BUILDINGENERGY BOSTON

A Tale of Two Cities: Multifamily Central Ventilation Systems

Building Energy Boston
August 14, 2020 – 1:00PM

Presented by

Tom Holmes

Aspen Environmental Services

tholmes@woodstockenergy.com

Doug Kumph

Petersen Engineering

doug@petersenengineering.com

John Twomey

IAQ Champs

johnt@iaqchamps.com

Copyright Materials

ASPEN ENVIRONMENTAL

PE | Petersen Engineering

INDOOR AIR QUALITY IAQ CHAMPS

Course Description

Central ventilation systems in multifamily buildings are a vital building system with significant energy, sustainability and occupant health & safety implications. Recent code requirements place increased emphasis on getting them right in both new construction and retrofit projects.

This session explores how these systems work and why, quite often, they *don't* work. It builds on lessons learned from a number of retrofit projects and offers recommendations for designing and constructing both new and retrofit systems.

Learning Objectives

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

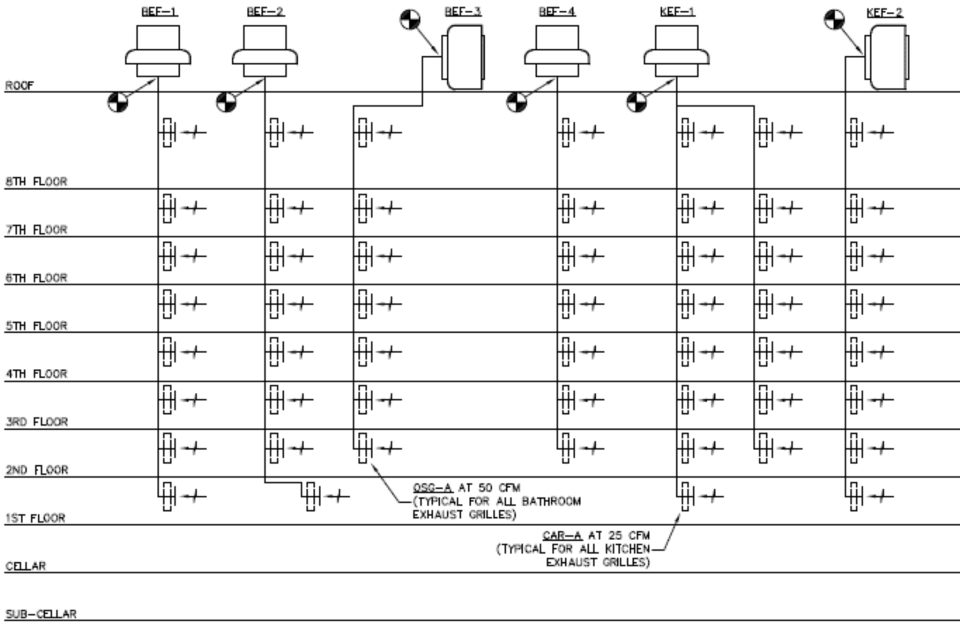
1. Understand the design, equipment & field considerations that help determine how central ventilation systems actually work
2. Identify the important project design considerations that lead to reliable performance in retrofit & new construction applications
3. How to design, specify & set performance objectives that can be reliably & cost-effectively achieved
4. Understand ways to inspect, evaluate & commission projects that achieve & sustain building performance objectives

Learning Objectives

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

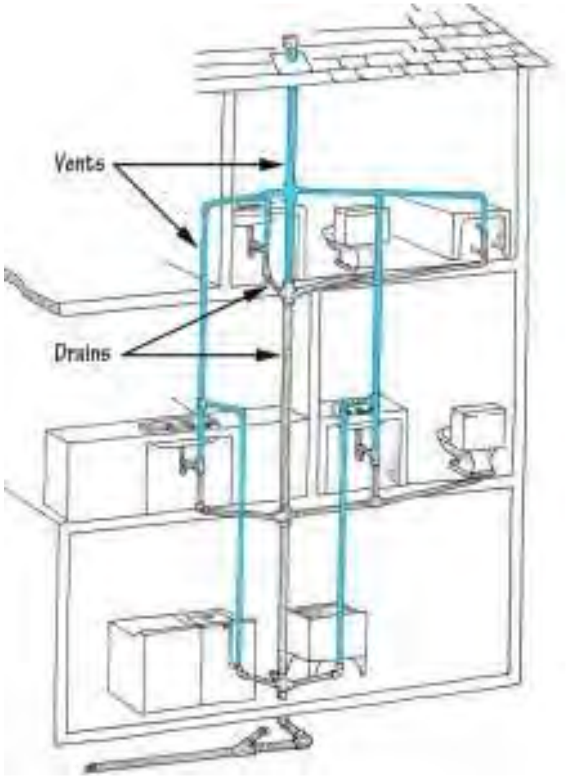
1. Understand the design, equipment & field considerations that help determine how central ventilation systems **actually work**
2. Identify the important project design considerations that lead to reliable performance in retrofit & new construction applications
3. How to design, specify & set performance objectives that can be reliably & cost-effectively achieved
4. Understand ways to inspect, evaluate & commission projects that achieve & sustain building performance objectives

Used Air Drainage System



EXHAUST RISER DIAGRAM BUILDING 2
N.T.S.

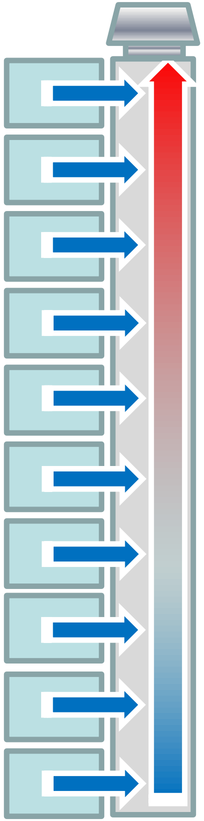
=



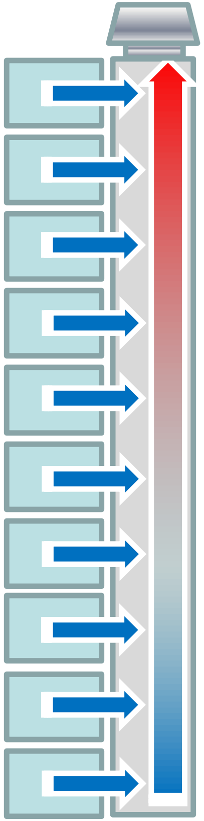
Existing Systems: What We Expect




- Roof exhaust fan draws air from the riser
- Exhaust air flows up the riser to the fan
- Apartments exhausted through grilles to risers
- Fresh air replaces stale air



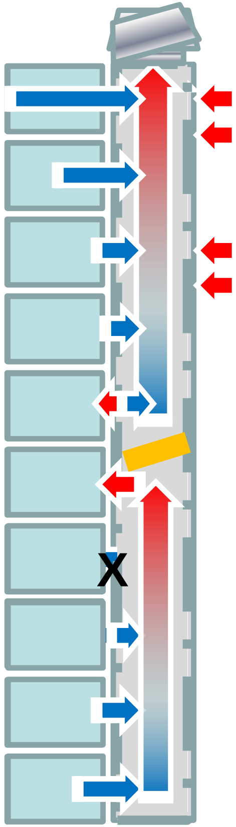
Existing Systems: What We Expect



But…

Existing Systems: What We Find

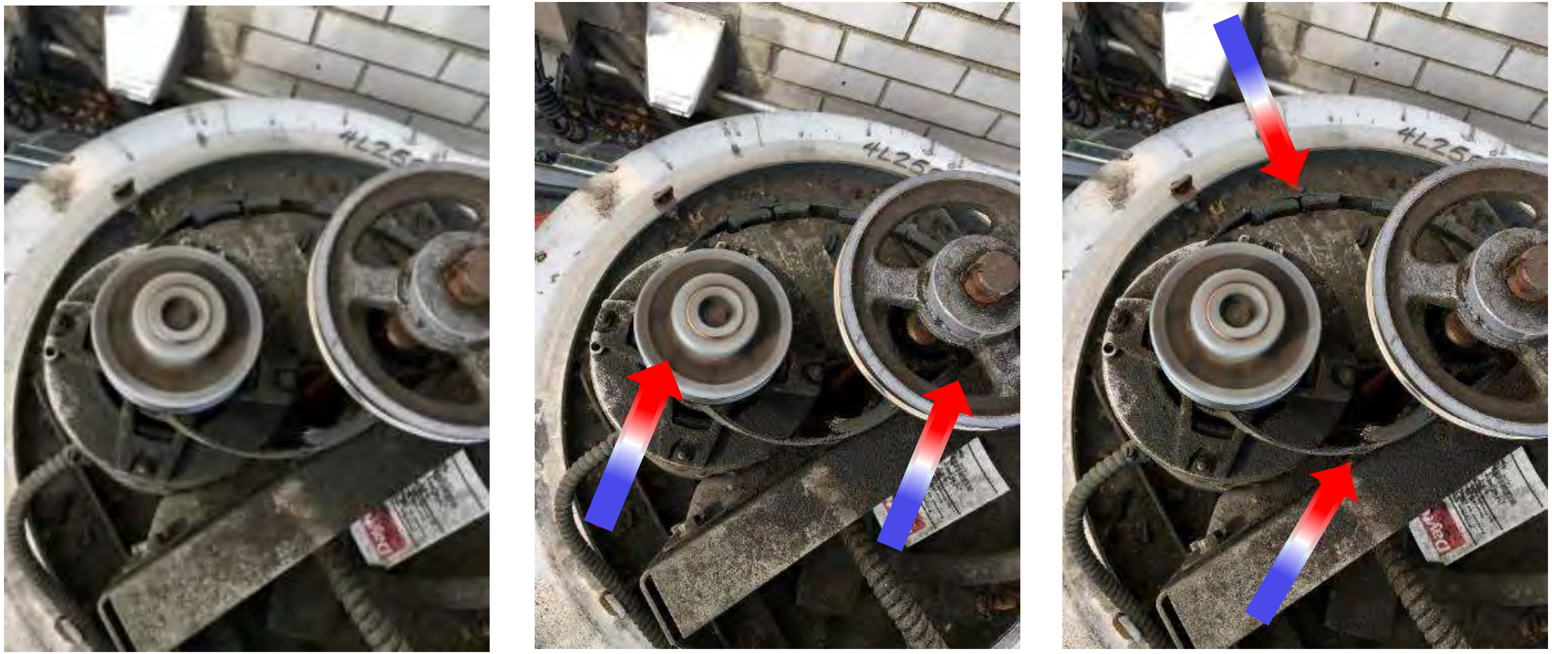
- The fan is switched off, broken, missing its belt or otherwise not functioning properly
- The riser has gaps and holes that compete with the vents or sometimes the "duct" is missing altogether
- Air flows at the vents vary wildly, sometimes flowing *into* the apartments or changing direction with the wind
- Shaft blockages or accumulated leaks prevent lower floors from removing any air at all or send it into apartments above
- Occupants block up their vents or neglect them to the point where no flow can get through.

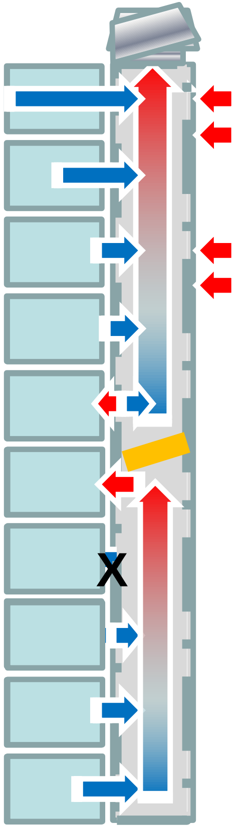


Existing Systems: What We Find

Fan Not Exhausting Air

The Fans Belt Is Broken

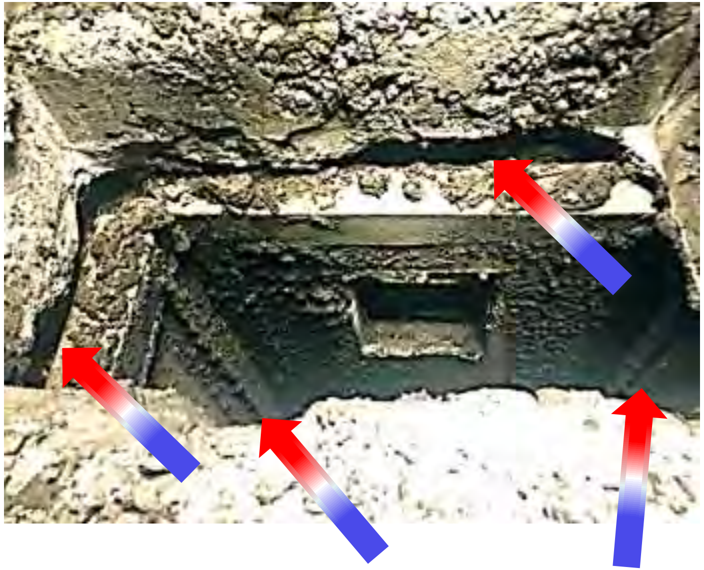


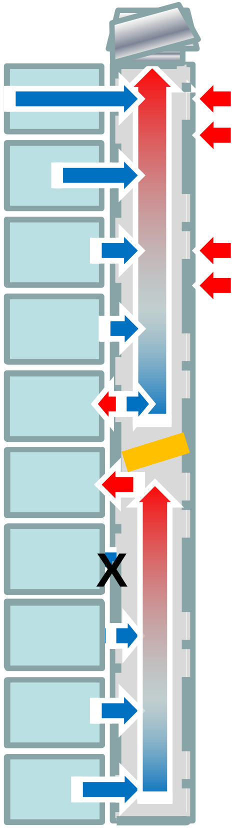


Motor/Pulley #1 Are At Full Speed, While 2nd Pulley Connected To Fan Blades Is Stopped

Existing Systems: What We Find

Sheetrock Exhaust Shafts

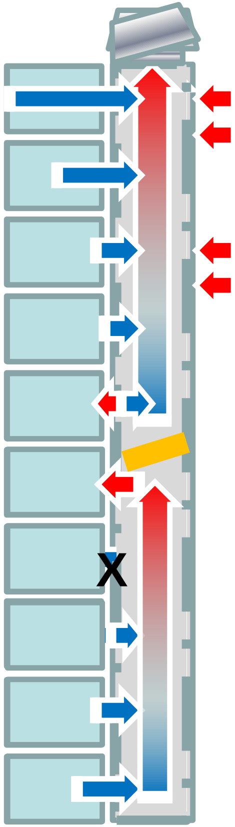




Existing Systems: What We Find

Masonry Tile Exhaust Shafts

- Mortar Deteriorates Over Time Leading To An Increased Amount Of Unintended Leakage
- Often Contain Electrical and Plumbing Lines Along With Large Unsealed Penetrations
- Lateral Sections Composed Of Sheetmetal With Large Gaps At Masonry Connections
- Haphazard Renovations Are Common Leading To Large Unintended Openings In Shaft Walls And Blockages In The Floors Below



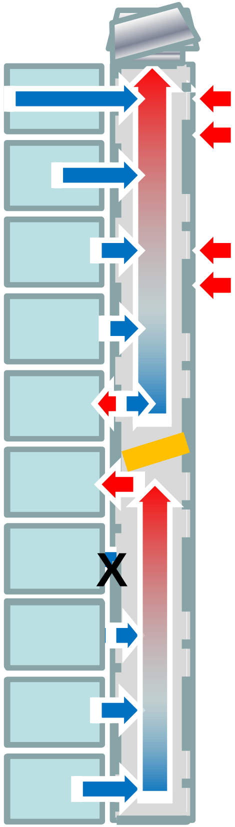
Existing Systems: What We Find

Exhaust Shaft Blockages

Lateral Blockage

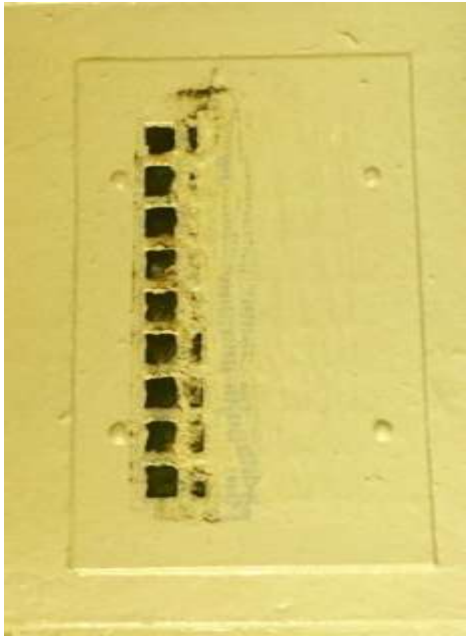
Register Blockage

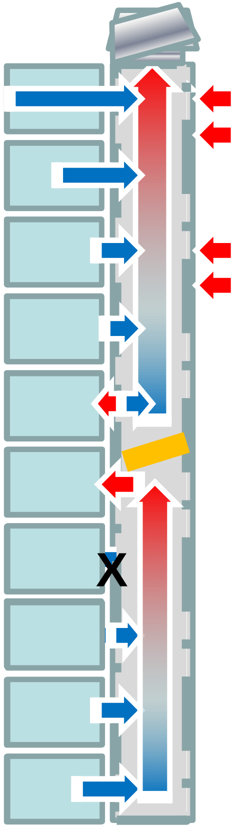
Vertical Shaft Blockage



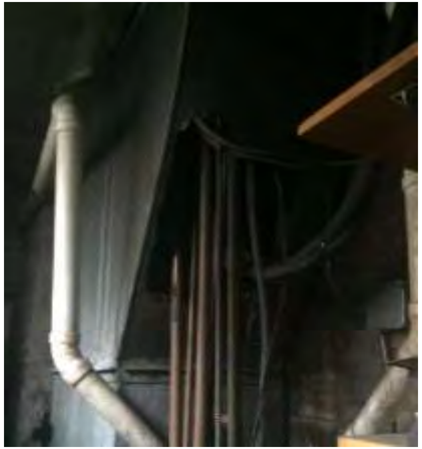
Existing Systems: What We Find

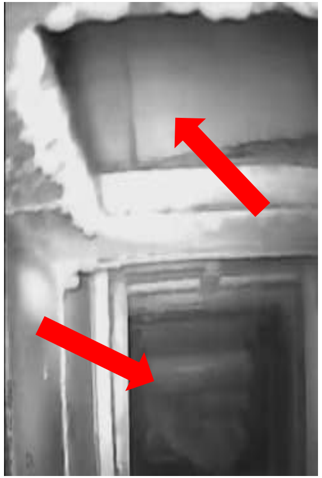
Obstructions And Leakage Points Found At The Unit Level

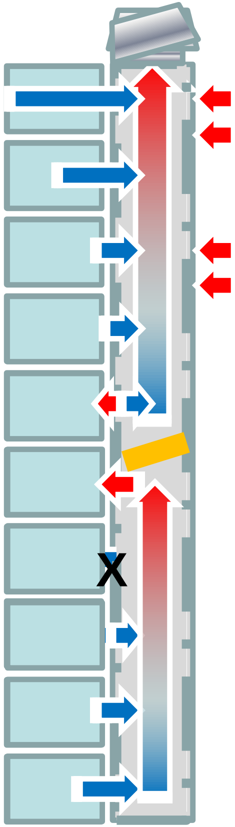




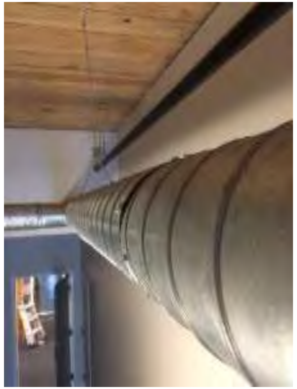
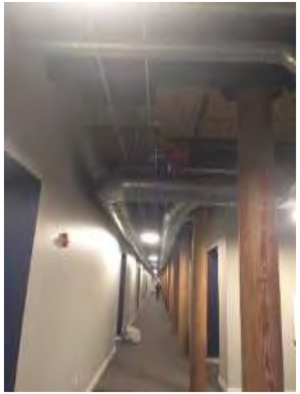
Existing Systems: What We Find

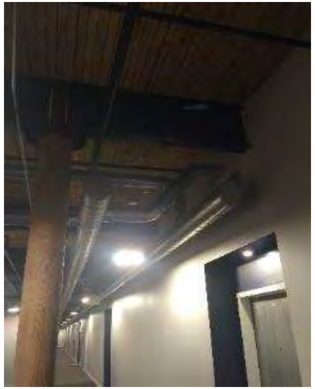




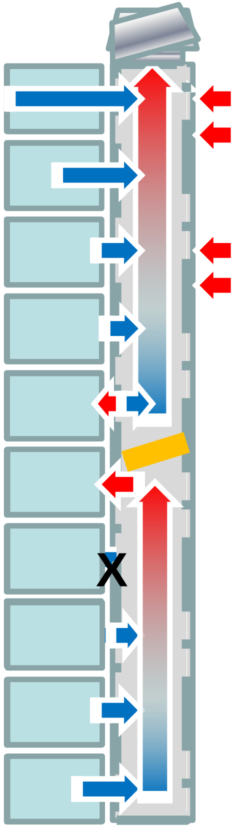


Existing Systems: What We Find

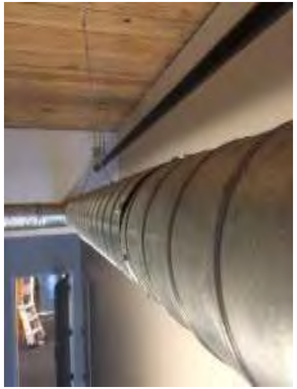




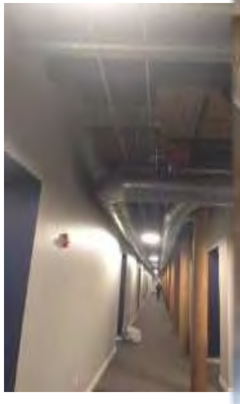


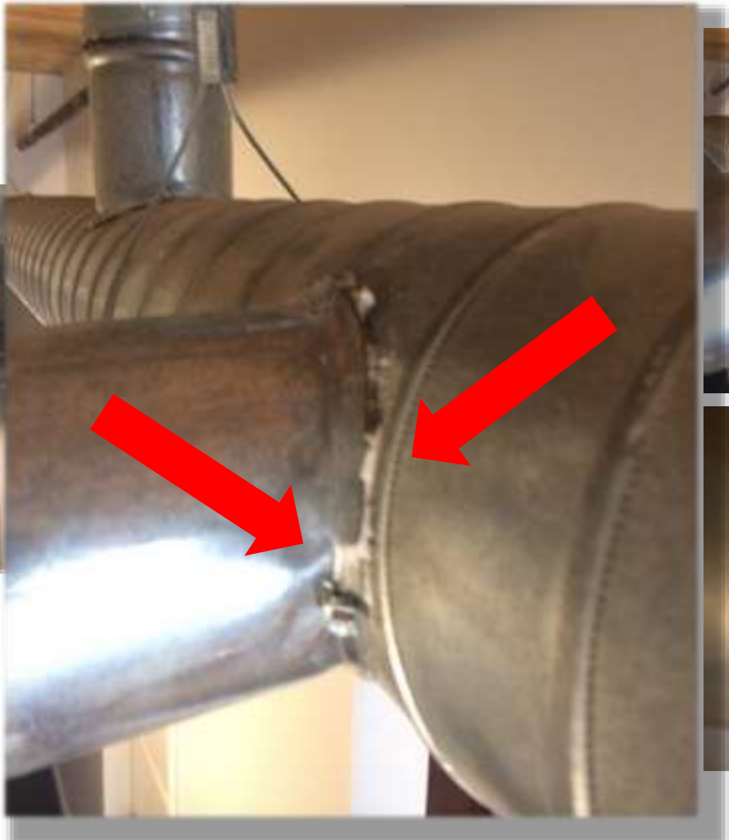


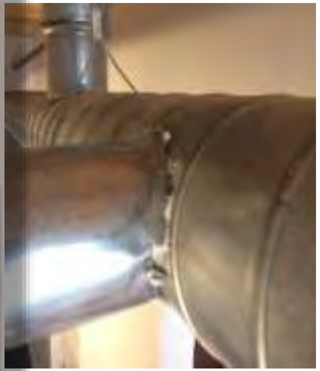


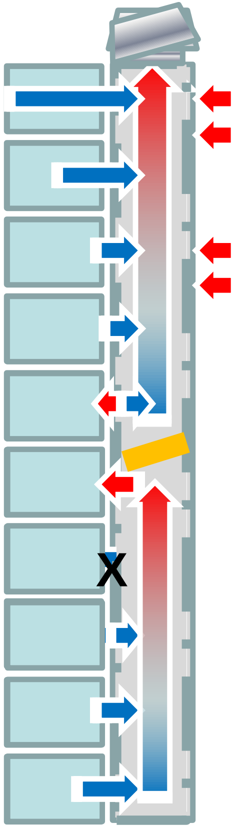
Existing Systems: What We Find











Existing Systems: What We Find

System	Sealing Event	Operating Pressure (Pa) *	Design CFM *	Starting Leakage (CFM) **	Ending Leakage (CFM) **
		312.5		Total: 9723.2	Total: 318.1
ERV-01 Exhaust		312.5	3650	Total: 7229.0	Total: 220.3
	1st Floor East	312.5	530	1167.4	6.4
	1st Floor West	312.5	1160	1154.7	25.5
	2nd Floor East	312.5	480	1102.4	8.2
	2nd Floor West	312.5	410	1089.2	17.8
	3rd Floor East	312.5	500	1093.7	70.1
	3rd Floor West And Riser	312.5	605	1621.7	92.4
ERV-01 Supply		312.5	4170	Total: 2494.2	Total: 97.9
	1st Floor East	312.5	525	431.9	17.8
	1st Floor West	312.5	1010	436.0	32.8
	2nd Floor East	312.5	480	350.9	8.6
	2nd Floor West	312.5	410	355.0	9.6
	3rd Floor East And West	312.5	1105	920.3	29.1

System	Sealing Event	Operating Pressure (Pa) *	Design CFM *	Starting Leakage (CFM) **	Ending Leakage (CFM) **
		250		Total: 8330.0	Total: 145.3
ERV-02 Supply		250	4055	Total: 1453.9	Total: 62.1
	1st Floor West	250	260	87.6	9.6
	1st Floor East-No Corridor	250	790	220.9	8.0
	2nd Floor West	250	505	208.6	12.3
	2nd Floor East	250	790	222.1	7.6
	3rd Floor East and West	250	750	714.6	24.7
ERV-02 Exhaust		250	3480	Total: 6876.1	Total: 83.2
	1st Floor West	250	260	498.0	18.7
	1st Floor East	250	790	1149.3	10.7
	2nd Floor West	250	555	1084.0	6.0
	2nd Floor East	250	790	1276.7	15.1
	3rd Floor East and West and Riser	250	1085	2868.0	32.6

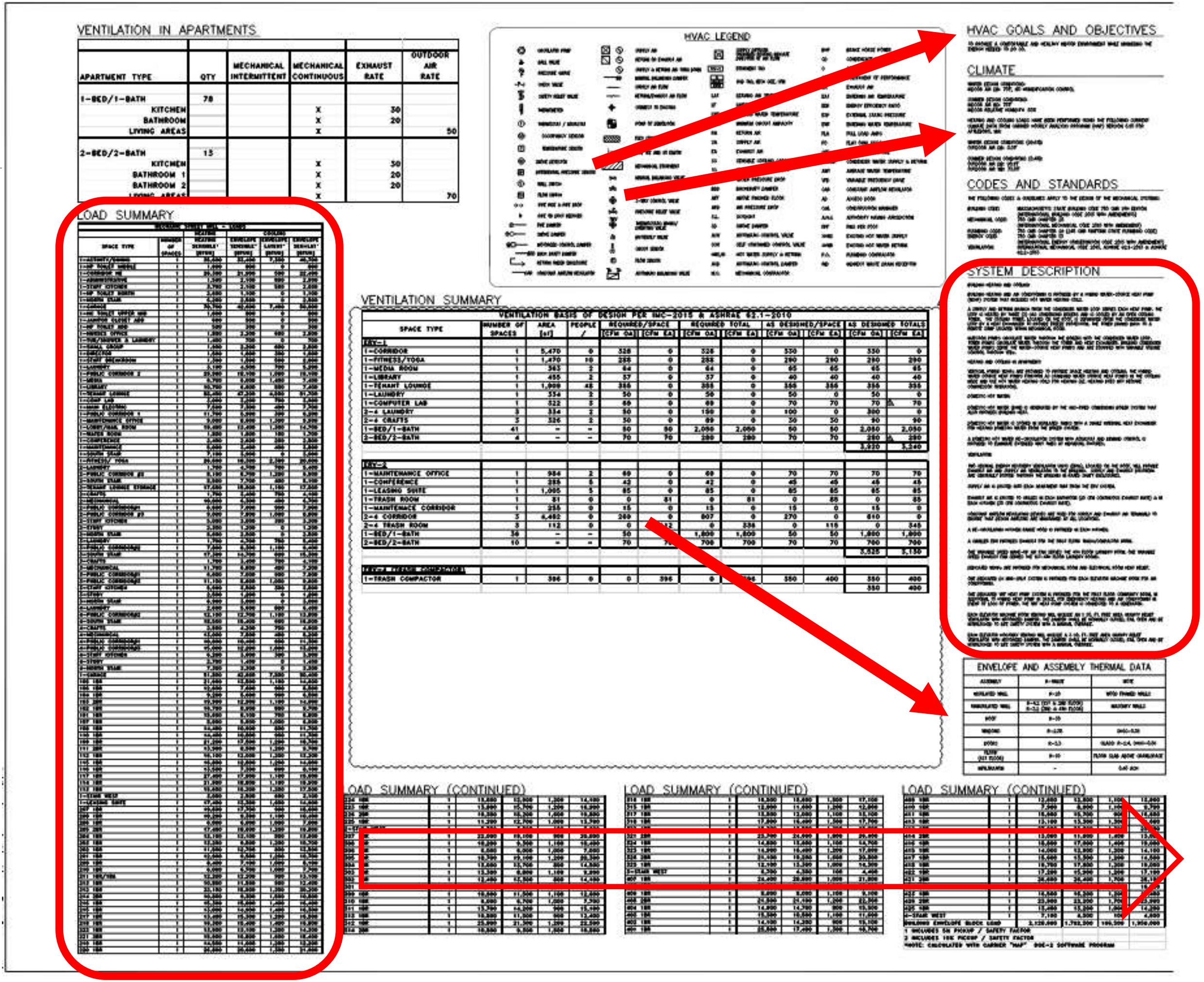
Learning Objectives

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

1. Understand the design, equipment & field considerations that help determine how central ventilation systems actually work
2. Identify the important project design considerations that lead to reliable performance in retrofit & new construction applications
3. How to design, specify & set performance objectives that can be reliably & cost-effectively achieved
4. Understand ways to inspect, evaluate & commission projects that achieve & sustain building performance objectives

Design Objectives

Basis of Design

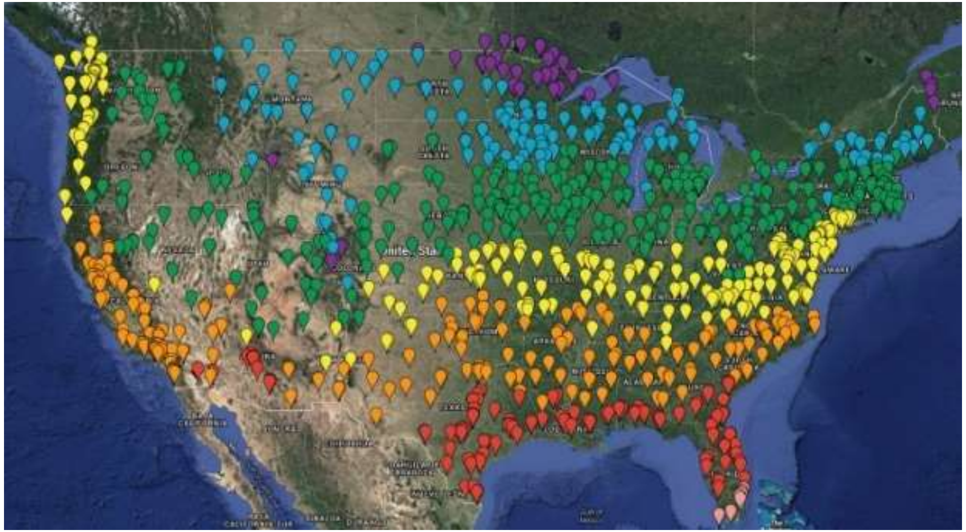


Design Objectives

- ✓ Owner Requirements → Basis of Design
- ✓ Codes and Standards
- ✓ *It needs to work!*

Codes and Standards

PHIUS
Passive House Institute US



Codes and Standards

Codes and Standards

Example - 900 SF 2 BR apt with 9' Ceilings = 8,100 CUFT:

- IMC 2015 (0.35 ACH) =
- ***47 CFM***
- IMC 2015 (OCC) =
- ***45 CFM***
- ASHRAE 62.2 (2007) =
- ***32 CFM***
- ASHRAE 62.2 (2013) =
- ***50 CFM***
- PHIUS (0.3 ACH) =
- ***41 CFM***
- PHIUS (18 CFM /OCC) =
- ***54 CFM***

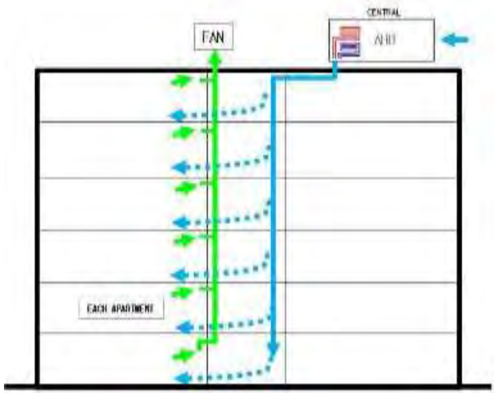
Learning Objectives

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

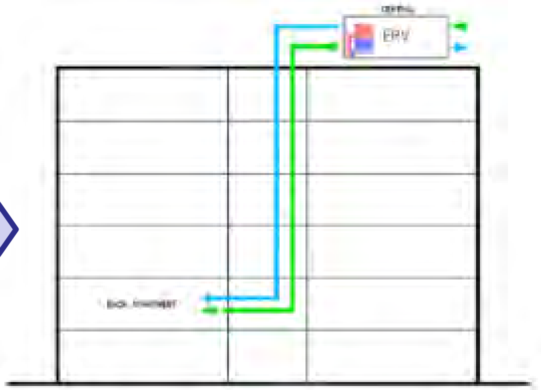
1. Understand the design, equipment & field considerations that help determine how central ventilation systems actually work
2. Identify the important project design considerations that lead to reliable performance in retrofit & new construction applications
3. How to design, specify & set performance objectives that can be reliably & cost-effectively achieved
4. Understand ways to inspect, evaluate & commission projects that achieve & sustain building performance objectives

System Types

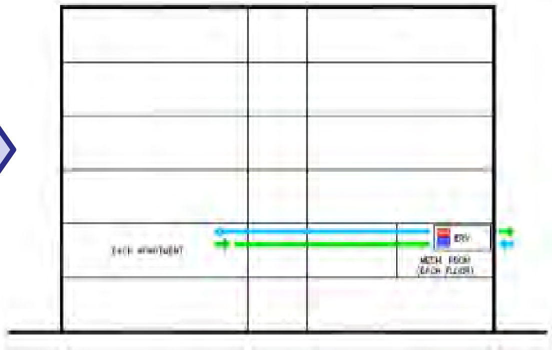
“Old Code” Central



Rooftop ERV

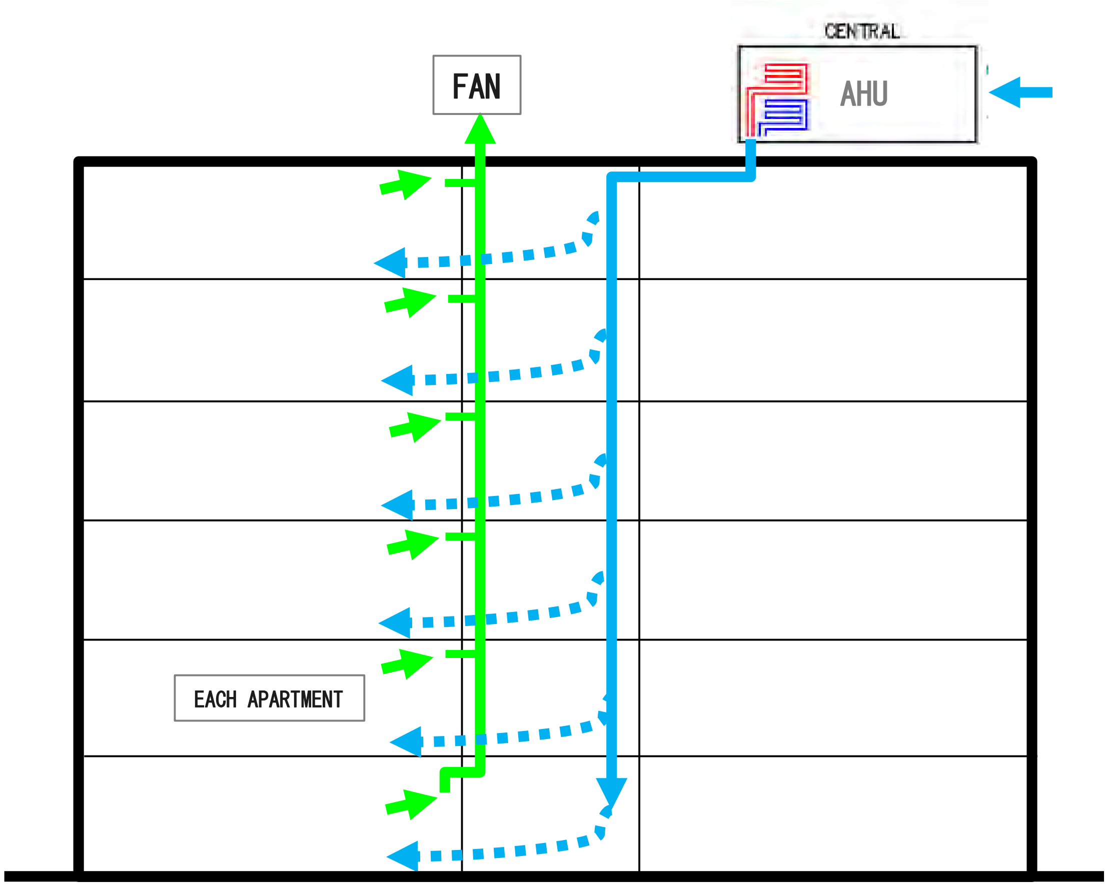


Floor by Floor



Unit Level

“Traditional” Rooftop Exhaust Only - Schematic



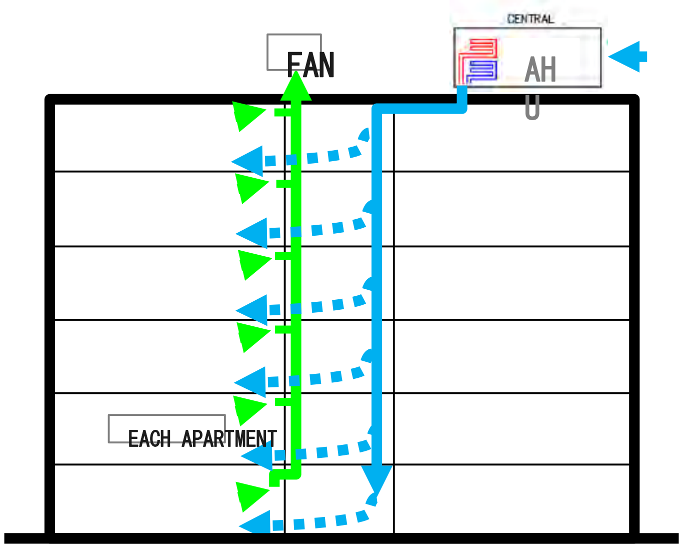
“Traditional” Rooftop Exhaust Only – Make it Work

Pros

- It’s What We Got

Cons

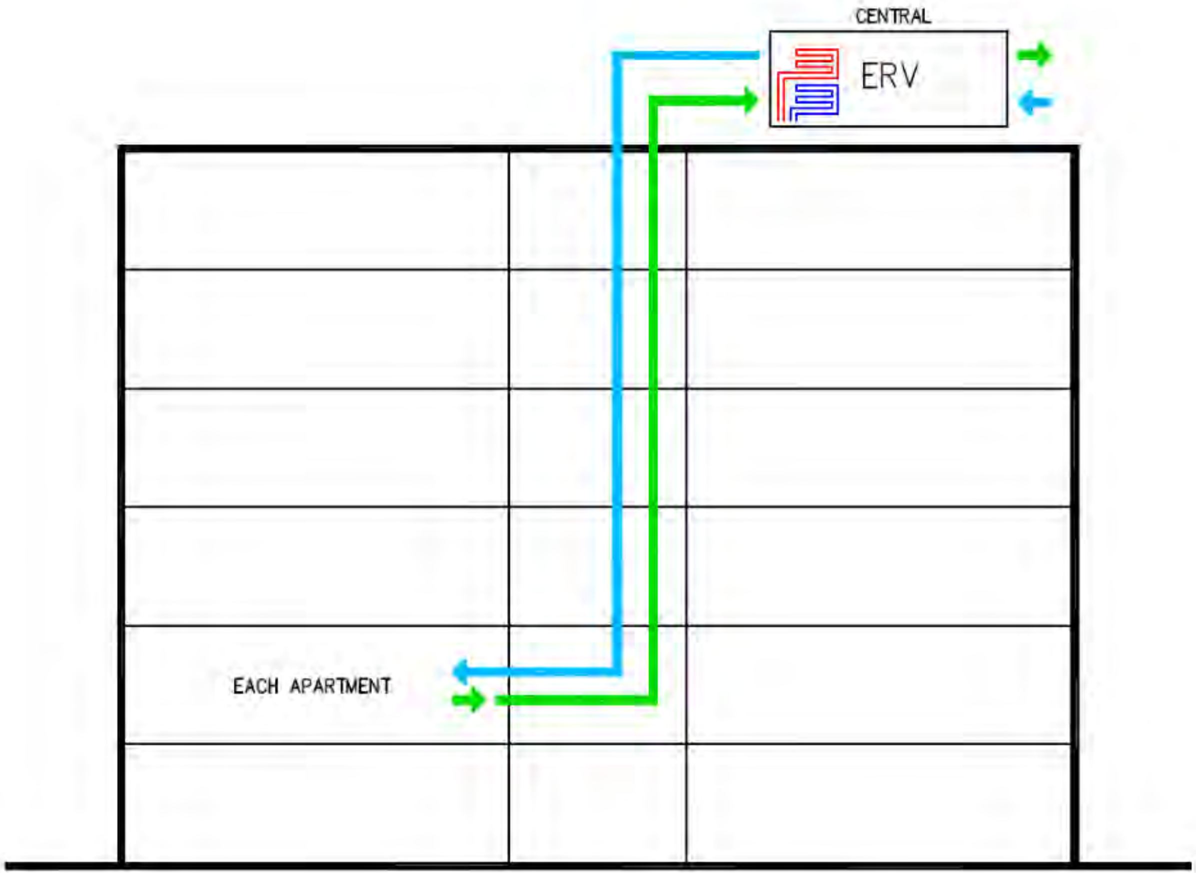
- 100% “Lost Air” Energy Penalty - $$$
- NO DIRECT MAKE UP FRESH AIR
- Ducts Leak, are Blocked or filled with Mold
- Rarely in Balance
- Rarely EVER Work!



Making them WORK

- Seal the “Big Gaps” (10%-15% leakage max)
- Set Design Flows *at least* 50% above minimum thresholds – “gauge” more than measure flows
- Expect that vents will need periodic cleaning/ maintenance
- Can Repair Line By Line

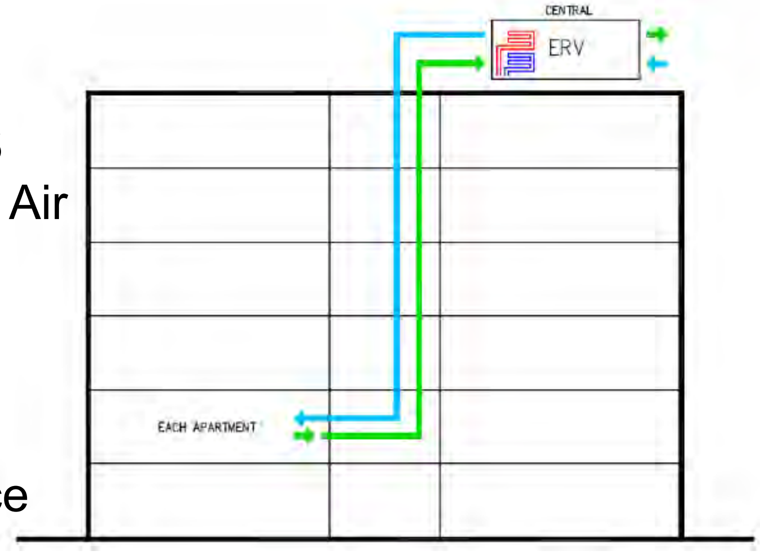
Central Rooftop ERV - Schematic



Central ERV – Make it Work

Pros

- Centralized Equipment
- Energy Recovery Reduces Energy Penalty $$
- *Modern Systems* Provide Unit-Level Make Up Air



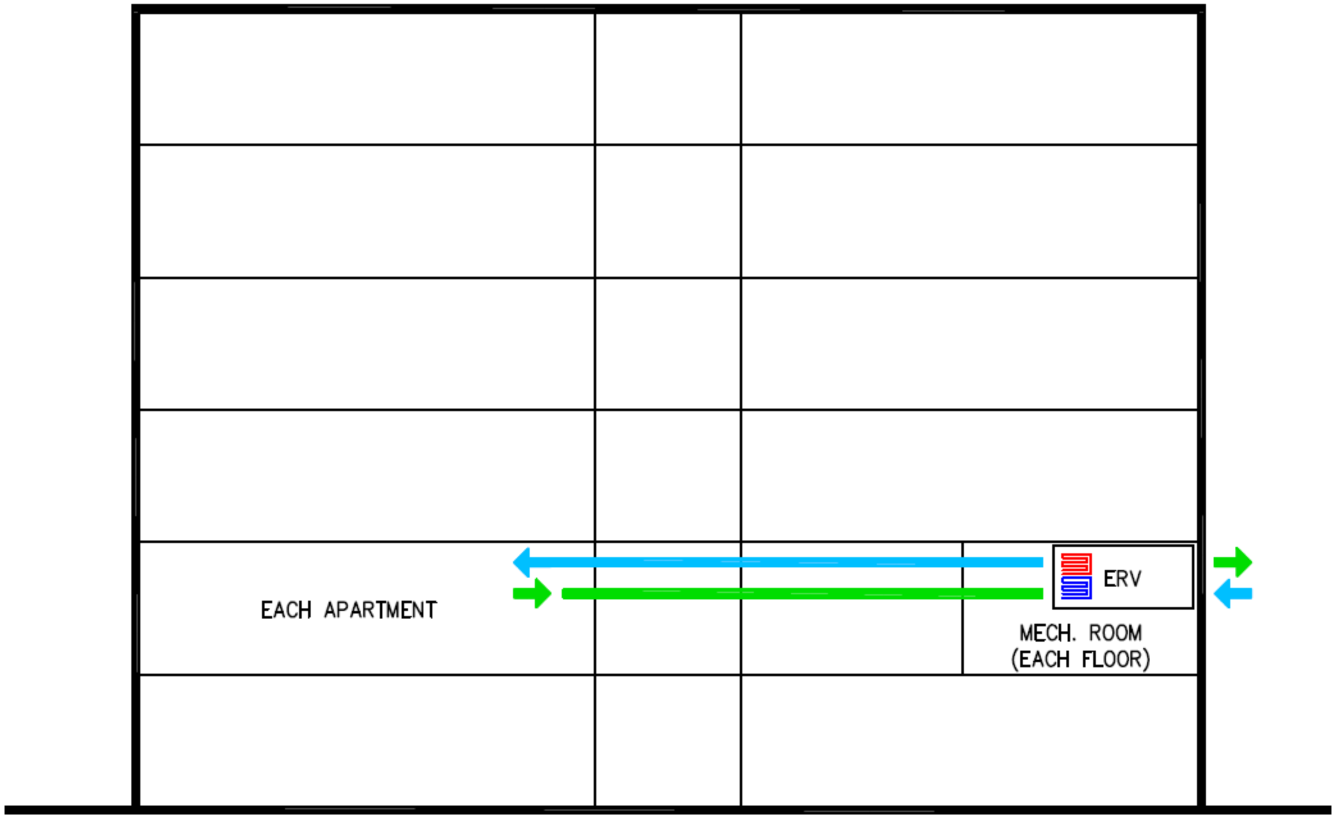
Cons

- "Old Code" Systems – NO MAKE UP AIR
- Ducts Must Be Tight
- Too Many Vent Connections Hurt Performance

Making them WORK

- Really Tight Sheet Metal Ducts (3%-5% leakage max)
- Set Design Flows *at least* 20% above minimum thresholds – flows WILL fade farther from the fans
- Expect that vents will need periodic cleaning/ maintenance

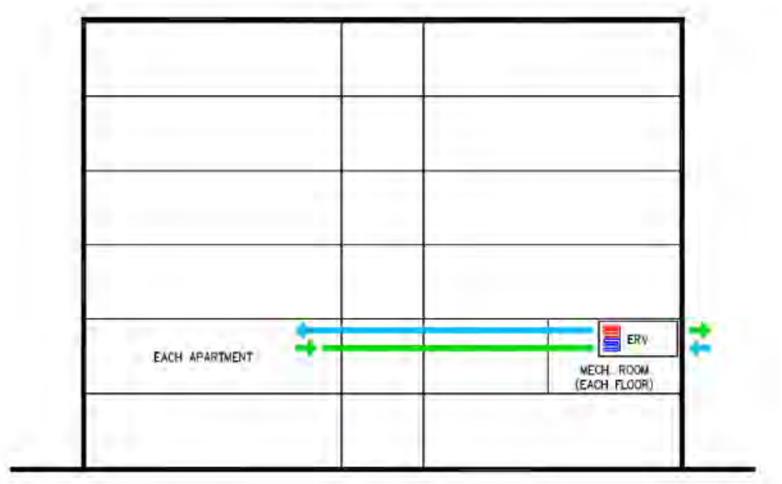
Floor-by-Floor Ventilation – Schematic



Floor-by-Floor ERV – Make it Work

Pros

- Energy Recovery Reduces Energy Penalty $$
- Eliminates Stack Effect, No Riser Shafts
- Better Building Compartmentalization



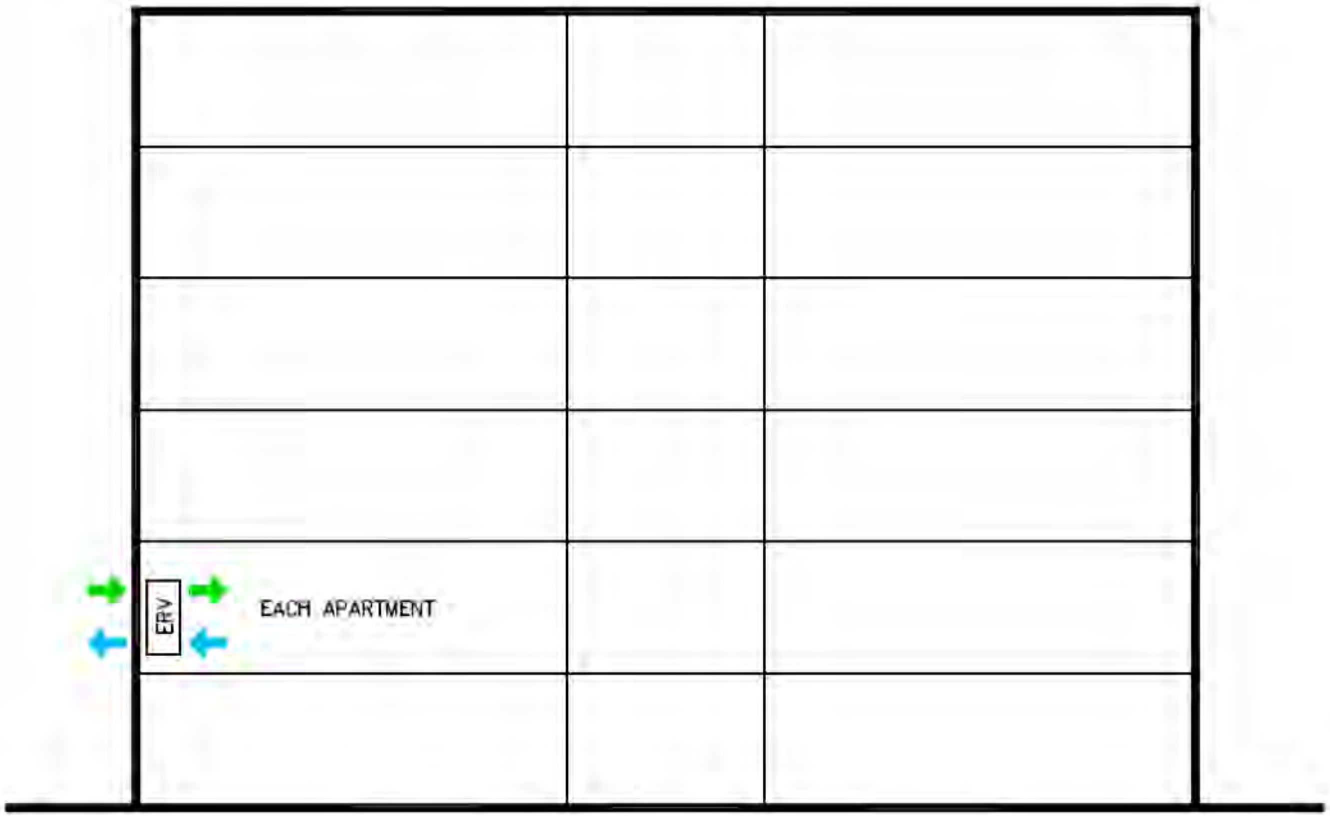
Cons

- Mechanical Spaces on Every Floor (Noise)
- Requires Corridor Ceiling Space for Ducts
- More Machines that Require Maintenance

Making them WORK

- Tight Sheet Metal Ducts (5% leakage max)
- Set Design Flows *at least* 20% above minimum thresholds
- Expect that vents will need periodic cleaning/ maintenance

Unit Level Ventilation – Schematic



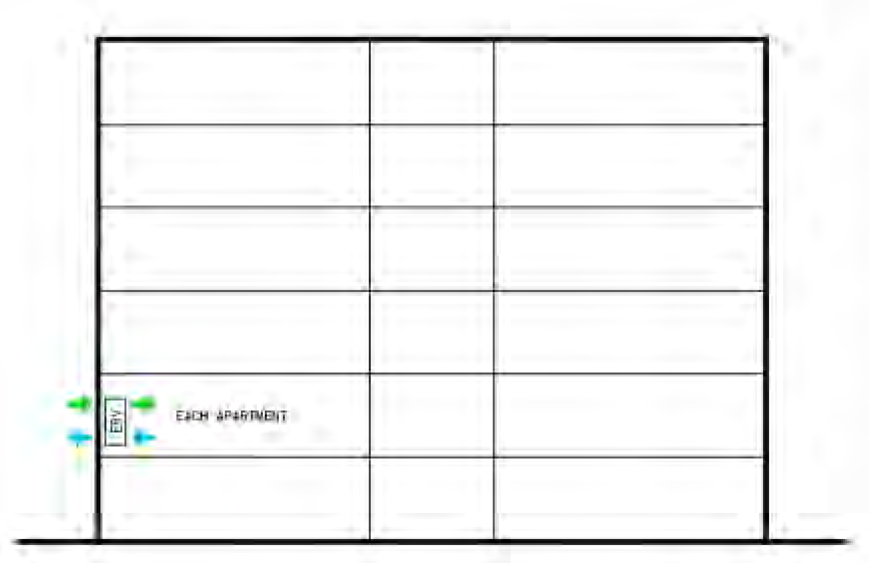
Unit Level Ventilation – Make it Work

Pros

- Ductwork minimized
- Easy to balance
- No fire smoke dampers

Cons

- Filter changes in every apartment, acces
- Requires space in each unit
- Insufficient dehumidification



Making them WORK

- Access, access, access. These cannot be buried.
- Keep decoupled from heating and cooling
- Residential commissioning

System Types: **Pros** & Cons

Pro	"Old Code" Exhaust Only		Modern Code with In-Unit Make Up Air		
	Central Exhaust Only	Central Exhaust Only ERV	Central with ERV	Floor-by-Floor	Unit Level
Already Installed in Existing Building	☑	☑			
Centralized Equipment	☑	☑	☑		
Mechanical Access from Common Spaces Only	☑	☑	☑	☑	
Up to 75% Energy Recovery		☑	☑	☑	☑
Direct Make Up Air to Apartments			☑	☑	☑
No Riser Shafts				☑	☑
Easier to Balance				☑	☑
Better Compartmentalization				☑	☑
No Fire/ Smoke Dampers					☑
Occupant Pays for Energy Use					☑
Occupant Controls Ventilation Directly					☑

System Types: Pros & **Cons**

Con	"Old Code" Exhaust Only		Modern Code with In-Unit Make Up Air		
	Central Exhaust Only	Central Exhaust Only ERV	Central with ERV	Floor-by-Floor	Unit Level
100% Lost Air	☒				
Duct Risers Penetrate Floors	☒	☒	☒		
Make-up Air Equipment Outside Envelope	☒	☒	☒		
Stack Effect	☒	☒	☒		
Fire/ Smoke Dampers	☒	☒	☒	☒	
Uses Corridor Ceiling Space	☐	☐	☐	☒	
Multiple Inside Mechanical Spaces				☒	☒
In Unit Mechanical Service					☒
Unit-Level Thru-Wall Penetrations					☒

Equipment, Parts & Pieces

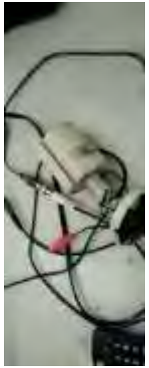
Equipment, Parts & Pieces

Hands On Discussion

Equipment, Parts & Pieces





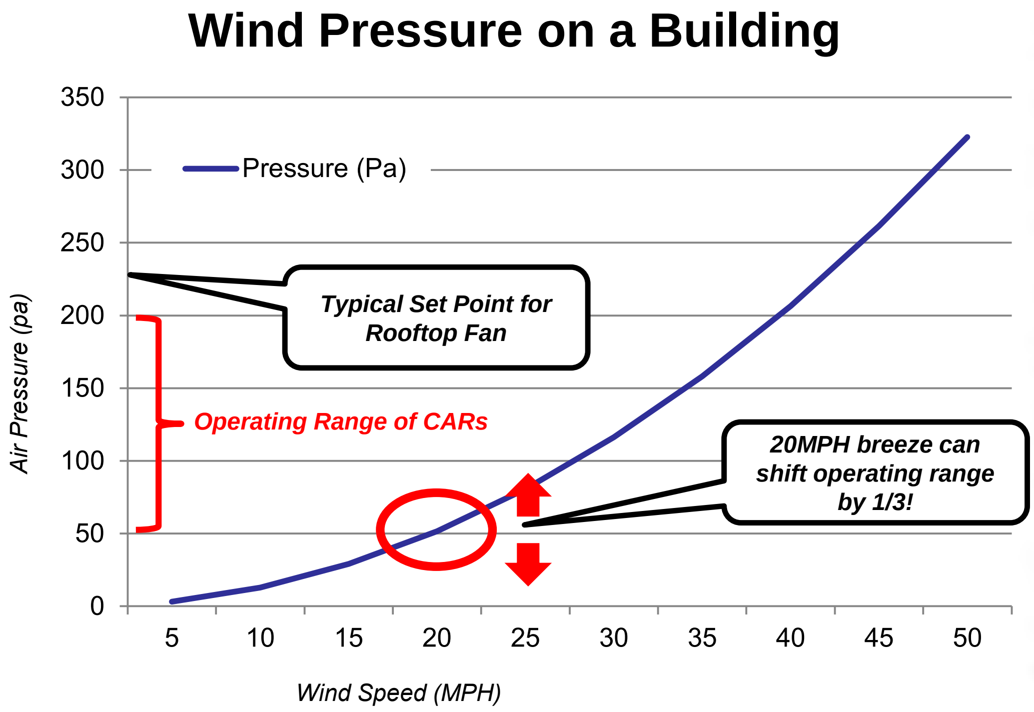









The Vents

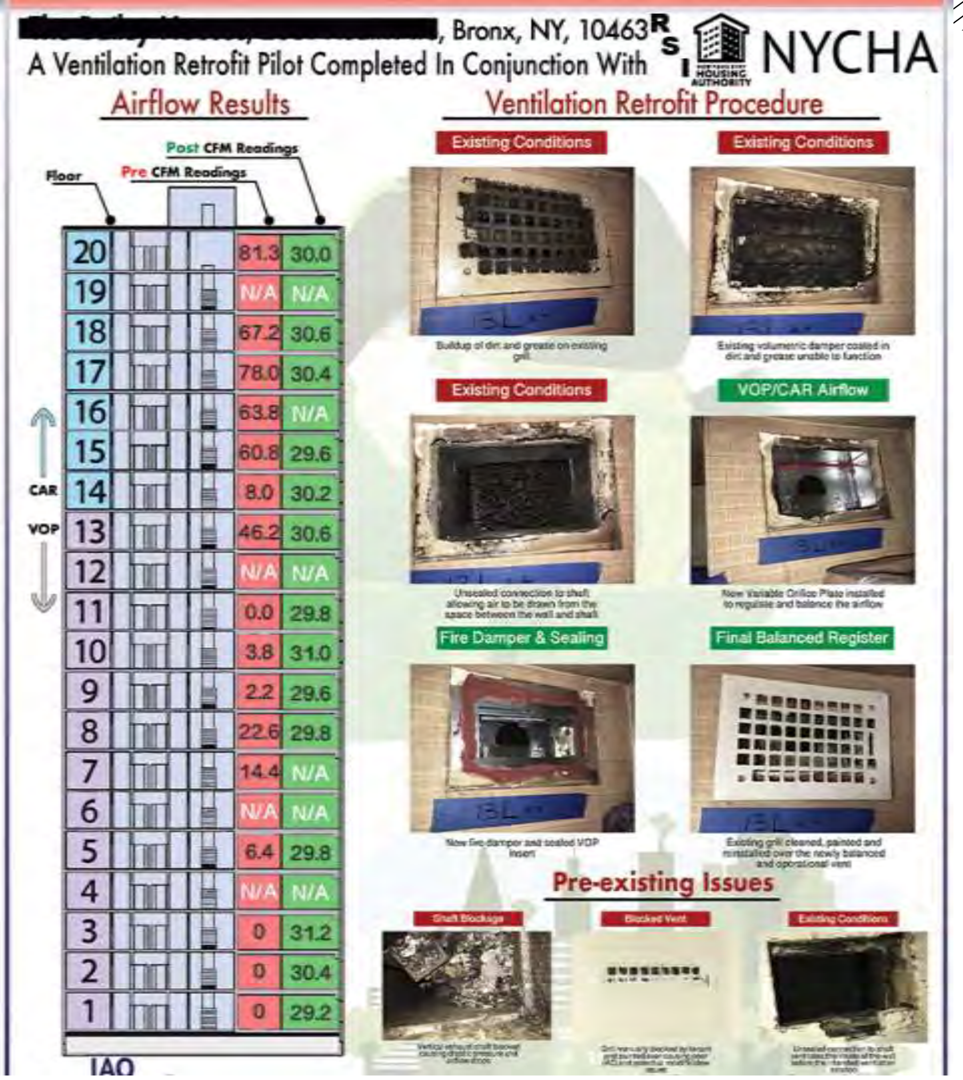


Beaufort Wind Scale

Beaufort No.	Description of wind	Observation	Wind speed			
			m/s	mph	knots	ft/min
0	Calm	Smoke rises vertically. The sea is mirror smooth.	0 - 0.15	0 - 0.3	0 - 0.5	0 - 25
1	Light Air	Direction of wind shown by smoke drift but not by vanes. Scale-like ripples on sea, no foam on wave crests.	0.15 - 2.7	0.3 - 6	0.5 - 3	25 - 525
2	Light Breeze	Wind felt on face, leaves rustle, ordinary vanes moved by wind. Short wavelets, glassy wave crests.	2.7 - 3.6	6 - 8	3 - 7	525 - 700
3	Gentle Breeze	Leaves and small twigs in constant motion, wind extends light flag	3.6 - 7.2	8 - 16	7 - 10	700 - 1400
4	Moderate Breeze	Raises dust and loose paper, small branches moved. Fairly frequent whitecaps occur.	7.2 - 8.9	16 - 20	10 - 15	1,400 - 1,800
5	Fresh Breeze	Small trees in leaf begin to sway. Moderate waves, many white foam crests.	8.9 - 12.5	20 - 28	15 - 21	1,800 - 2,500
6	Strong Breeze	Large branches in motion, whistling heard in telegraph wires. Some spray on the sea surface.	12.5 - 14.5	28 - 32	21 - 27	2,500 - 2,800
7	Moderate gale	Whole trees in motion, inconvenience felt when walking into wind. Foam on waves blows on streaks.	14.5 - 20	32 - 44	27 - 33	2,800 - 3,900
8	Gale	Twigs broken of trees, generally impeded progress. Long streaks on foam appear on sea.	20 - 22	44 - 50	33 - 40	3,900 - 4,400
9	Strong gale	Straight structural damage, e.g. slates and chimney pots removed from the roofs. High waves, crest start to roll over.	22 - 28	50 - 62	40 - 48	4,400 - 5,450
10	Storm	Trees uprooted, considerable structural damage. Exceptionally high waves, visibility affected.	28 - 31	62 - 70	48 - 55	5,450 - 6,150
11	Violent Storm	Widespread damage	31 - 37	70 - 82	55 - 63	6,150 - 7,200
12	Hurricane	Air is filled with spray and foam.	> 37	> 82	> 63	> 7,200

Exhaust Only Ventilation: Older Buildings

CAR Dampers vs. Variable Orifice Plates

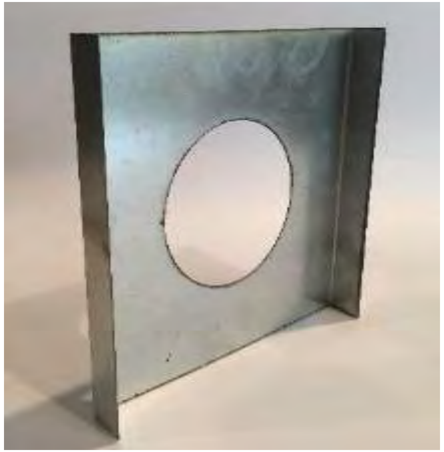


Car Damper Issues Observed

This image is from a four year old 20 story building located in Long Island City.

The Vents

Manual
Vent Damper



SEO/ VOP
Vent Damper

Self-Regulating
Vent Damper (CAR)

The Vents

ALDES

RUSKIN

E FLOW

The Vents

CAR Regulators - Limitations

- ✓ Rated flows +/- 15%: a 30CFM “spec” = 25-35CFM design.
- ✓ Requires minimum 50pa (0.2” wg) to operate properly
- ✓ Smaller opening “competes” more with system leakage – ***Requires Tighter Ducts***

Lessons Learned

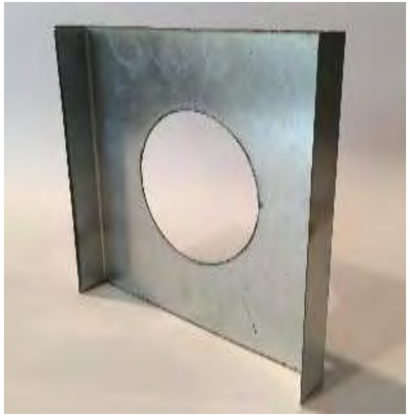
CAR Regulators – Will work well when…

- ✓ Overall duct systems are tight enough to hold negative pressures *along the entire riser (3%-5%)*
- ✓ Fans have sufficient power to maintain static pressures *along entire riser*
- ✓ Regulators are not "competing" with large gaps, especially at fan curbs & at the boots
- ✓ Open windows, windy conditions *will* influence performance of even very good systems!

The Vents

Manual/ SEO/ VOP - Limitations

- ✓ Manually Set Flows Vary with Building Pressure Dynamics
- ✓ Tolerance +/- 30%: a 35CFM “spec” = 25-45CFM design.
- ✓ Smaller opening “competes” more with system leakage – ***STILL Need to Fix Ducts***



The Vents

ALDES FEA II
New Construction

Custom Assembly
Retrofit

Fans

Energy Performance: Reduce Fan Energy

Fan Savings

- ✓ 25 Rooftop Fans
- ✓ Average Measured Fan Power: 300W/ Fan
- ✓ New Measured Fan Power: 140W/ Fan
- ✓ Savings: 1,400 kWh/ fan = $300/ year savings
- ✓ 25 Fans = 4kW off Demand Load
- ✓ Typically Direct Drive, 15 – 20 year life
- ✓ Installed Cost: $1,800/ Fan
  - ✓ *Pro Tip – Know Your Building! Is there enough of the RIGHT power for the fans you specify?*

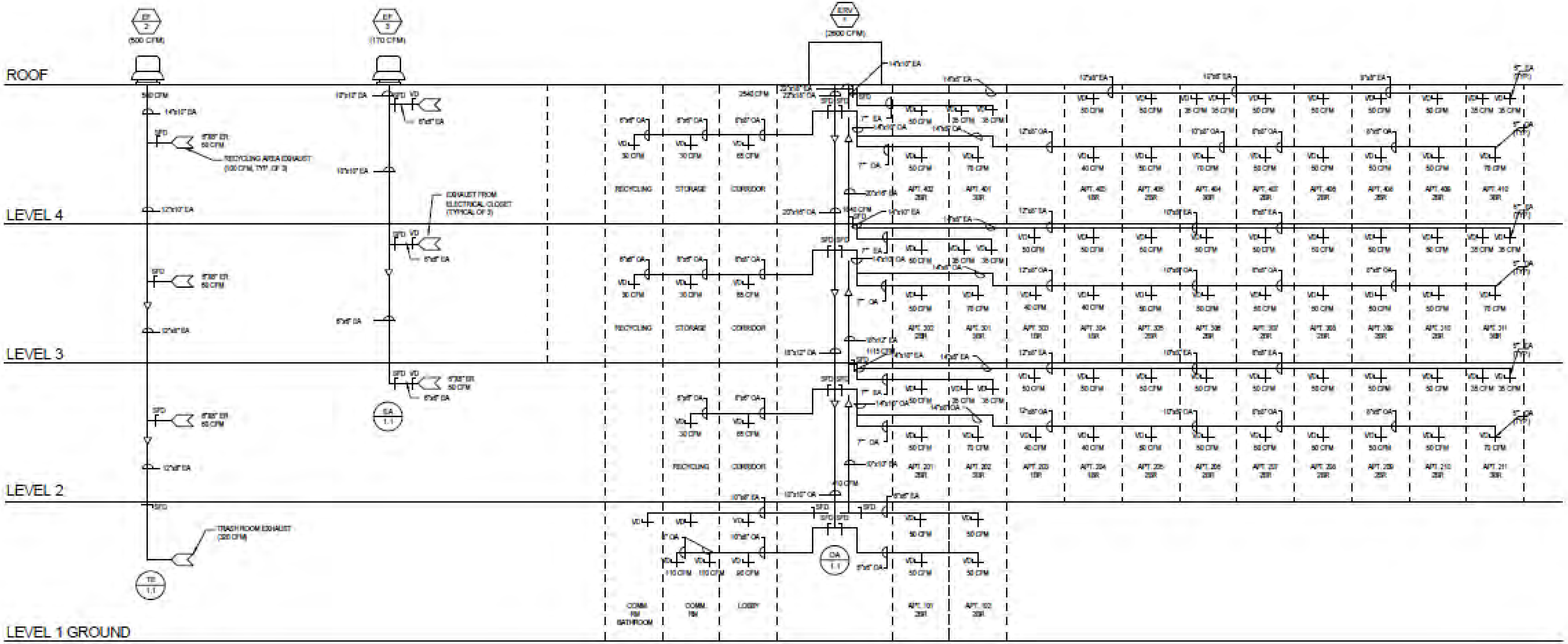
The Risers

Rooftop Curbs/ Tops of Risers

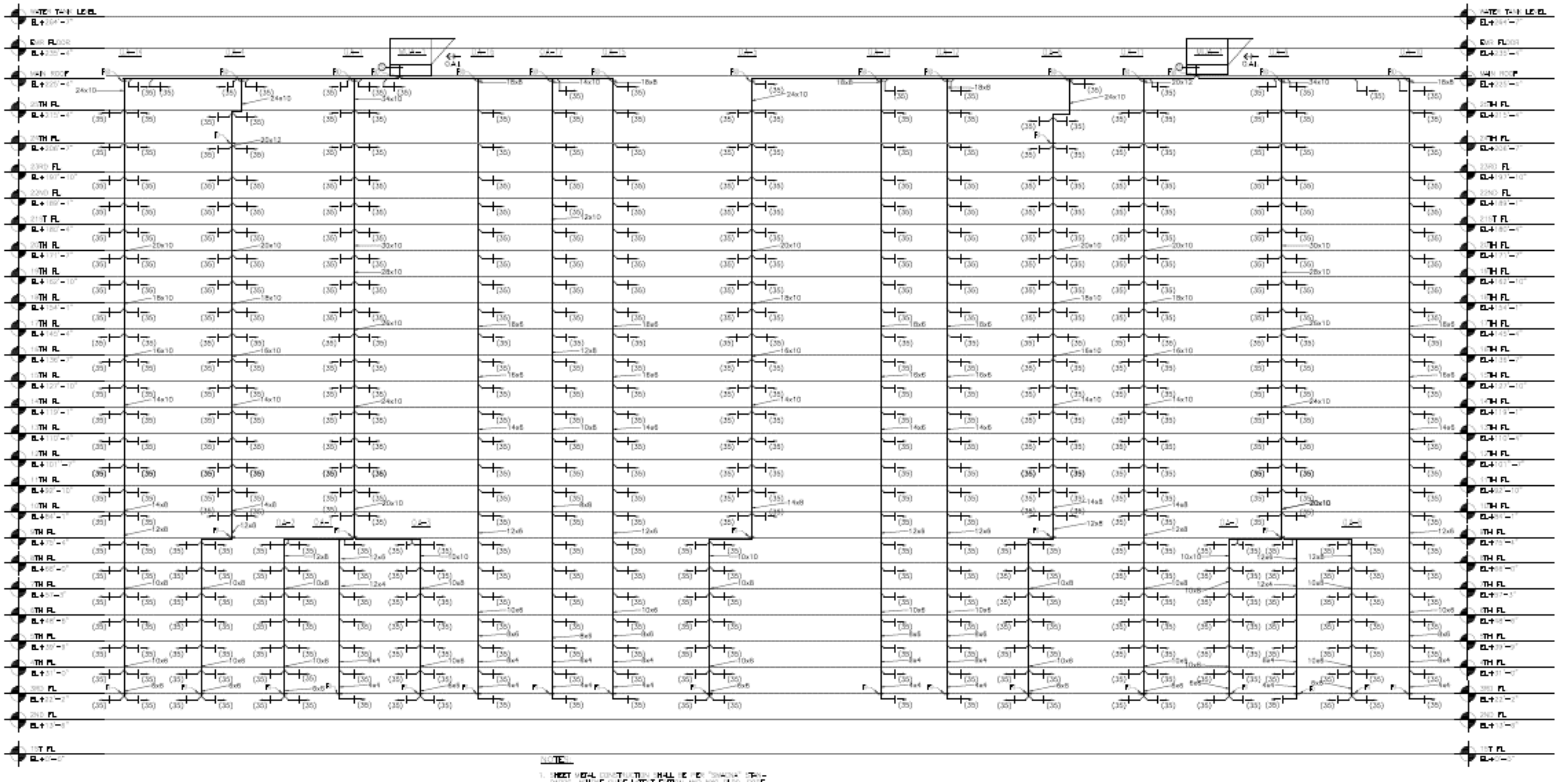
- ✓ Blockages, restrictions through the roof deck
- ✓ Failed joints or visible holes in risers
- ✓ Gaps inside the curb or between the deck and duct
- ✓ Are there even any ducts at all?

Energy Recovery Ventilators (ERV)

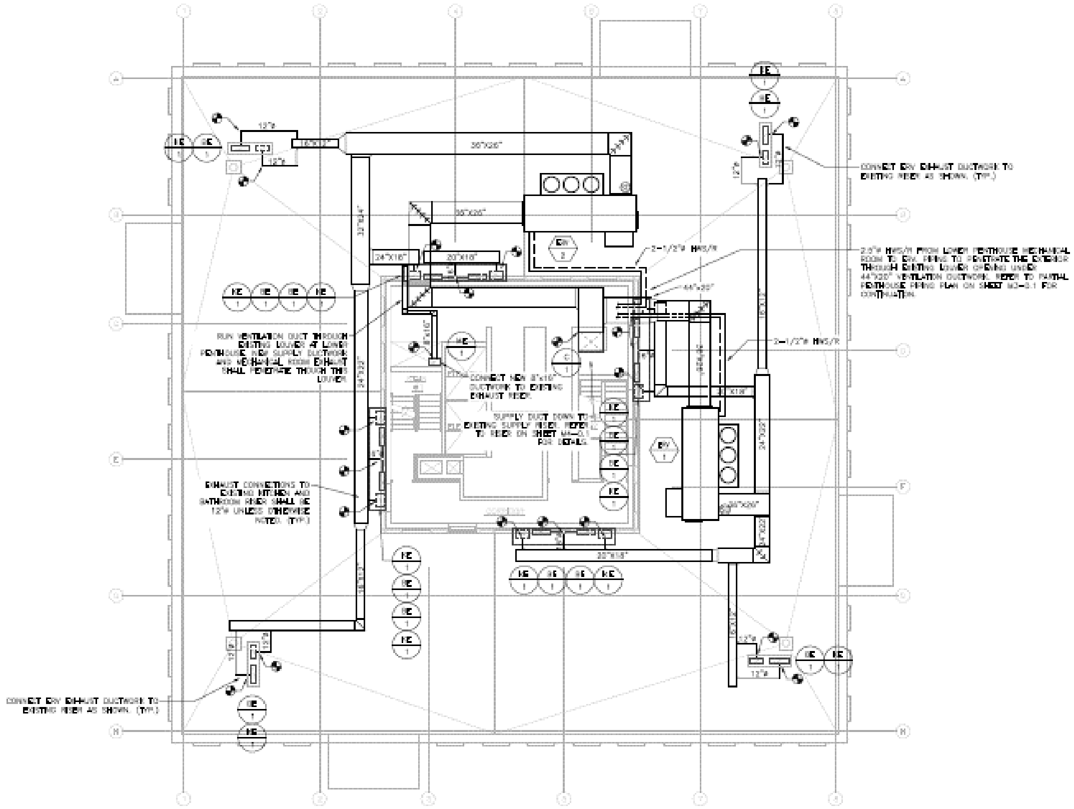
Horizontal Buildings



Vertical Buildings

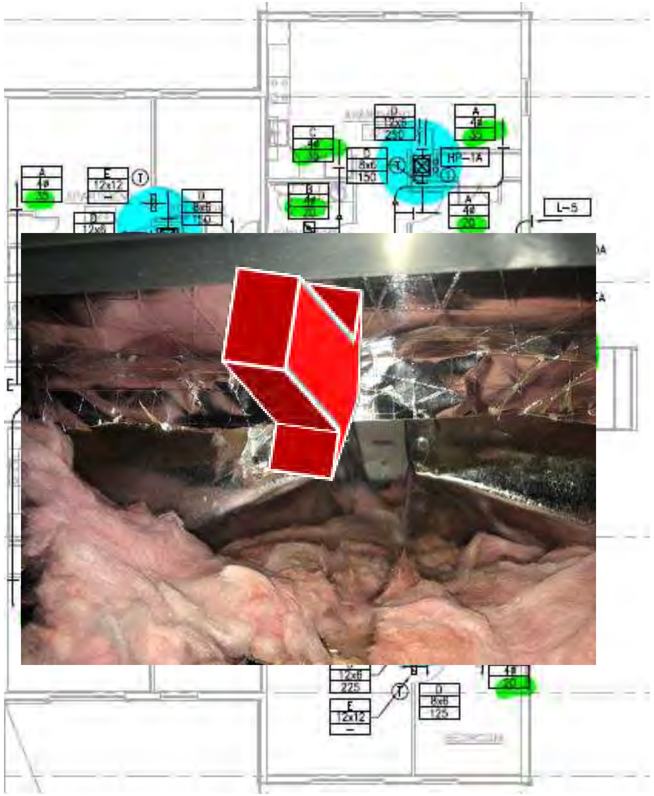


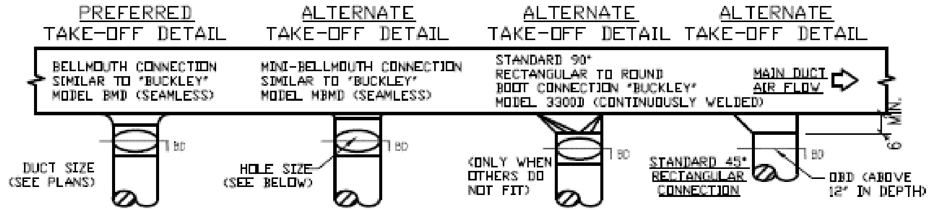
Vertical Buildings



Floor-by-Floor & In Unit – Equipment

Floor-by-Floor Buildings



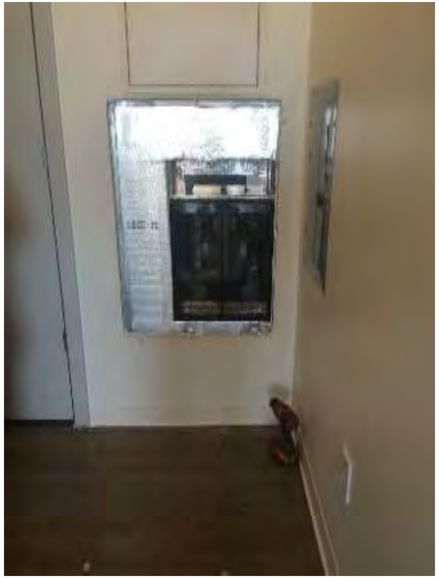


SCALE: NTS

In Unit

In Unit



IAQ Issues Associated With Improper Fan Installations

Fans that are not sealed at the roof level become significant sources of wasted energy. These end up ventilating the roof prior to the intended locations, leading to low airflow rates at the unit level.

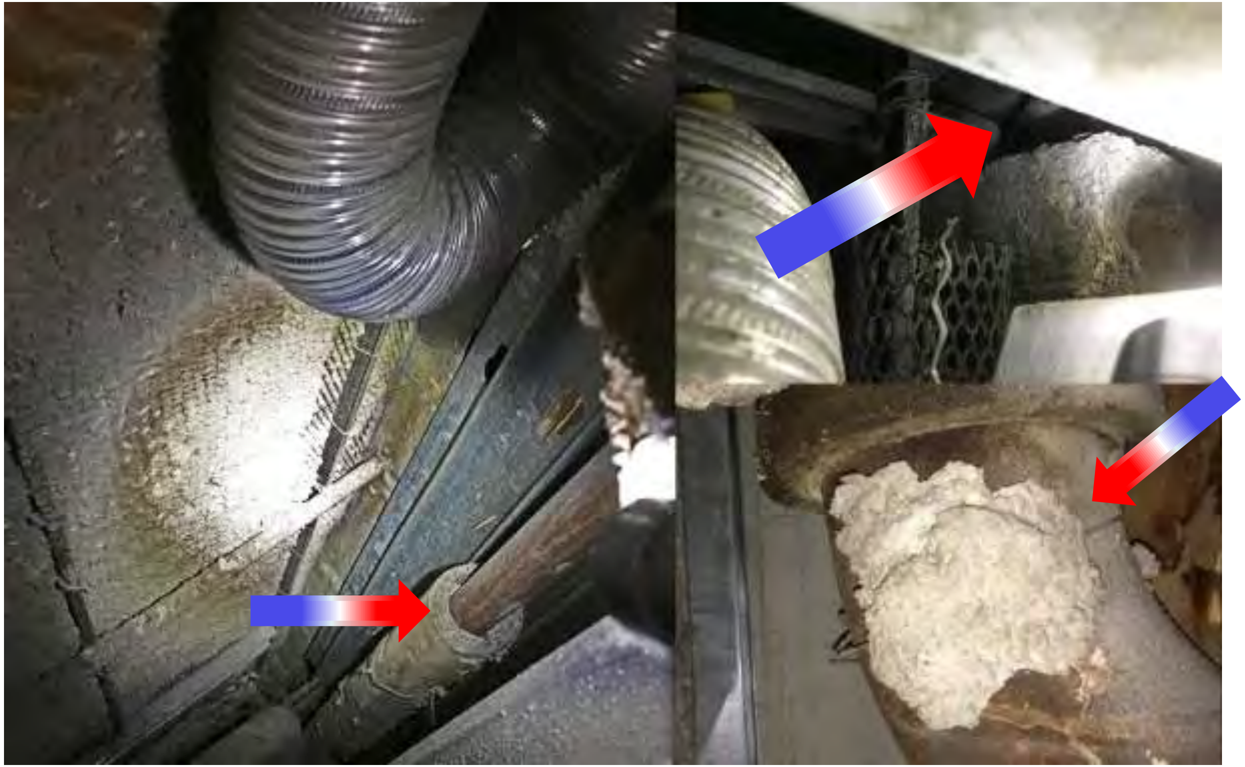
IAQ Issues Associated With Masonry Shafts

Upper East Side Condo and Co-op Buildings

- Co-op Building With 153 Units Constructed In 1962
- Ventilation Assessment Performed Due To Constant Odor And Airflow Complaints Throughout Building
- Masonry Risers In Terrible Shape Having Never Been Maintained.
- 40% Of The Units In This Building Consist Of Reckless Renovations

IAQ Issues Associated With Masonry Shafts

Careless and Unsupervised Remodels Spur Much Larger Issues



IAQ Issues Associated With Sheetrock Shafts

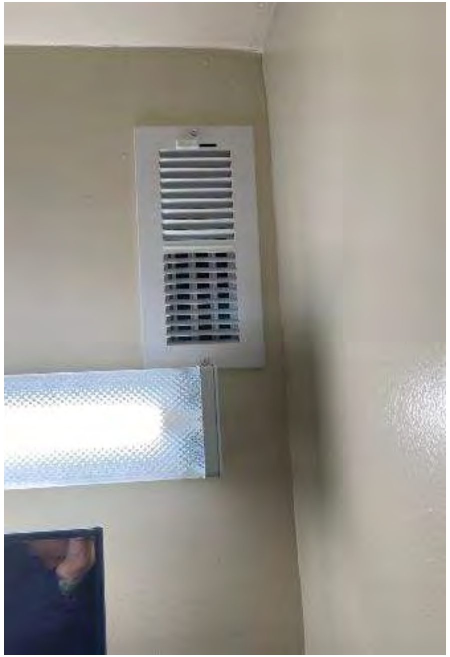
- Water damage and staining caused by discontinuous shafts have caused several of the bottom caps to rot out and significantly increase stack effect
- Mold growth in several lower portions of the shafts
- Uncontrolled Air flowing from the exhaust shafts back INTO the units, often contains mold spores, friable asbestos fibers, bacteria, viruses, and other unsafe contaminants.

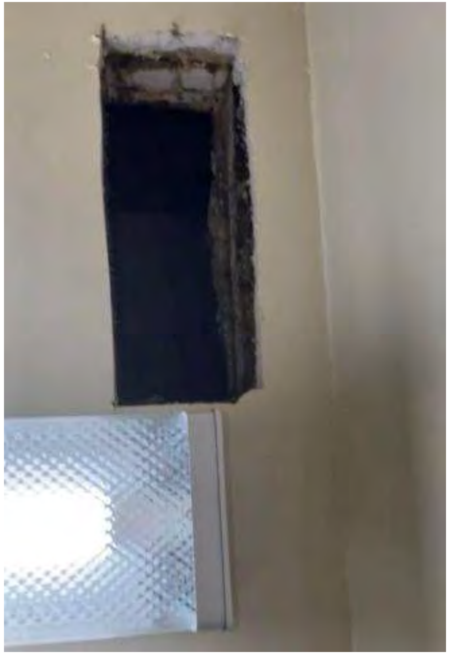
IAQ Issues Associated With Sheetrock Shafts

If not addressed in a timely manor, these shafts will continue to deteriorate until they become unsalvageable and remain wet to the touch.

IAQ Issues Associated With Sheetrock Shafts

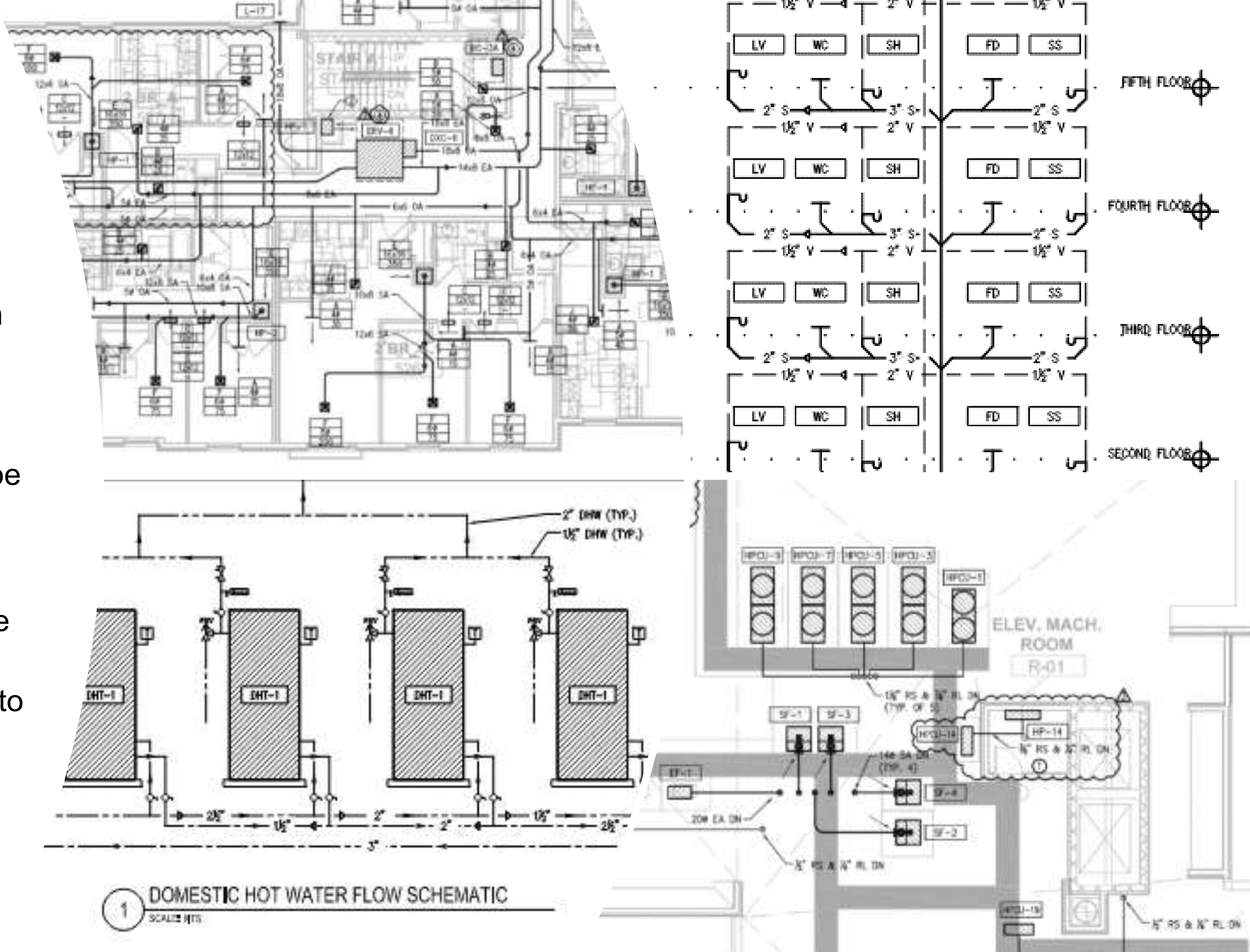
Everything may appear in working order, but an investigation of the exhaust shaft must be performed.



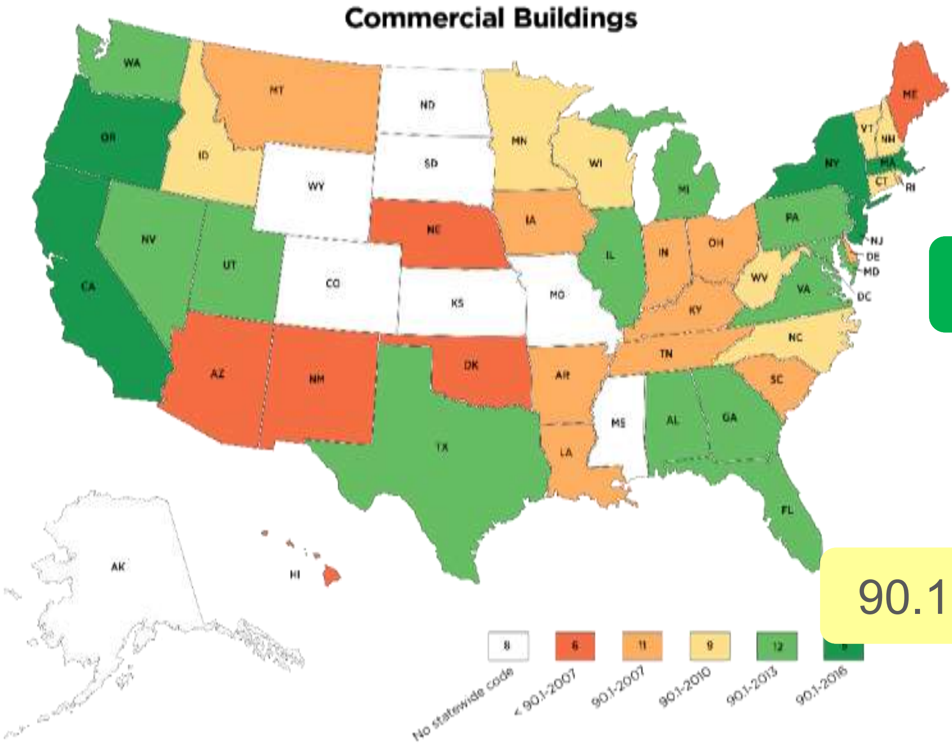


Pandemic

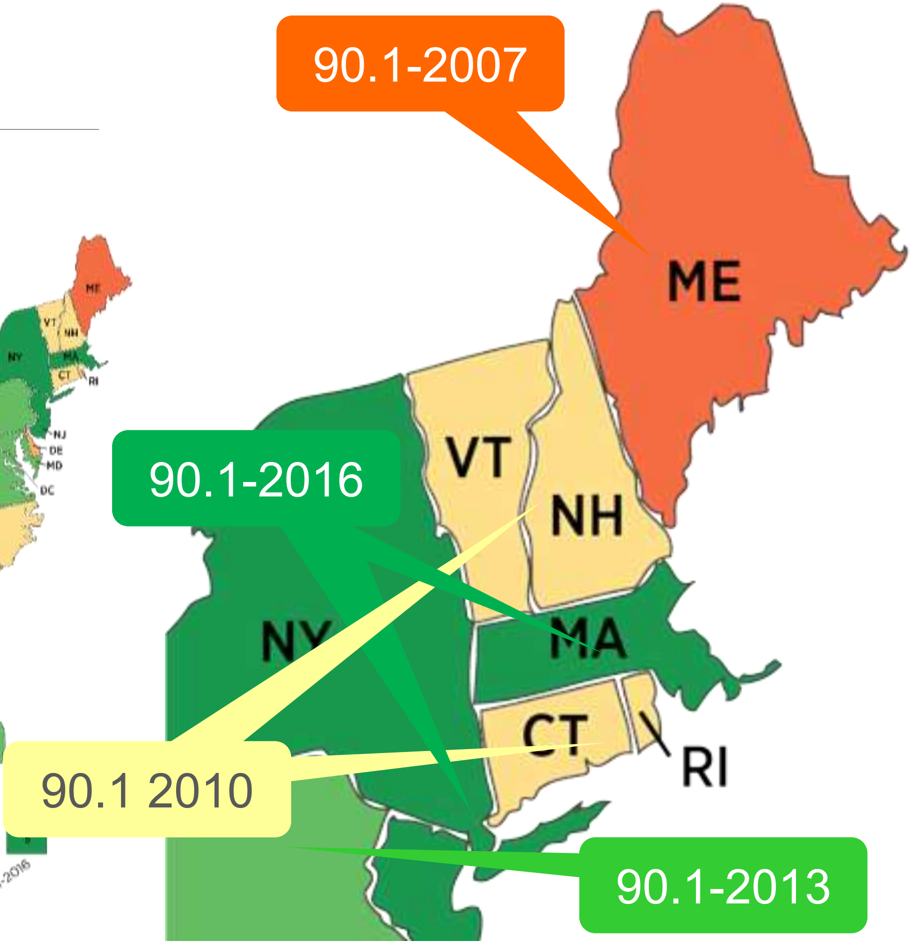
- ASHRAE Keep ventilation systems running
- ASHRAE Don't change system settings
- ASHRAE Systems must be well maintained and **working correctly**
- Wash your hands, cough into your elbow, PPE, face coverings
- Building Humidity? Refer to previous item



Energy Code



Commercial Buildings
WA
OR
CA
NV
ID
MT
WY
UT
AZ
NM
CO
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MS
MI
IN
OH
KY
TN
AL
GA
FL
SC
NC
VA
WV
PA
NY
VT
NH
ME
MA
CT
RI
NJ
DE
MD
DC
AK
HI
8
6
11
9
12
No statewide code
< 90.1-2007
90.1-2007
90.1-2010
90.1-2013
90.1-2016



90.1-2007
ME
VT
NH
90.1-2016
NY
MA
CT
RI
90.1 2010
90.1-2013

If you CAN'T Control the

AIR

You CAN'T Control the

ENERGY

Codes and Standards

Example - 900 SF 2 BR apt with 9’ Ceilings = 8,100 CUFT:

- IMC 2015 (0.35 ACH) =
- ***47 CFM***
- IMC 2015 (OCC) =
- ***45 CFM***
- ASHRAE 62.2 (2007) =
- ***32 CFM***
- ASHRAE 62.2 (2013) =
- ***50 CFM***
- PHIUS (0.3 ACH) =
- ***41 CFM***
- PHIUS (18 CFM /OCC) =
- ***54 CFM***

Energy Performance: Cost of Lost Air

- $1 ft^3$ of air = 1.08 BTU/hr/degree F
- Average Northern Winter $\Delta T = 30^0 – 40^0$ F ≈ 40BTU/hr
- ***Each CFM*** of air flow X 4,350 hrs/ heating season = ***170,000 BTU*** per heating season
  - *1.7 therms of natural gas*
  - *50 kWh of electricity*
  - *1.2 gallons of heating oil*

Energy Performance: Cost of Lost Air

Note – *These savings estimates are for "post production" energy that* ***doesn't*** *include system losses (boiler/ chiller efficiency, condensate temps, etc.)*

Annual Energy Cost *per CFM* of Lost

- ✓ Building Heating System is…
  - Electric Resistance - $0.225/ kWh = *$10.77* ***PER YEAR****/ CFM reduced*
  - Electric ASHP (COP 2.5) = *$4.38* ***PER YEAR/*** *CFM reduced*
  - Oil - $3.28/ gallon = *$3.90* ***PER YEAR****/ CFM reduced*
  - Natural Gas - $1.58/ Therm = *$2.84* ***PER YEAR****/ CFM reduced*
- ✓ Summer Cooling adds an extra 20% savings (by fuel type)
  - Buildings with chillers or with common area central AC
  - Buildings with PTAC units
  - ASHP
  - Depending on fuels, cooling may offer the ***greater*** cost savings!

Energy Performance: Reduced Ventilation Rates

"Old Code" Buildings built before 2008 have higher ventilation rates:

	Kitchens	Bathrooms
Pre-2008 Building Code	100 CFM	50 CFM
Revised Ventilation Rate	50 CFM	35 CFM
Net Reduction for *Continuous* Ventilation	(50 CFM)	(15 CFM)

Energy Performance: Reduce Ventilation Rates

ANNUAL Heating Savings Opportunity *Per Apartment…*

	Kitchens	Bathrooms
Natural Gas @ $1.58/ Therm	$142	$43
#2 Heating Oil @ $3.28/ Gal.	$195	$59
Electricity @ $0.225/ kWh	$539	$162

Learning Objectives

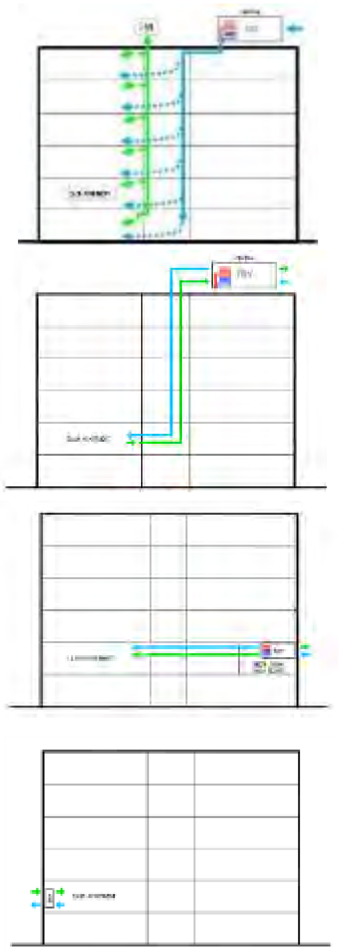
At the end of this course, participants will be able to:

1. Understand the design, equipment & field considerations that help determine how central ventilation systems actually work
2. Identify the important project design considerations that lead to reliable performance in retrofit & new construction applications
3. How to design, specify & set performance objectives that can be reliably & cost-effectively achieved
4. Understand ways to inspect, evaluate & commission projects that achieve & sustain building performance objectives

Commissioning: The Ducts

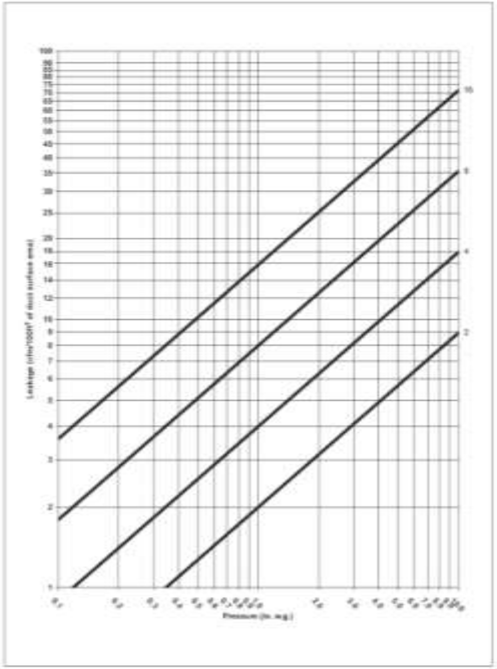
Was it Built to Design?

- Multi-unit systems are COMMERCIAL
  - ✓ Fans designed for operating flow/ SP
  - ✓ Ducts designed for a known leakage
  - ✓ Tolerances should reflect project parameters
  - ✓ Put it in the specs
- In-unit systems are RESIDENTIAL
  - ✓ RESNET, PHIUS – put it in the specs



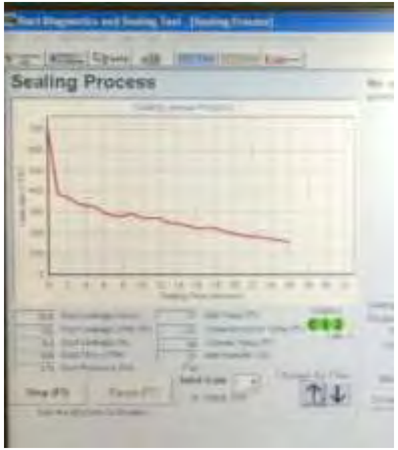
Commissioning: SMACNA Method

- Seal & Leakage Class Well Defined
- X CFM per 100SF of *DUCT* @ YSP
  - ✓ Duct Only - Excludes curbs, vent boxes, etc.
  - ✓ Done as sampling only throughout construction (when engineers stay on it)
- Lower volume systems with lots of ducts pass at higher leakage percentages



Commissioning: Percent of Flow Method

- Specified % of Design Flow
- Measures entire system
  - ✓ Curb to Vent
  - ✓ Test at OP – 1.5 OP
- Can test sections, but subsequent tests should include prior tests until the whole system is measured.
- Can be riskier if they wait till the system is complete



Compare Allowable Leakage

- Size: 8”
- Len: 2,500 ft
- Area: (5,236 SF)
- OP: 1” WG
- Vents: 25 @ 35CFM
- Sys Flow: 835 CFM

SMACNA

- 1” WG

  Class 2: 105 CFM

  Class 4: 209 CFM

  Class 8: 419 CFM
- 1.5” WG

  Class 2: 136 CFM

  Class 4: 272 CFM

  Class 8: 545 CFM

Percent of Flow

- 1” WG

  10%: 84 CFM

  5%: 42 CFM

  3%: 26 CFM
- 1.5” WG

  10%: 84 CFM

  5%: 42 CFM

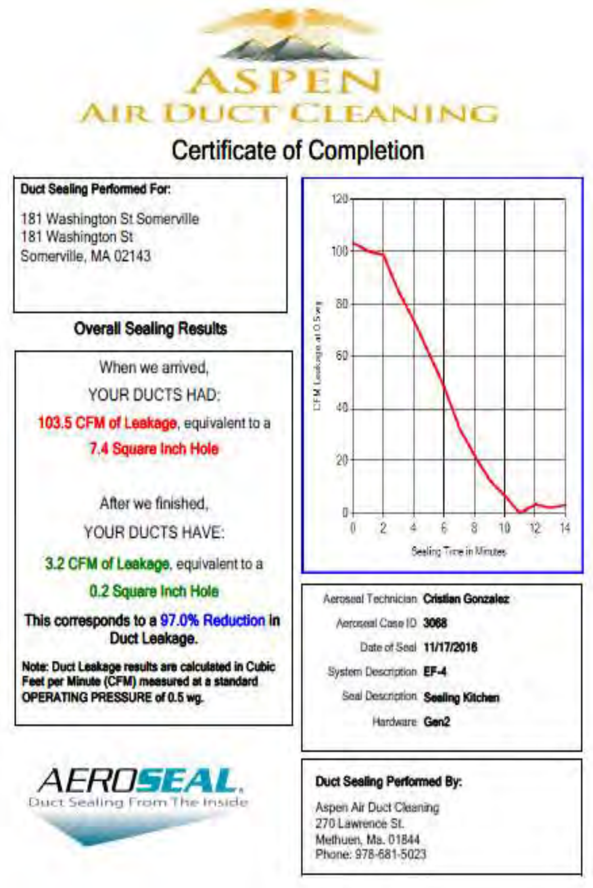
  3%: 26 CFM

“Open Book” Commissioning

100% Testing and Verification

- ✓ Test system *at operating pressure (up to 2 ½” WG)*
- ✓ You can test to SMACNA Standards using identical protocol.
- ✓ Test In/ Seal/ Test Out –

  Can be witnessed by engineer or owner’s rep.



Commissioning: The Fans

ECM fans allow “tuning” of the system.

- ✓ Our method:
  - Tachometer for fan speed
  - Manometer for SP reading
  - Plot on the fan curve
- ✓ Quick, easy, repeatable

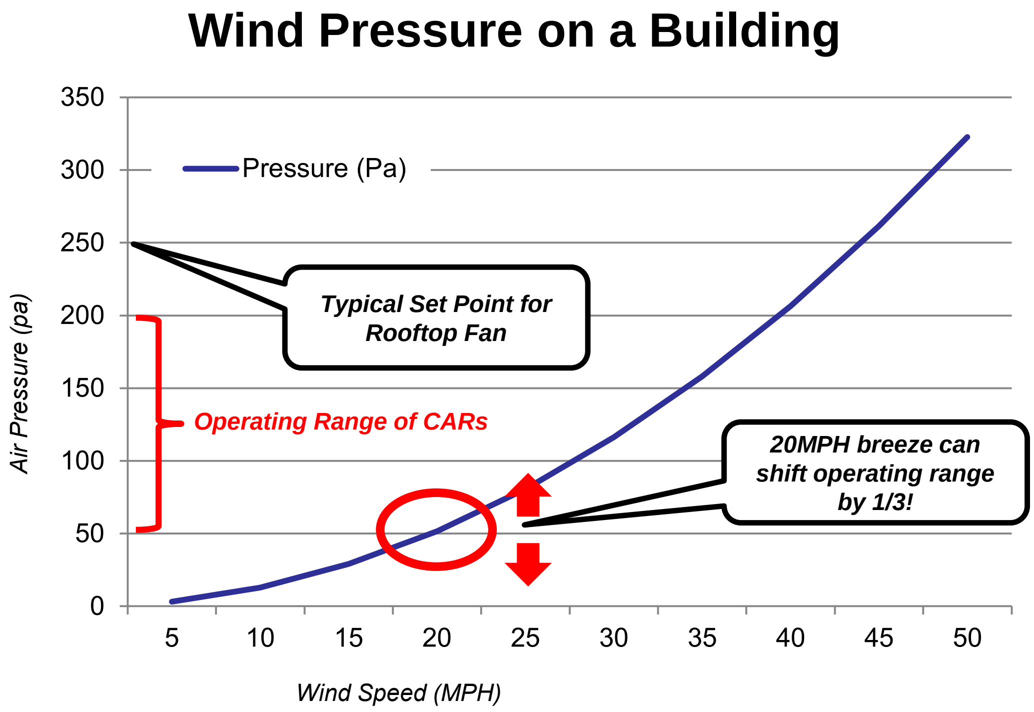
Energy Recovery Ventilators (ERV)

Commissioning: The Vents

Establish Performance Parameters

- ✓ Place unit under operating conditions
    - Close windows, doors
    - Note overall building conditions
    - Make sure the fans are operating properly
- ✓ Get a good seal/ get reliable readings
- ✓ YMMV, depending on…
    - Time of year – summer VS winter conditions
    - High winds – open windows, even in adjacent units!

Commissioning: The Vents



Beaufort Wind Scale

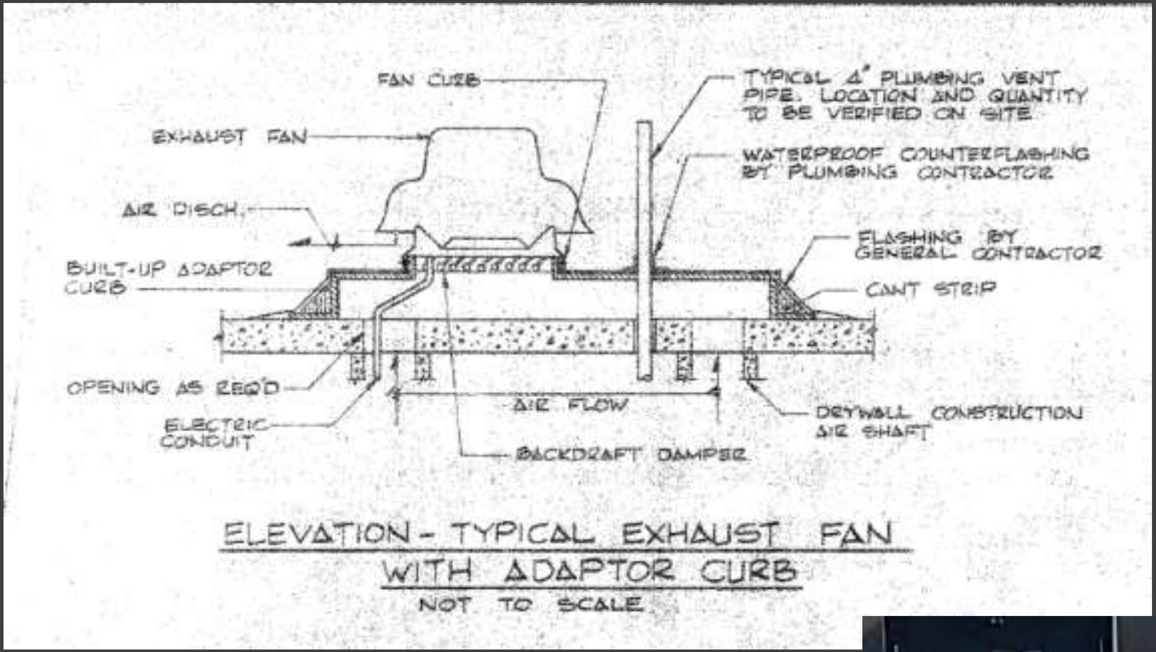
Beaufort No.	Description of wind	Observation	Wind speed m/s	Wind speed mph	Wind speed knots	Wind speed ft/min
0	Calm	Smoke rises vertically. The sea is mirror smooth.	0 - 0.15	0 - 0.3	0 - 0.5	0 - 25
1	Light Air	Direction of wind shown by smoke drift but not by vanes. Scale-like ripples on sea, no foam on wave crests.	0.15 - 2.7	0.3 - 6	0.5 - 3	25 - 525
2	Light Breeze	Wind felt on face, leaves rustle, ordinary vanes moved by wind. Short wavelets, glassy wave crests.	2.7 - 3.6	6 - 8	3 - 7	525 - 700
3	Gentle Breeze	Leaves and small twigs in constant motion, wind extends light flag	3.6 - 7.2	8 - 16	7 - 10	700 - 1400
4	Moderate Breeze	Raises dust and loose paper, small branches moved. Fairy frequent whitecaps occur.	7.2 - 8.9	16 - 20	10 - 15	1,400 - 1,800
5	Fresh Breeze	Small trees in leaf begin to sway. Moderate waves, many white foam crests.	8.9 - 12.5	20 - 28	15 - 21	1,800 - 2,500
6	Strong Breeze	Large branches in motion, whistling heard in telegraph wires. Some spray on the sea surface.	12.5 - 14.5	28 - 32	21 - 27	2,500 - 2,800
7	Moderate gale	Whole trees in motion, inconvenience felt when walking into wind. Foam on waves blows on streaks.	14.5 - 20	32 - 44	27 - 33	2,800 - 3,900
8	Gale	Twigs broken of trees, generally impeded progress. Long streaks on foam appear on sea.	20 - 22	44 - 50	33 - 40	3,900 - 4,400
9	Strong gale	Straight structural damage, e.g. slates and chimney pots removed from the roofs. High waves, crest start to roll over.	22 - 28	50 - 62	40 - 48	4,400 - 5,450
10	Storm	Trees uprooted, considerable structural damage. Exceptionally high waves, visibility affected.	28 - 31	62 - 70	48 - 55	5,450 - 6,150
11	Violent Storm	Widespread damage	31 - 37	70 - 82	55 - 63	6,150 - 7,200
12	Hurricane	Air is filled with spray and foam.	> 37	> 82	> 63	> 7,200

Car Damper Issues Observed

A four year old 20 story building located in Long Island City, with clogged CAR dampers unable to modulate.

It needs to work

- This didn’t work



Built as designed

This probably never worked well.

Fan sizing

Fan sizing

Learning Objectives

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

1. Understand the design, equipment & field considerations that help determine how central ventilation systems actually work
2. Identify the important project design considerations that lead to reliable performance in retrofit & new construction applications
3. How to design, specify & set performance objectives that can be reliably & cost-effectively achieved
4. Understand ways to inspect, evaluate & commission projects for that achieve & sustain building performance objectives

Thank You

ASPEN ENVIRONMENTAL

PE | Petersen Engineering

INDOOR AIR QUALITY IAQ CHAMPS

Tom Holmes
tholmes@woodstockenergy.com

Doug Kumph
doug@petersenengineering.com

John Twomey
johnt@iaqchamps.com