- Presentation will begin shortly
- Session will be recorded
- All attendees are muted
- Please be aware of Q&A at bottom of screen – ask your questions there
- We will address questions at various points in the session

www.chulavistaca.gov/clean

Sustainability Webinars

Summer Sustainability Series and Sustainable Buildings recorded webinars are available through the City of Chula Vista CLEAN website

www.chulavistaca.gov/clean

SUSTAINABILITY SERIES

City of Chula Vista Sustainability Series

The "Ins & Outs" and Importance of Ventilation

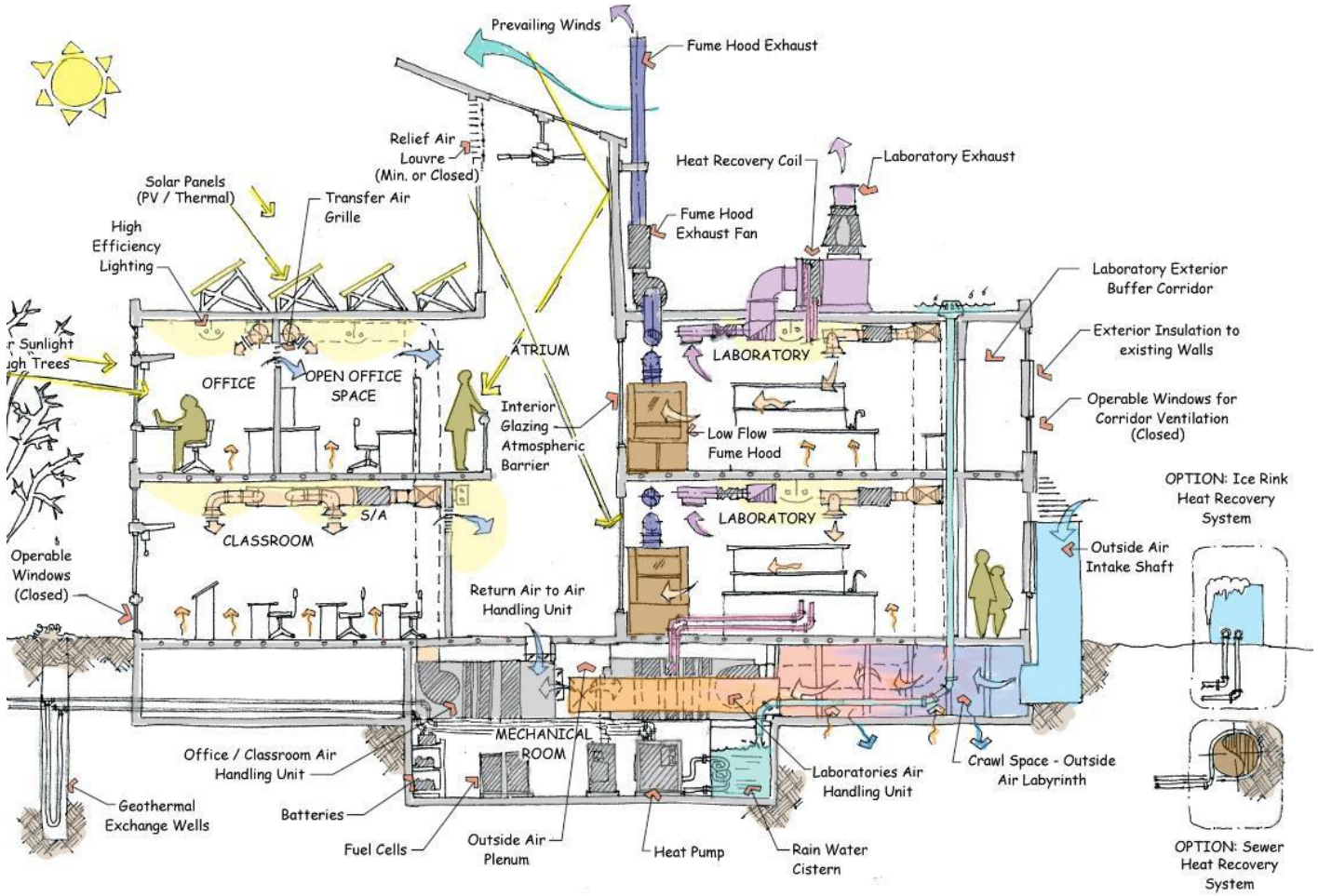
Calina Ferraro, PE
Principal, San Diego
cferraro@integralgroup.com

INTEGRAL

What is Ventilation

- Fresh **Outside Air** entering a building
- Contaminated or "used" **Exhaust Air** leaving a building

- CFM = cubic foot per minute
- ACH = air changes per hour



Why Ventilate?

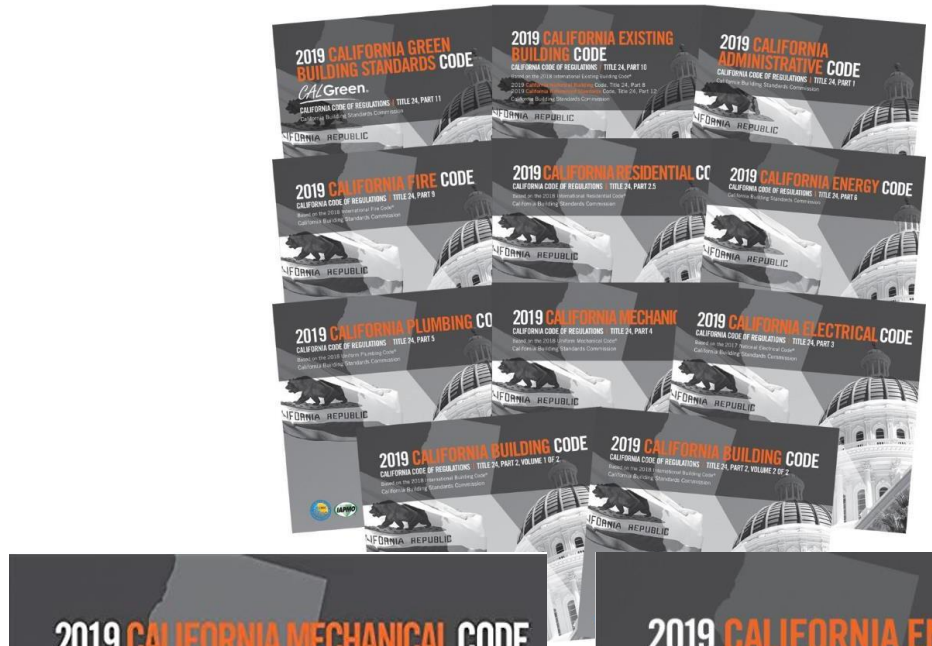
- Human Health
- Productivity & Alertness (CO_2)
- Moisture/humidity control
- Odor & Contaminant removal
- Pressurization

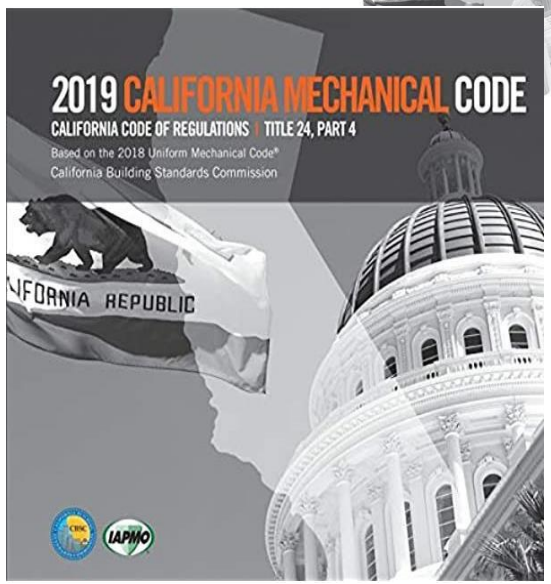
For Occupants

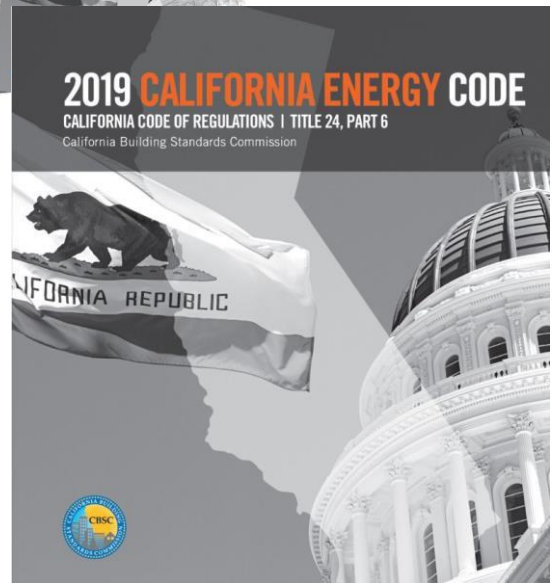
How Much Ventilation is Required?

- Building Codes establish ***minimum*** required ventilation rates
- Application specific design requirements (Labs, Healthcare, Cleanrooms)
- Voluntary High Performance "Green" standards

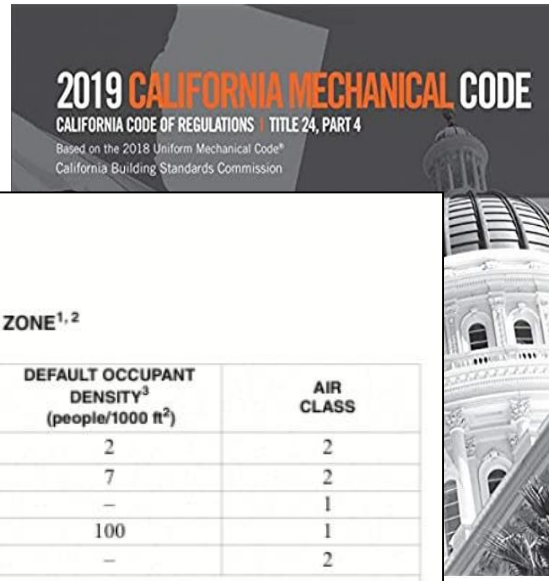
California Code of Regulations (C.C.R), Title 24







Code Required Ventilation



VENTILATION AIR

TABLE 402.1 (continued)
MINIMUM VENTILATION RATES IN BREATHING ZONE[1, 2]
[ASHRAE 62.1: TABLE 6.2.2.1]

OCCUPANCY CATEGORY[4]	PEOPLE OUTDOOR Air Rate *Rp* (cfm/person)	AREA OUTDOOR Air Rate R_A (cfm/ft²)	DEFAULT OCCUPANT DENSITY[3] (people/1000 ft²)	AIR CLASS
Shipping/receiving[b]	10	0.12	2	2
Sorting, packing, light assembly	7.5	0.12	7	2
Telephone closets	–	–	–	1
Transportation waiting	7.5	0.06	100	1
Warehouses[b]	10	0.06	–	2
PUBLIC ASSEMBLY SPACES				
Auditorium seating area	5	0.06	150	1
Courtrooms	5	0.06	70	1
Legislative chambers	5	0.06	50	1
Libraries	5	0.12	10	1
Lobbies				
Museums (c				
Museums/ga				
Places of rel				

TABLE 403.7
MINIMUM EXHAUST RATES
[ASHRAE 62.1: TABLE 6.5]

OCCUPANCY CATEGORY[8]	EXHAUST RATE (cfm/unit)	EXHAUST RATE (cfm/ft²)	AIR CLASS
Arenas[2]	–	0.50	1
Art classrooms	–	0.70	2
Auto repair rooms[1]	–	1.50	2
Barber shops	–	0.50	2
Bathroom[11,12]	*20/50*	–	2
Beauty and nail salons	–	0.60	2
Cells with toilet	–	1.00	2
Copy, printing rooms	–	0.50	2
Darkrooms	–	1.00	2
Educational science laboratories	–	1.00	2
Janitor closets, trash rooms, recycling	–	1.00	3
Kitchens – commercial	–	0.70	2
Kitchenettes	–	0.30	2

NONRESIDENTIAL, HIGH-RISE RESIDENTIAL HOTEL/MOTEL OCCUPANCIES, AND COVERED PROCESSES—MANDATORY REQUIREMENTS

TABLE 120.1-A—continued
MINIMUM VENTILATION RATES

OCCUPANCY CATEGORY	AREA OUTDOOR AIR RATE[1] R_a cfm/ft²	MIN AIR RATE FOR DCV[2] cfm/ft²	AIR CLASS	NOTES
Office Buildings				
Breakrooms	0.50	0.15	1	
Main entry lobbies	0.50	0.15	1	F
Occupiable storage rooms for dry materials	0.15		1	
Office space	0.15		1	F
Reception areas	0.15		1	F
Telephone/data entry	0.15		1	F
Miscellaneous Spaces				

- Occupant based: CFM/person
- Area based: CFM/sqft

High Performance Ventilation

CONVENTIONAL

INDOOR ENVIRONMENTAL QUALITY CONDITIONS

Carbon dioxide levels at

950

parts per million

Ventilation rates at

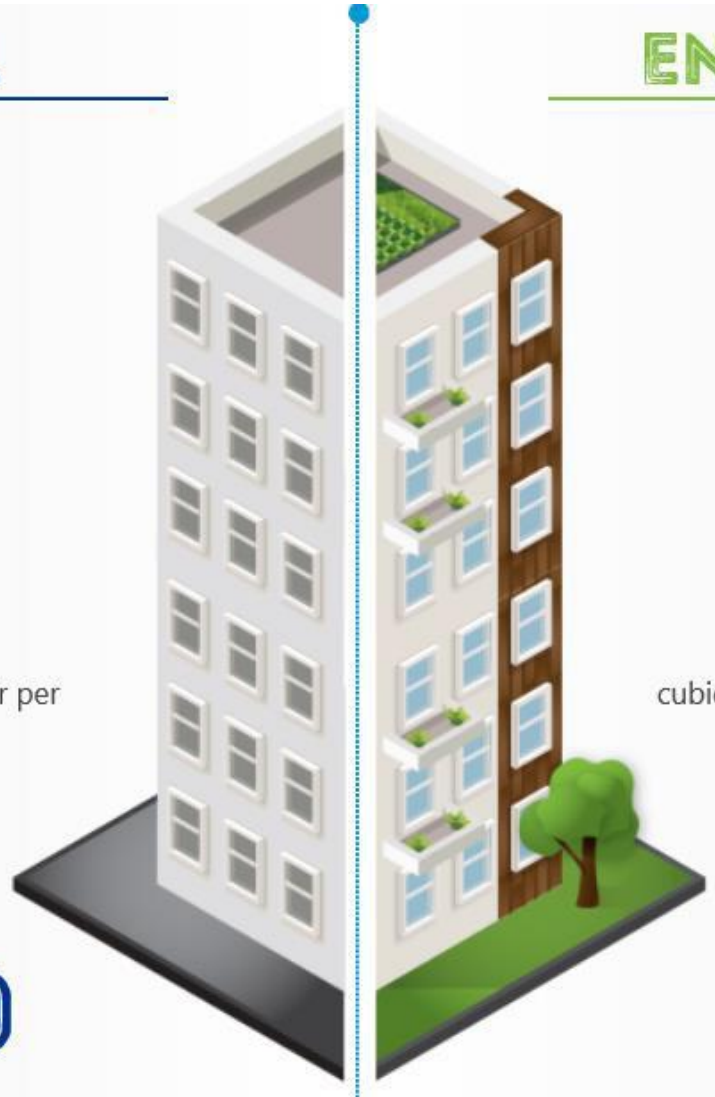
20

cubic feet per minute of outdoor air per person

Indoor total volatile organic compounds

BETWEEN 500-700

micrograms/cubic meter



ENHANCED GREEN

INDOOR ENVIRONMENTAL QUALITY CONDITIONS

Carbon dioxide levels at

600

parts per million

Ventilation rates at

40

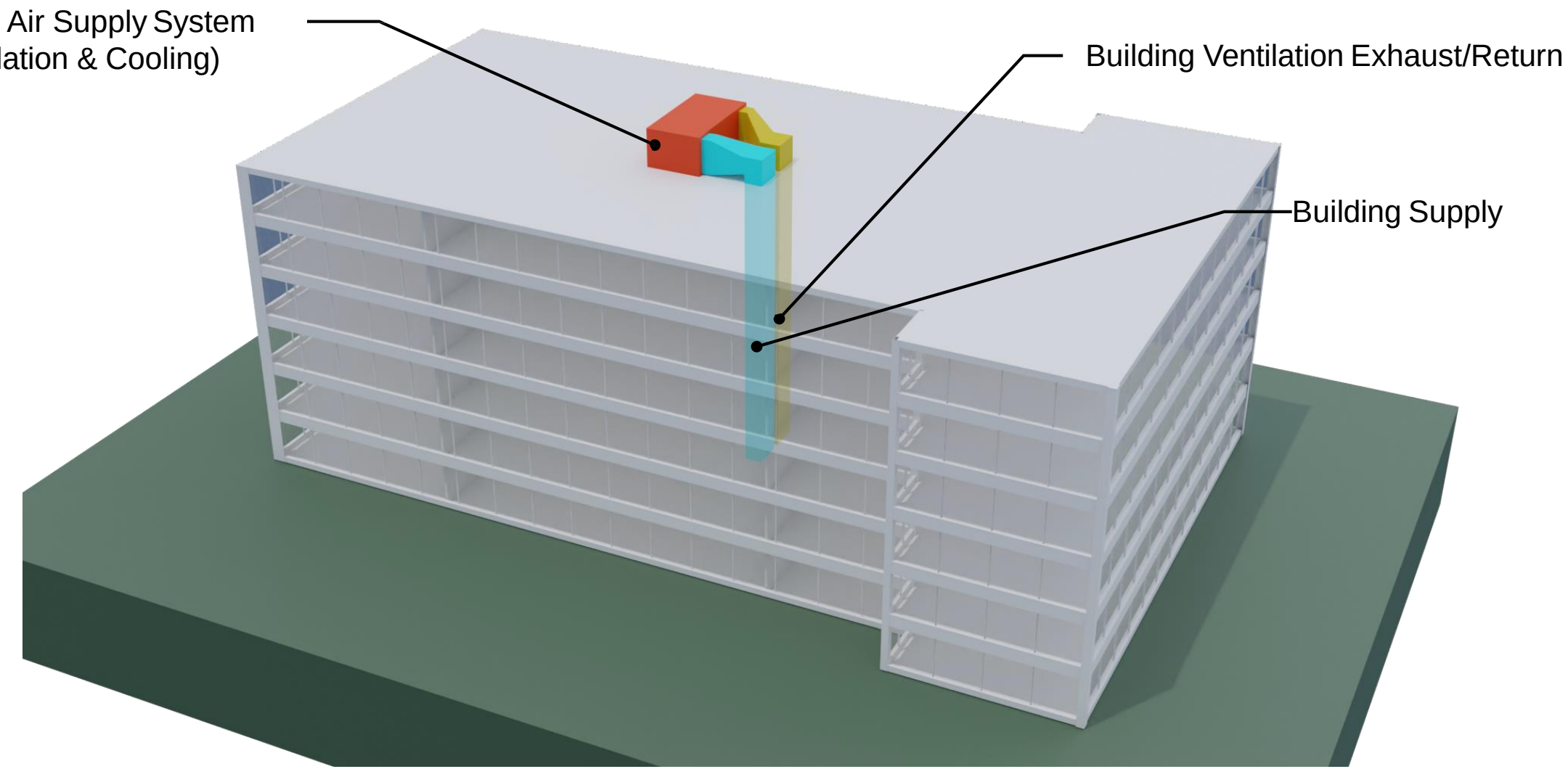
cubic feet per minute of outdoor air per person

Indoor total volatile organic compounds

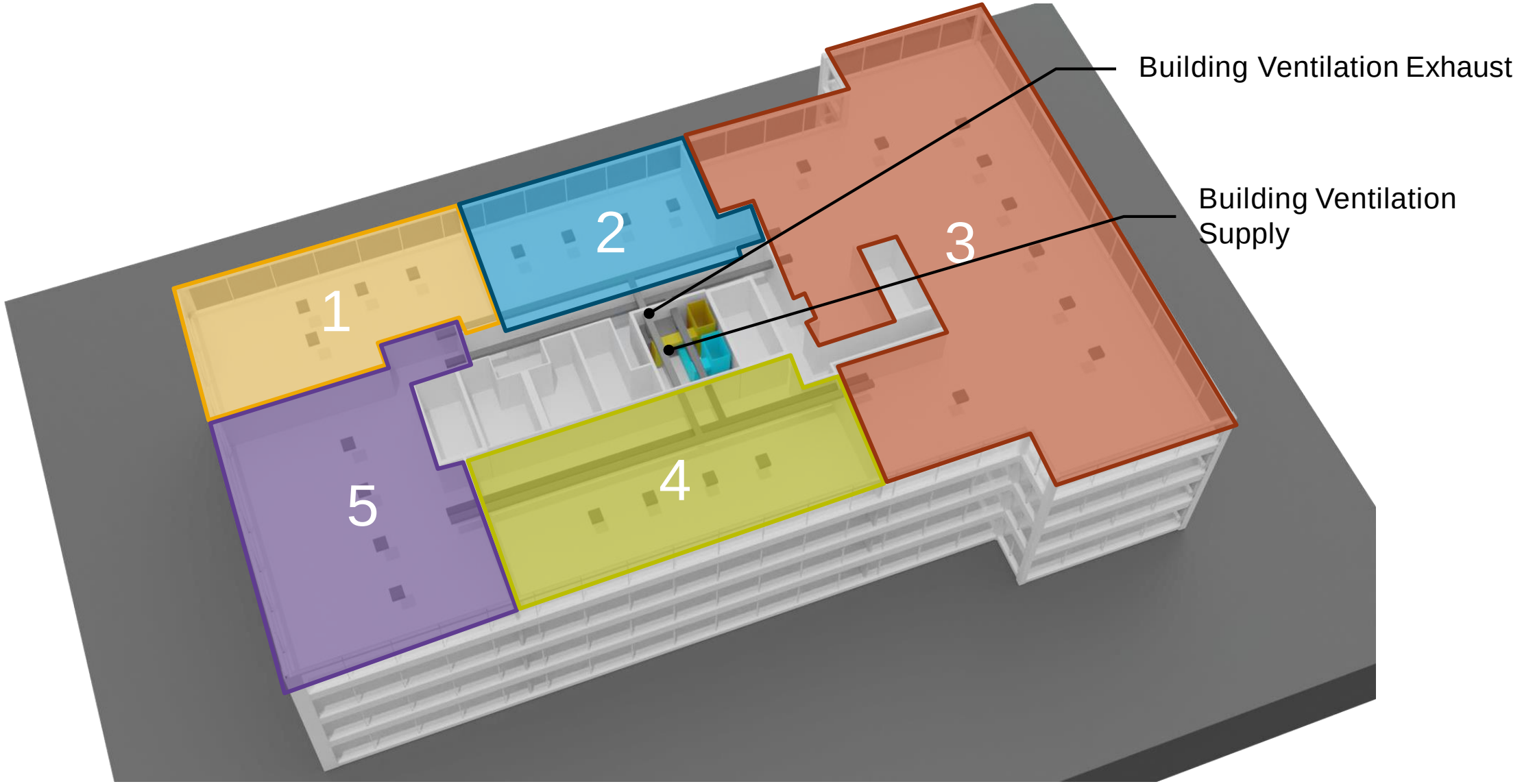
LESS THAN 50

micrograms/cubic meter

Conventional Non-Residential Ventilation

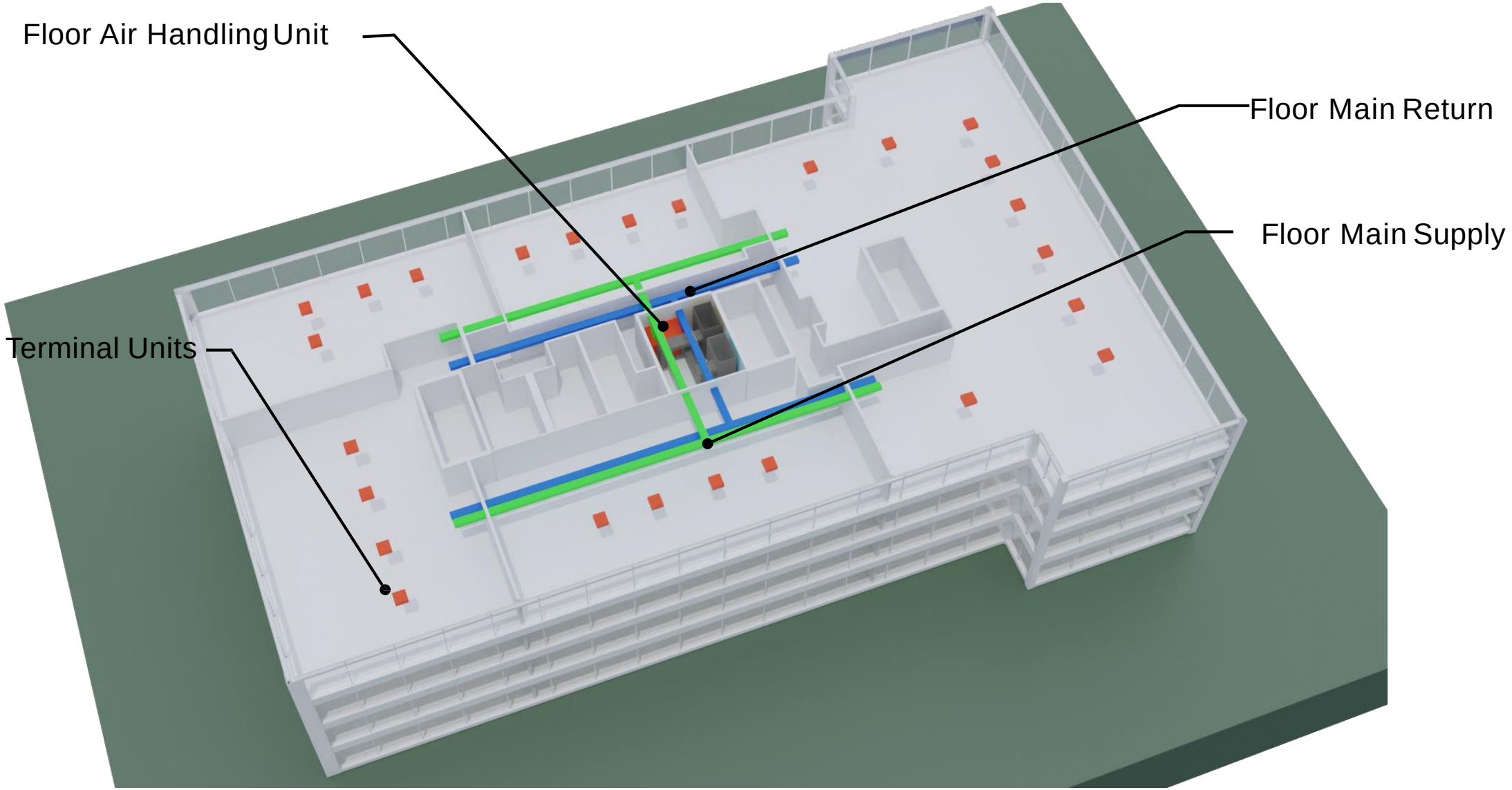


Conventional Non-Residential Ventilation



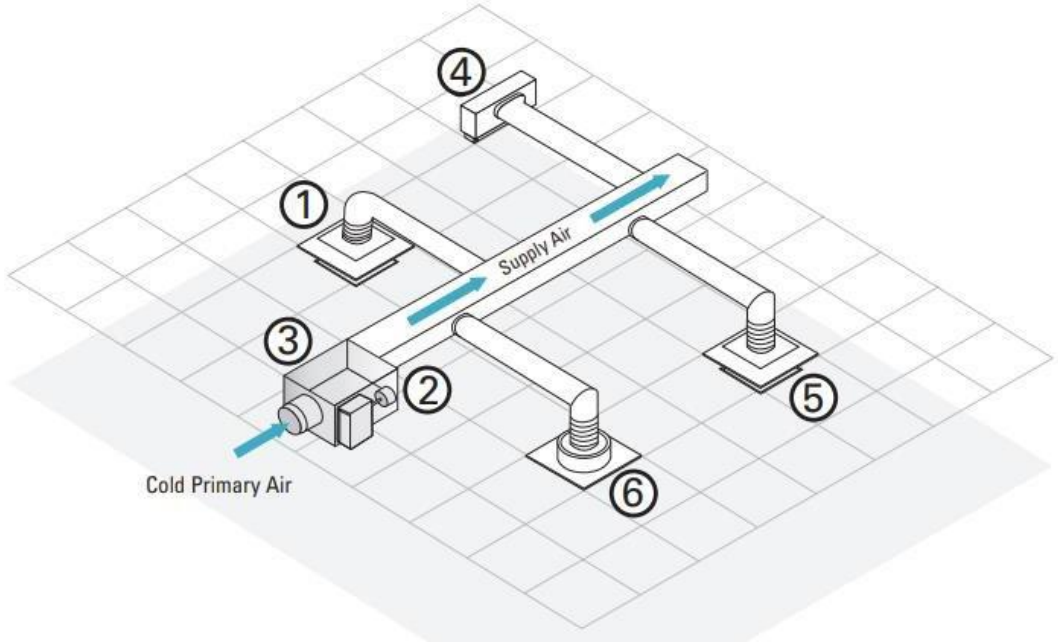
INTEGRAL

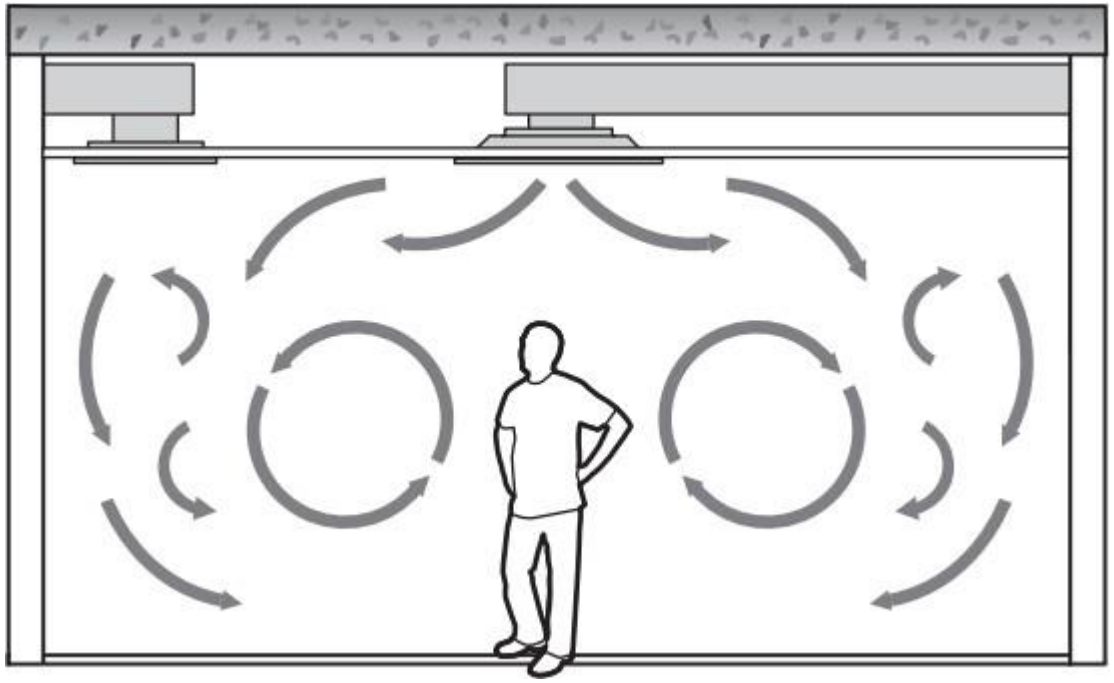
Conventional Non-Residential Ventilation



INTEGRAL

Conventional Non-Residential Ventilation





Typical Values

- (Mixed) Supply Airflow Rate: 0.75 – 1.5 cfm/sqft
- Ventilation (Outside air) percentage: 15-20%
- Ventilation airflow: 0.15-0.2 cfm/sqft
- Total air changes per hour (ACH): 4-6
- Outside Air ACH: ~1

Images credit: www.priceindustries.com

Filtration

MERV Rating = Minimum Efficiency Reporting Value

MERV Rating	Microparticle Performance Rating (MPR) .3-1.0 micron (µm)	Performace Rating Particles sized 1.0 to 3.0 microns (µm)	Performace Rating Particles sized 3 to 10 microns (µm)	Typical Application	Common Filter Types - Types of Particles
5	< 20%	< 20%	20% - 34%	• Industrial Workplace • Paint Booth • Commercial Buildings • Standard Residential	• Disposable/ Throwaway • Pocket Filters • Pleated Filters *Pollen, Dust Mites, Spray Paint, Carpet Fibers*
6	< 20%	< 20%	35% - 49%		
7	< 20%	< 20%	50% - 69%		
8	< 20%	< 20%	70% - 85%		
9	< 20%	Less than 50%	85% or Better	• Better Commercial Buildings • Hospital Labs • Better Residential	• Bag Filters • Pleated Filters • Box Filters *Lead Dust, Flour, Auto/Welding Fumes*
10	< 20%	50% - 64%	85% or Better		
11	< 20%	65% - 79%	85% or Better		
12	< 20%	80% - 90%	90% or Better		
13	Less than 75%	90% or Better	90% or Better	• Superior Commercial Buildings • Hospitals • Smoking Lounges	• Pleated Filters • Cartridge Filters • Box Filters *Bacteria, Smoke, Sneezes*
14	75% - 84%	90% or Better	90% or Better		
15	85% - 94%	95% or Better	90% or Better		
16	95% or Better	95% or Better	90% or Better		
17	99.97%	99% or Better	99% or Better	• Pharmaceutical Mfg. • Carcinogenetic Materials • Cleanrooms	• HEPA & ULPA *Viruses, Carbon Dust, < .30 pm*
18	99.997%	99% or Better	99% or Better		
19	99.9997%	99% or Better	99% or Better		
20	99.9997%	99% or Better	99% or Better		

Previous Code Requirement
(2016 & earlier)

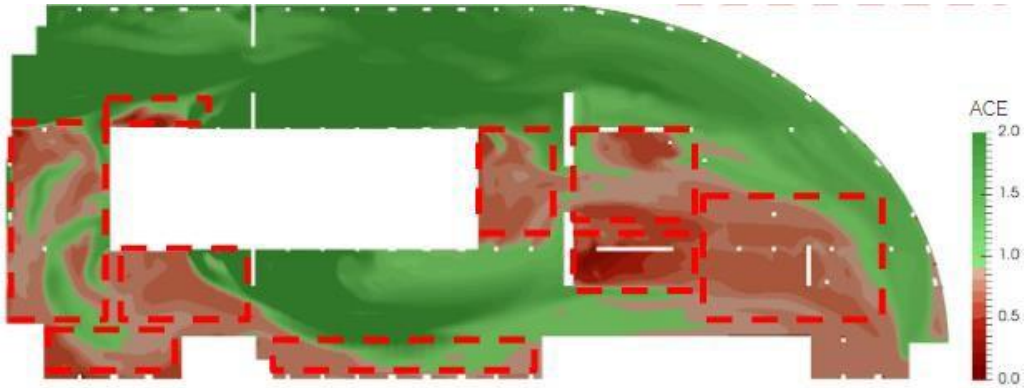
Current Code Requirement
(2019 in effect since Jan 1, 2020)

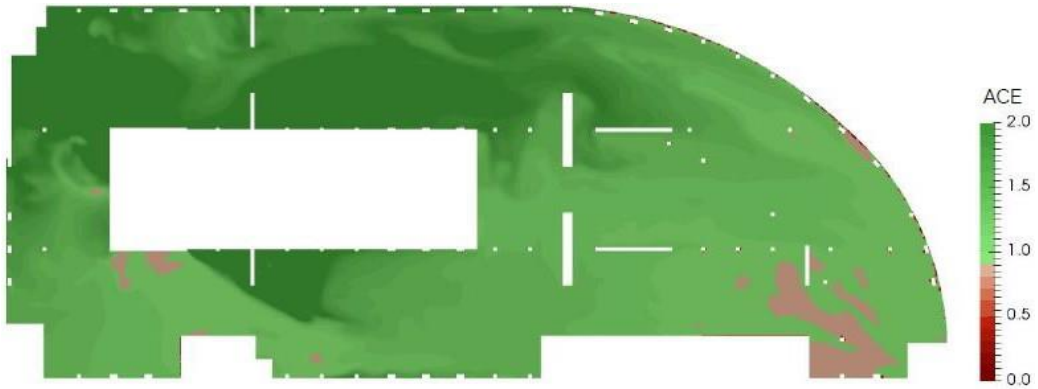
2019 CalGreen (Title 24, Part 11, 5.504.5.3)
In mechanically ventilated buildings, provide regularly occupied areas of the building with air filtration media for outside and return air that provides a Minimum Efficiency Reporting Value (MERV) of 13.

INTEGRAL

Challenges with Ventilation

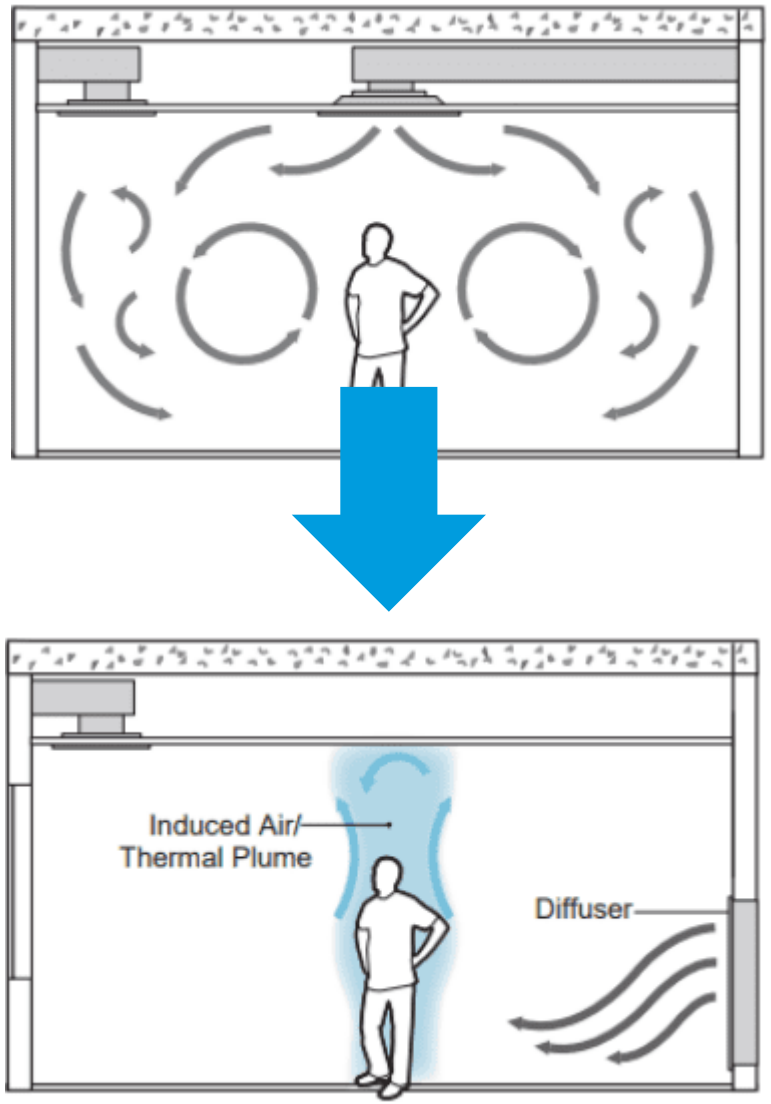
- Energy use (fan power & heating/cooling)
- Space (ductwork, shafts, mechanical equipment)
- Cost (first cost & operation)
- Effectiveness

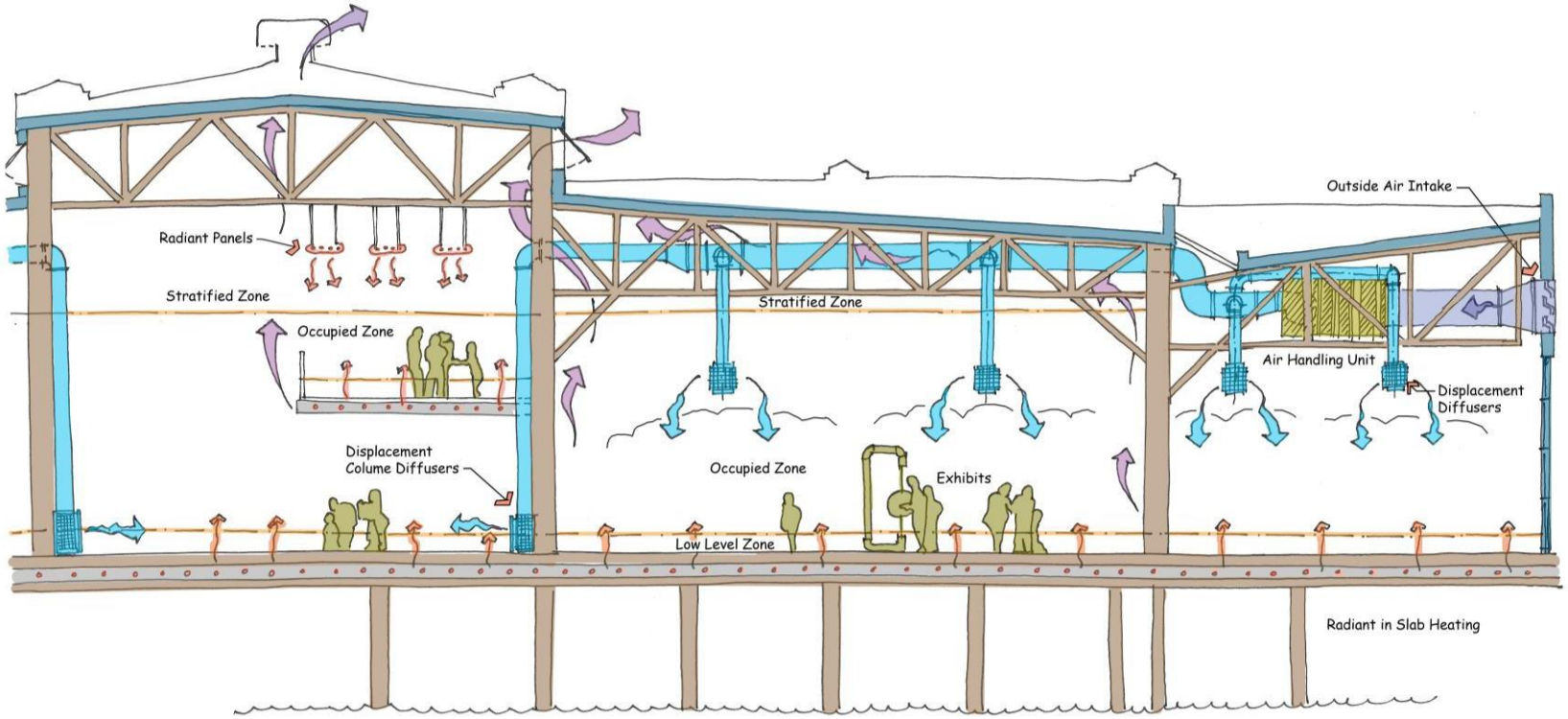




Areas with High Potential of pollutant accumulation

Alternate Ventilation Strategy – Displacement

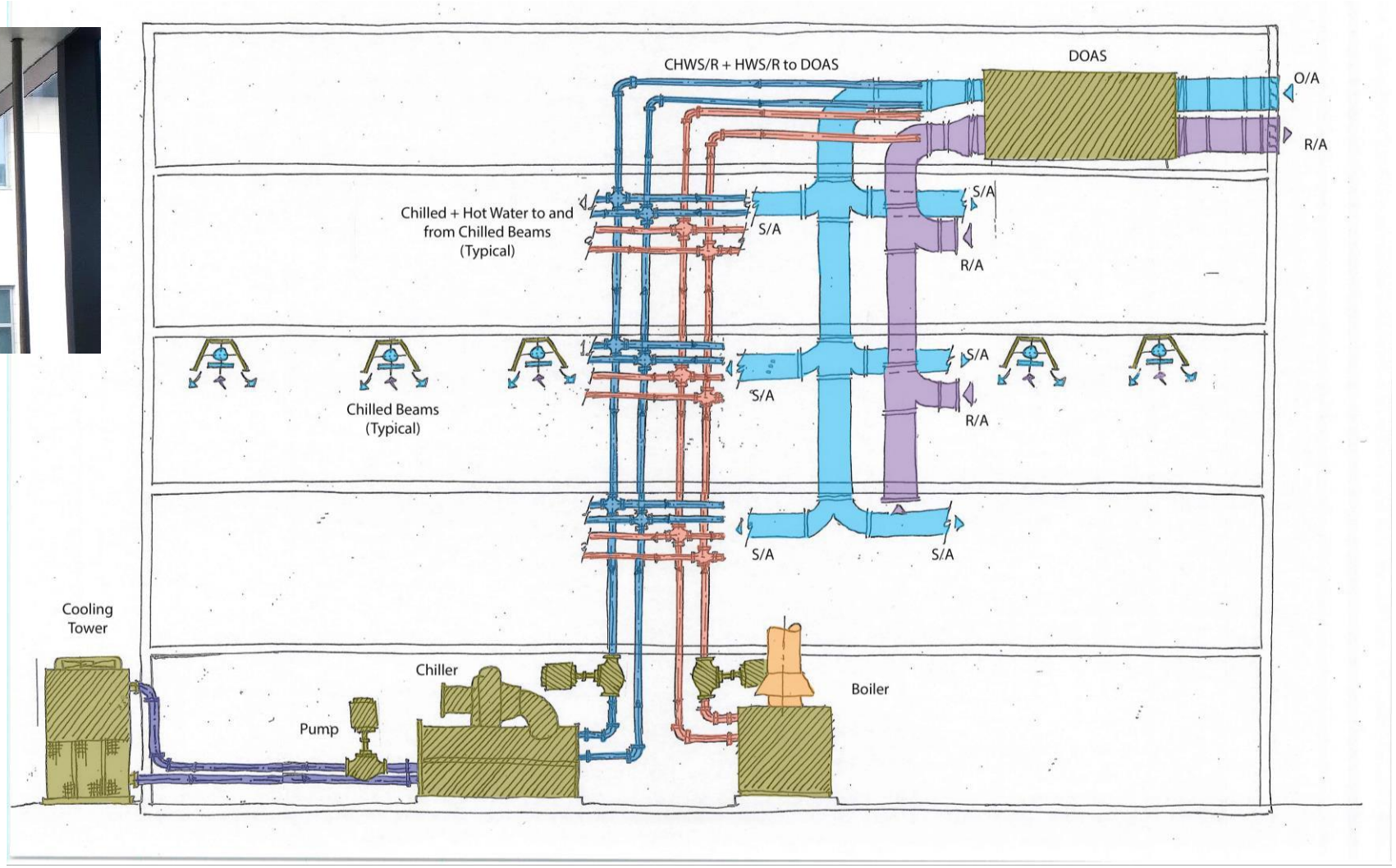




INTEGRAL

Alternate Ventilation Strategy – Dedicated Outside Air System (DOAS)

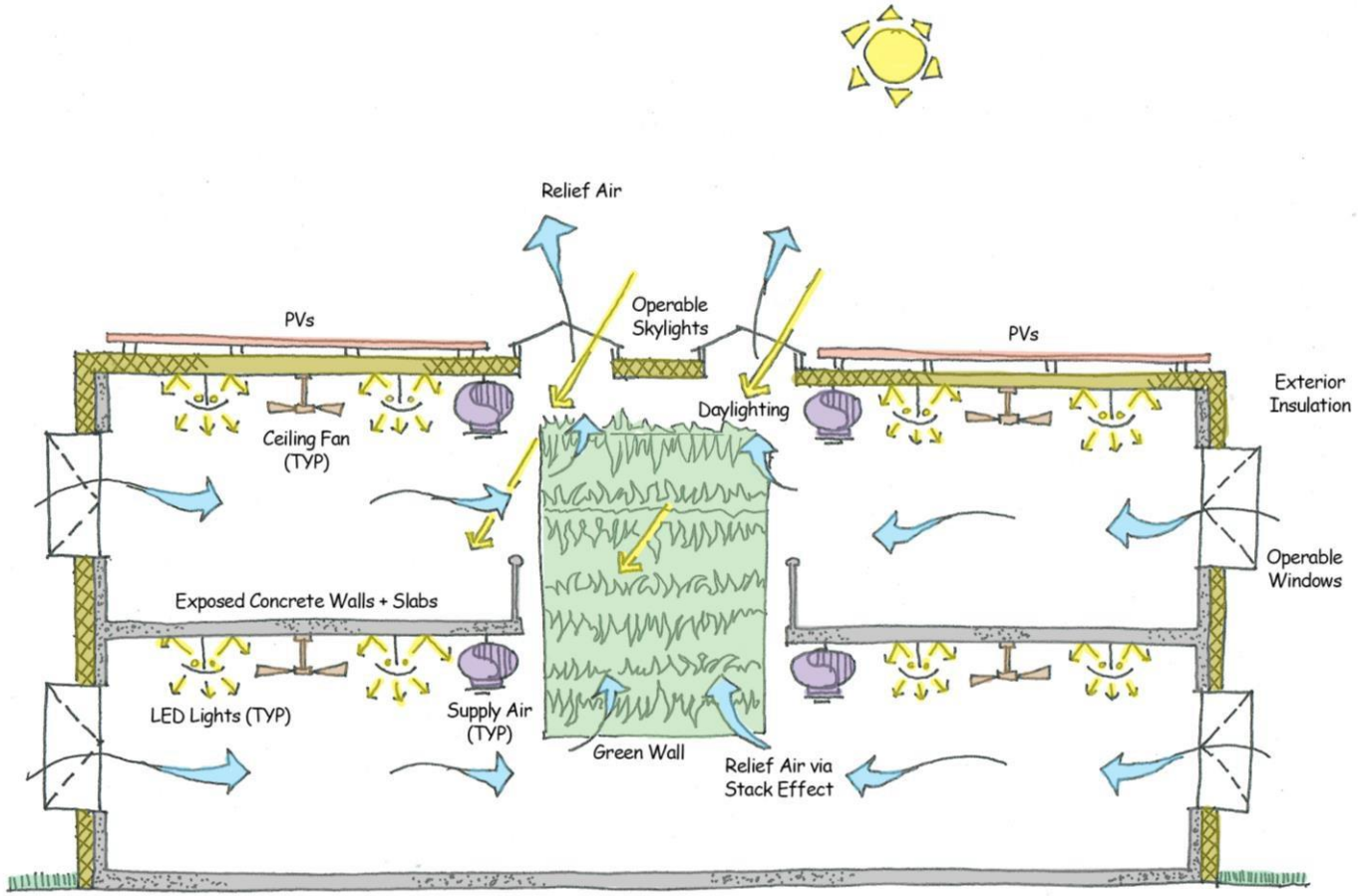
↑
Chilled Beams



INTEGRAL

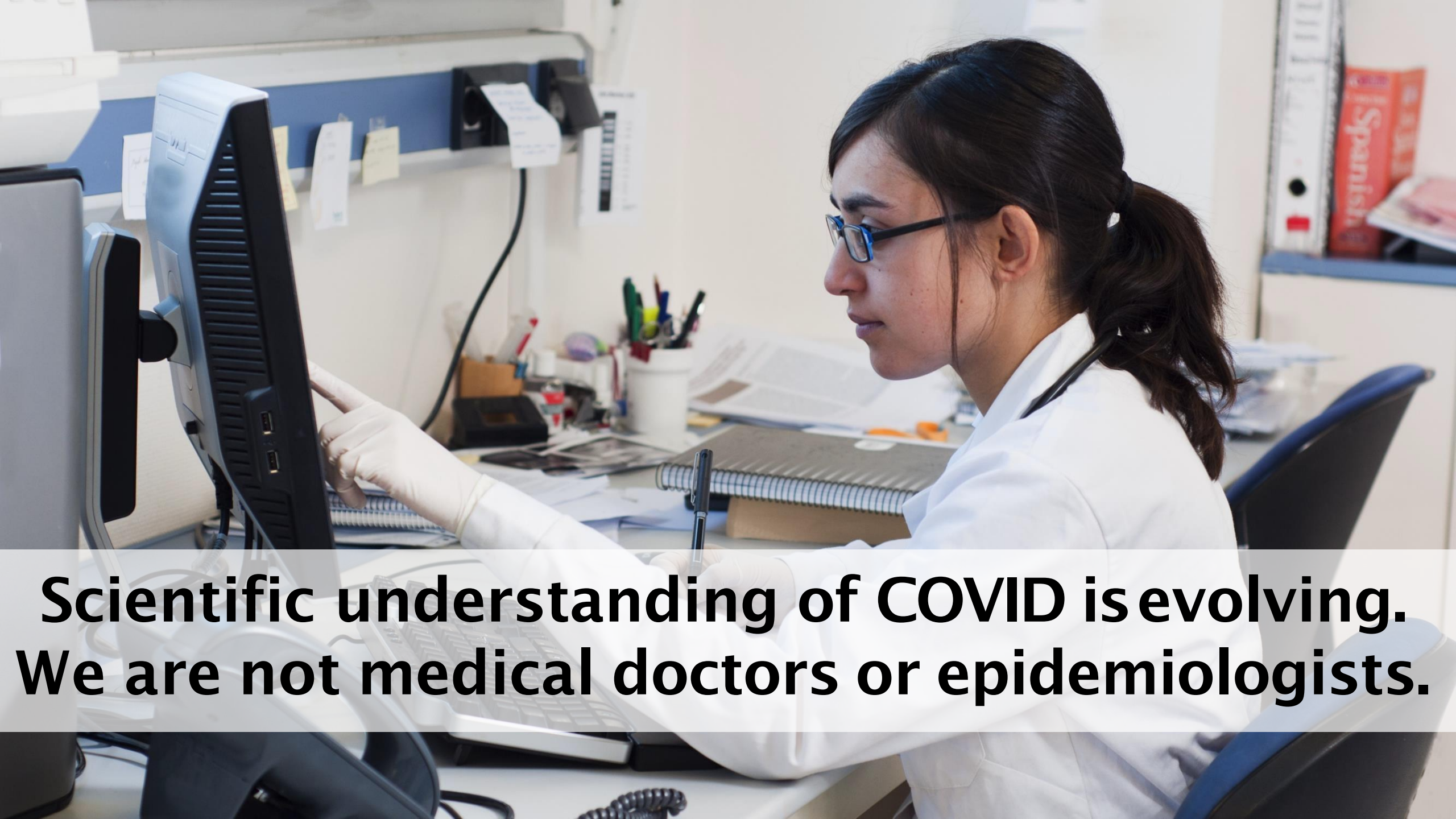
Alternate Ventilation Strategy – Natural Ventilation

- Operable windows, louvers
- Cooling & ventilation
- Stack effect
- Supplement with fans
- Up to 20-25 ACH is common



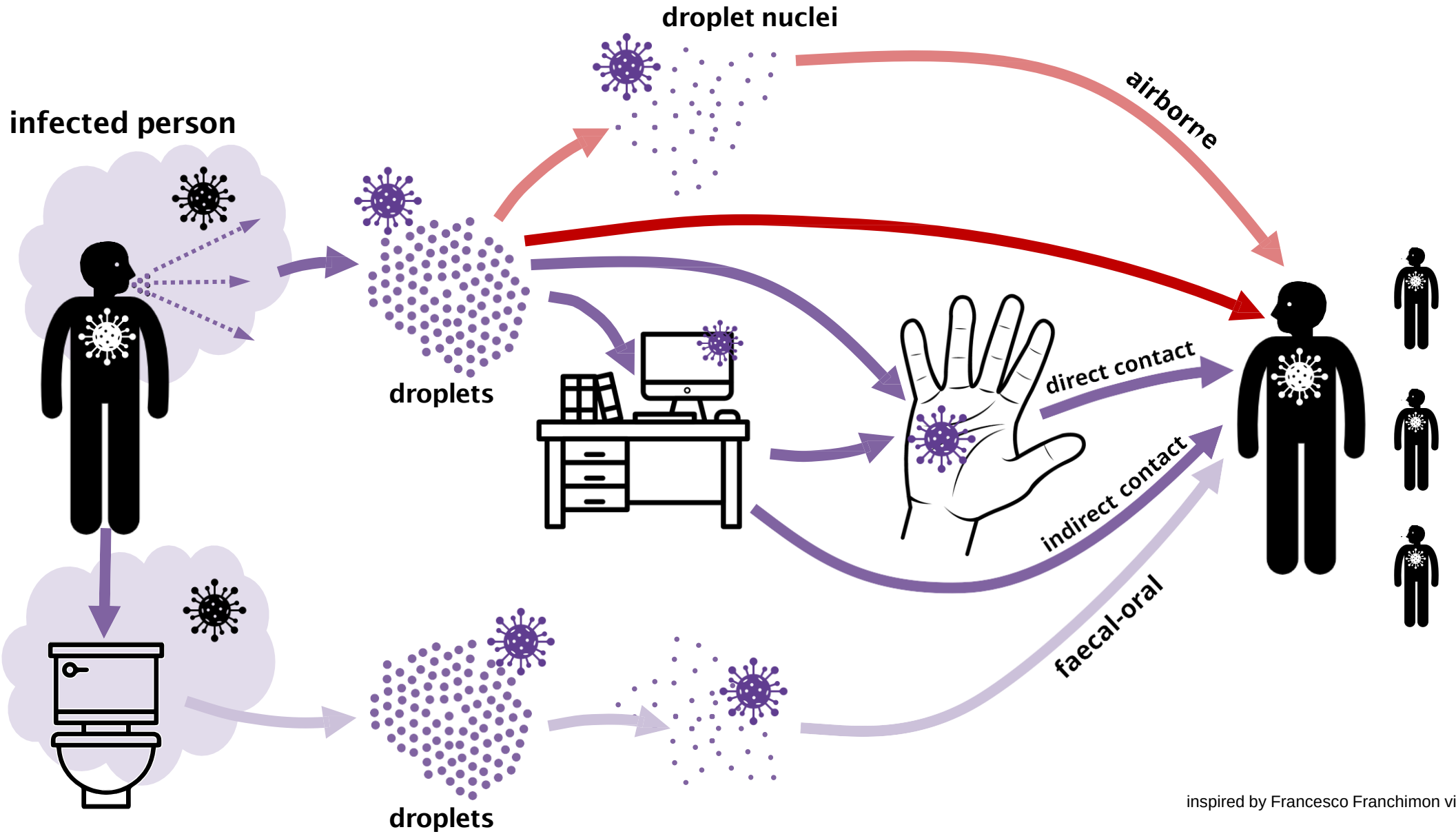
Adapting ventilation in response to COVID.

INTEGRAL



Scientific understanding of COVID is evolving.
We are not medical doctors or epidemiologists.

Ventilation and COVID-19

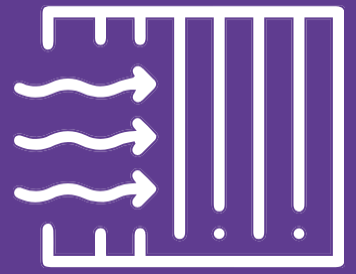


inspired by Francesco Franchimon via REHVA

INTEGRAL

Maximize Ventilation

Minimize Recirculation



Optimize Filtration

INTEGRAL

Ventilation and COVID-19

Existing Buildings:

- In-person audit of existing systems
- Validate system operation & control sequences
- Tailor solutions to fit systems and usage

New Buildings:

- Natural ventilation & Outdoor spaces
- Re-consider system types and zoning
- CFD for spaces in new buildings

INTEGRAL

City of Chula Vista Sustainability Series

Questions?

Calina Ferraro, PE
Principal, San Diego
cferraro@integralgroup.com

INTEGRAL

City of Chula Vista
Sustainability Series

Residential Ventilation in California

Rich Williams

Vice President, Alliance Green Builders

December 2020

AGB
ALLIANCE GREEN BUILDERS

CALIFORNIA CODE for RESIDENTIAL VENTILATION

2019 Building Energy Efficiency Standards:

4.6 Indoor Air Quality and Mechanical Ventilation

The 2019 Energy Standards include requirements for **mandatory mechanical ventilation** intended to improve indoor air quality (IAQ) in homes… and ventilation systems that **provide outside air** to the occupiable space of a dwelling.

As specified by §150.0(o), single-family detached dwelling units, and multifamily attached dwelling units **must meet the requirements of ASHRAE Standard 62.2-2016**

ASHRAE 62.2 – 2016

(American Society of Heating, Refrigeration, and Air Conditioning Engineers)

1) CFM = (0.03 x Floor Area) + (7.5 x (Number of Bedrooms + 1)

example: (0.03 x 3,000sq.*ft.) + (7.5 x (3-bedrooms +1)) = 120 CFM*

90 + (7.5 x 4)

90 + 30

~~2) Single Family Infiltration Credit, not available for multi-family:~~

~~Infiltration = Conditioned Volume x 2-ACH50/60~~

There's no need to fear, your CF1R is here!

CERTIFICATE OF COMPLIANCE

Project Name: EPB Residence Revised
Calculation Description: Title 24 Analysis

Calculation Date/Time: 2020-08-12T15:55:46-07:00
Input File Name: EPBrev.ribd19x

IAQ (INDOOR AIR QUALITY) FANS

01	02	03	04	05	06
Dwelling Unit	IAQ CFM	IAQ Watts/CFM	IAQ Fan Type	IAQ Recovery Effectiveness (%)	IAQ Recovery Effectiveness - SREIAQ Recovery Effectiveness - SRE
SFam IAQVentRpt 1-1	100	0.25	Balanced HRV	51	n/a

PROJECT NOTES

Energy Pro uses Ashrae for HVAC design.

Revised roof areas with the R-22 min and pos 4.

Ran 64-67 w 62 episodes / Syndication to 74

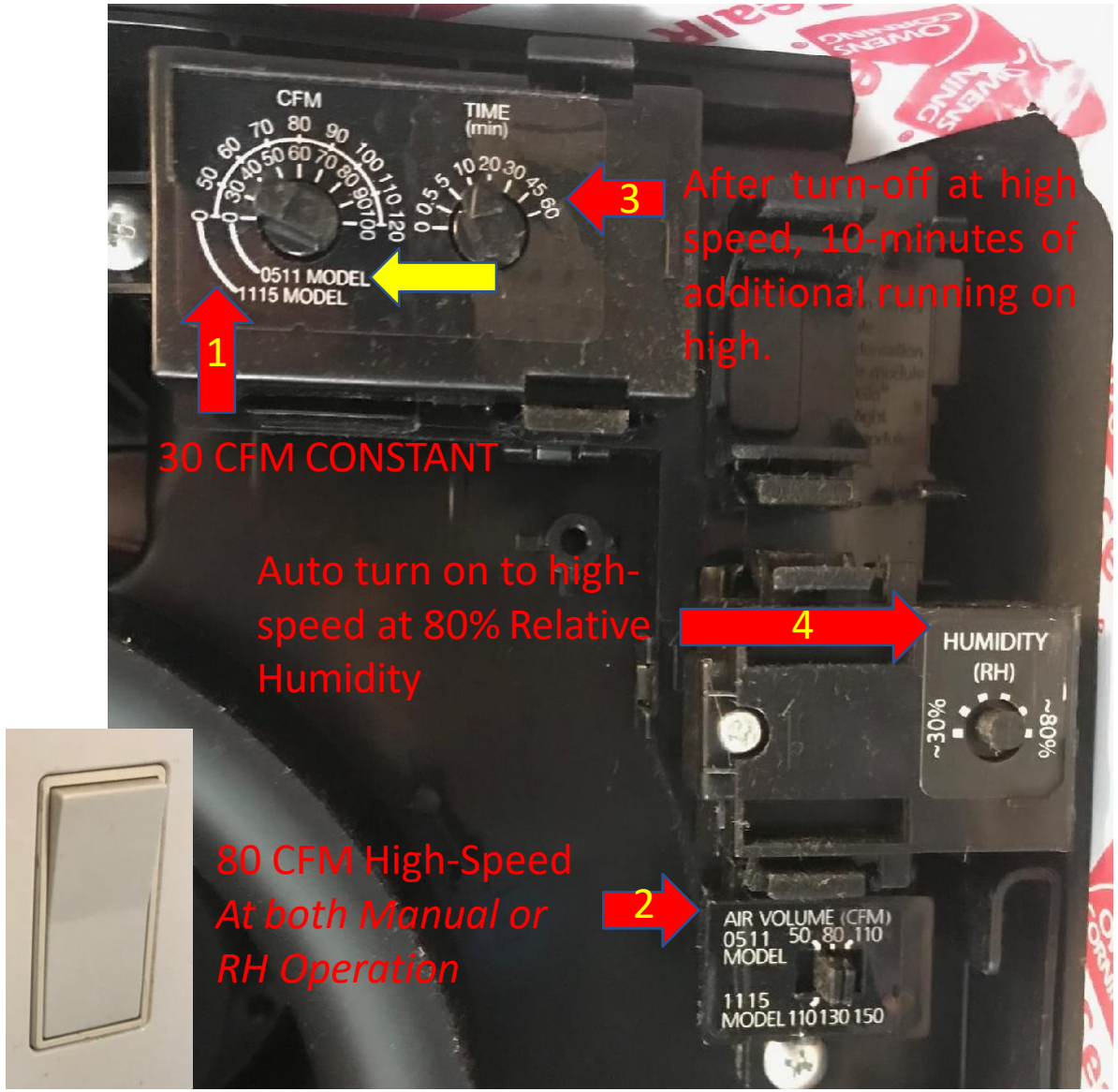
ASHRAE options for Continuous Mechanical Ventilation

- Exhaust-Only, ~~or Supply Only~~:
  - 2-Speed Bath Fans for Exhaust-Only Ventilation
  - Requires Infiltration through building envelope, or alternatively supply air from “passive inlets”

- Balanced Ventilation
  - Heat Recovery Ventilators (HRV) or Energy Recover Ventilators (ERV)
  - Allows for elimination of bath fans & laundry fan

EXHAUST-ONLY VENTILATION *with 2-Speed Bath Fans*

EXHAUST-ONLY VENTILATION *with 2-Speed Bath Fans*



EXHAUST-ONLY VENTILATION *with 2-Speed Bath Fans*

PROS:

- Inexpensive strategy to meet code
- Generally works OK, it's better than nothing!

CONS:

- Noisy (motors ramp up speed to achieve required airflow)
- Fan grilles require constant cleaning
- Sucking "fresh air" through the building envelope (uncontrolled infiltration)
- Doesn't provide IAQ anywhere near as well as balanced ventilation does.

EXHAUST-ONLY VENTILATION *with 2-Speed Bath Fans*

Addressing uncontrolled infiltration: "Passive Inlets" to provide control for supply-air locations.

CONS:

- *Max 18 CFM airflow and thus requires several locations.*
- *Where to locate to dump unconditioned air?*
- *Minimal filtration, but filters still require frequent cleaning in order to provide adequate airflow.*

EXHAUST-ONLY VENTILATION
with 2-Speed Bath Fans

That was then, this is now…

- California is trying to move us away from lousy exhaust-only ventilation and towards balanced ventilation (using HRV's and ERV's), as well as encouraging us to build tighter building envelopes.
- As of January 1, 2020 the T24 Energy Modeling is providing a significant credits for 1) incorporating HRV's and ERV's into projects, and 2) making buildings more airtight.
- ***AND*** the Energy Modeling provides a much bigger credit by incorporating **BOTH** HRV/ERV's **+** making buildings more airtight (providing a "superbump" in credits.)

Building Science 101: "Build Tight, Ventilate Right"

HRV's and ERV's:
OPTIMUM VENTILATION STRATEGY FOR IAQ

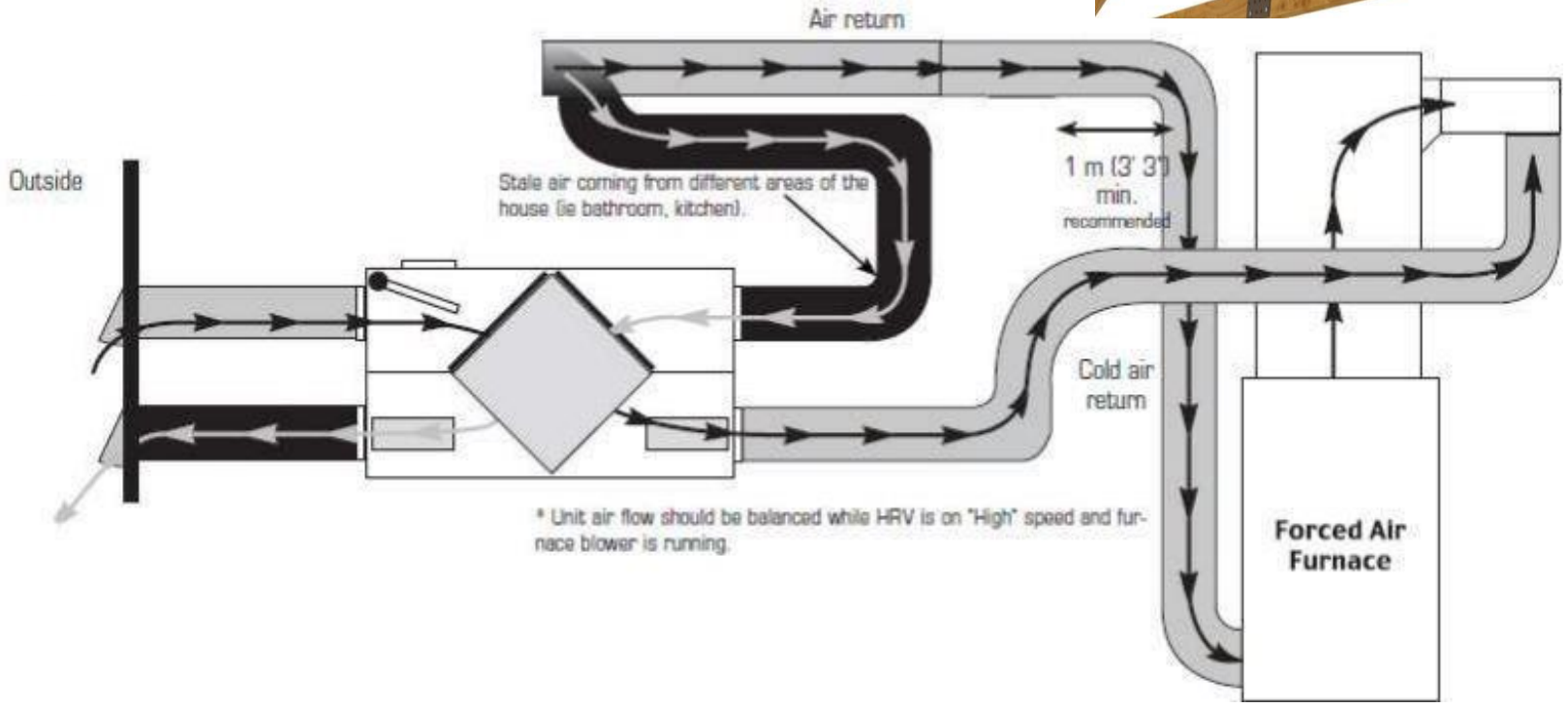
Balanced ventilation that exhausts "stale" air and provides fresh, filtered supply air directly from outdoors.

HRV'S and ERV'S

Heat Recover Ventilator (Sensible Heat Exchange Only) or Energy Recovery Ventilator (both Sensible and Latent Heat Exchange.)

Can be either a Dedicated Stand-Alone HRV/ERV System, or it can be incorporated into the forced-air system.

HRV incorporated into forced-air system



HRV incorporated into forced-air system

PROS:

- Relatively inexpensive and quick to install

CONS:

- Uses the return(s) for exhaust, and therefore as *controlled* as a dedicated, stand-alone system which exhausts only from "wet" areas and supplies only to "living" areas.
- Not as *balanced* as a dedicated, stand-alone system which has adjustable ports to provide airflow suitable to spaces.

Dedicated, Stand-Alone ERV

Dedicated, Stand-Alone ERV

Dedicated, Stand-Alone HRV

Low-Cost “Paired HRV” systems

15-20 CFM Per Pair

2,852 sq.ft SFR requiring 59 cfm, with 3 x Pairs providing 60 cfm

1,200 sq.ft ADU requiring 34.5 cfm, with 2 x Pairs providing 40 cfm

Dedicated, Stand-Alone ERV

PROS:

- Provides the bees knees for optimum indoor air quality, exhausting air we want to exhaust and bringing fresh, filtered air to where we need it most.
- Provides excellent distribution of fresh air throughout a structure.

CONS:

- Can be expensive… but then again what is the value of healthy air?
- Whole-House Systems are complex to install, hard to find installers who know how to do it properly.
- Requires adequate spaces for equipment to be housed.
- Low-Cost “Paired HRV” Systems still require bath and laundry fans, which would in turn require an integrated make-up air system (adding more $$$)

Grateful Clients

You don’t know what you’ve got til it’s gone

City of Chula Vista
Sustainability Series

Thank you!

Questions?

Rich Williams

Rich@AllianceGreenBuilders.com

AGB
ALLIANCE GREEN BUILDERS

City of Chula Vista Sustainability Series

Indoor Air Quality, Strategies for **Residential** and Non **Residential** Buildings

Joe Medosch

Healthy Building Scientist @ Hayward Score

December 2020

HAYWARD™ SCORE

SO YOU CAN FEEL BETTER

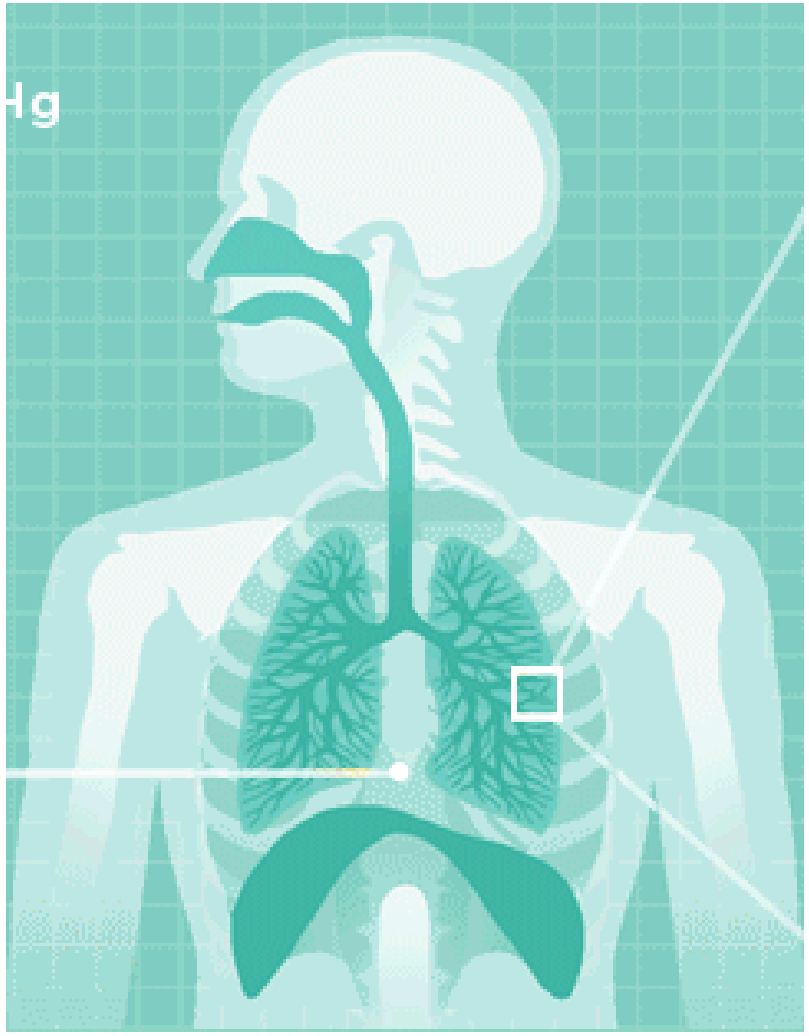
What are you breathing?

*Lawrence Berkley Labs (LBL) MERV 8-13

Air Leakage / Infiltration = Exposure pathway

What are you breathing?

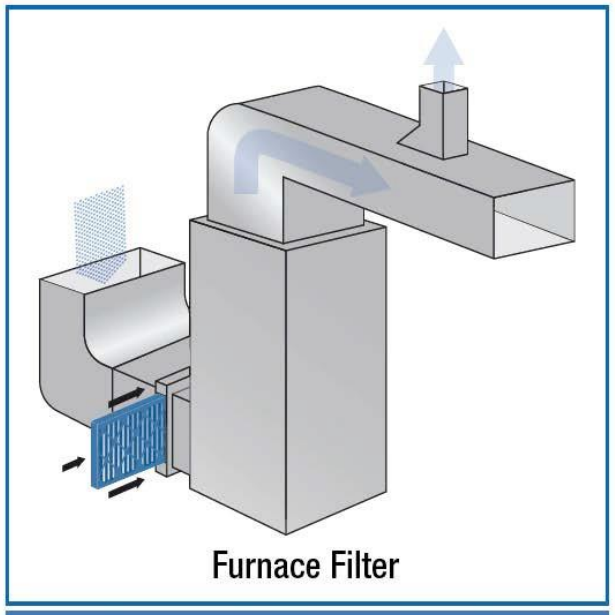
10’ x 10’ x 4’



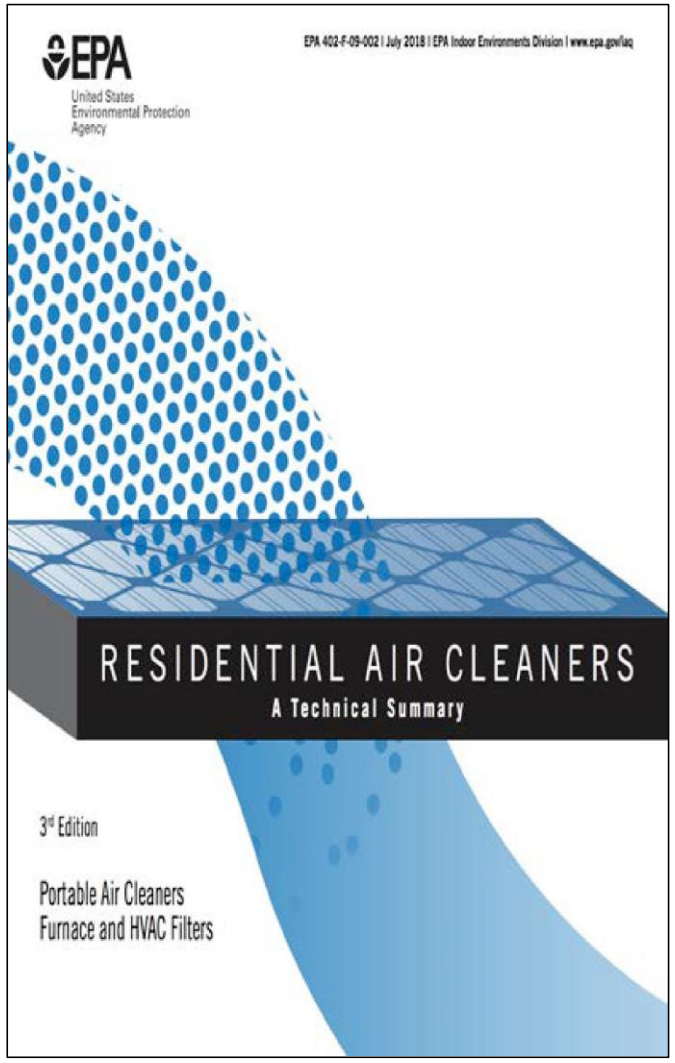
3000 gallons of air every day.

FURNACE AND HVAC SYSTEM FILTERS

Furnace and HVAC filters work to filter the air only when the system is operating. In most cases, HVAC systems run only when heating or cooling is needed (usually less than 25% of the time during heating and cooling seasons). In order to get more filtration, the system would have to run for longer periods. This may not be desirable or practical in many cases since longer run times increase electricity costs and may also result in less reliable humidity control during the cooling season.



Furnace or HVAC filter—Select a filter rated at least MERV 13 or as high as your system will accommodate.



Air Handler Upgrade

16x25x1 MERV 12

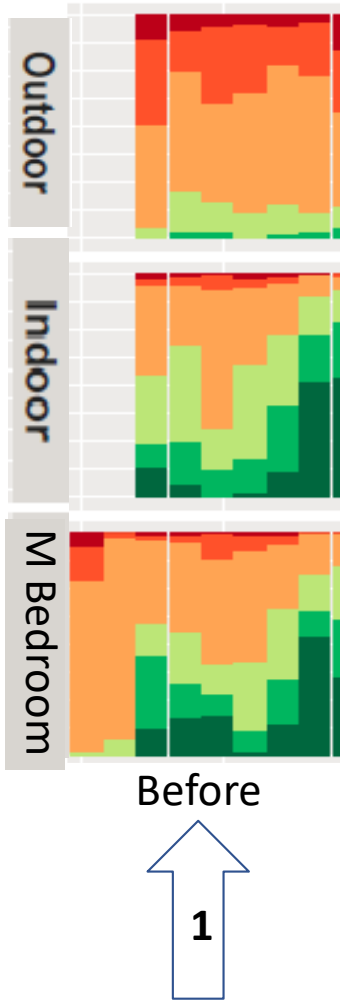
20x25x4 MERV 13

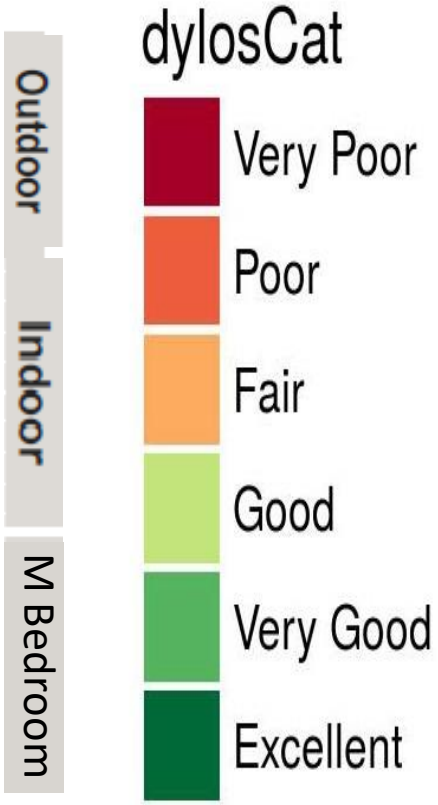
CASE STUDY: Indoor Air Quality Interventions
Chris Guignon, evolveEA

Source: Linda Wigington

24/7 Air Handler w High MERV Filter

1) Using existing 1” pleated filter





Before

1

Dylos particles ≥0.5 µm

Date
(by periods of 3 weeks)

CASE STUDY: Indoor Air Quality Interventions
Chris Guignon, evolveEA

Source: Linda Wigington

24/7 Air Handler w High MERV Filter

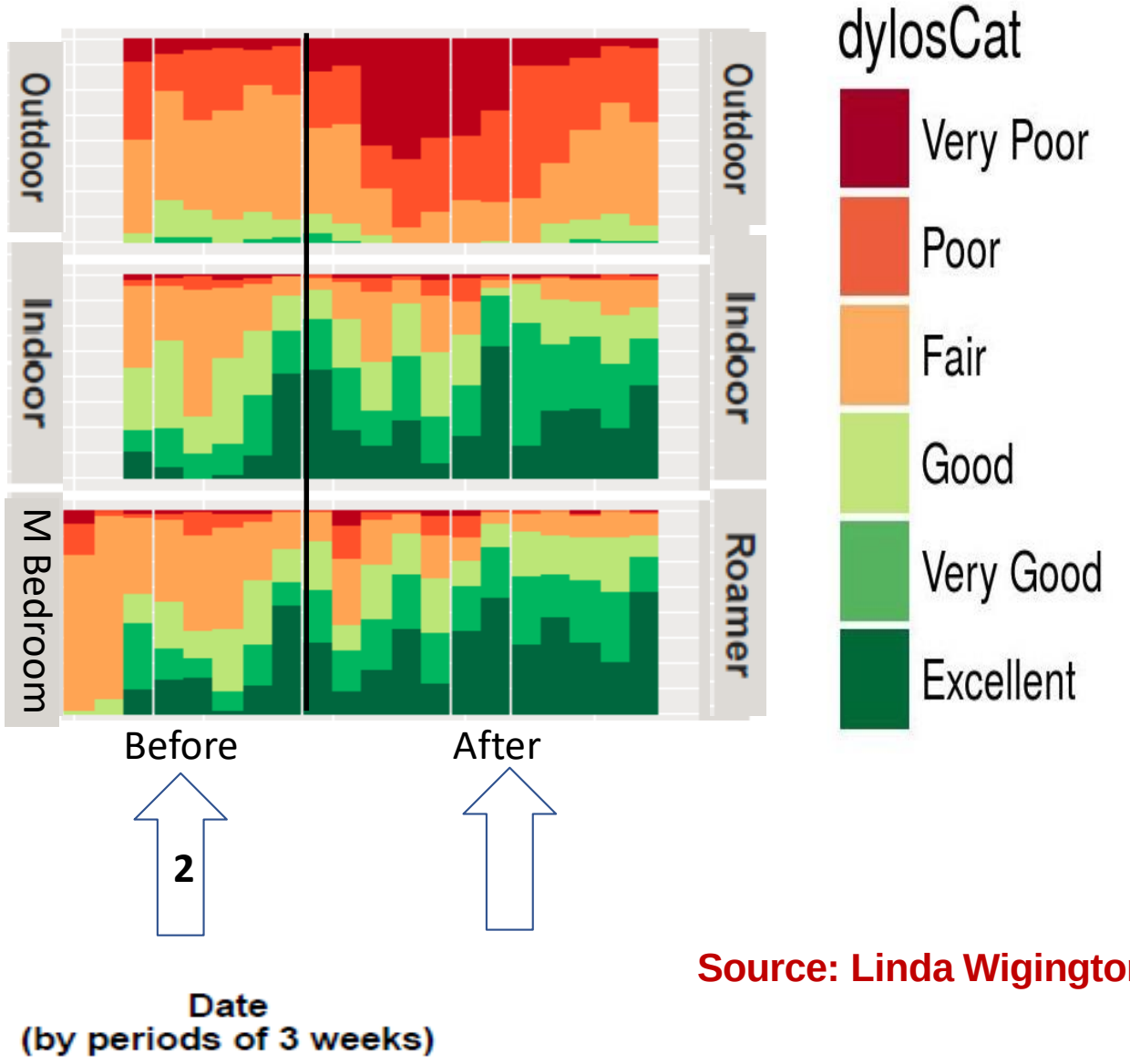
1) Using existing 1” pleated filter

2) Return drop modification

w/ turning vanes

4”, 20”x 25” MERV 13 filter

Dylos particles ≥0.5 µm



Source: Linda Wigington

CASE STUDY: Indoor Air Quality Interventions
Chris Guignon, evolveEA

HAYWARD™ SCORE

SO YOU CAN FEEL BETTER

FREE Tool for Occupants

~80,000 Individual Scores

www.HaywardScore.com

House Type

Occupant Behaviors

Occupant Health Symptoms

Determine if your home is impacting your health!

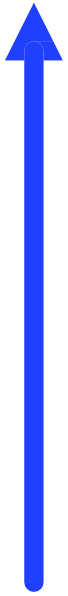
SUSTAINABILITY SERIES

HAYWARD SCORE

Hayward Score calculates a proprietary "Score" based on the occupants answers

Higher Score = Healthier Home = Less symptoms

Healthier



Hayward Score	# of Symptoms
92	3.9
79	4.7
58	6.2
28	8.2

Post Hayward Score Follow up Responses

	Made Changes	No Changes	Moved	n
Owner	199	125	2	326
Renter	102	70	28	200
	301	195	30	**526**

57% Made Changes

61% Owners Made Changes

51% Renters Made Changes

6% Moved

1% Owner Moved

14% Renters Moved

Roughly half of the respondents took action and made changes. Owners were a little more likely to make changes.

What did they do?

57% of Follow up respondents indicated they made a change.

Replaced Furnace Filters	45%
Did Testing	**29%**
Added Air Purifiers	24%
Fixed Leaks	23%
Removed Mold	21%
Replaced Vacuum	21%
Added HRV	**17%**
Removed Carpets	16%
Reduced Chemical Exposure	15%
Cleaned Ducts	**14%**
Added Humidifiers	**12%**
Added Dehumidifier	**11%**
Installed Exhaust Fans	**9%**
Completed Maintenance	8%
Sealed Crawlspace	**5%**

SUSTAINABILITY SERIES

HAYWARD SCORE

Post Hayward Score Follow up Responses

Respiratory Symptoms Improved

Sinus Congestion	67%
Coughing	50%
Allergies	48%
Trouble Sleeping	38%
Other	16%

Non- Respiratory Symptoms Improved

Feeling Sick	50%
Sore Throat	33%
Freq Headaches	26%
Infrequent Headaches	26%
Depressed	24%
Nausea	22%
Dry Eyes	22%
Extreme Fatigue	22%
Night Sweats	20%

Self-reported Improved Symptoms

How energy efficiency can reduce health risks

Insulation
Air Sealing

Heating System Upgrades

Ventilation
Vent Dryers

Efficient Cooking Appliances

→ Warmer drier air, improved indoor temperatures & relative humidity

→ <u>Less</u> moisture, mold, particulates, pollutants, combustion by-products, allergens

→ Lower bills, better comfort

→ Fewer heat or cold related deaths

→ Less hypertension, heart disease

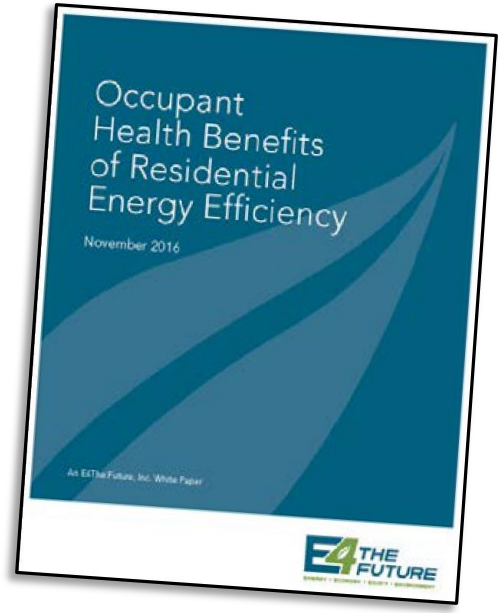
→ **Fewer asthma symptoms, respiratory risks, COPD**

→ Fewer heart disease risks

→ Fewer cancer risks due to radon, formaldehyde, other sources

→ Less stress, better mental health

Reduced hospital and medical visits

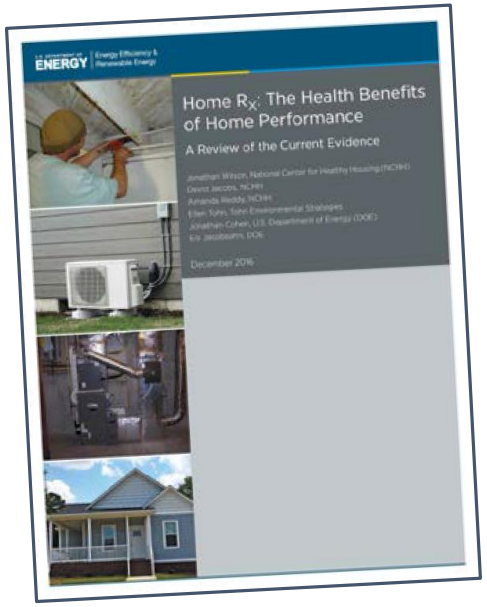


https://e4thefuture.org/wp-content/uploads/2016/11/Occupant-Health-Benefits-Residential-EE.pdf

Air Sealing, Thermal upgrades and Heating Tune-Up

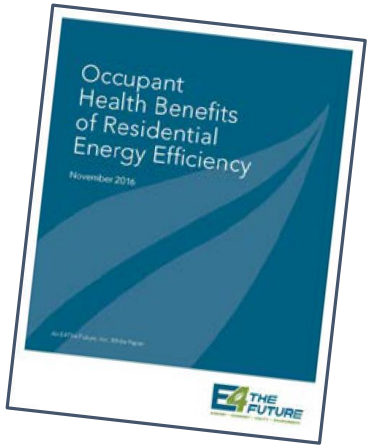
Conditions Reduced with education and upgrades

gases and particulates
occupants use less medications
dampness
mold
risk of cancer
arthritis
depression
energy bills
pollutants
days off work / school
cardiovascular issues
dust mites - known to cause asthma
asthma triggers and contaminants that cause symptoms
use of chemicals



Improvements

savings / more income
general health
mental health
lower respiratory symptoms
blood pressure/hypertension or other
upper respiratory symptoms and headaches.
cooler climates improve comfort with less humidity
human health by reducing thermal stress
daily exposure to cleaner air
less stress and worry about “unknown” indoor air



most studies recommended IAQ Testing

Better quality of life

Remember for these health impacts it’s about long-term health impact and long-term costs in health care $$ and quality of life.

Energy Audit

- Determine infiltration / air leakage
- Used to calculate T24
- Find air leakage location
- Measure ZPD
- Air leakage = heat transfer

Blower Door Test

Healthy Home Assessment

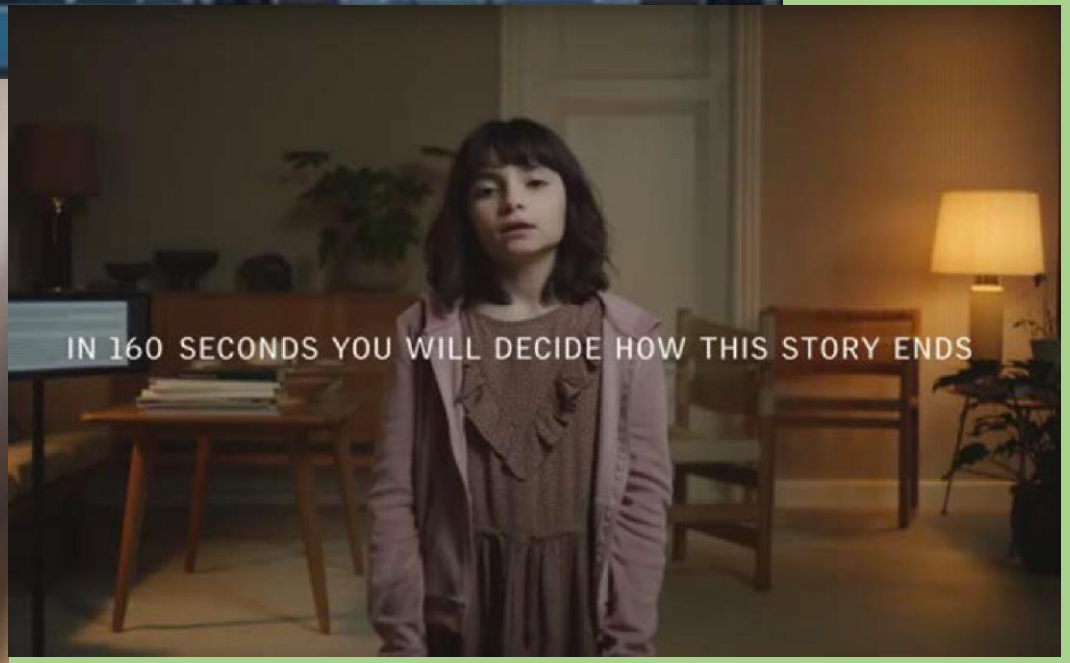
- **Exposure pathway measurement device**
- Measure connectivity between locations with contaminants like garage, attic and crawlspace
- Tighter homes can reduce or contain moisture
- Tight homes require enhanced ventilation

SUSTAINABILITY SERIES

NEVER HOME ALONE

From MICROBES to MILLIPEDES,
CAMEL CRICKETS, and HONEYBEES,
the NATURAL HISTORY of WHERE WE LIVE

ROB DUNN



Velux https://youtu.be/ygHU0mQGuJU

City of Chula Vista
Sustainability Series

Thank you!

Questions?

Joe Medosch
Healthy Building Scientist @ Hayward Score

December 2020

HAYWARD™ SCORE
SO YOU CAN FEEL BETTER

www.HaywardScore.com