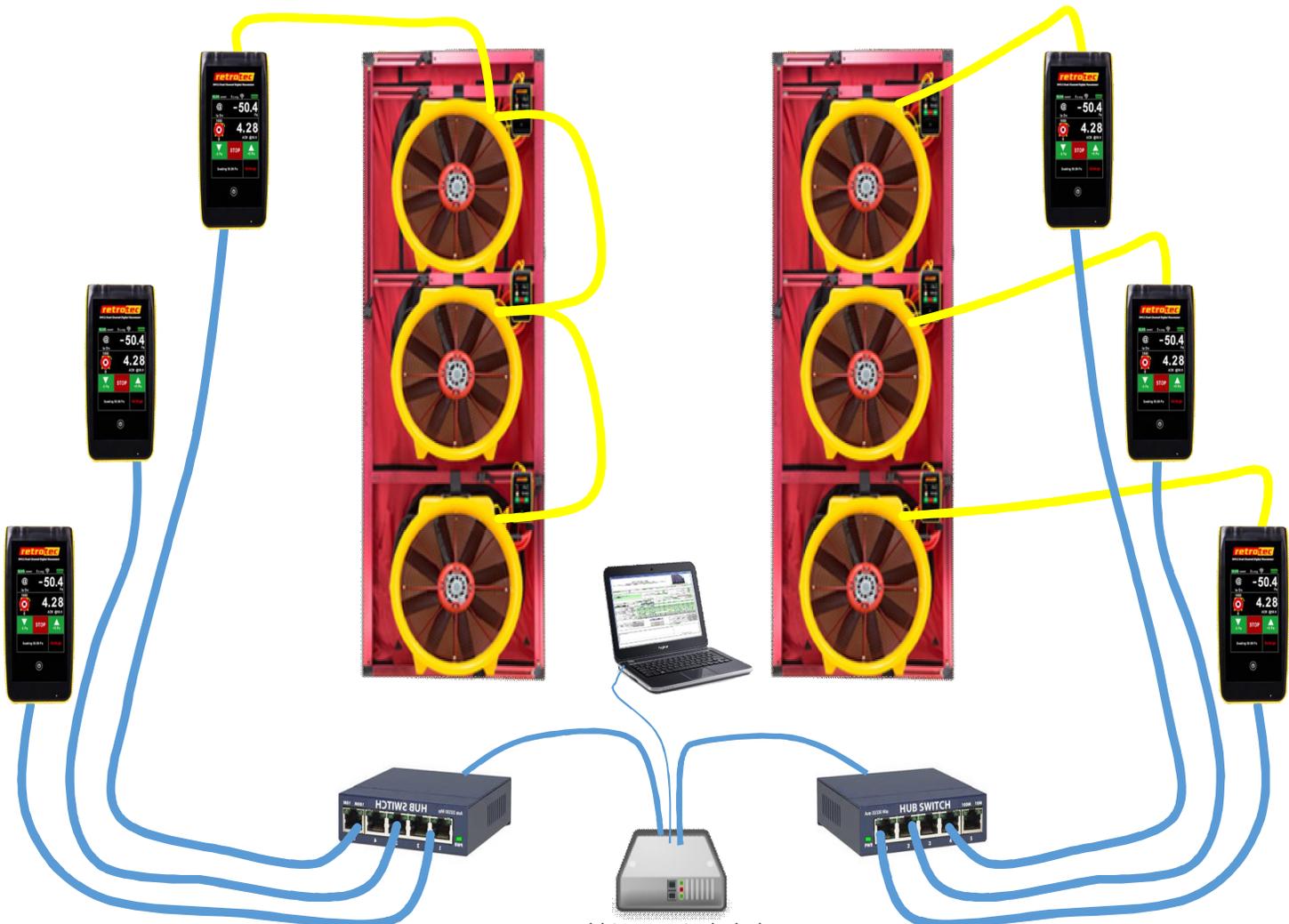


Android



PC app is Virtual Gauge





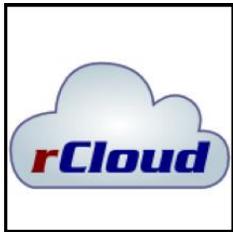
tubbing not included

rCloud

runs on any internet enabled 4G tablet or
phone



Direct Data from gauge Geotag (map) & Time Date Stamp Stored & Shared on the Cloud



The screenshot shows the rCloud mobile application interface. At the top left is the rCloud logo. The user's name, Joe Medosch, and email, energyaz@gmail.com, are displayed in the top right. Below the logo are three red buttons: 'New Auto Test', 'My Test Map', and 'Upload Tests'. A message states: 'You have tests that need to be uploaded. Tap 'Upload Tests' to save them to the cloud.' The main section is titled 'My test locations' with a refresh icon. It displays a grid of six satellite map thumbnails, each with a location name, address, and area/sq ft. The top-right thumbnail is highlighted with a red border and a checkmark. A diagonal watermark 'Beta Software - currently in development' is visible across the bottom half of the screen. A plus icon in a circle at the bottom right is labeled 'New test at this location'.

rCloud

Joe Medosch
energyaz@gmail.com

My test locations ↻

- New Auto Test
- My Test Map
- Upload Tests

You have tests that need to be uploaded. Tap 'Upload Tests' to save them to the cloud.

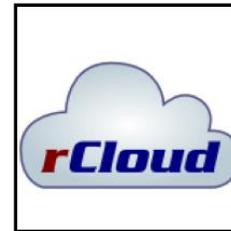
Location	Address	Area / sq ft
nata Circle, Stockton, CA	200 Brookwood Ave, Santa Rosa, CA 95404	2140 sq ft
200 Brookwood Ave, Santa Rosa, CA 95404	145 Fair Oaks Ln, Atherton, CA 94027	Built 1982, 900 sq ft
145 Fair Oaks Ln, Atherton, CA 94027	653 Home Ave SE, Atlanta, GA 30312	Built 1959, 3200 sq ft
653 Home Ave SE, Atlanta, GA 30312	18980 Pacific Coast Hwy, Malibu, CA	Built 1925, 1161 sq ft
18980 Pacific Coast Hwy, Malibu, CA		
V Frazer Ln, Bend, OR	1440 B St, Eureka, CA 95501	

Beta Software - currently in development

New test at this location

New Test

rCloud



Location Photos Equipment

test location

Street address *
653 Home ave

City, State or Zip *
30312

Search

* Required fields

1 address found

 **653 Home Ave SE, Atlanta, GA 30312**
Built 1925 1161 sq ft
72° F 83% Relative Humidity

Elevation 961 ft

Outside humidity 83%

Building type
Stand Alone

Floor area *
1161

Year constructed
1925

Phone

Volume *
12000

Inside temperature *
76

Outside temperature *
72

Inside humidity

Beta Software – currently in development

Cancel Next

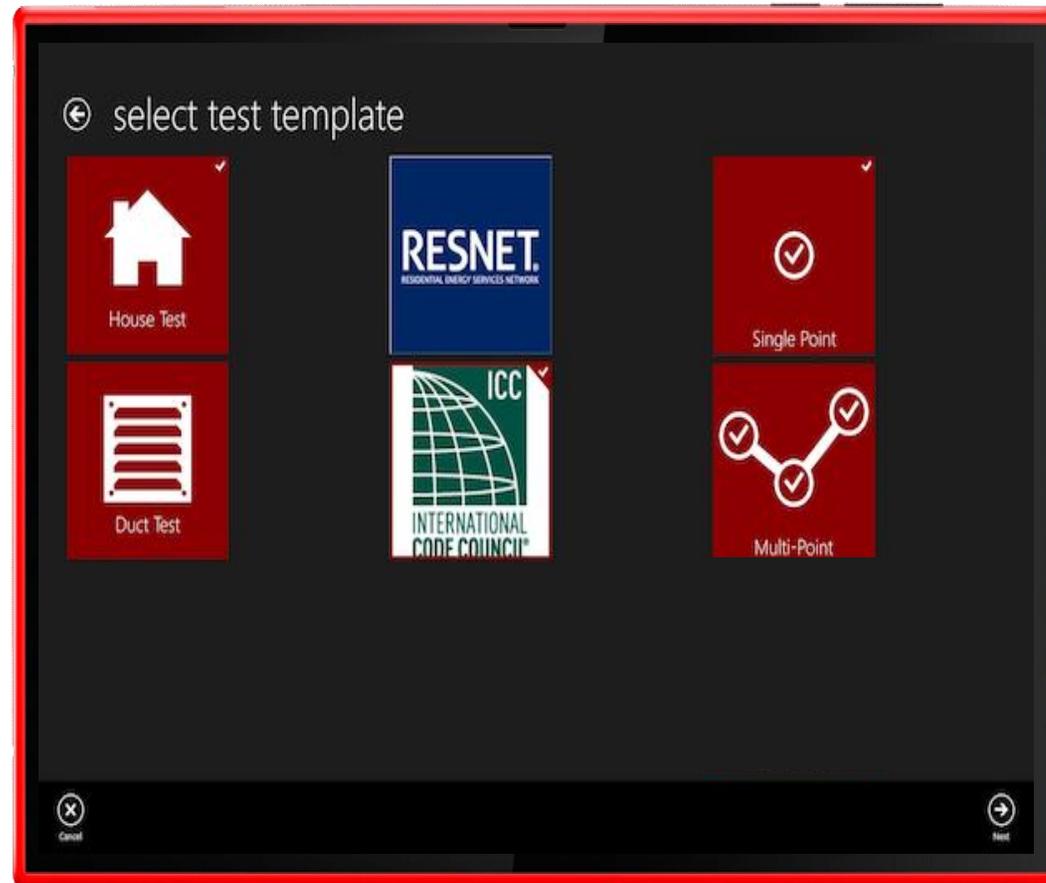
rCloud - local testing protocols

Automated testing, (no manual entry)

- Blower door test

- single point test
- multipoint test

- Duct test



SAMSUNG

Location

Photos

Equipment

Auto test

equipment setup

Connected test equipment

Test gauge

✓  **SIMULATED**
Valid until 5/14/2020

Test fan

✓  **1FN001776**
1000
Open

Connect to gauge

My saved gauges

 **401377**
401377
10.1.10.24

Connect

Settings

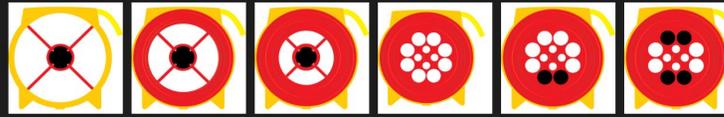
Select test fan

My saved fans

 **1FN001776**
1000

Manage

Select fan range



Open

A

B

C8

C6

C4



C2

C1

L4

L2

L1



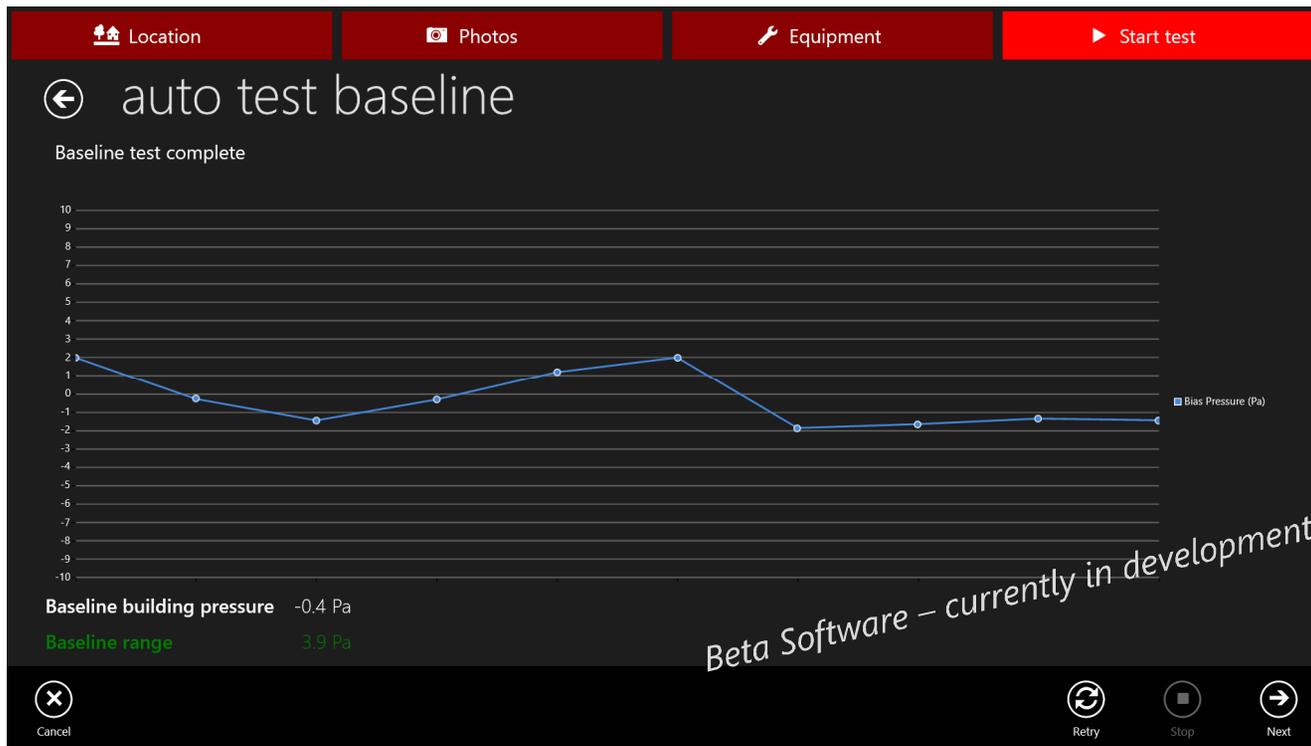
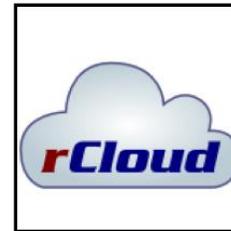
Cancel



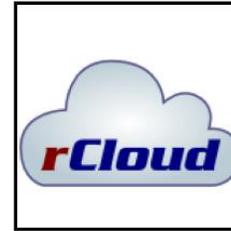
Next

New Test

rCloud

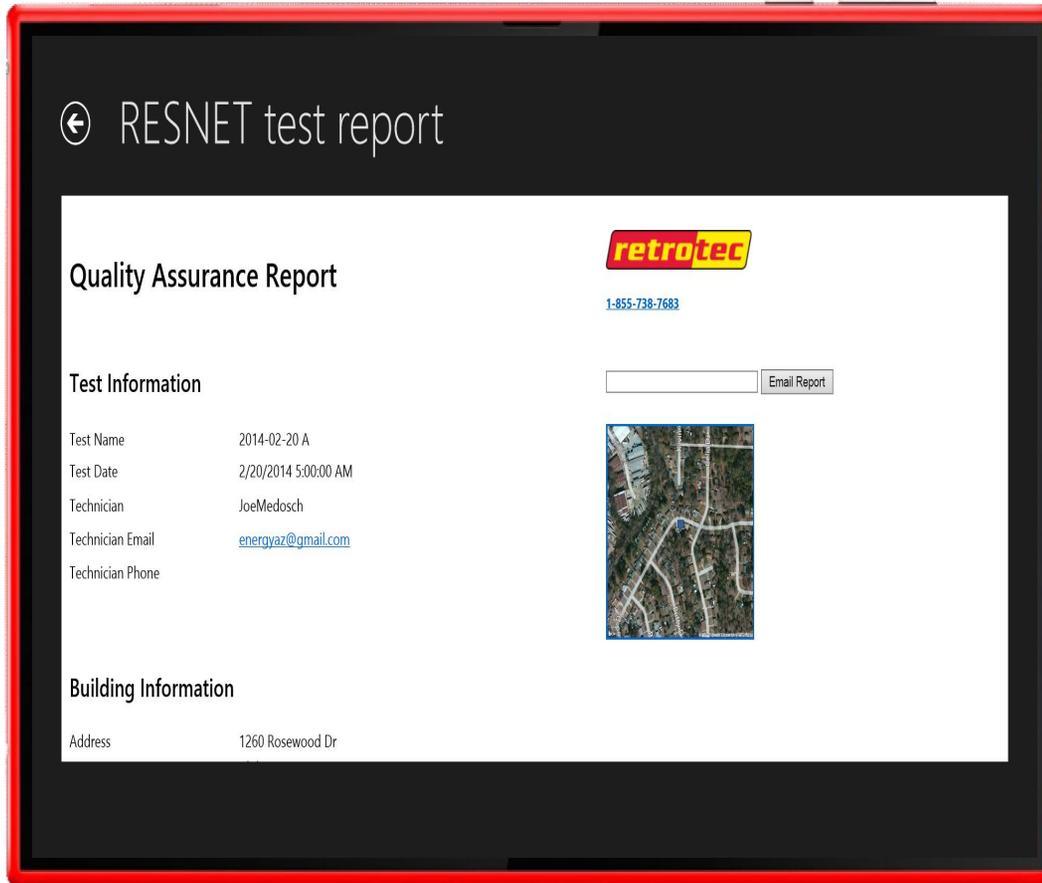


rCloud



Beta Software – currently in development

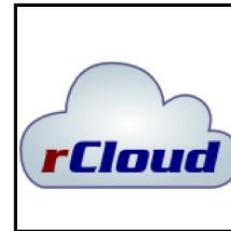
rCloud - reports can be emailed



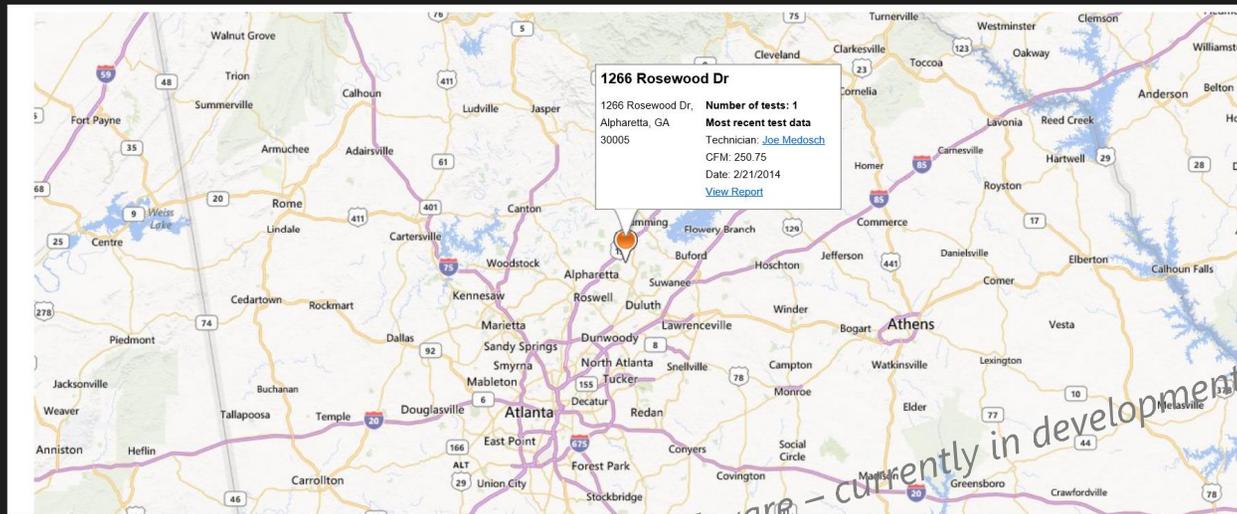
reports can
also be viewed
online.

Test Map

rCloud



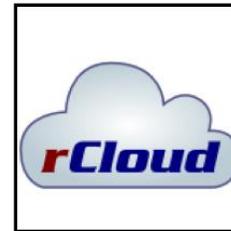
← my tests



Beta Software - currently in development

New Test

rCloud



rCloud (offline)

My test locations ↻

New Auto Test

<p>3109 Sonata Circle, Stockton, CA 95212 Built 2005 2140 sq ft</p>	<p>200 Brookwood Ave, Santa Rosa, CA 95404 Built 1982 900 sq ft</p>	<p>145 Fair Oaks Ln, Atherton, CA 94027 Built 1959 3200 sq ft</p>
<p>2327 NW Frazer Ln, Bend, OR 97701 Built 2012 1412 sq ft</p>	<p>1440 B St, Eureka, CA 95501 Built 1982 9298 sq ft</p>	<p>18980 Pacific Coast Hwy, Malibu, CA 90265 Built 1992 2820 sq ft</p>

Beta Software - currently in development

3 New applications



- ” Stick with your expertise
- ” Add services to what you do already
- ” Find strategic partnerships

Under Floor Air Distribution testing

0.15 CFM/ square foot

@ 12.5 Pa



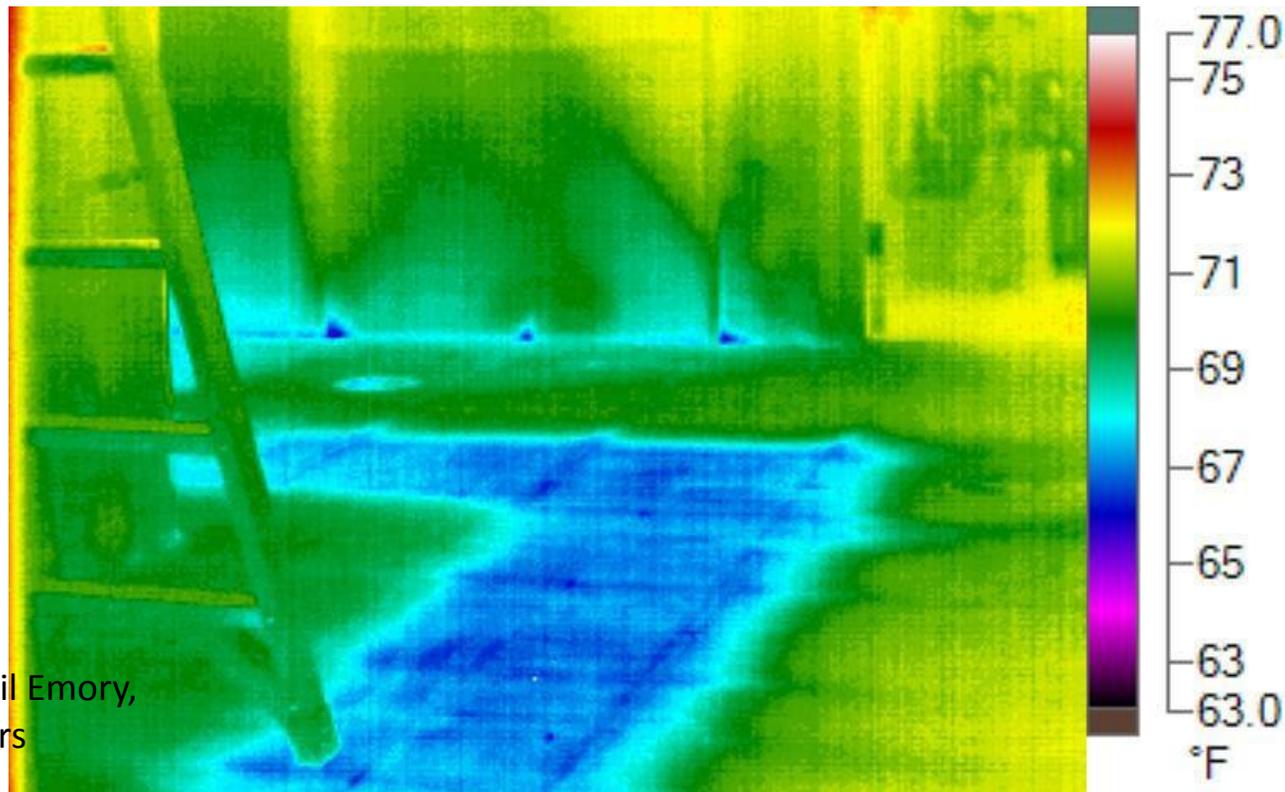
Compliments of Phil Emory,
Neudorfer Engineers

UFAD Testing “Ducted System”



Compliments of Phil Emory,
Neudorfer Engineers

UFAD Testing “Ducted System”



Compliments of Phil Emory,
Neudorfer Engineers

Area of Refuge, Critical Care

FEMA 453



Risk Management Series

Safe Rooms and Shelters

Protecting People Against Terrorist Attacks

FEMA 453 / May 2006



FEMA



Large building



Integrity test



Temporary Refuge test

“Component testing
doors, fixtures, materials

“Control room pressurization

Window testing



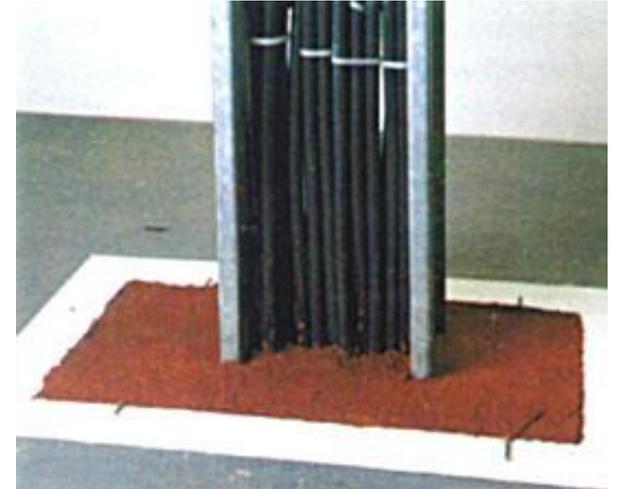
Enclosure Integrity Testing



Enclosure Integrity Testing



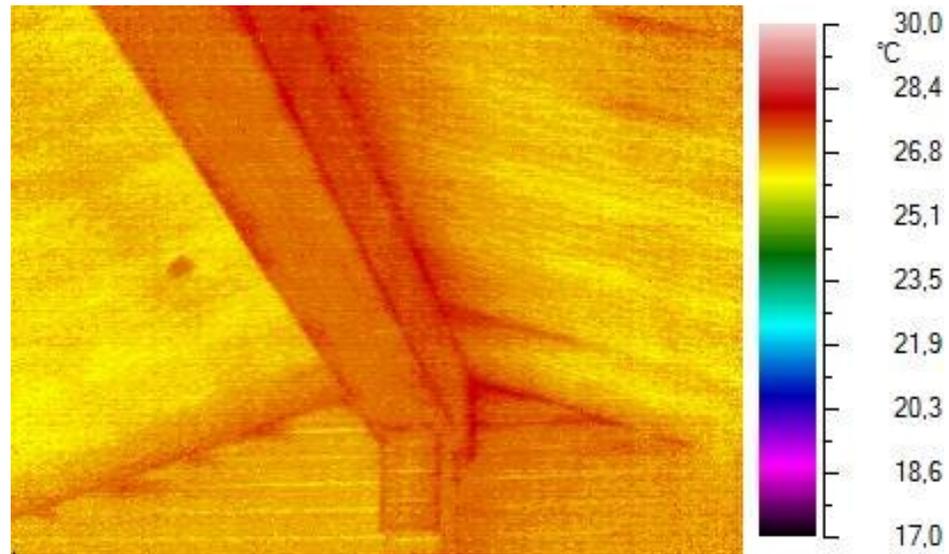
Enclosure Integrity Testing – air sealing



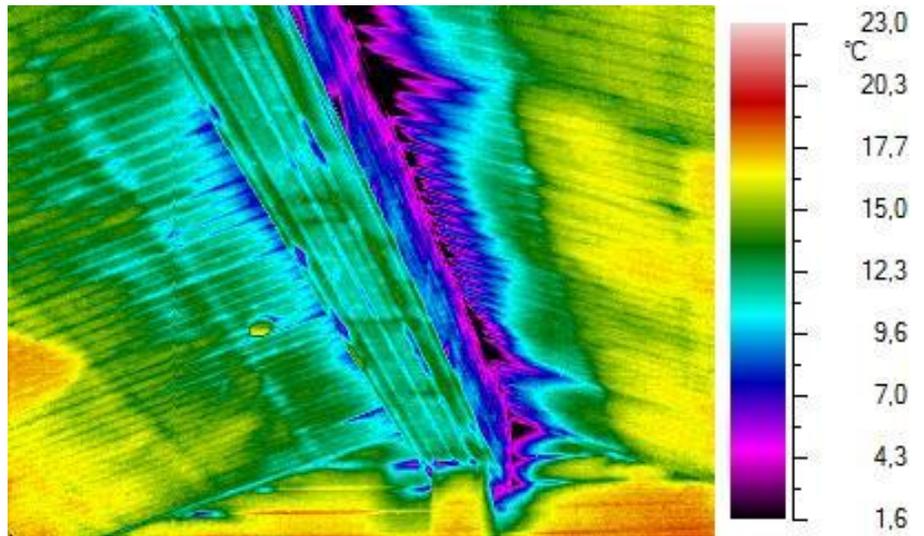
Enclosure Integrity
Peak Pressure now
required in 2012 NFPA



Infrared on Steroids

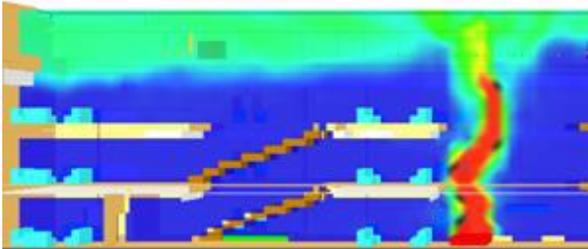


$\Delta P = + 8 \text{ Pa}$



$\Delta P = - 8 \text{ Pa}$

Passive and Active Smoke control systems

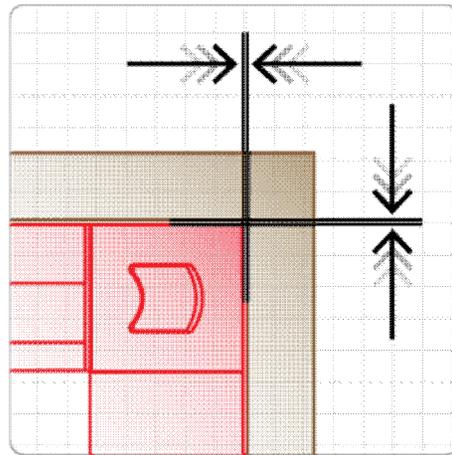
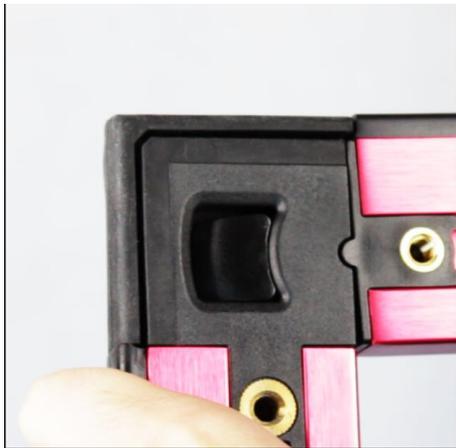


Disconnect Floors



Passive House

0.6 Airchanges per hour = 30 square inches
Average Frame 3.5 square inches



Pressure mapping and diagnostics

Pressure Diagnostics for Experienced Air Leakage Testers

Colin Genge | Retrotec



Measurement and evaluation of air pressures inside large buildings (multifamily or offices) provides us with invaluable insights. Experienced testers use these insights to create interior pressure maps that help identify air movement and wasted energy. These maps also help testers evaluate compromised areas in fire safety and indoor air quality. But achieving these insights can prove difficult for even the most experienced Air Leakage Tester. True- it's no simple task to create and evaluate pressure in large buildings, but many of the best test methods only require a manometer and a clipboard.

This article examines pressure diagnostics in large buildings from the perspective of experienced air leakage testers. It's divided into 3 sections:

1. Ambient Pressure Diagnostics
2. Induced Pressure Diagnostics
3. Consequences Caused by Air Leakage

Part 1 - Ambient Pressure Diagnostics

There are numerous tests, protocols and methods for pressure diagnostics in a large building. Each of these diagnostics fall under one of two groups:

- **Ambient Pressure Diagnostics:** How air flows within a building under normal operating pressures, including those from mechanical ventilation.
- **Induced Pressure Diagnostics:** How air flows within a building under an artificially increased or decreased pressure condition, like that created with one or more blower doors
- Both groups can yield valuable information about energy performance and indoor air quality in a building. Yes, the data collected can be used as guide to point to possible energy solutions,
- but they're better as a tool to generate questions-no answers.

Experienced testers place great emphasis on due diligence of test buildings. Every effort is made to

interview anyone with working knowledge of the building. Including but not limited to:

- the owner,
- engineer,
- HVAC service company,
- anyone completing recent repairs and
- some occupants.

They pay considerable attention to the HVAC system(s), the ventilation methods and any additional installations that move air (example: range hoods in restaurants). The more they discover before the tests - the more they understand about the test results. For example, preparation time for complex buildings can be as much as 10 times greater than the inspection time.

All pressure diagnostics produce a "snapshot" of the condition at the time of the measurement. The condition is affected by a number of dynamic factors, including:

- **Temperature Effect** – Solar radiation has a direct effect on building pressure. Building orientation and amount of glazing, shading (as well as time of year and time of day), affect how much solar radiation enters the building. Solar radiation drives the temperature effect (see above) due to its direct impact on temperature differences, as well as modulating the change of temperature through thermal mass
- **Wind Effect** – The direction and intensity of wind at the time of the test can significantly affect the measurement. A pressure measurement of a room on the windward side may be much smaller than a room on the leeward side. Wind speed is also affected by time of day since early morning and late afternoon see less wind than midday.

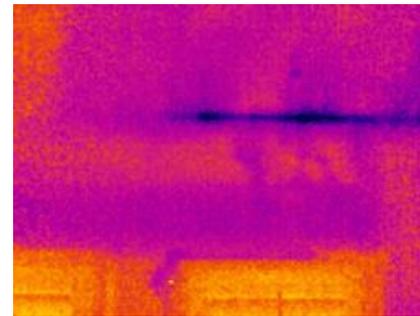
Rain penetration testing



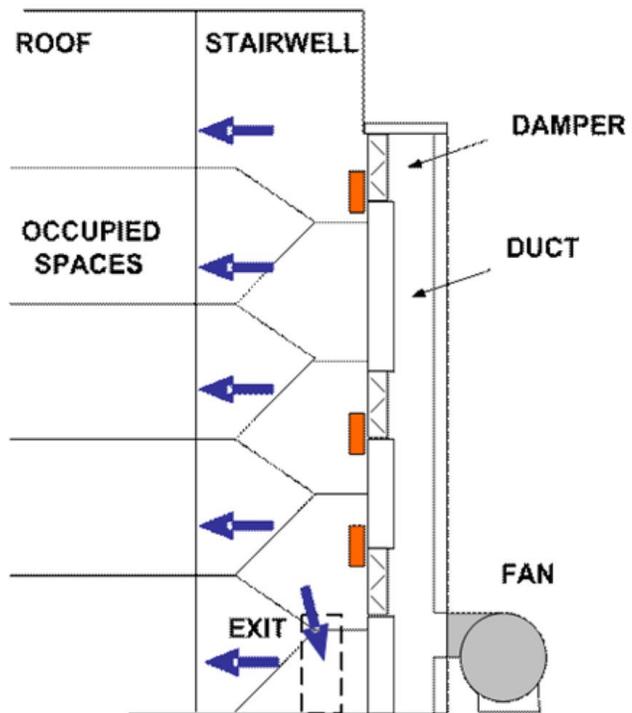
1 phase in
3 phase 240 Volt out



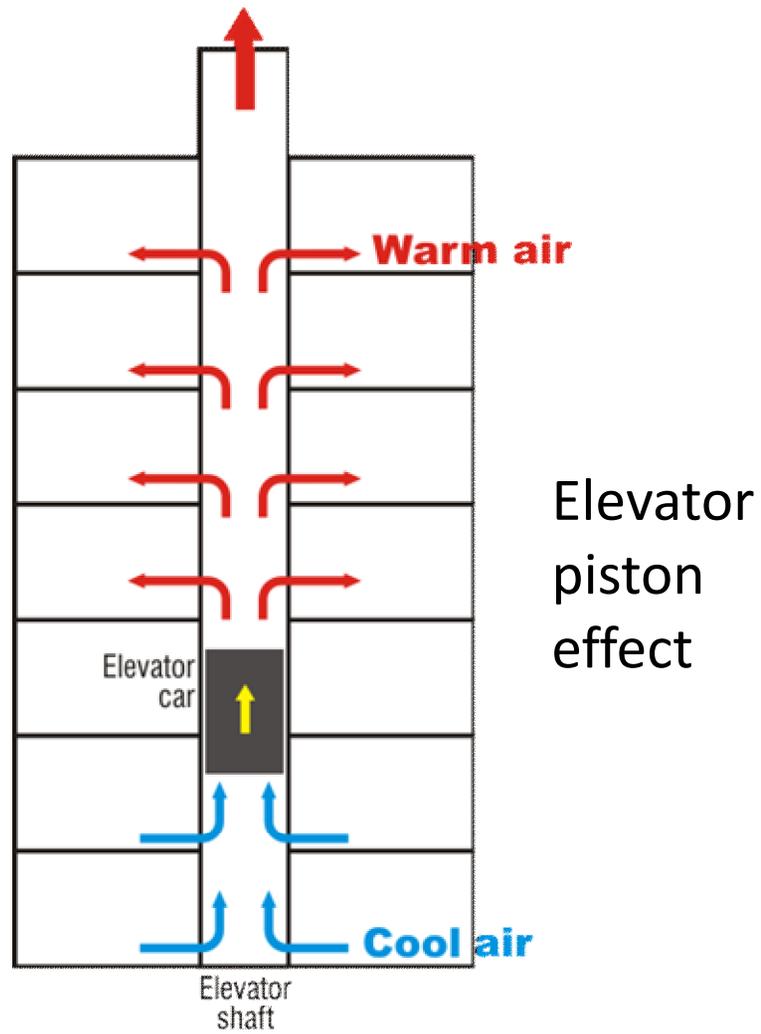
Roof membrane testing



Pressurized stairwells



Seal shafts



Compartmentalize the laundry room



Tools



Residential, Low Flow, High Pressure



Residential, Commercial, High Pressure



Powered Flow HOOD

with your Blower Door



Sierra Building Science, CA

Create partnerships

“ Bank of America

“ Amazon

“ Home Depot

“ Walmart

Are all investing in conservation

Ally with associated companies, insulation, solar, building science specialists,

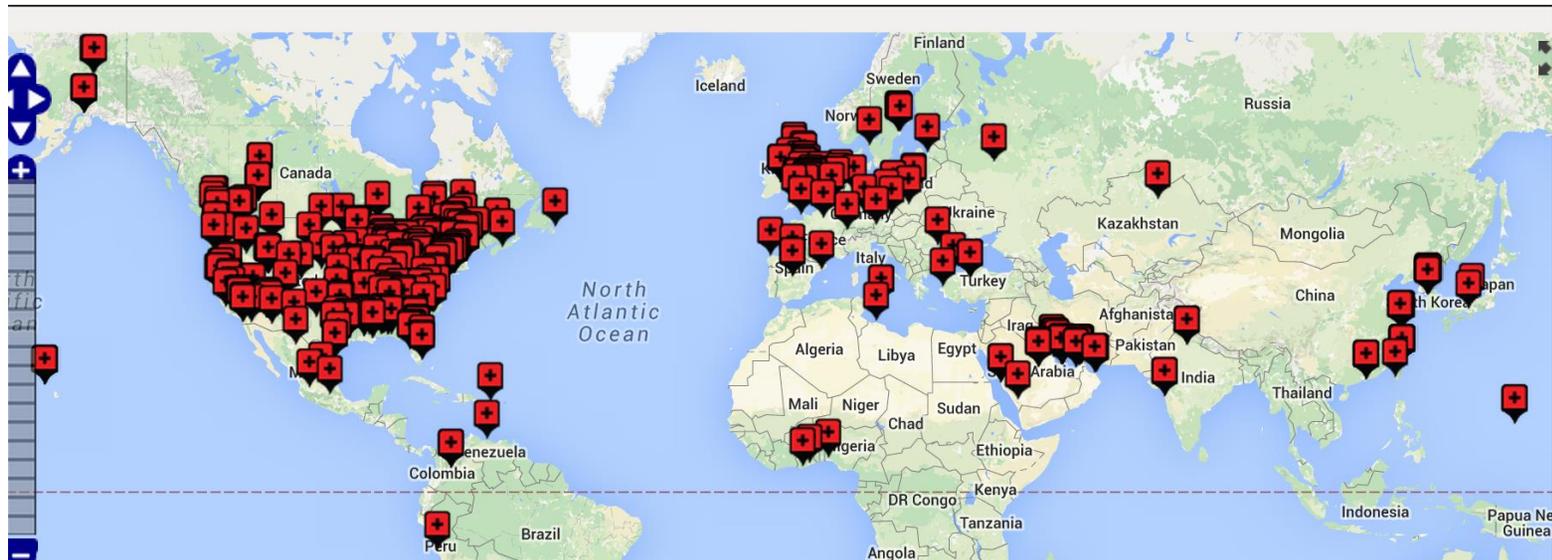
Bouygues Building Canada



Find Partners worldwide

Distance
8000
Miles from
Enter partial address here, 123

Search



List your services - partner up

colin@retrotec.com

Air Sealing Services –shafts, enclosures, floor to floor, smoke containment
Airtightness Testing multi-fan testing, air barrier testing
Commercial Duct Testing
Component Testing of doors and windows. Water penetration testing
Enclosure Zone testing: Area of Refuge, Raised Floor, Pressurized Stairwells, Control Rooms
Fire Enclosure Integrity Testing for Hold Times and Peak Pressure evaluation
HVAC Engineering
HVAC installation
Performance Modelling
Testing and Balancing
Commissioning

