

 fishbeck

Engineers | Architects | Scientists | Constructors



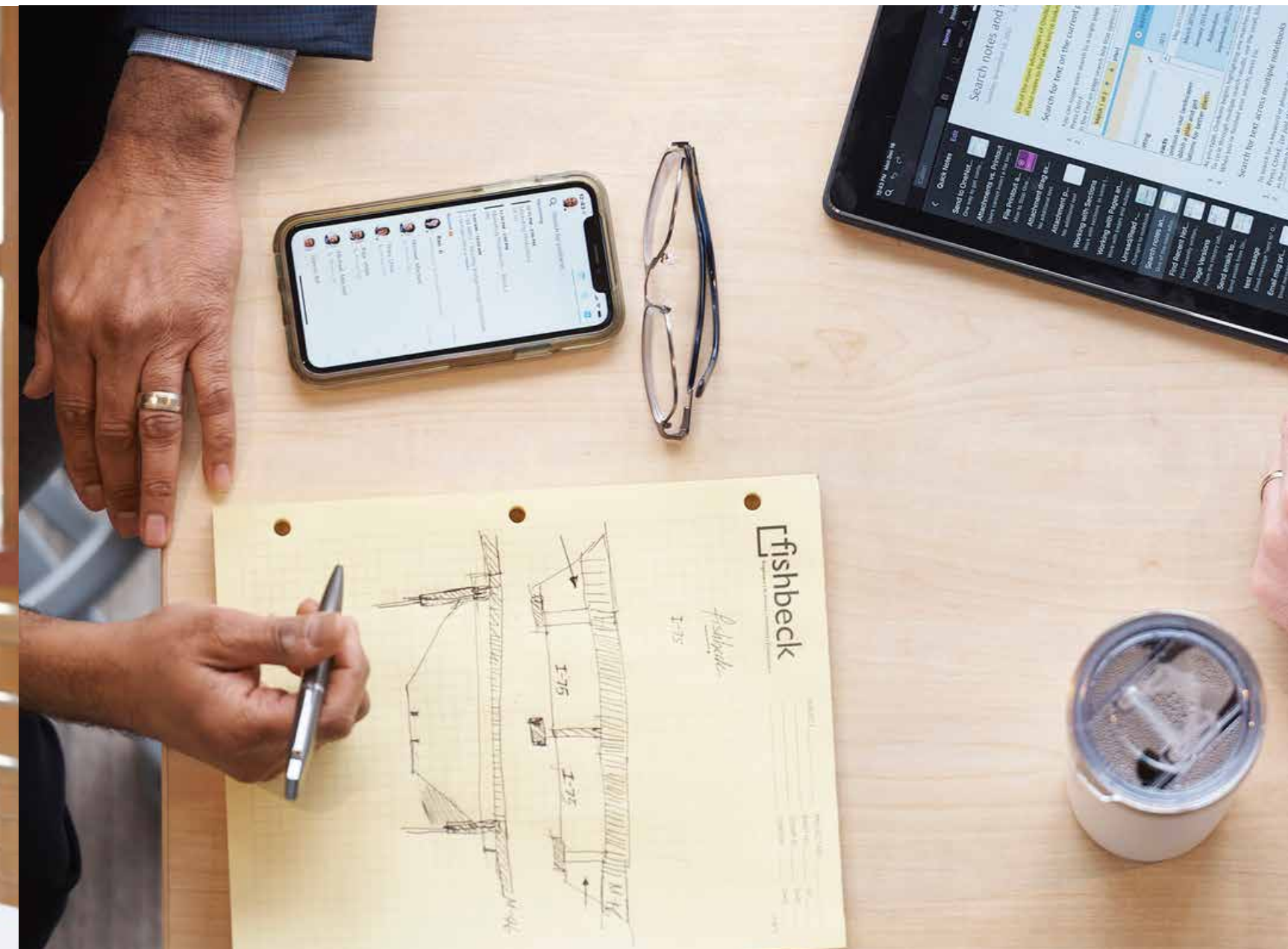
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Senior Mechanical Engineer**

DIVERSITY IN SERVICES

AIR QUALITY ENGINEERS · ARCHITECTS · CHEMICAL ENGINEERS AND CHEMISTS · CIVIL ENGINEERS · CIVIL FIELD ENGINEERS AND INSPECTORS · CONSTRUCTION MANAGERS AND SUPERINTENDENTS · ENVIRONMENTAL ENGINEERS · GEOLOGISTS · GIS ANALYSTS · HYDROGEOLOGISTS · INDUSTRIAL HYGIENISTS · INTERIOR DESIGNERS · MECHANICAL, ELECTRICAL, AND STRUCTURAL ENGINEERS · OCCUPATIONAL SAFETY AND HEALTH MANAGERS · PROJECT MANAGERS · SURVEYORS · TRANSPORTATION ENGINEERS · WATER AND WASTEWATER ENGINEERS



A large industrial fan is the central focus, with its circular metal grille and central motor housing clearly visible. The fan is set against a background of a mechanical room, with other fans and structural elements visible in the distance. The entire image is overlaid with a semi-transparent blue filter. The text is centered over the fan's motor housing.

FACILITY MECHANICAL STRATEGIES FOR COVID-19

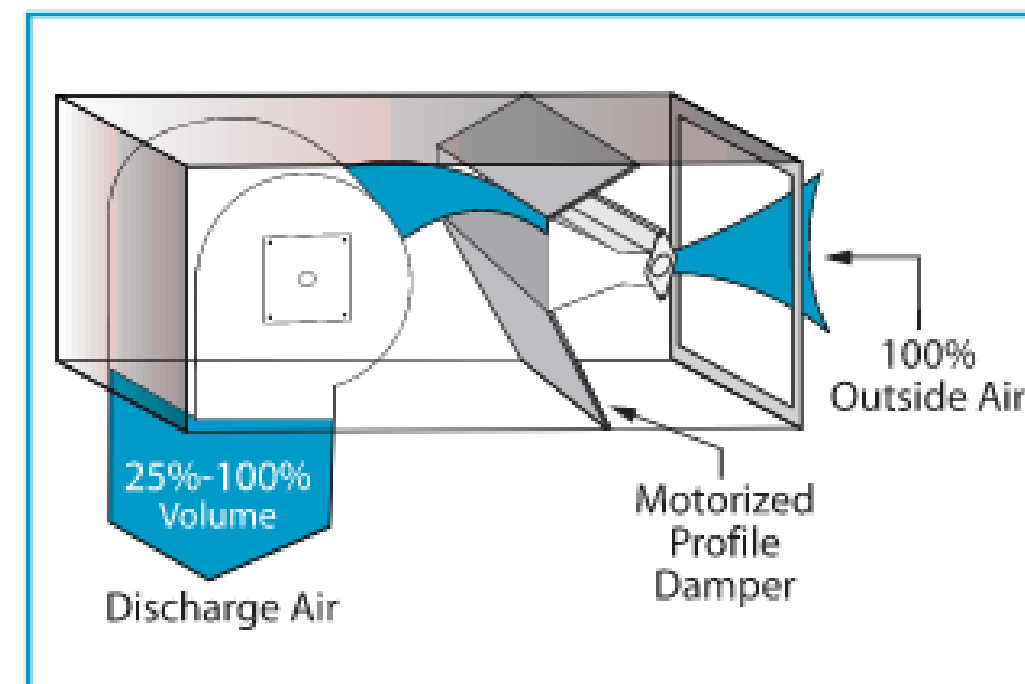
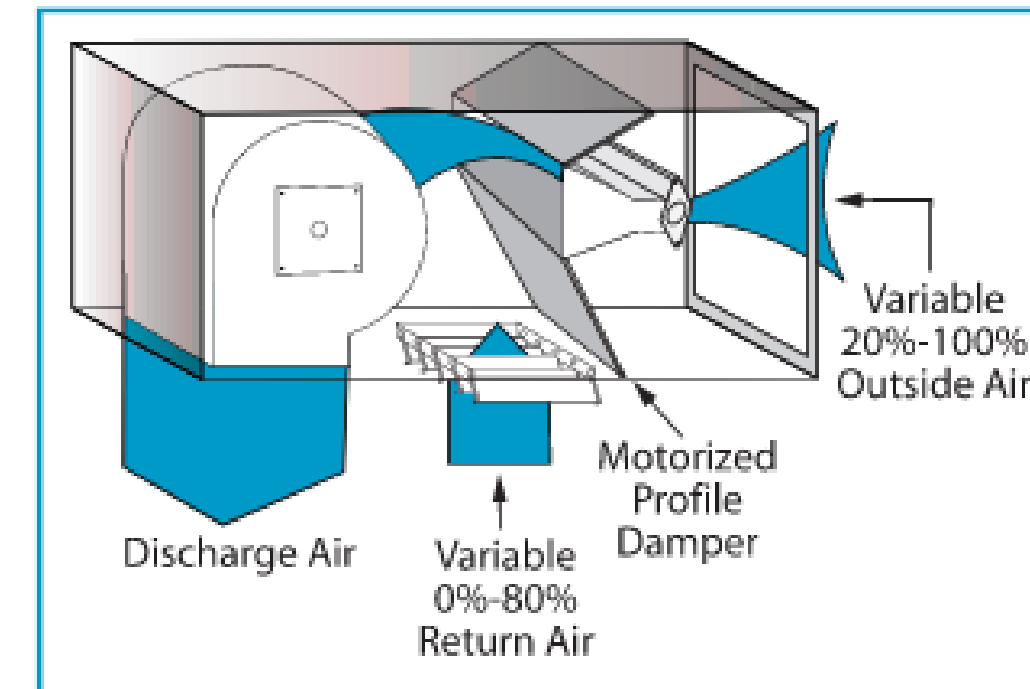
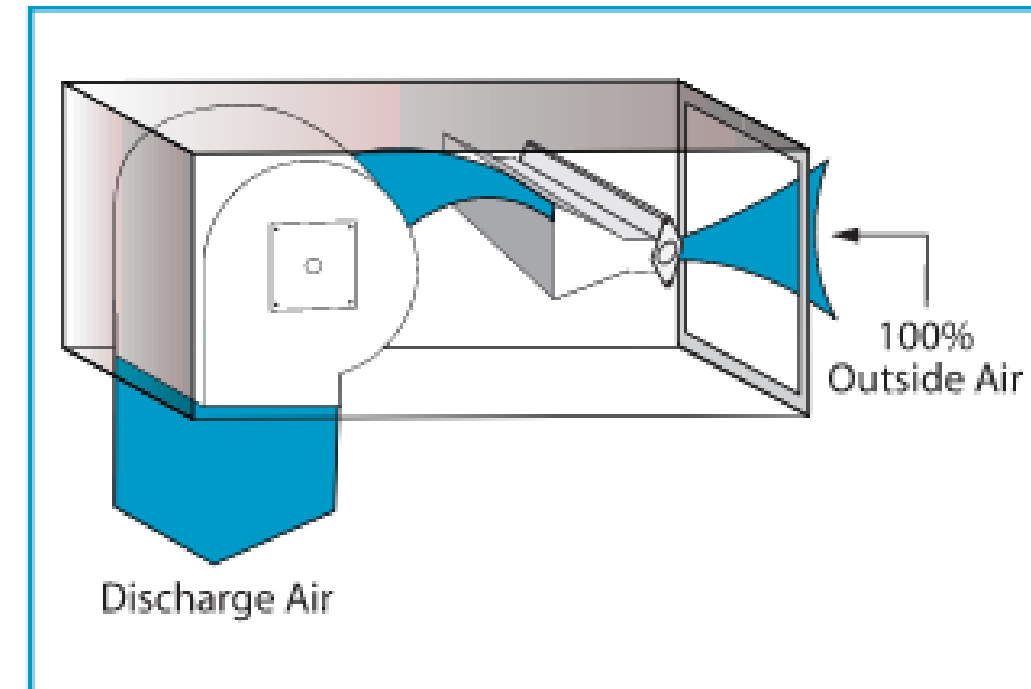
ENGINEERING CONTROLS

- Ventilation
- Filtration
- Disinfection
- Humidity control
- Bipolar ionization





ENGINEERING CONTROLS



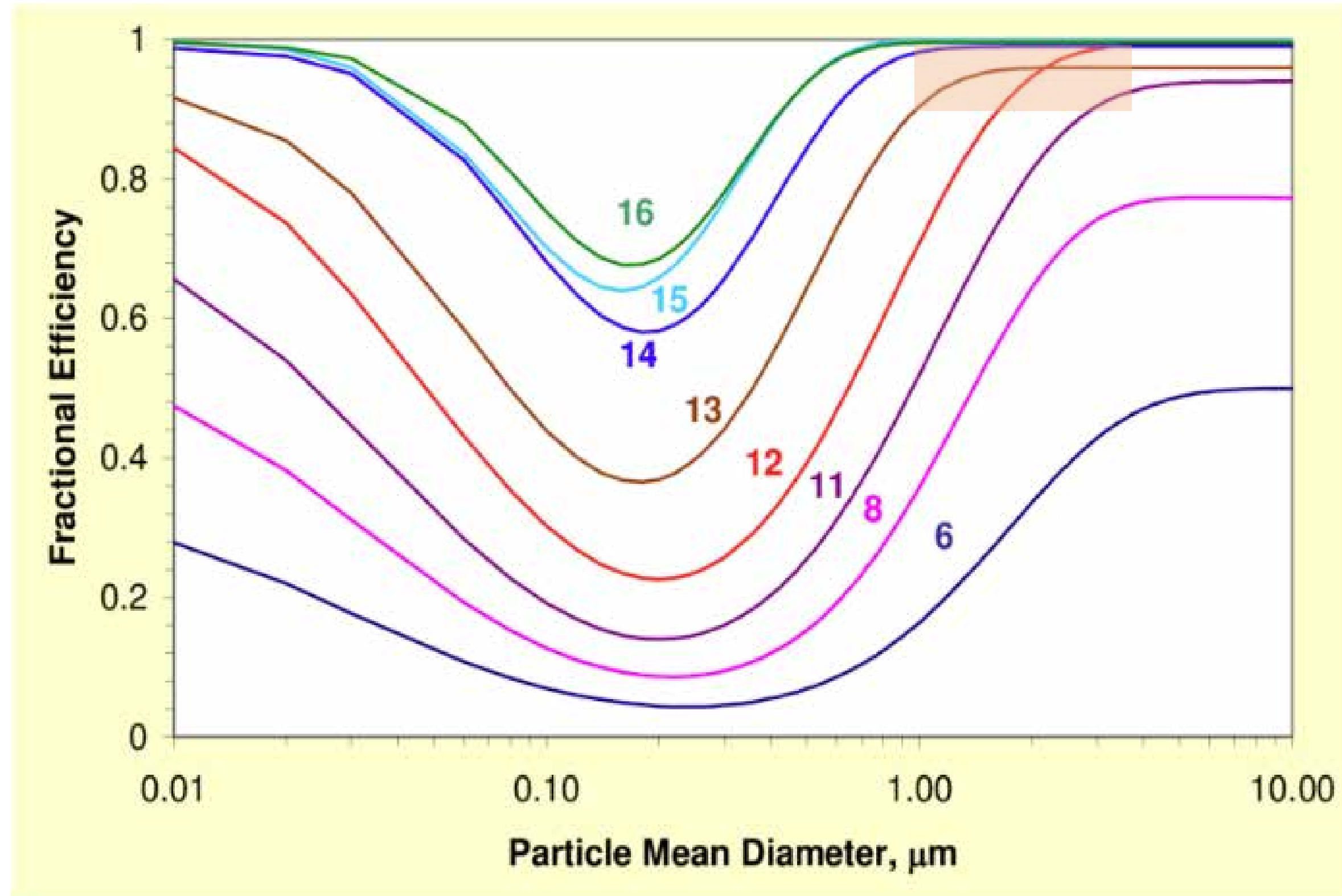
Ventilation

- Outdoor air dilutes contaminants
- Can be energy intensive
- Needs to be coordinated with exhaust and pressurization strategies to isolate/contain
- Not feasible with some HVAC system types



ENGINEERING CONTROLS

Filtration



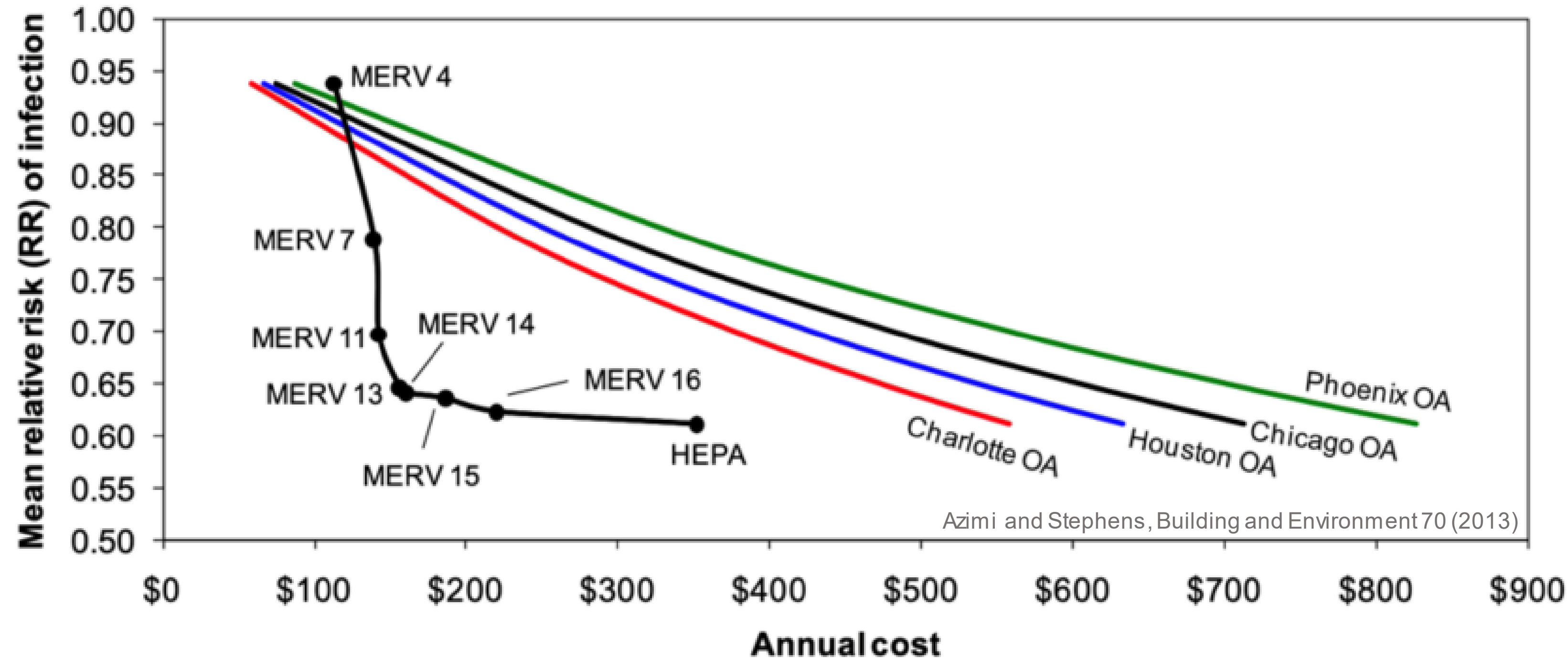
Kowalski and Bahnfleth, Pennsylvania State University (2002)

- ASHRAE 52.2 defines Minimum Efficiency Reporting Value (MERV)
- Particle fraction removed is efficiency
- Higher MERV values = higher efficiency
- Requires air recirculation
- Most existing systems use MERV 8 filters based on minimum standards
- MERV 13 and higher \geq 90% efficiency at droplet nuclei size

ENGINEERING CONTROLS

Filtration

- Based on hypothetical office model
- MERV 13 and 14 filters provide low risk at least cost
- HEPA filters provide 4% lower relative risk at double the cost



ENGINEERING CONTROLS

Filtration

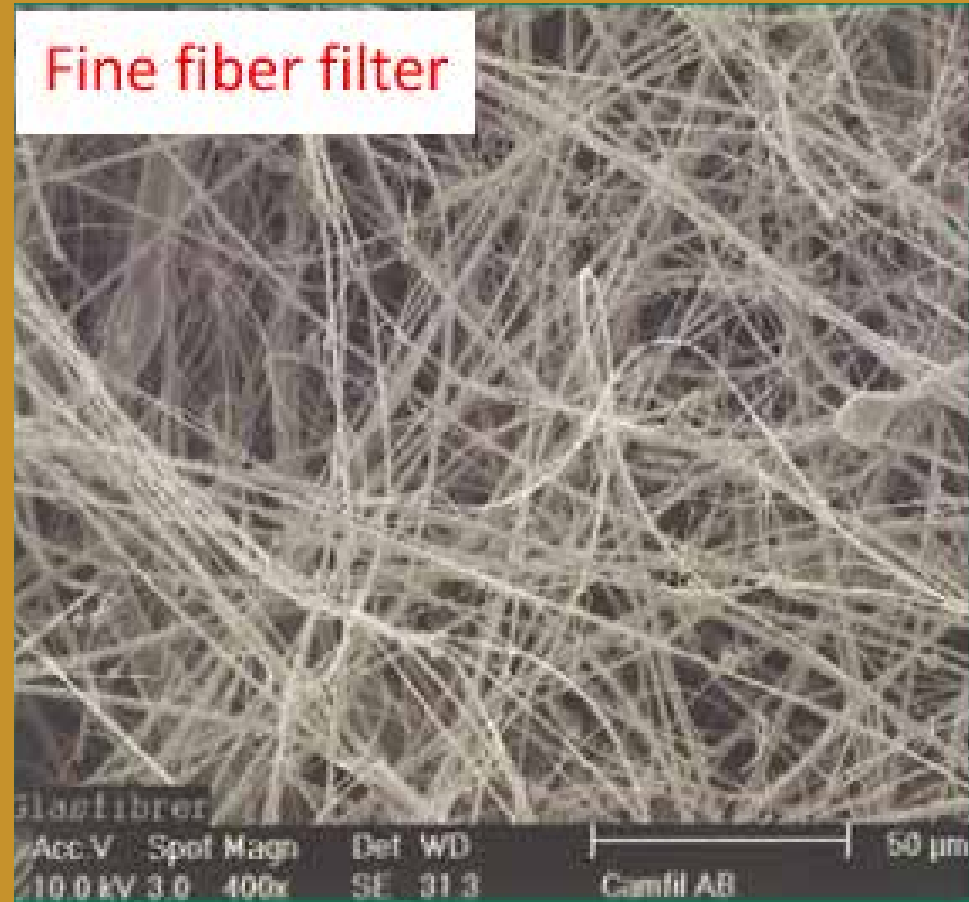
MERV 13 Filter

Not all filters are created equal

- Typically 12 inches thick
- Fine fibers
- Captures particles through diffusion and interception
- Consistent efficiency throughout filter life

- Typically 2 or 4 inches thick
- Coarse fibers
- Requires charge to attract and hold particles
- As fibers become insulated by contaminants, charge is lost
- Filter efficiency is reduced

Fine fiber filter



Coarse fiber filter w/
electrostatic charge



ENGINEERING CONTROLS

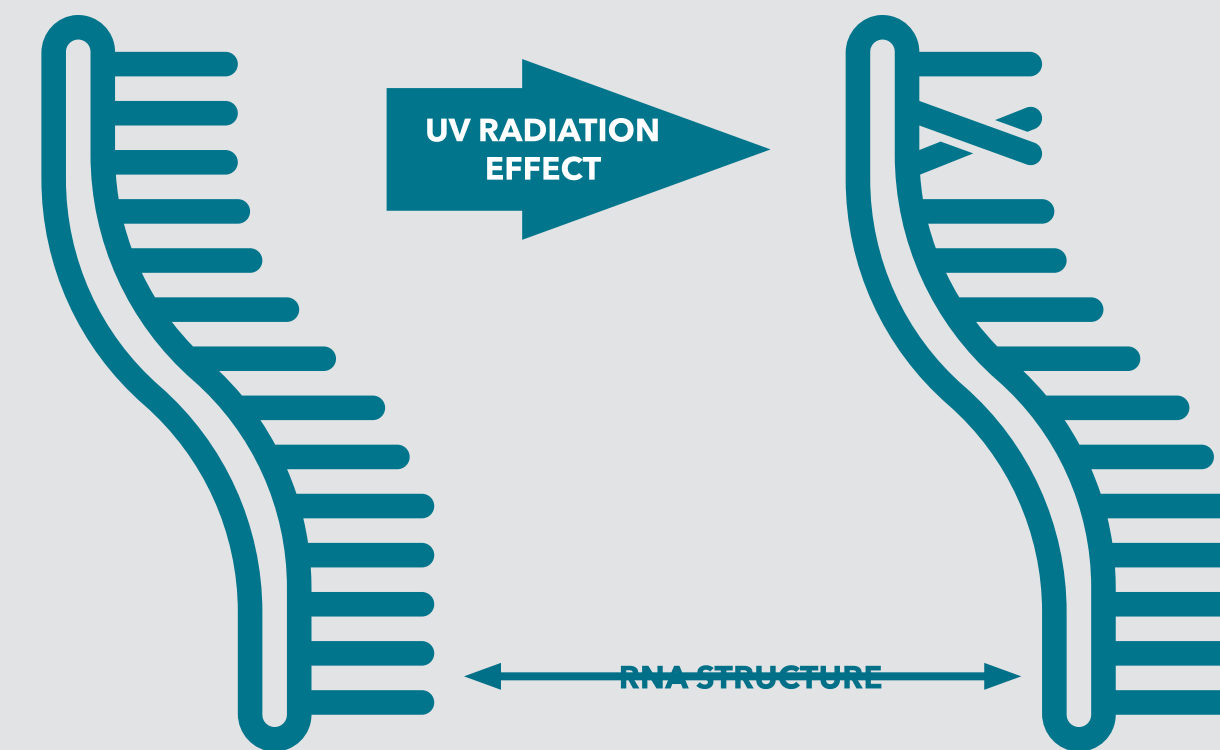


Image courtesy of UV Resources

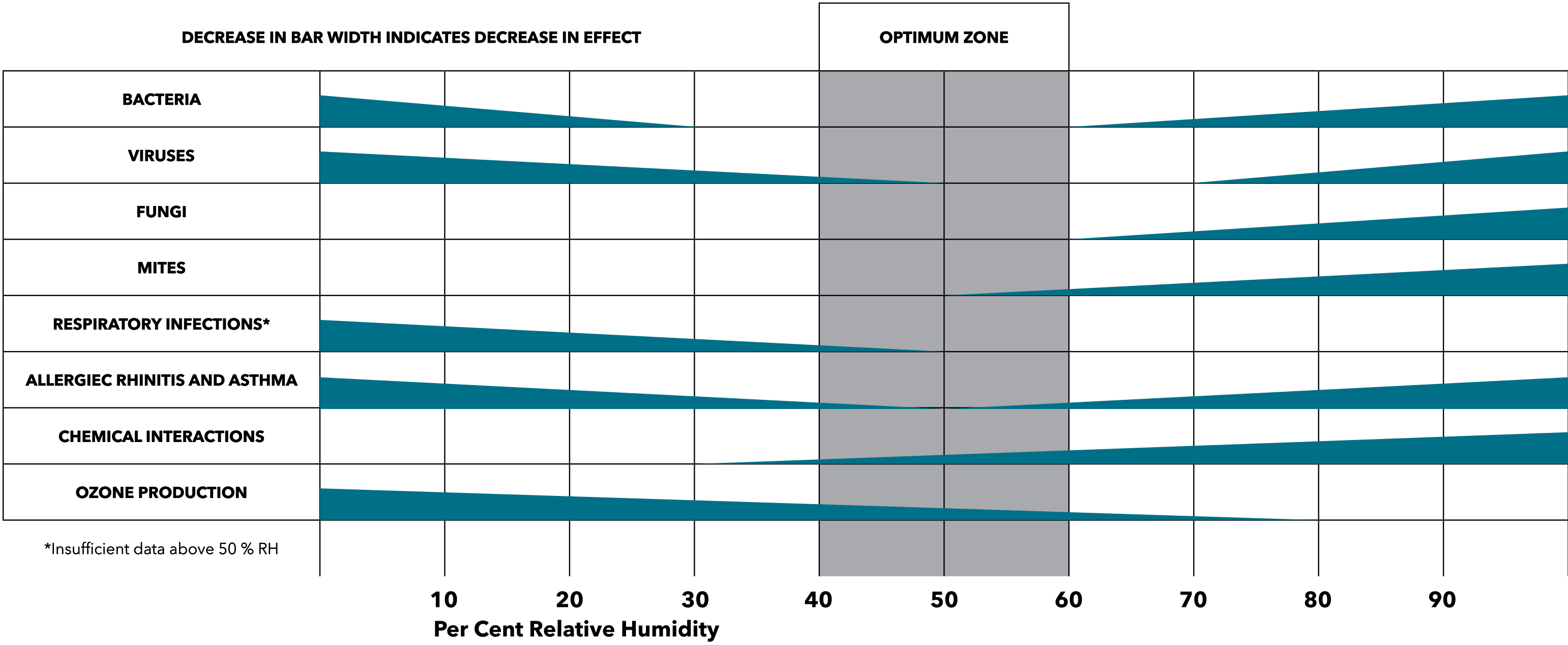
Disinfection

Germicidal UV Light

- Disrupts virus chemical bonds
- Makes virus unviable and unable to replicate
- Used in food, air, and water purification applications inactivating bacteria, viruses, and fungi. Coronavirus susceptibility is good.
- Two treatment types used in HVAC air handlers:
 - Surface: stationary biofilm on cooling coils and drain pans
 - Airborne: particles in airstream
- Well-vetted by CDC



ENGINEERING CONTROLS



Humidity Control

- Most respiratory viruses survive longer at lower RH
- Coronavirus' fatty envelope falls apart in warmer, more humid conditions
- Studies indicate viral infection is reduced between 40 and 60% RH
- Droplets evaporate slower and settle out faster
- Our mucous membranes are less receptive
- Virus is less infective

SAR-CoV-2 AIRBORNE DECAY CALCULATOR

UV INDEX

0 10

2

TEMPERATURE

50 86

70 °F / 21.1 °C

RELATIVE HUMIDITY

20 70

50 %

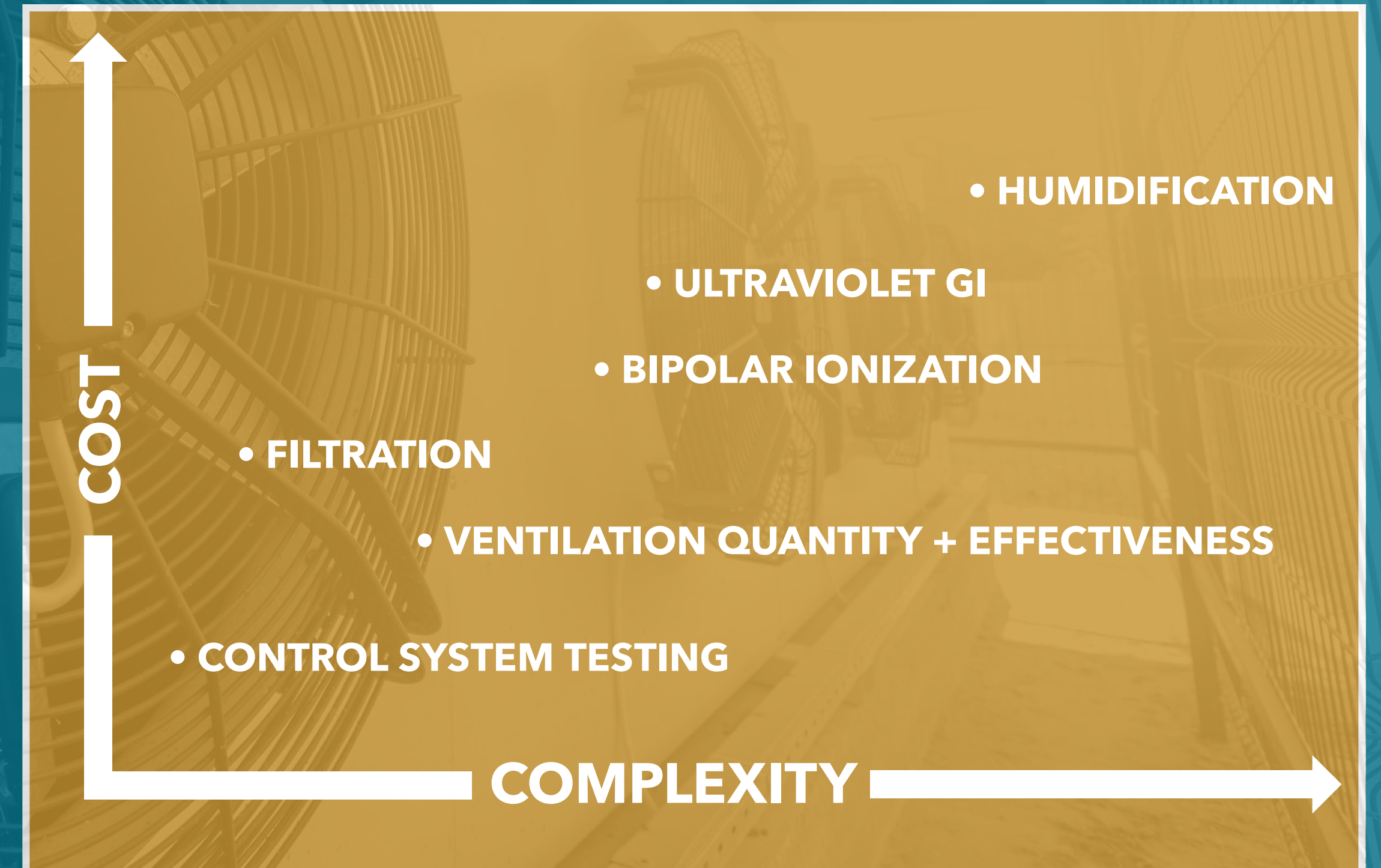
COVID STABILITY

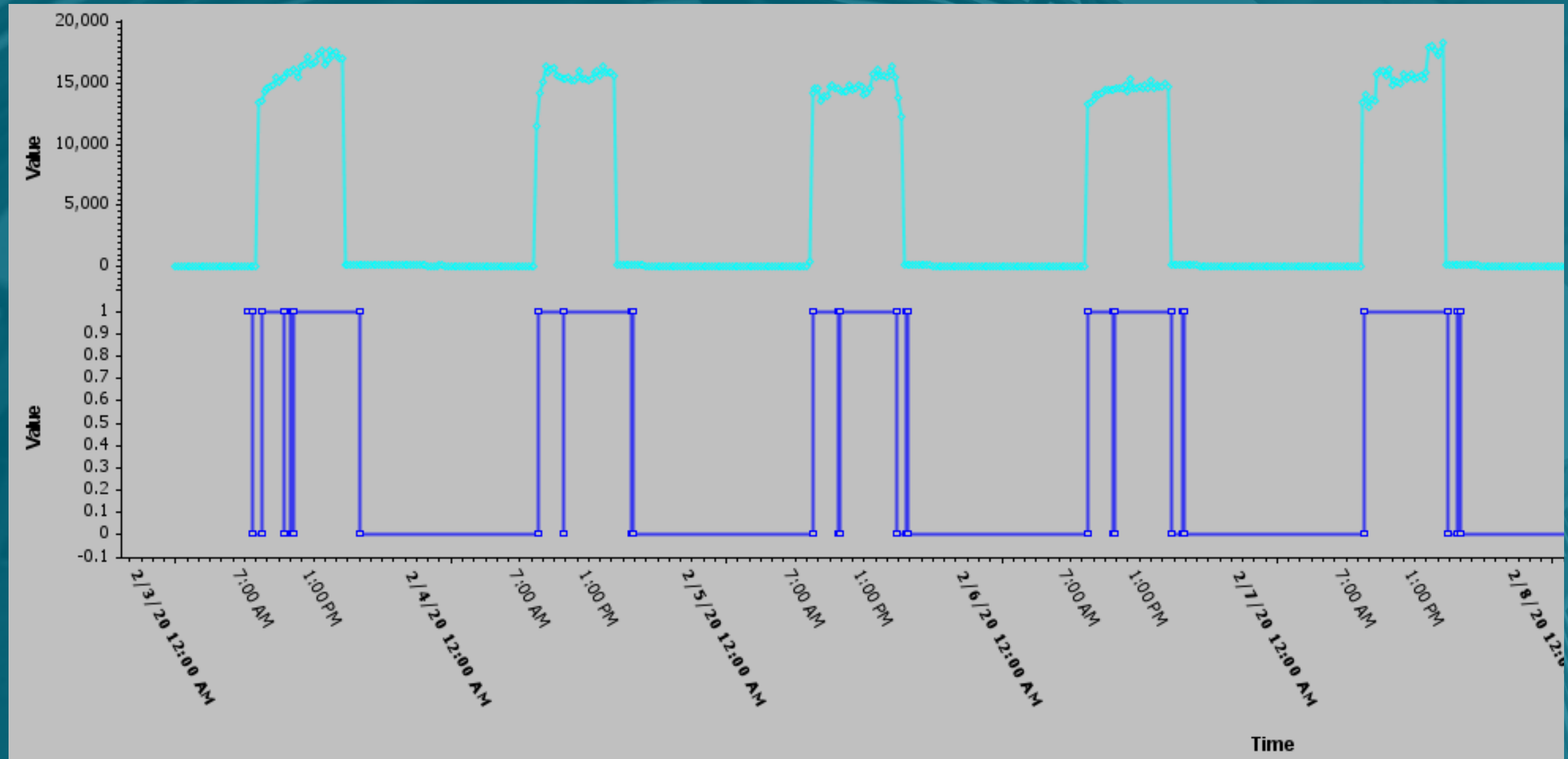
% VIRUS DECAY	MINUTES	HOURS
50% (half-life) :	9.35	0.16
90%:	31.07	0.52
99%:	62.14	1.04

ENGINEERING CONTROLS

What to do?

- What is the best approach for control system testing?
- Can my fans handle the increased static pressure of new filters?
- Will IAQ testing be right for me?
- Can I increase filtration instead of increasing ventilation?
- Is my building envelope suited for increased humidification?
- How will humidity affect UVGI?
- How much ventilation can my cooling coils and central plant handle?
- Is MERV-13 a sufficient filtration level?
- Should I consider bipolar ionization?
- Do my air systems meet ASHRAE 62.1 and should I increase ventilation further?
- What will be the impact on my energy and operational costs?





PRACTICAL MECHANICAL STRATEGIES

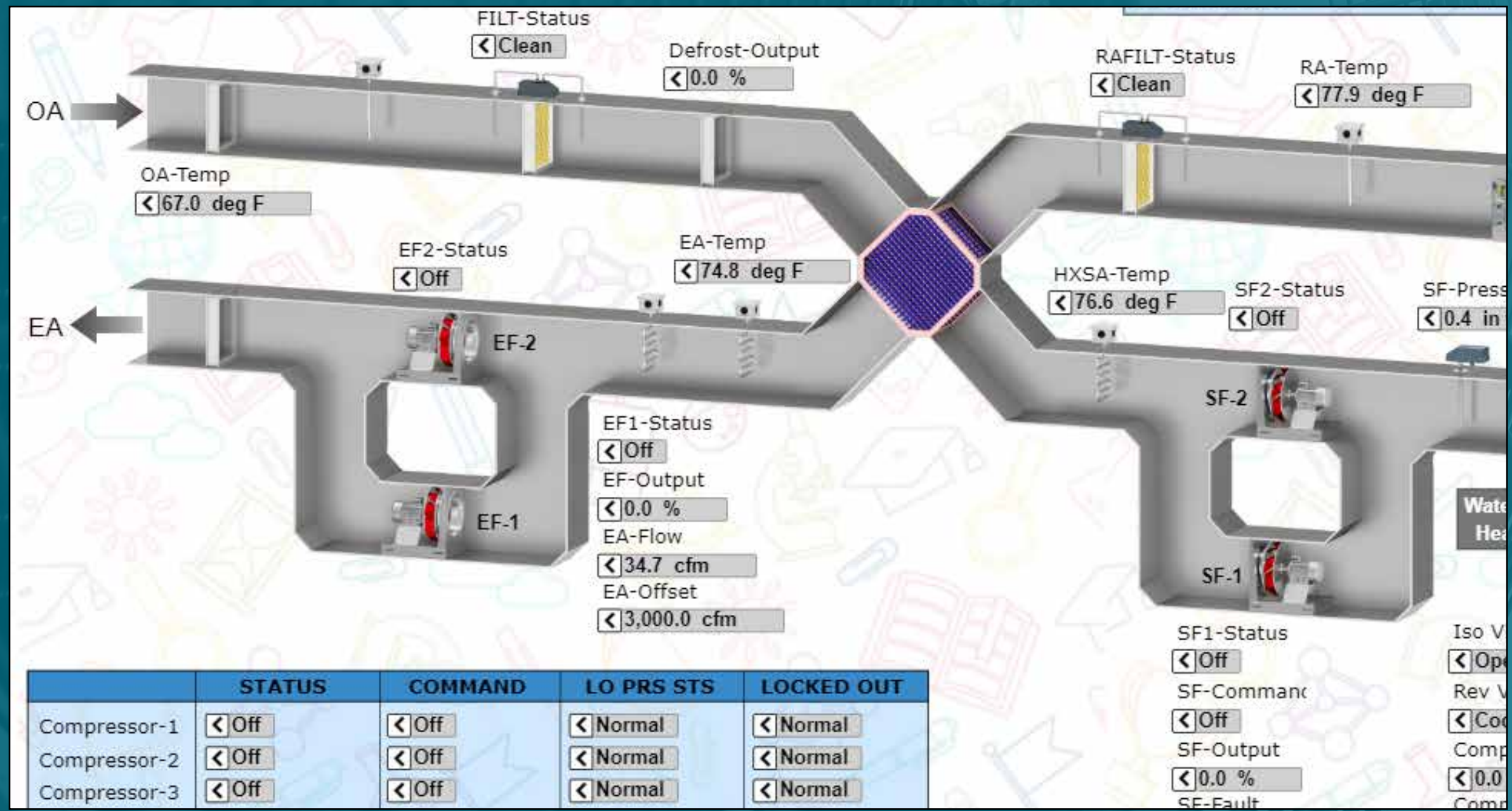
Good: Control System Review

Control Settings

- Temperature and humidity
- Energy recovery functioning
- Exhaust fans

Schedules

- Ventilation schedules
- Separate from AC
- Trend review
- Minimum OA flow and dampers



	SUN	MON	TUE	WED	THU	FRI	SAT
3:00 AM							
6:00 AM	ocOccupied	ocOccupied 6:30 AM - 6:00 PM	ocOccupied 6:30 AM - 6:00 PM	ocOccupied 6:30 AM - 6:00 PM	ocOccupied 6:30 AM - 6:00 PM	ocOccupied 6:30 AM - 6:00 PM	ocOccupied
9:00 AM							
12:00 PM							
3:00 PM							
6:00 PM							
9:00 PM	ocOccupied						ocOccupied
		ocOccupied	ocOccupied	ocOccupied	ocOccupied	ocOccupied	

PRACTICAL MECHANICAL STRATEGIES

Better: Controls + Physical Inspections

- Outside air intakes
- Condition
- Location
- Dampers and control devices working
- Filters
- Installed properly (e.g. bag orientation)
- Seals, clips – no air bypass (light test)
- Clean filters?

ASHRAE Research

½" filter gaps result in:

- 20% air bypass
- MERV 15 reduces to MERV 8

ASHRAE Inspection Checklist

- Epidemic conditions in place
- Maintenance checks



Practical Mechanical Strategies

Best: Controls + Physical Inspections + ASHRAE 62.1 Verification

- Outdoor air: original design vs. current required vs. actual
- Calculations and measurements
- Ways to simplify:
- Square-foot basis
- Engineering judgment



Practical Mechanical Strategies

Best: Controls + Physical Inspections + ASHRAE 62.1 Verification

- Enhanced indoor air quality: revised sequences
- Flush-out
- “Emergency Mode”
- Demand limiting
- Demand control ventilation?
- 30% increase in outdoor air
- Increased economizer range, extended ventilation hours



"ZONE NAME AND NUMBER"	"OCCUPANCY CATEGORY"	"ZONE FLOOR AREA" AZ (SQ FT)	ARE YOU USING DEFAULT VALUE FOR ZONE POPULATION?	"ZONE POPULATION" PZ (PEOPLE)	ZONE AIR DISTRIBUTION EFFECTIVENESS EZ	"ZONE OUTDOOR AIRFLOW" VOZ (CFM)	"ZONE DISCHARGE AIRFLOW" VDZ (CFM)	"ZONE PRIMARY AIRFLOW" VPZ (CFM)	ZONE SECONDARY RECIRCULATION FRACTION ER	ZONE PRIMARY AIR FRACTION Ep
JOE'S OFFICE	OFFICE SPACE	100	YES	0.50	1.00	8.50	80	20	1.00	0.25
OPEN OFFICES	OFFICE SPACE	1,200	YES	6.00	1.00	102.00	1,500	450	1.00	0.30
CONFERENCE ROOM	CONFERENCE / MEETING	325	YES	16.25	1.00	100.75	550	180	1.00	0.33
LUNCH	CAFETERIA / FAST FOOD DINING	450	NO	15.00	1.00	193.50	400	110	1.00	0.28
CORRIDOR	CORRIDORS	500	YES	0.00	1.00	30.00	300	30	1.00	0.10
LOBBY	LOBBIES	400	NO	6.00	0.80	67.50	710	100	1.00	0.14

SYSTEM NAME AND NUMBER	AHU-1
CONDITION ANALYZED (IMPACTS EZ, VDZ, VPZ AND VPS)	COOLING
ALL ZONES ARE INCLUDED IN THE VRP CALCULATION	YES

"SYSTEM NAME AND NUMBER"	"SYSTEM TYPE"	"ALL ZONES INCLUDED IN THE VRP CALCULATION?"	"CONDITION ANALYZED"	"SYSTEM FLOOR AREA" AS (SQ FT)	SYSTEM POPULATION PS (PEOPLE)	"OUTDOOR AIR INTAKE FLOW (REQUIRED BY 62.1)" VOT (CFM)	"OUTDOOR AIR INTAKE FLOW PROVIDED (MEASURED OR DESIGN)" (CFM)	"OUTDOOR AIR INTAKE FLOW PROVIDED MEETS OR EXCEEDS VOT?"	ZONE OUTDOOR AIRFLOW PROVIDED MEETS OR EXCEEDS VOZ FOR ALL ZONES?
MULTIPLE ZONE SYSTEMS									
AHU-1	MULTIPLE ZONE	YES	COOLING	2.975	35.00	515	520	YES	N/A

100% OUTDOOR AIR SYSTEMS									
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TOTALS				#NAME?	#NAME?	#NAME?	#NAME?		
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COVID-19 WASTEWATER SURVEILLANCE

Wastewater Surveillance

NOT A NEW CONCEPT

- Used to monitor for polio vaccine efficiency

USED AS A LEADING INDICATOR

- Designed to have results early in time for meaningful actions
- Current unknown

COMPLIMENT EXISTING PROTOCOLS

- Not a replacement for current precautions being taken



Wastewater Surveillance

MICHIGAN EGLE \$10 MILLION PILOT PROJECT

- Several other states have developed programs as well

NATIONAL WASTEWATER SURVEILLANCE SYSTEM (NWSS)

- CDC and HHS collaboration





Developing a Plan

WHAT IS YOUR GOAL?

- What will you do with the data?

WHAT IS YOUR TARGET?

- Facility?
 - By Shift?
- Campus?
 - Daily?
 - Zones?
- Community?

DETERMINE TARGET BASED ON GOALS



Developing a Plan

LIMITING FACTORS

- Time
- Laboratory capacities
- Cost
- Access to sampling points
- Ability to follow-up

Sampling

DIFFERENT METHODS

- Composite Sampling
 - Continuous vs. Flow Weighted
- Grab Samples

SAMPLES MUST BE KEPT COLD

HAVE ANALYZED AS SOON AS POSSIBLE

SHIP ACCORDING TO DOT AND IATA





Analysis

SEVERAL METHODS OF ANALYSIS AVAILABLE

TURN-AROUND TIME IS CRUCIAL

**DETECTING THE AMOUNT OF SARS-COV-2 RNA
IN THE SAMPLE**

- Versions of polymerase chain reaction (PCR)
- Cycle Threshold
 - # of cycles needed to detect the presence of the RNA
 - Non-Detect or Detect = Not Quantitative

Results

INFECTED INDIVIDUALS CONTRIBUTING TO THE WASTEWATER SYSTEM

- Symptomatic and asymptomatic individuals

LOOKING FOR A TREND

- Gathering data to analyze over time

ARE THEY NORMALIZED?

- PCR results compared to known markers
 - Viral and bacterial markers





Follow-up

NOW THAT YOU HAVE THE DATA, WHAT DO YOU DO WITH IT?

- Share with affected population?
- Increase in current protocols?
 - Implement new protocols?
- Increase in messaging?
- Conduct individual testing?

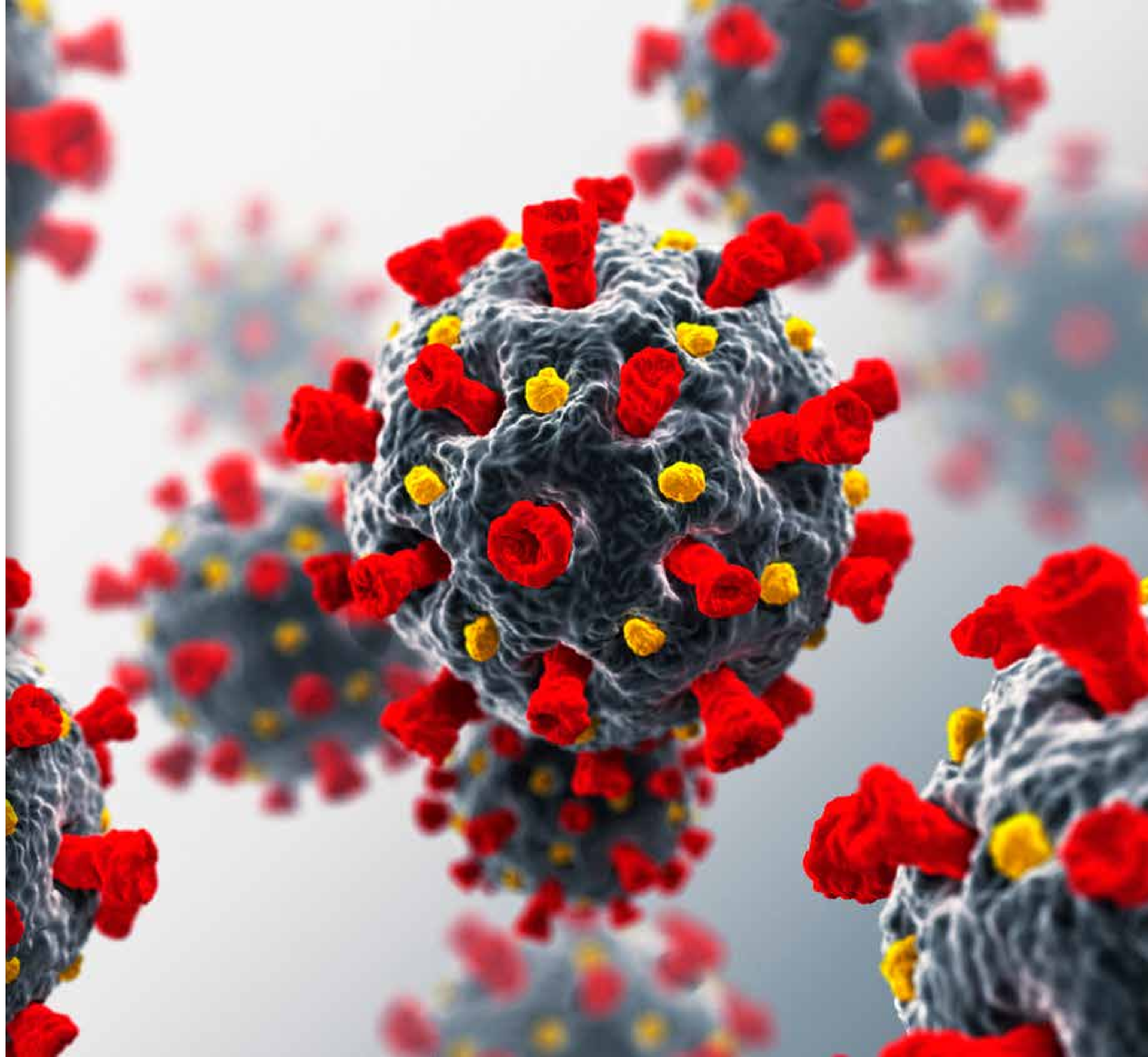
Conclusions

DETERMINING YOUR GOALS UPFRONT ARE KEY

- Determining limitations

GET RESULTS AS QUICKLY AS POSSIBLE TO BE ABLE TO MAKE DECISIONS

DOES THIS MAKE SENSE FOR YOU?



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Engineers | Architects | Scientists | Constructors