UNDERSTANDING THE SCIENCE BEHIND MITIGATING THE TRANSMISSION OF COVID-19

~~SESSION 1: TRANSMISSION PATHS~~
SESSION 2: AIRBORNE MITIGATION STRATEGIES
SESSION 3: ESTIMATING EFFECTIVENESS OF RISK MITIGATION STRATEGIES

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AIRBORNE MITIGATION

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November 12, 2020

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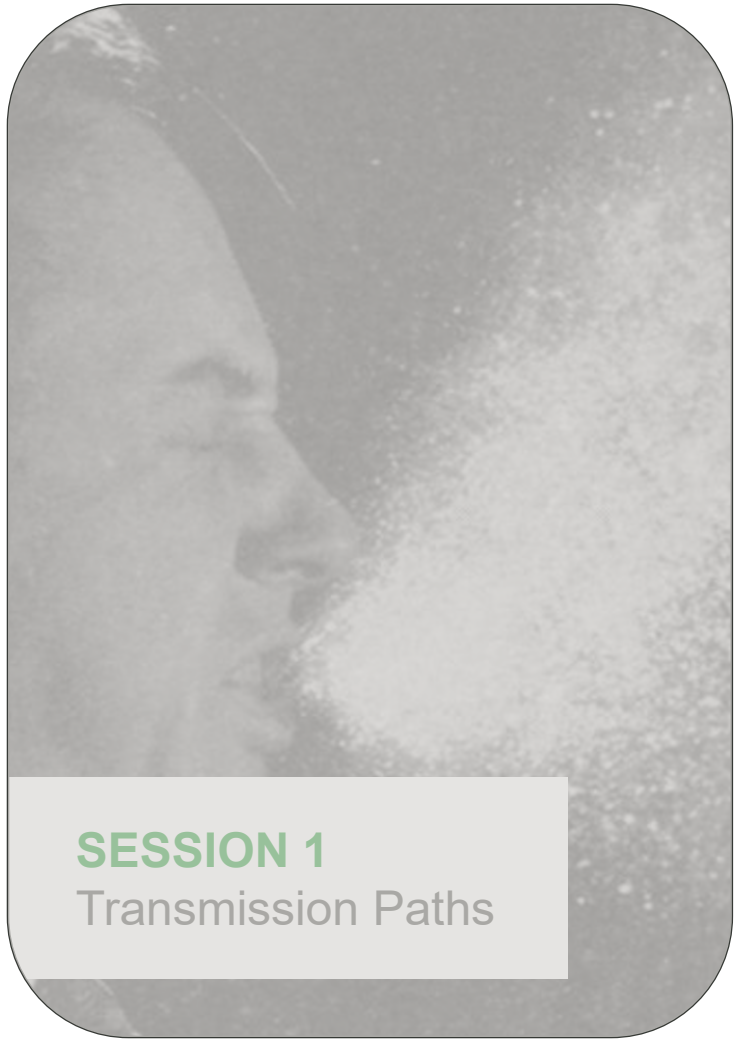
WHAT WE'RE GOING TO COVER



SESSION 1
Transmission Paths

SESSION 2
Airborne Mitigation

SESSION 3
Estimating Risk

REVIEW OF SESSION 1

- There are **3 main transmission paths**: Fomite (surface), Large droplet, and Aerosol
- Masks are very effective at large droplet capture & ~50% effective at capturing small ones
- Sunlight rapidly inactivates coronavirus
- UVc light also rapidly inactivates coronavirus
- Aerosol transmission is possible
- The virus that causes COVID-19 stays viable in the air for roughly 3 hours

SESSION 2: MITIGATING THE RISK OF AIRBORNE INFECTION

SARS-CoV-2 can spread through the air via small aerosols. Increasing building outside air ventilation rates, HVAC filtration efficiency, and utilizing UVc lighting can reduce the risk of infection transfer between building occupants. This presentation discusses these mitigation strategies and the merits and limitations of each based on scientific evidence.

At the end of this presentation you will be able to:

1. Discuss the role building ventilation plays in maintaining air quality for occupant comfort and health.
2. Describe how air filters are rated, and how that rating relates to efficiency of filtering viral particles in an air stream.
3. Identify the impact of air currents within a space on the risk of infection transmission.
4. Interpret the most current science describing the effectiveness of UVc lighting in controlling airborne infection.

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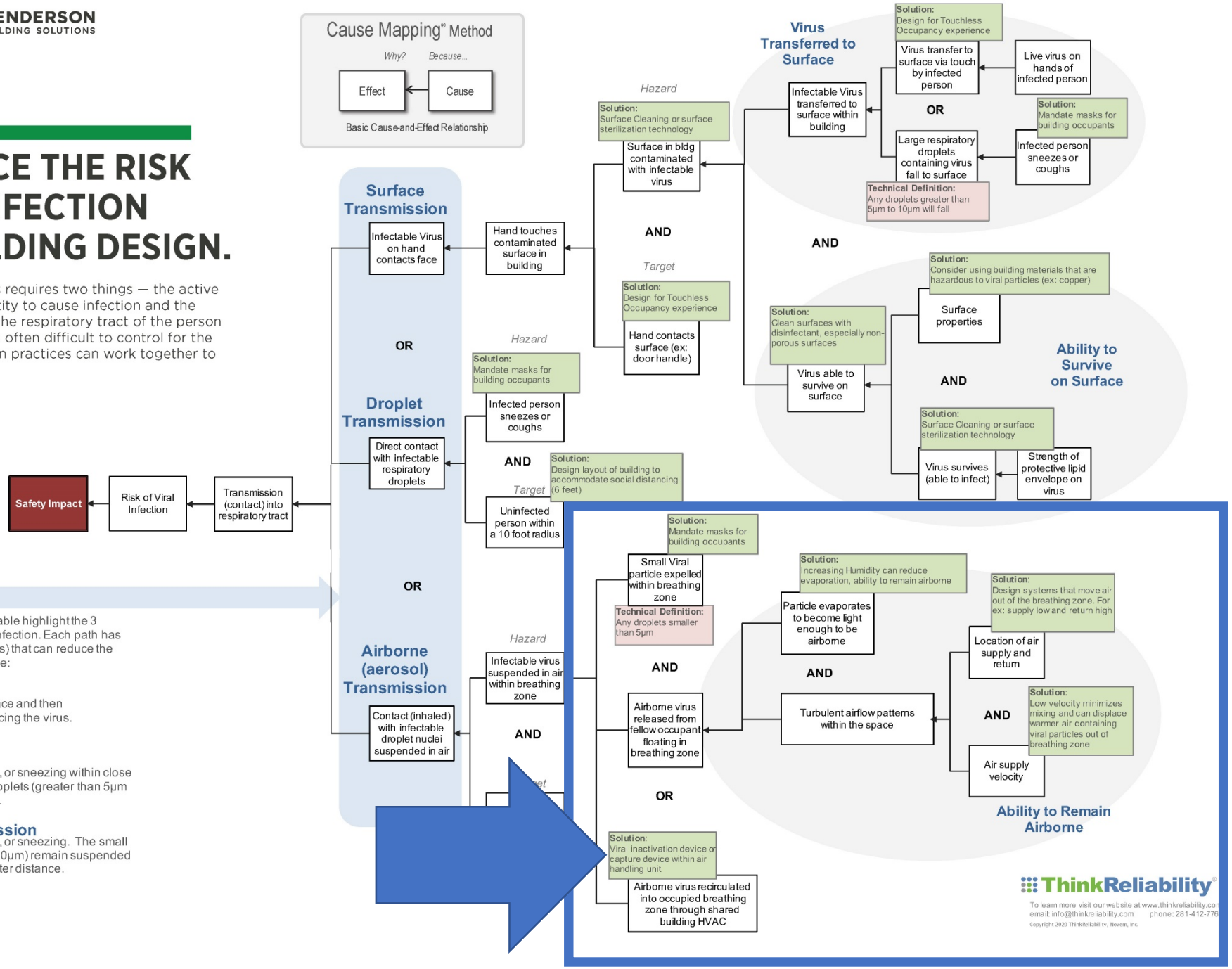
HOW TO REDUCE THE RISK OF COVID-19 INFECTION THROUGH BUILDING DESIGN.

Transmission of COVID-19 in buildings requires two things — the active virus being present in sufficient quantity to cause infection and the transmission of that active virus into the respiratory tract of the person being infected. In public buildings, it's often difficult to control for the presence of the virus, but good design practices can work together to reduce the overall risk of infection.



3 Transmission Paths

Using the Cause Map diagram we are able highlight the 3 potential transmission paths of a viral infection. Each path has different control opportunities (Solutions) that can reduce the risk of transmission. The 3 paths include:

Surface Transmission

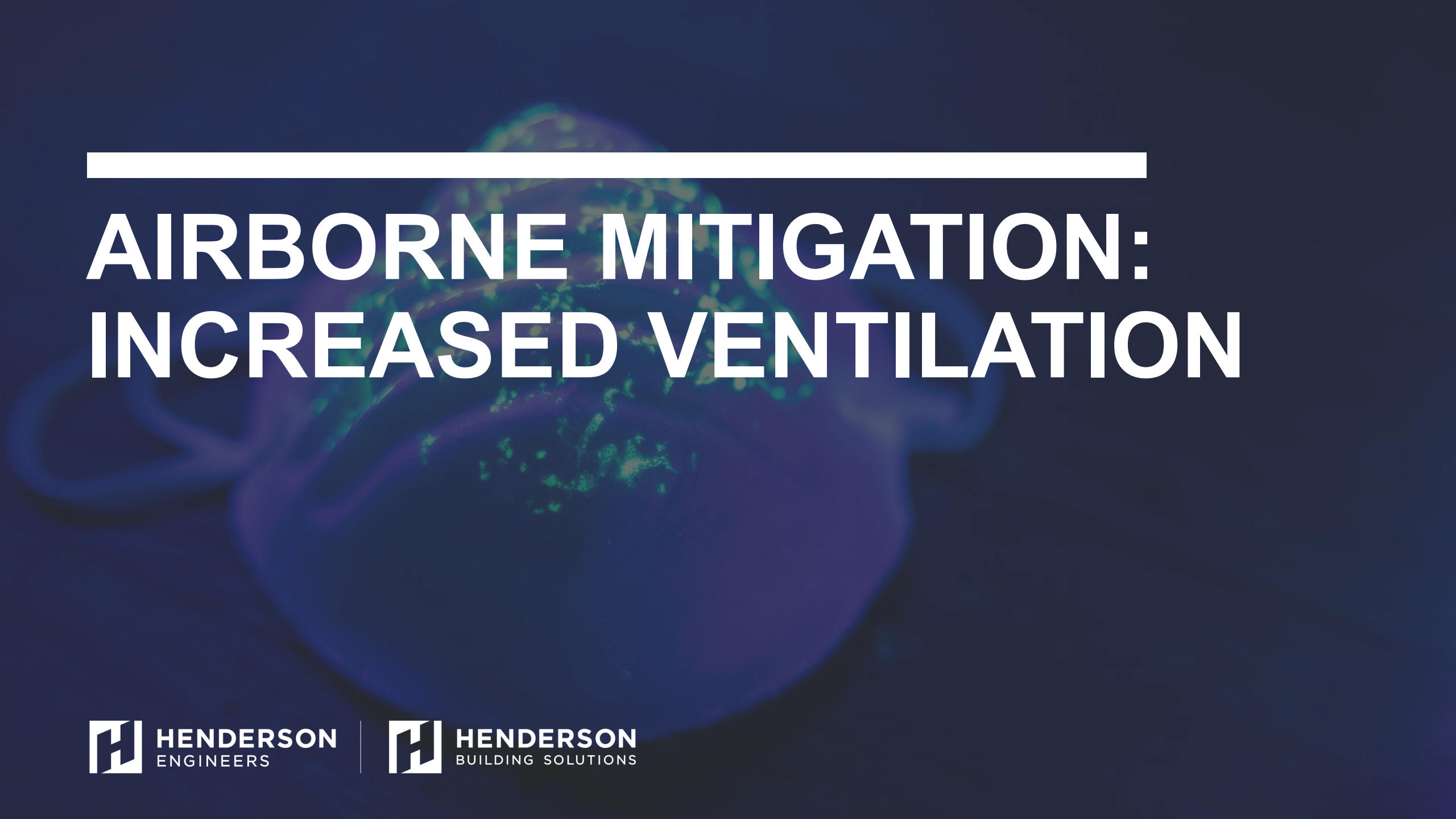
A person touches a contaminated surface and then inadvertently touches their face introducing the virus.

Droplet Transmission

An infected person is talking, coughing, or sneezing within close contact of others. Large Respiratory droplets (greater than 5µm to 10µm) makes direct contact to infect.

Airborne (aerosol) Transmission

An infected person is talking, coughing, or sneezing. The small respiratory droplets (less than 5µm to 10µm) remain suspended in air for a period of time and over greater distance.



AIRBORNE MITIGATION: INCREASED VENTILATION

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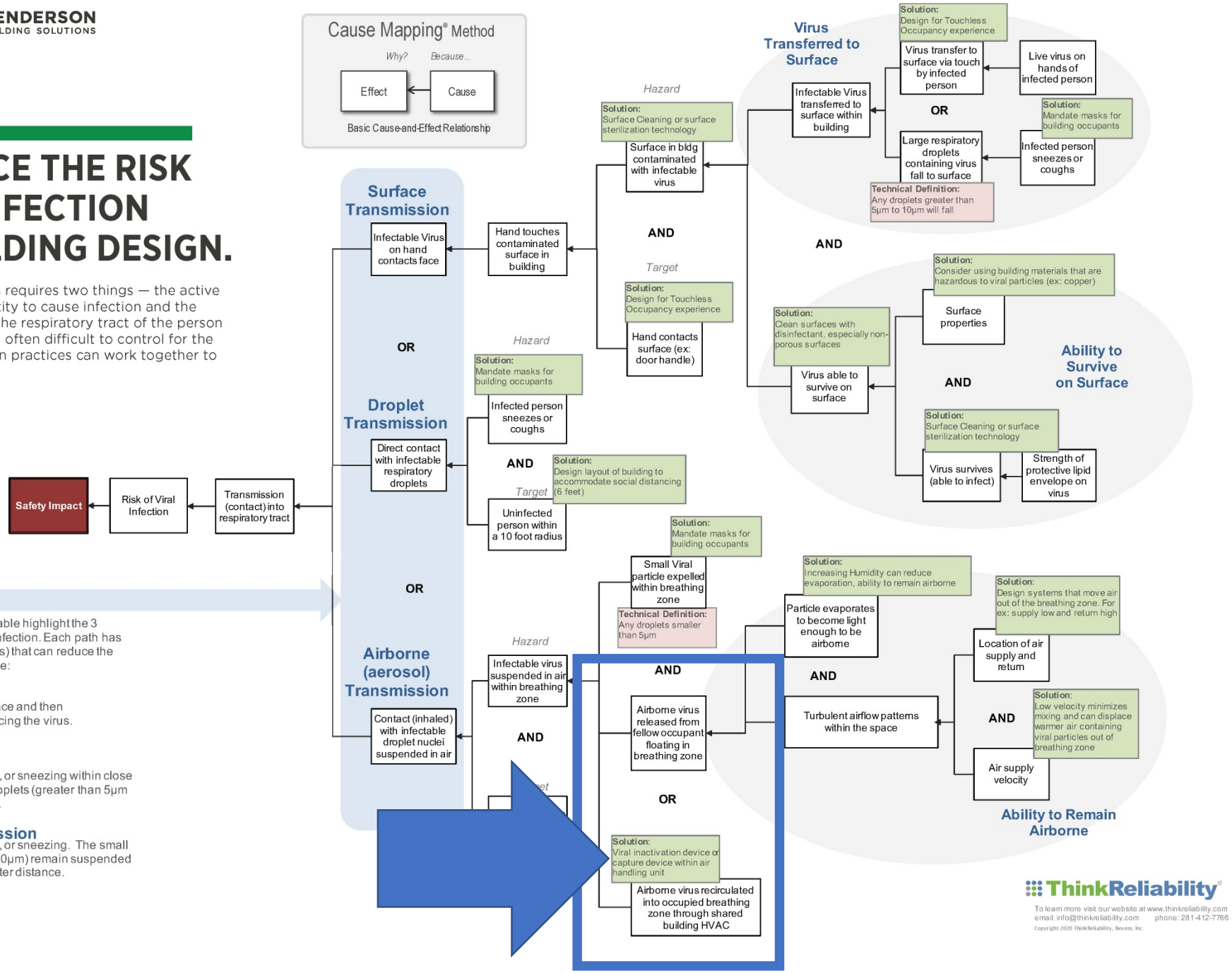

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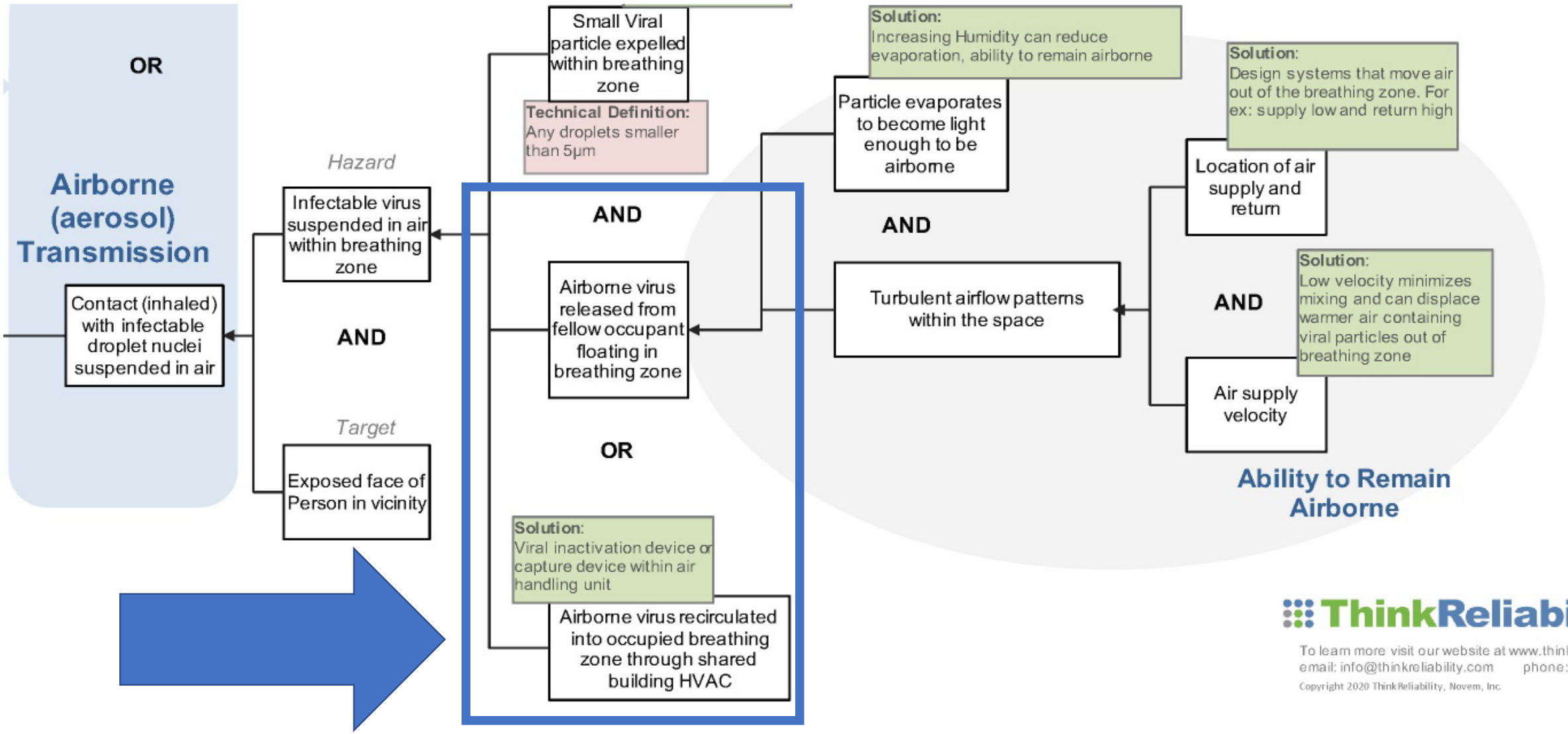
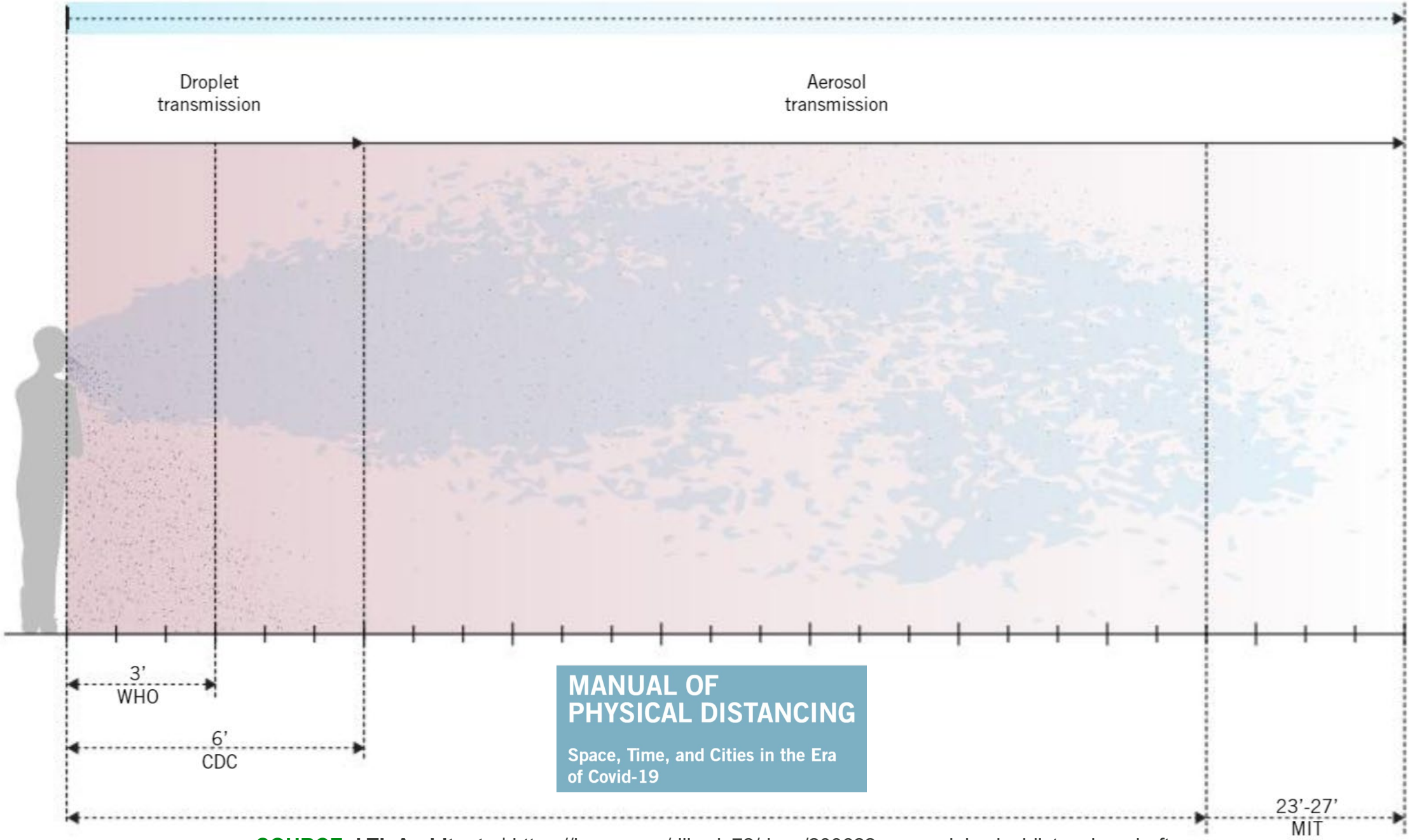


There is a risk of “shared space” or “recirculated air” aerosol transmission of COVID-19.

The 6 ft distance "rule" should be treated as a guideline not a rule, droplets fall in a gradient based on their size.

Keeping 6 ft away from an infected person will reduce (but not eliminate) the risk of large droplet contact, but will **do very little to minimize aerosol particle contact.**



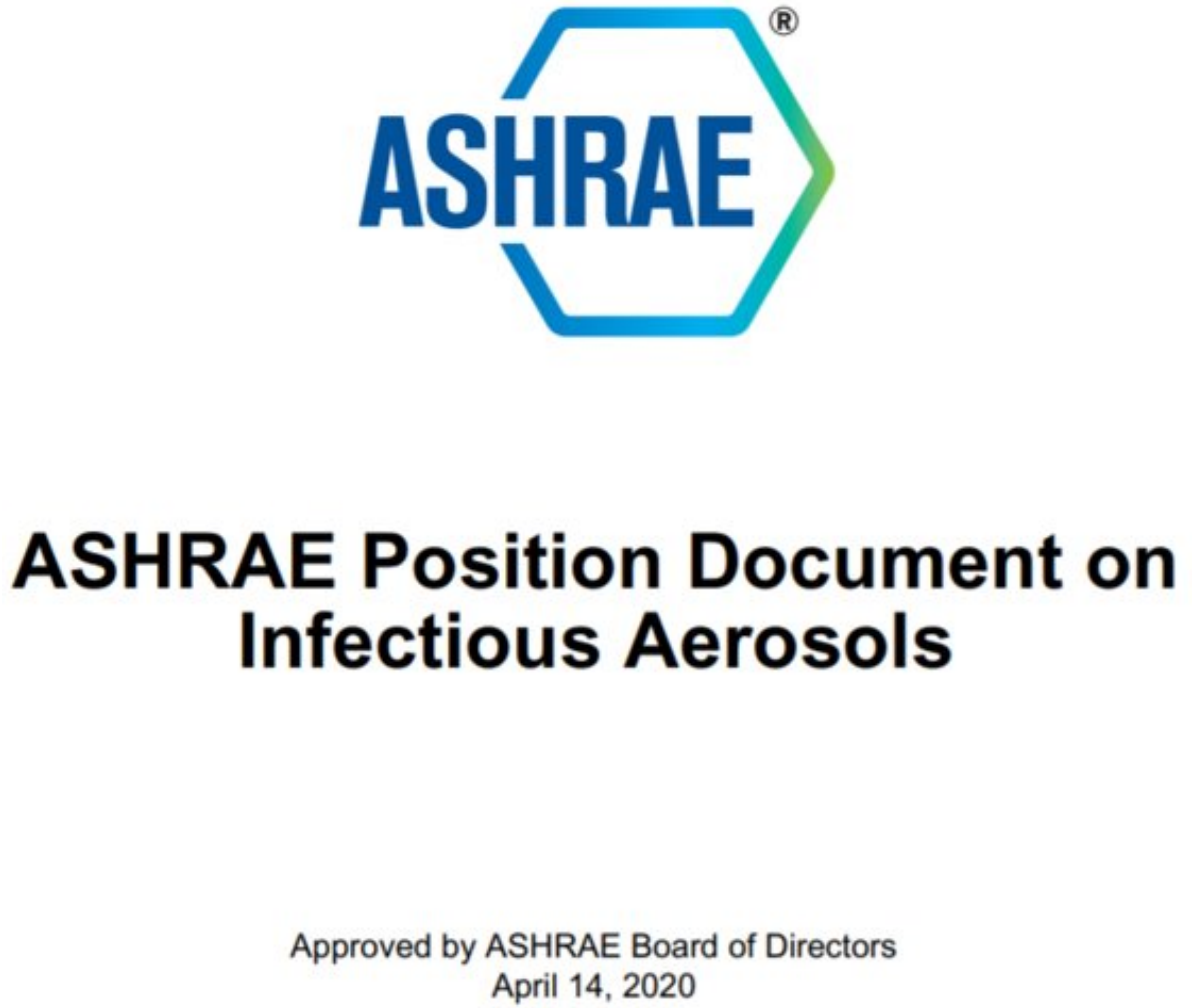
SOURCE: LTL Architects | https://issuu.com/djlewis72/docs/200622_manualphysicaldistancing_draft

ASHRAE POSITION DOCUMENT ON INFECTIOUS AEROSOLS - 2020

ASHRAE STATEMENTS

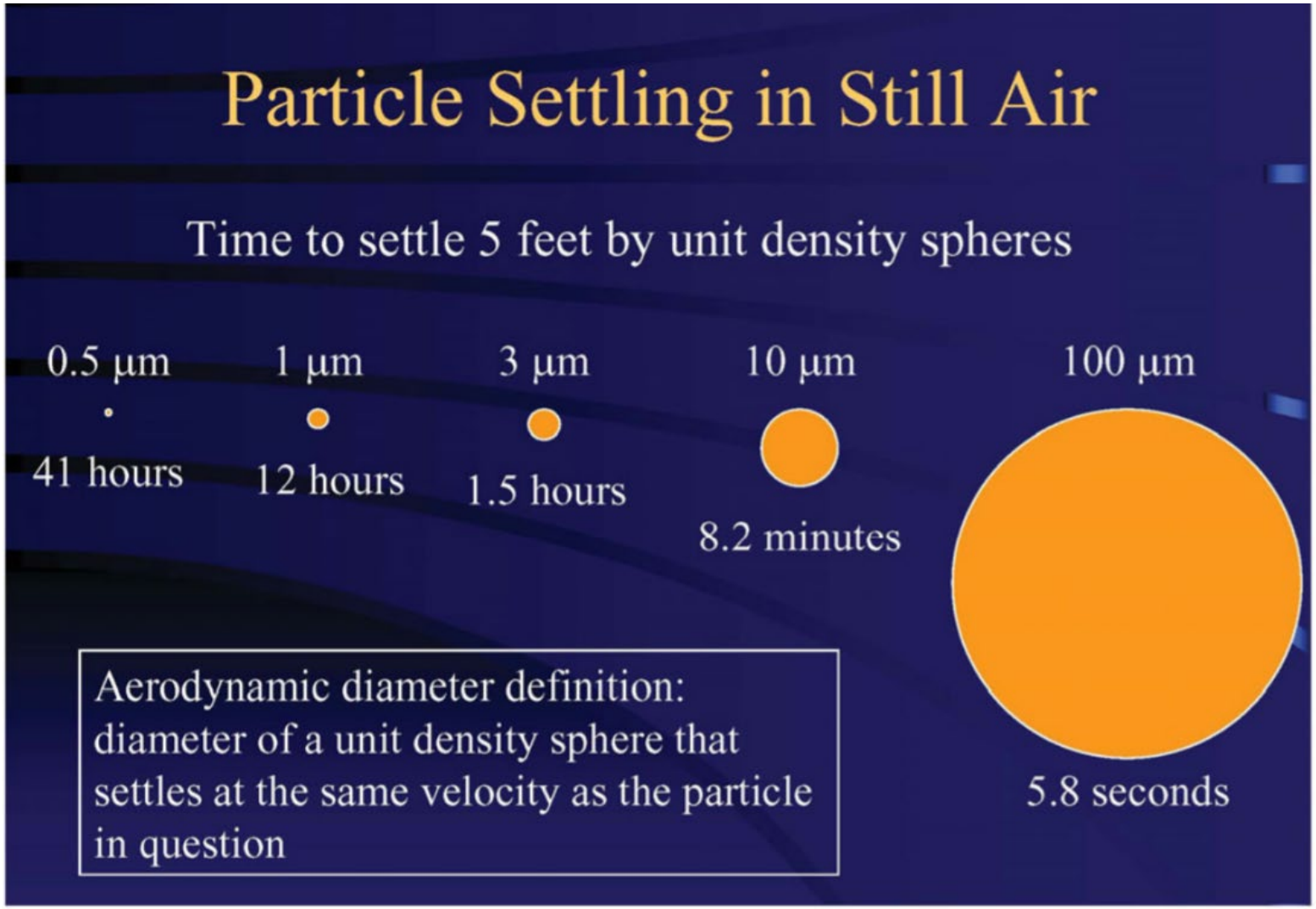
1. Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. **Changes to HVAC systems can reduce airborne exposures.**

2. HVAC ventilation and filtration can reduce the airborne concentration of SARS-CoV-2 and thus reduce transmission risk. Unconditioned spaces can cause thermal stress to people that may be directly life threatening and that may also lower resistance to infection. **Disabling HVAC systems is not recommended.**



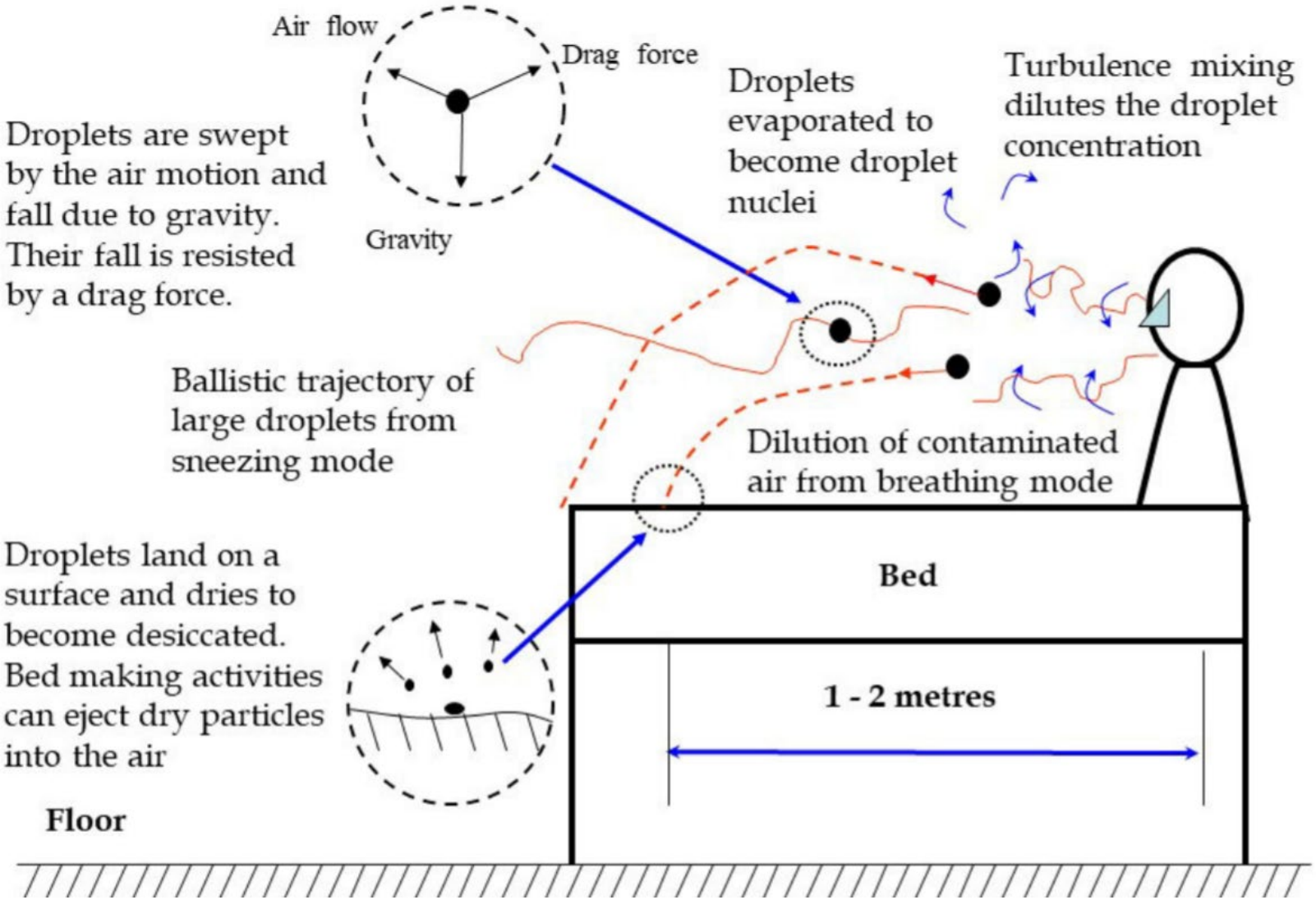
SOURCE: https://www.ashrae.org/file%20library/about/position%20documents/pd_infectiousaerosols_2020.pdf

COMPARATIVE SETTLING TIMES BY PARTICLE DIAMETER FOR PARTICLES SETTLING IN STILL AIR

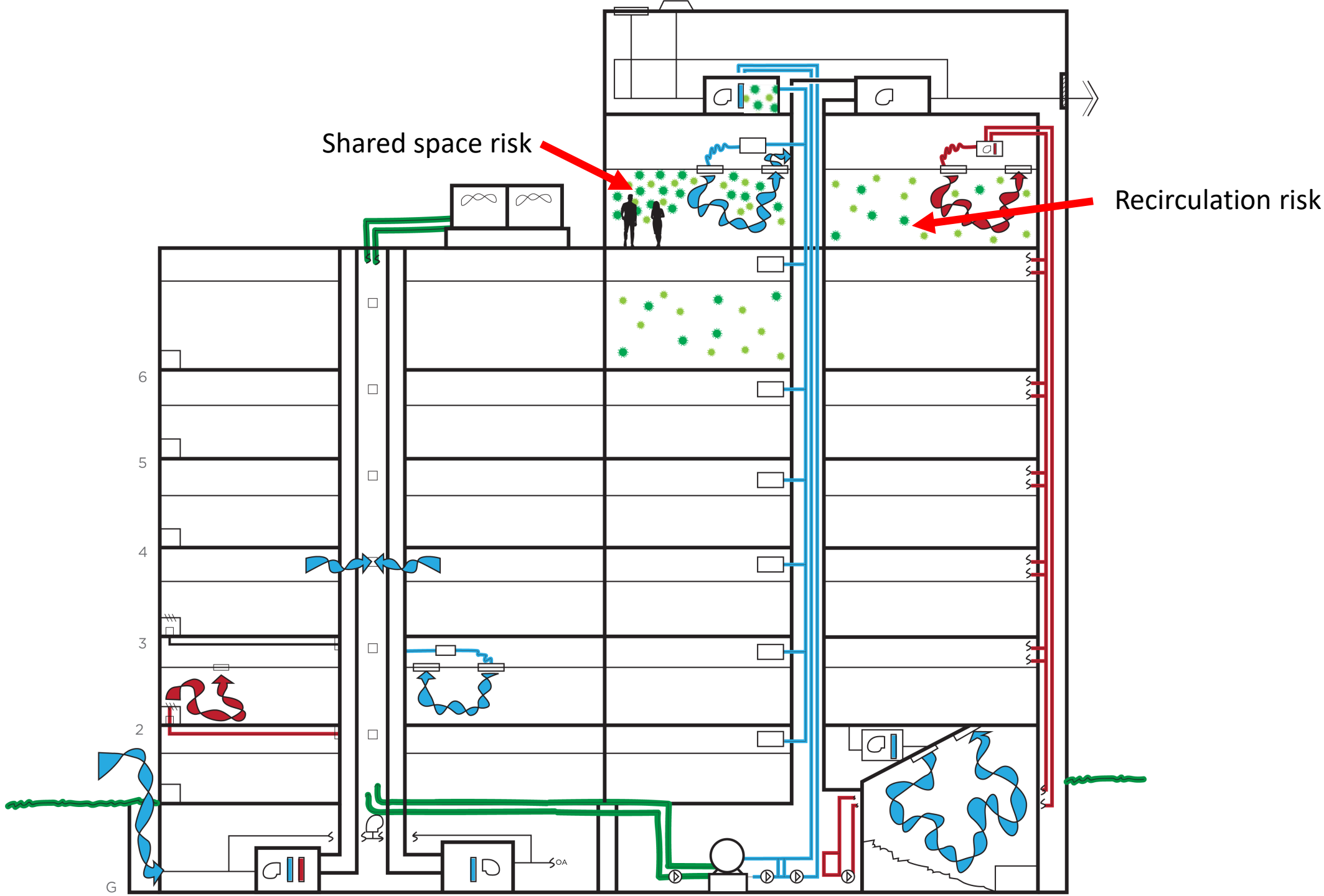


SOURCE: ASHRAE Position Document | https://www.ashrae.org/file%20library/about/position%20documents/pd_infectiousaerosols_2020.pdf

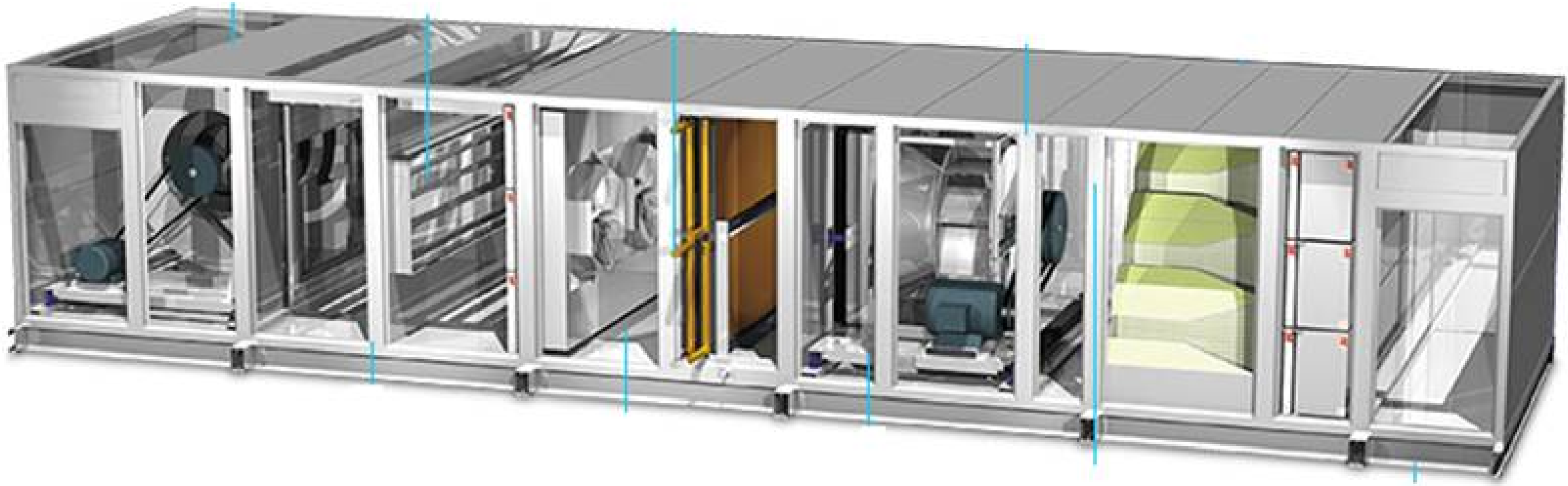
Theoretical Aerobiology of Transmission of Droplets and Small Airborne Particles Produced by an Infected Patient with an Acute Infection



SOURCE: ASHRAE Position Document | https://www.ashrae.org/file%20library/about/position%20documents/pd_infectiousaerosols_2020.pdf

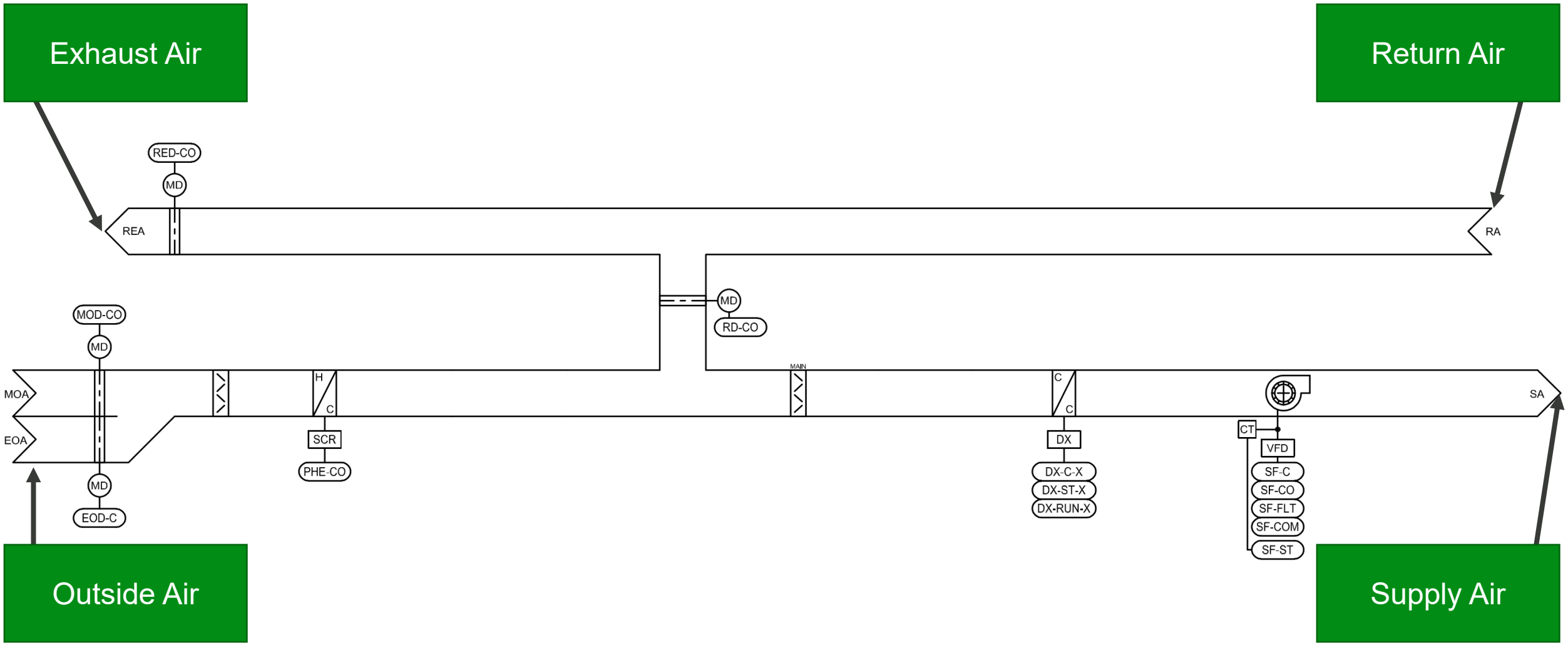

Shared space risk
Recirculation risk
6
5
4
3
2
G
OA

Increasing the percentage of outdoor air in the HVAC system will **reduce the concentration of recirculated virus**.

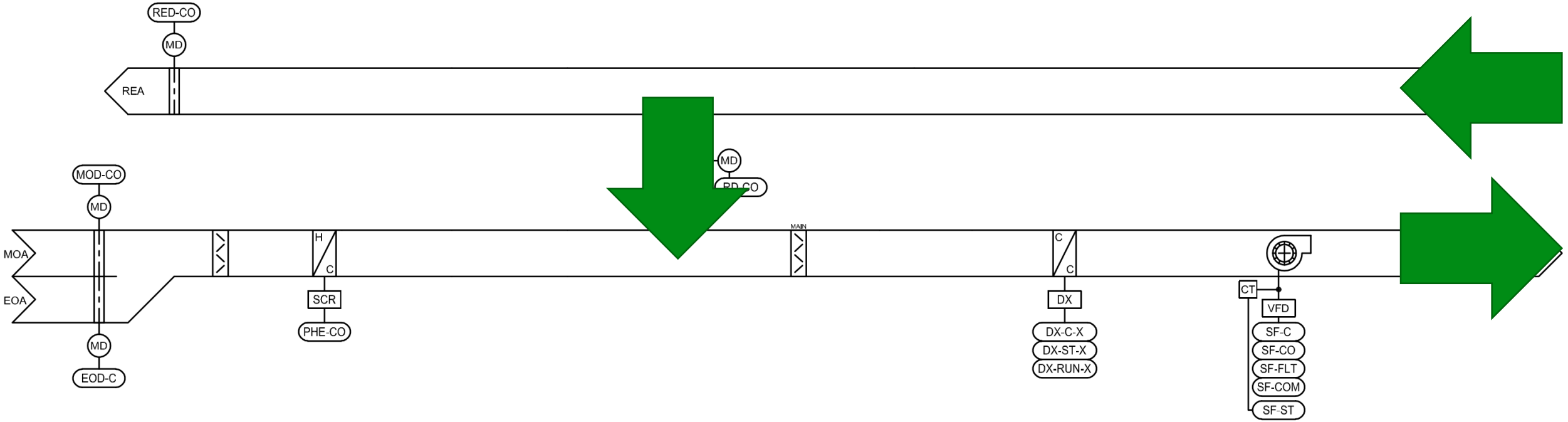


“STANDARD” HVAC SYSTEM

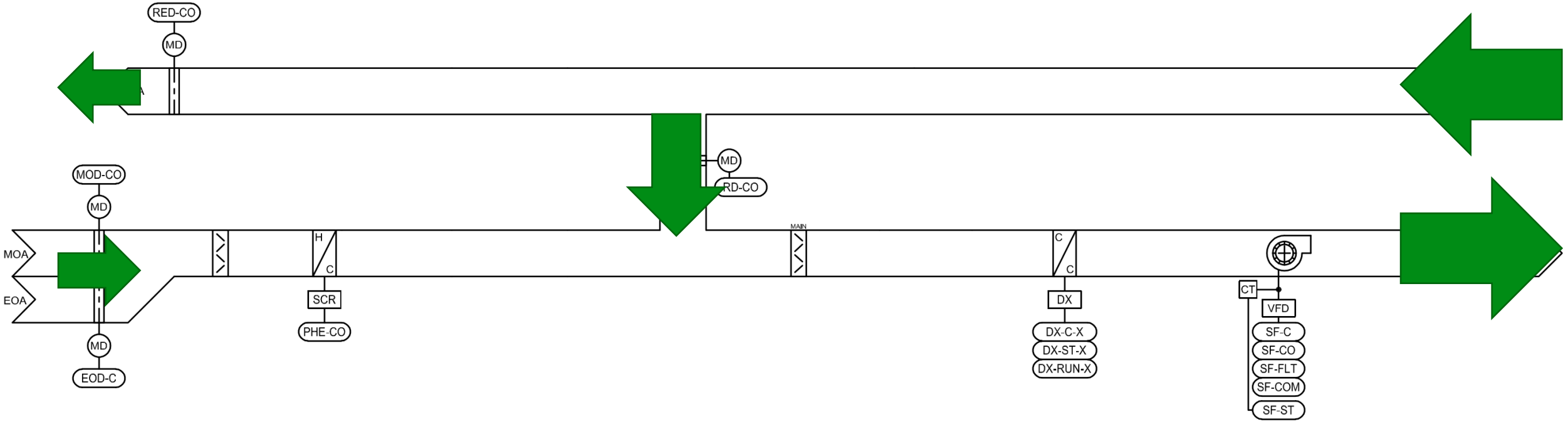
SOURCE: Daikin



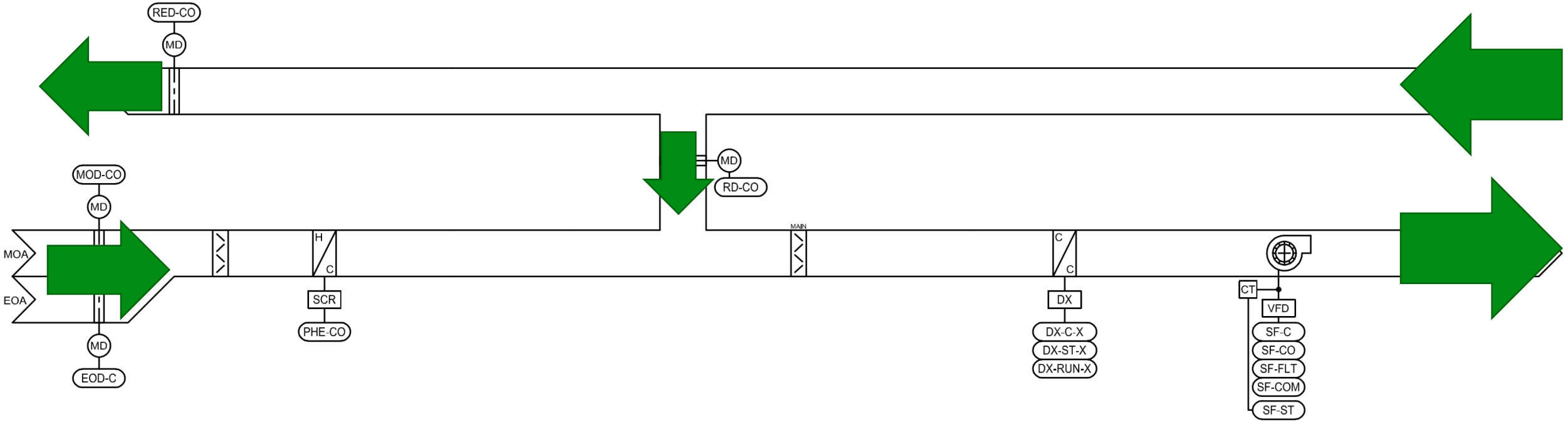
TYPICAL AIR HANDLING UNIT CONTROL DIAGRAM



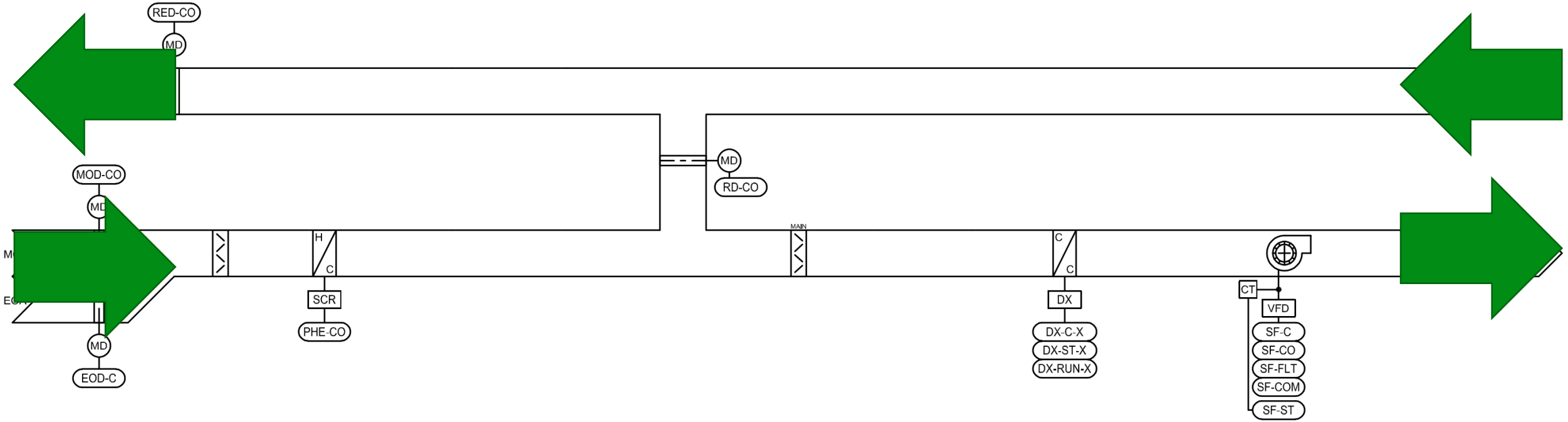
NO OUTSIDE AIR – FULL RECIRCULATION



MINIMUM OUTSIDE AIR – MIXED RECIRCULATION



INCREASED OUTSIDE AIR – MINIMIZED RECIRCULATION

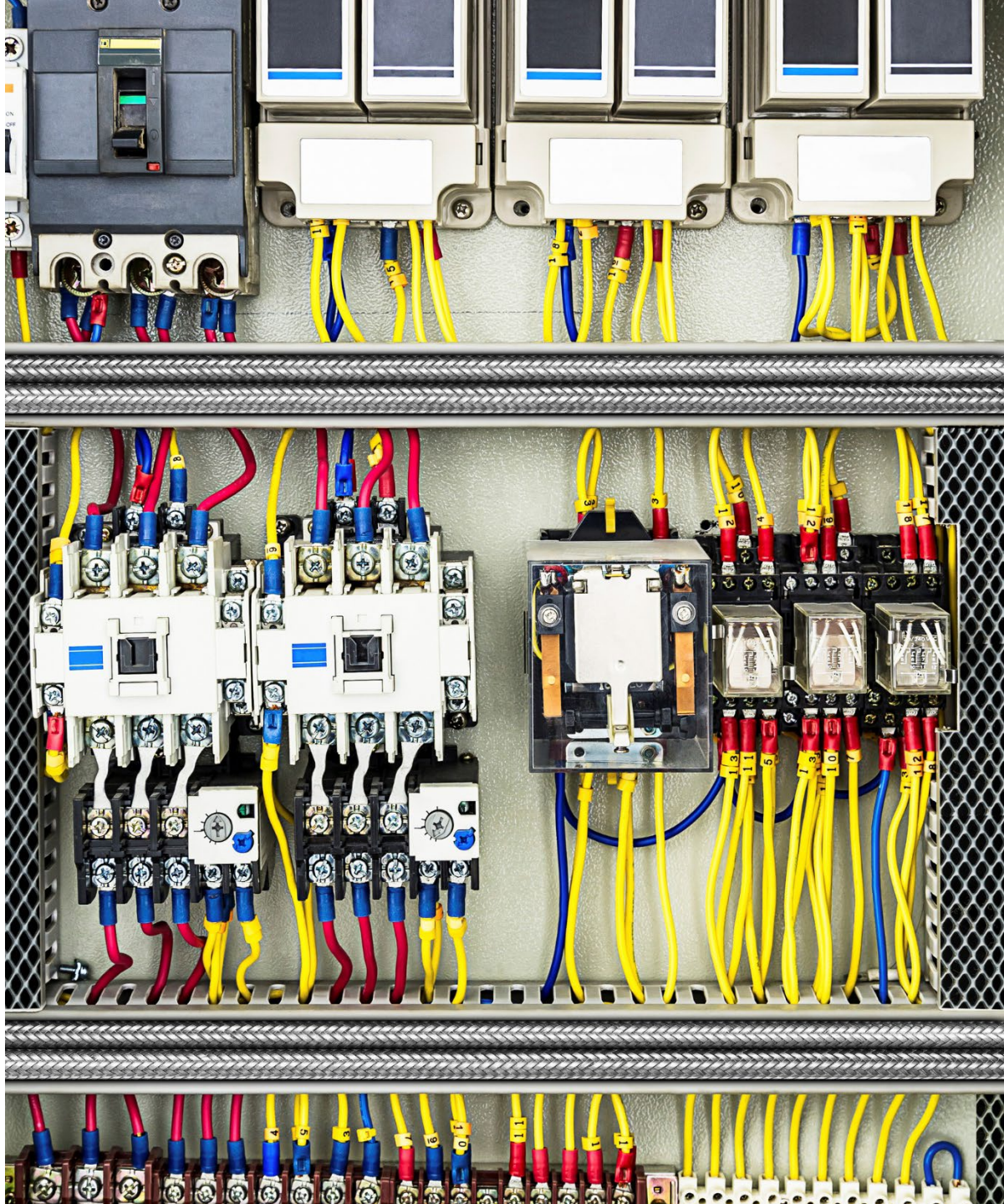


100% OUTSIDE AIR – NO RECIRCULATION

MAXIMIZE OUTSIDE AIR

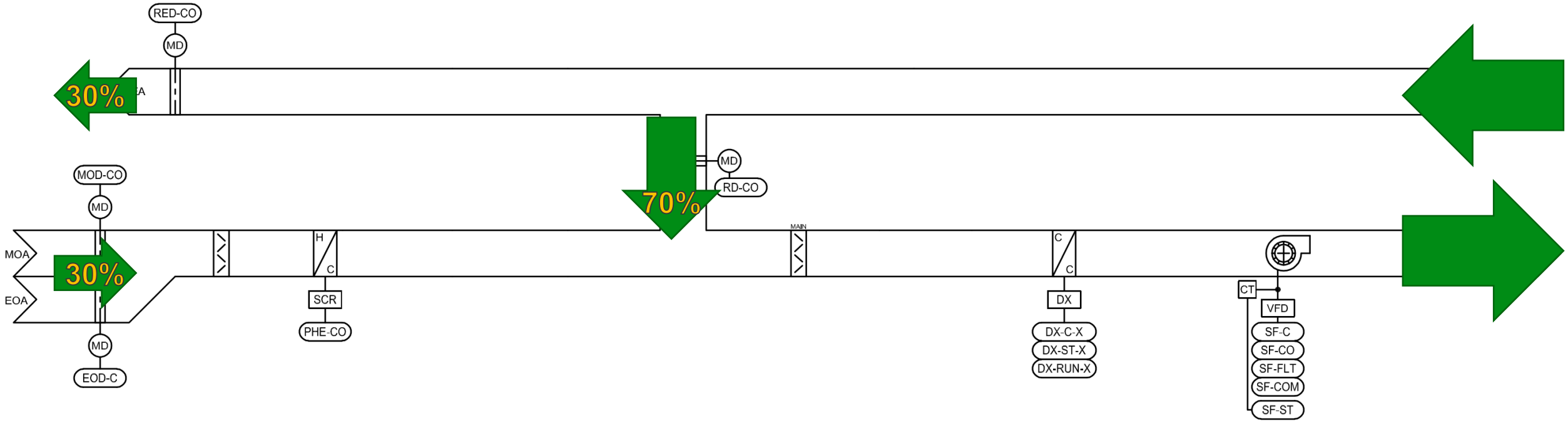
CONTROL SYSTEM MODIFICATIONS

- There is no “maximize OA” button
- Reset economizer setpoints
- Disable demand-control ventilation
- Override schedules to extend occupied hours



HOW DOES VENTILATION TRANSLATE TO VIRAL REMOVAL EFFICIENCY?

- Increased ventilation implies increased exhaust – the “bad” air is exchanged for “good”
- So a 30% outside air rate removes 30% of the viral load from the recirculated air and so on



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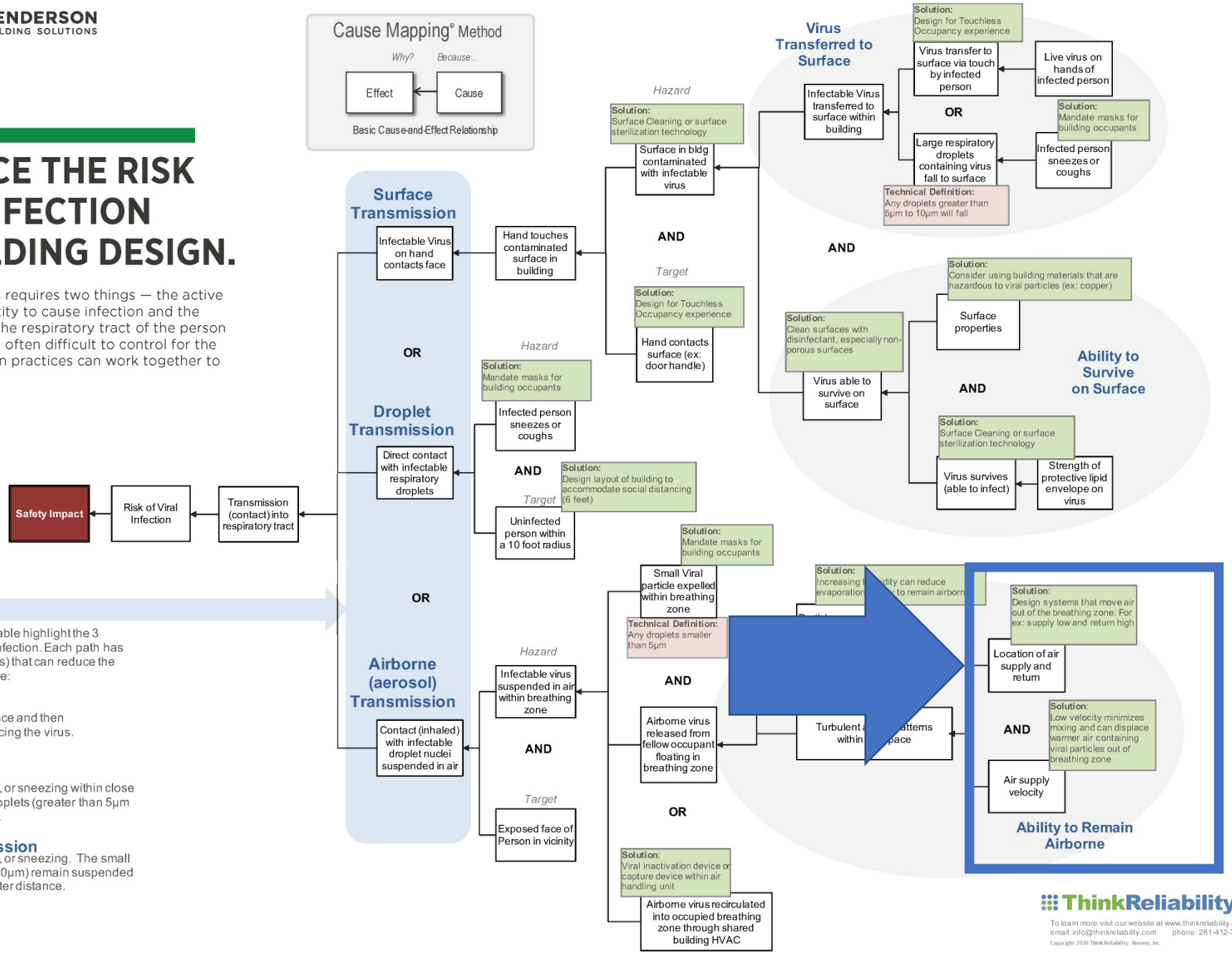

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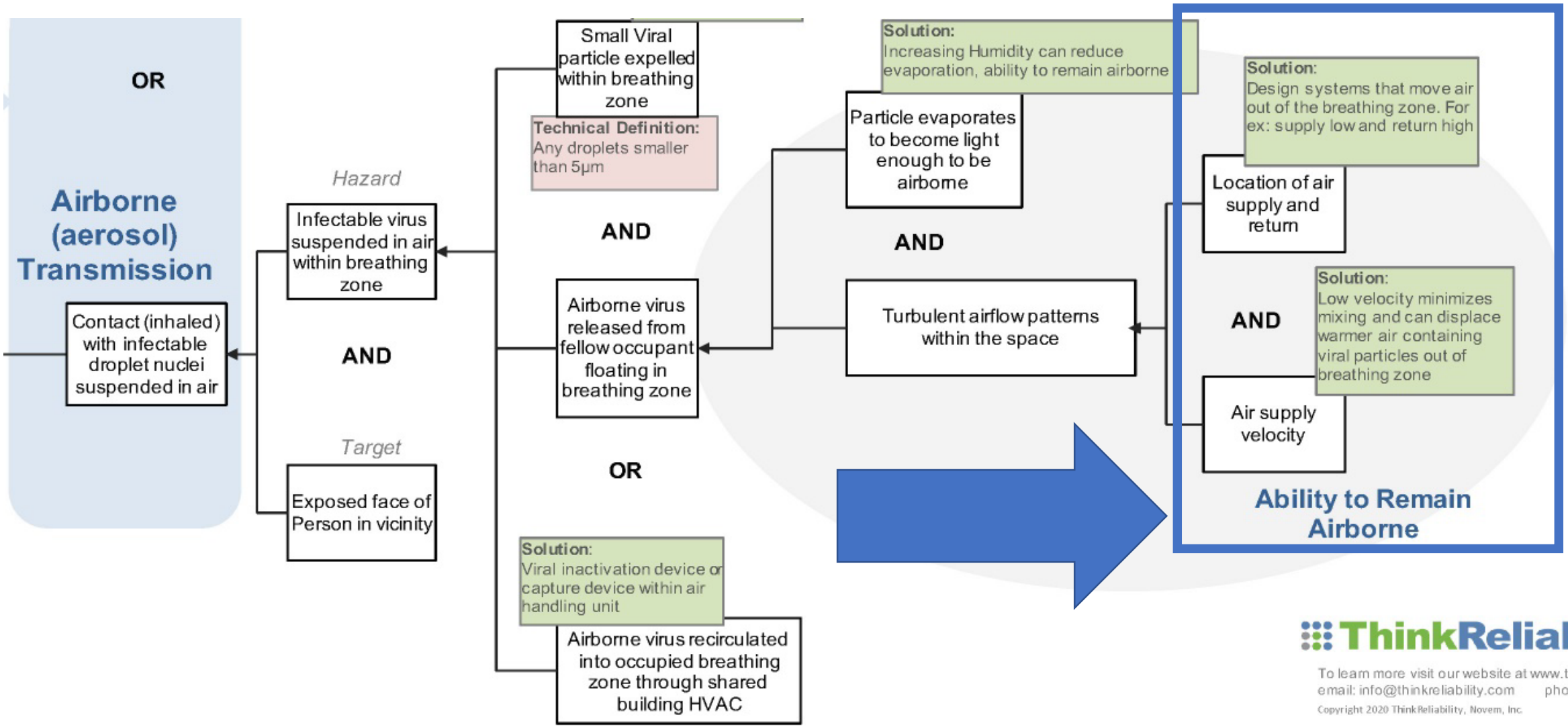
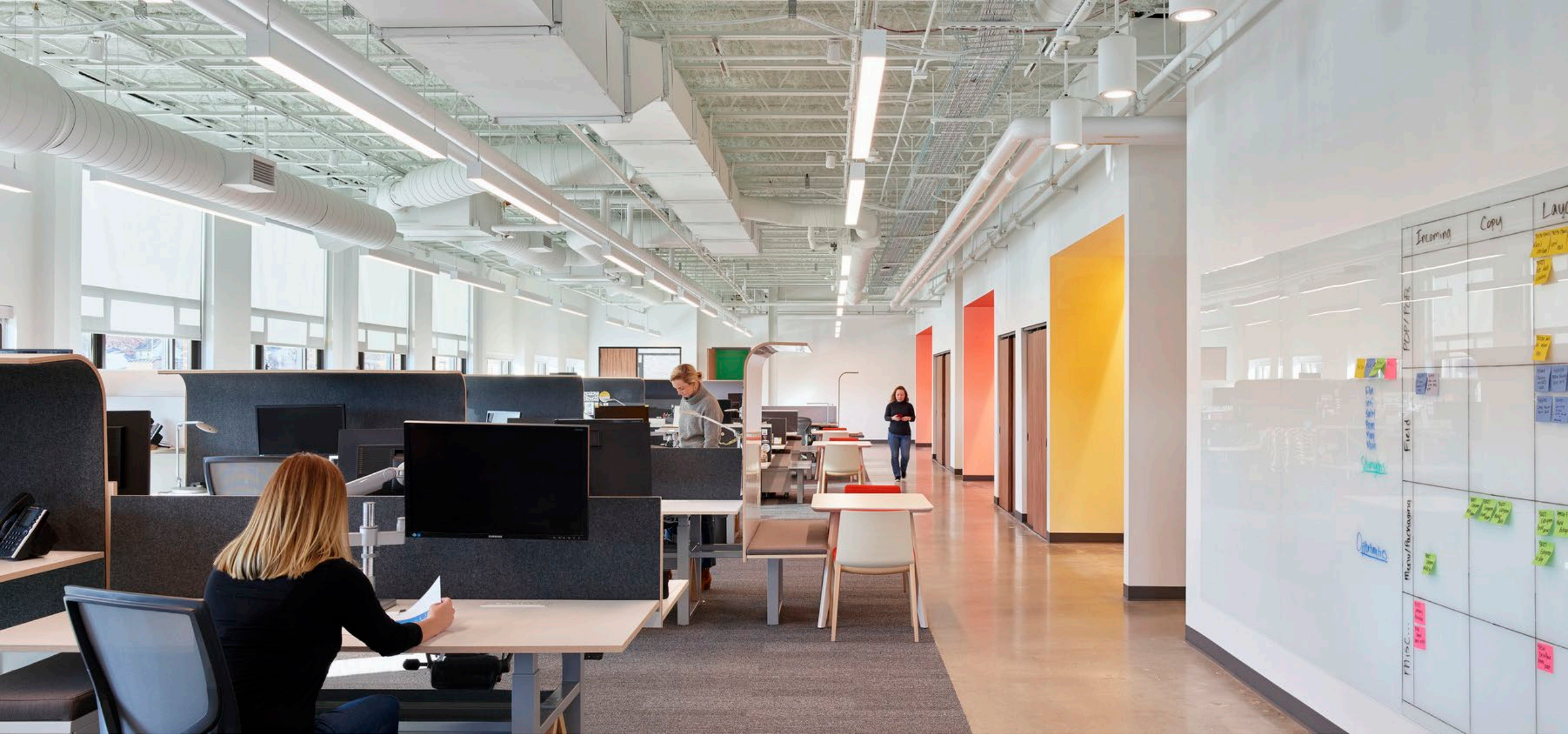
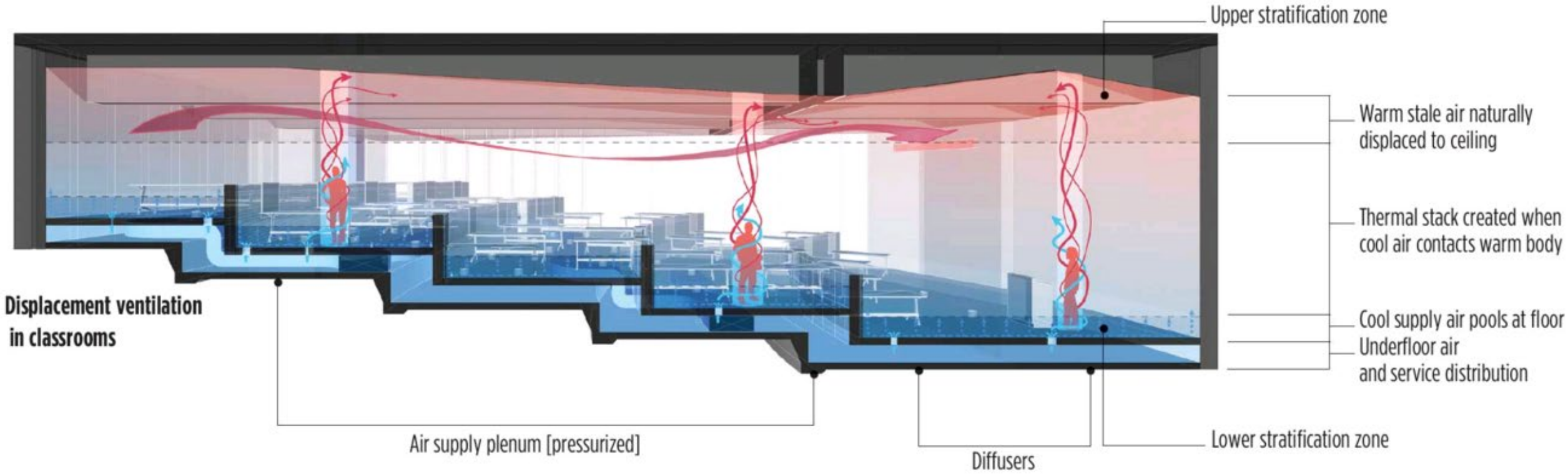


Airflow patterns within a space can **contribute significantly** to the “shared space” risk of airborne infection.

SOURCE: New York Times | https://www.Nytimes.Com/interactive/2020/08/10/nyregion/nyc-subway-coronavirus.Html?Action=click&module=top%20stories&pgtype=homepage



OVERHEAD MIXING SYSTEM

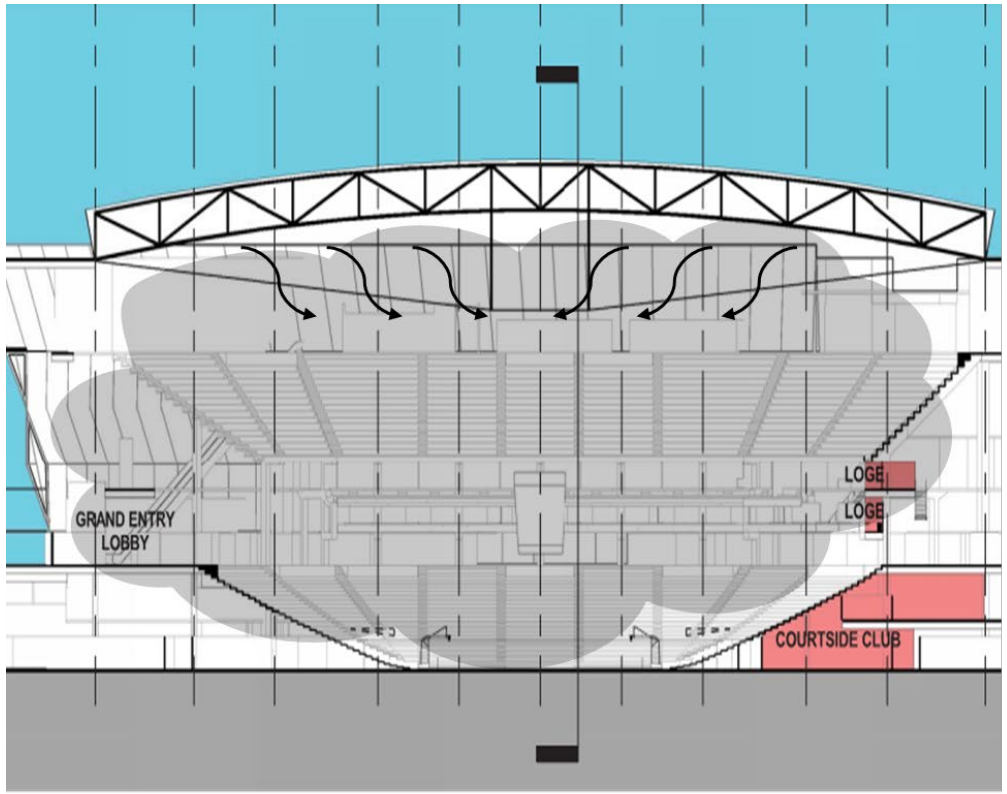


DISPLACEMENT VENTILATION

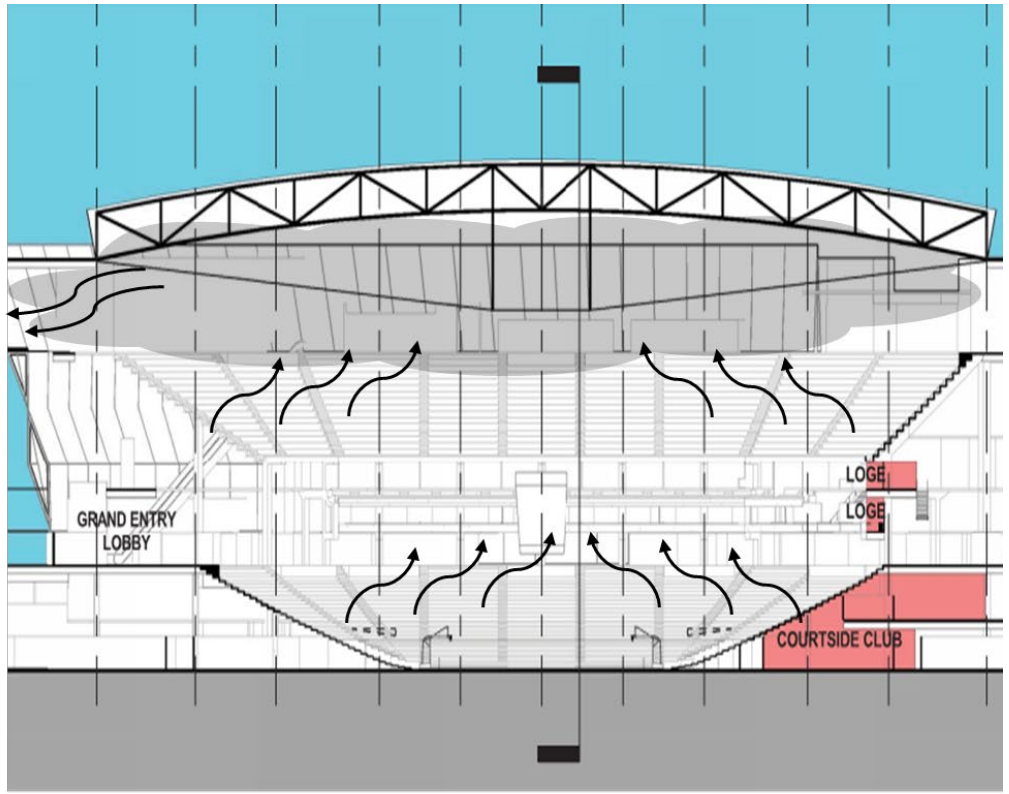
POSITIVE DISPLACEMENT SYSTEM

SUPPLY LOW, RETURN HIGH

- Removes contaminants from the breathing zone



STANDARD SYSTEM



POSITIVE DISPLACEMENT SYSTEM


DANGER
DANGER
DANGER
DANGER

DISPLACEMENT VENTILATION

QUIZ TIME

+

5 MINUTE BREAK

AIRBORNE MITIGATION: FILTRATION

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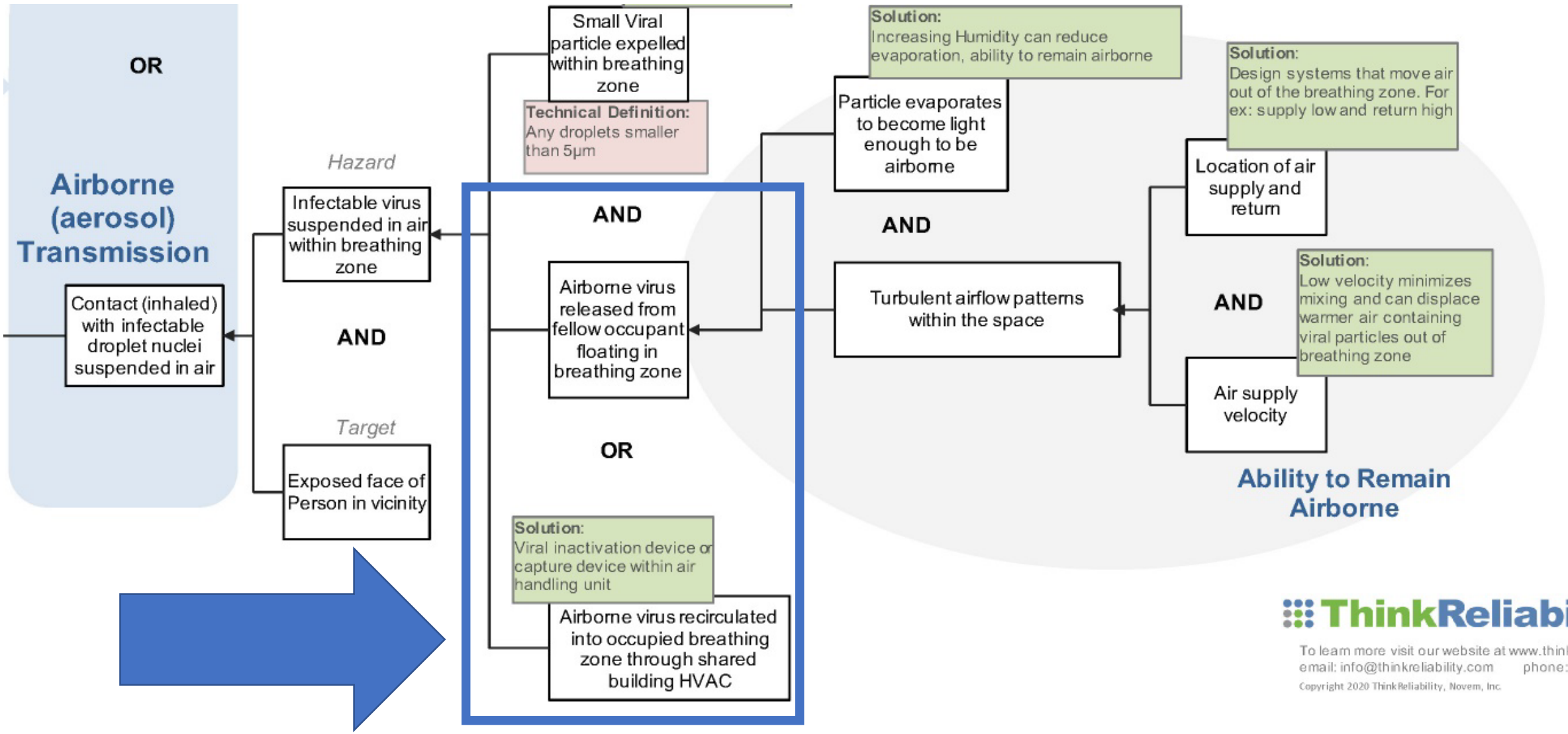
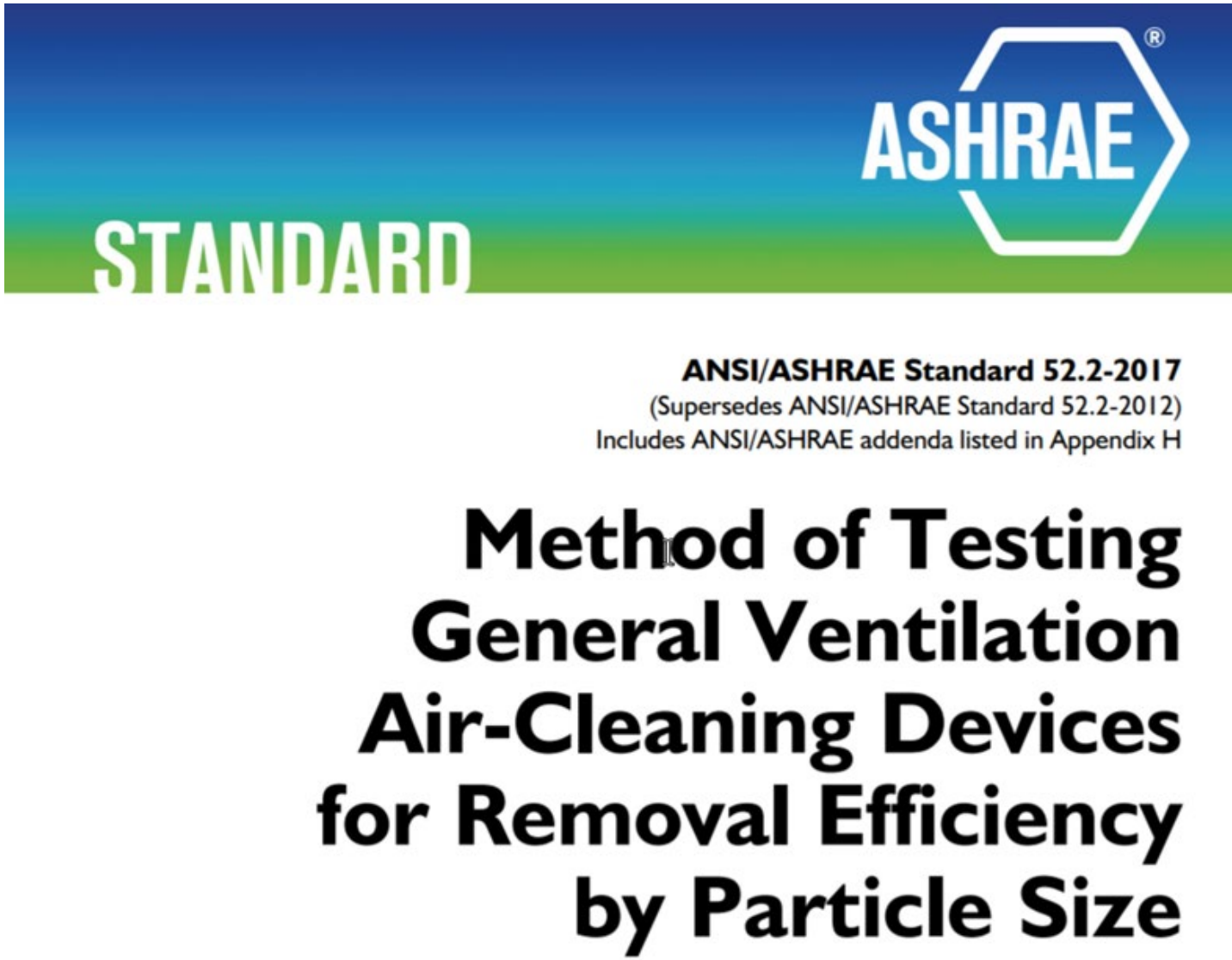


FILTRATION RATINGS

HOW ARE FILTERS RATED?

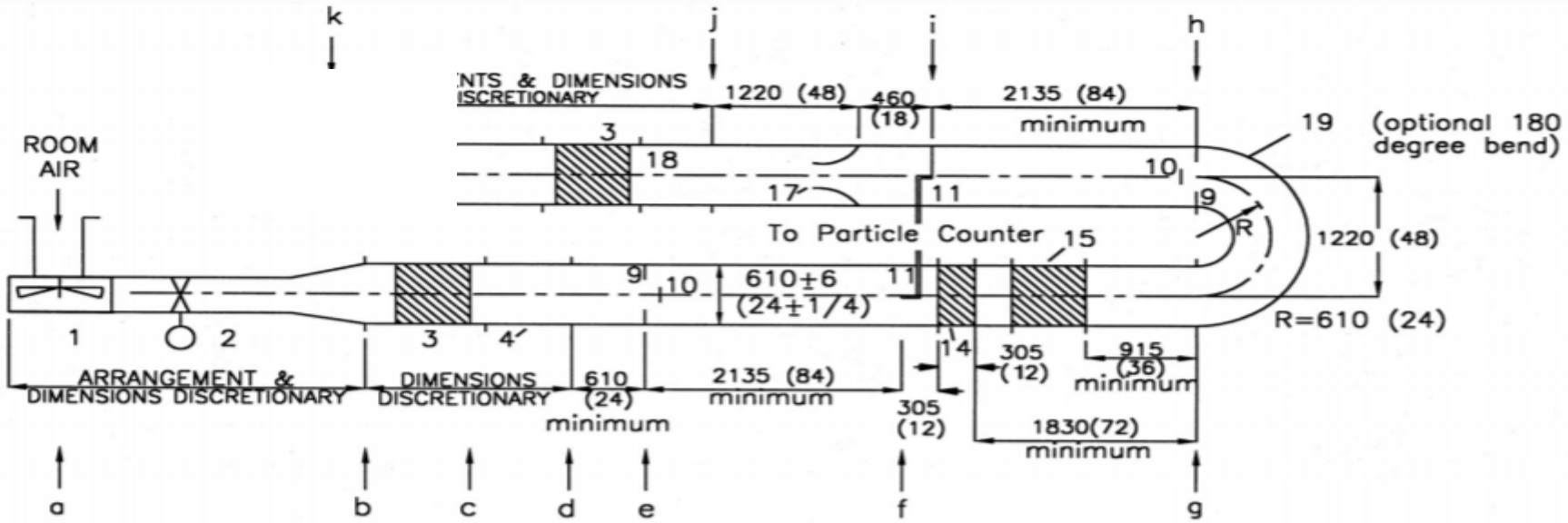
ASHRAE 52.2 Testing Procedure

- Known particle sizes released upstream of the filter being tested in the testing rig
- Particle counts taken up and down stream of the filter for 12 ranges of particle sizes
- Average performance for various particle sizes over six test cycles determines the filter rating

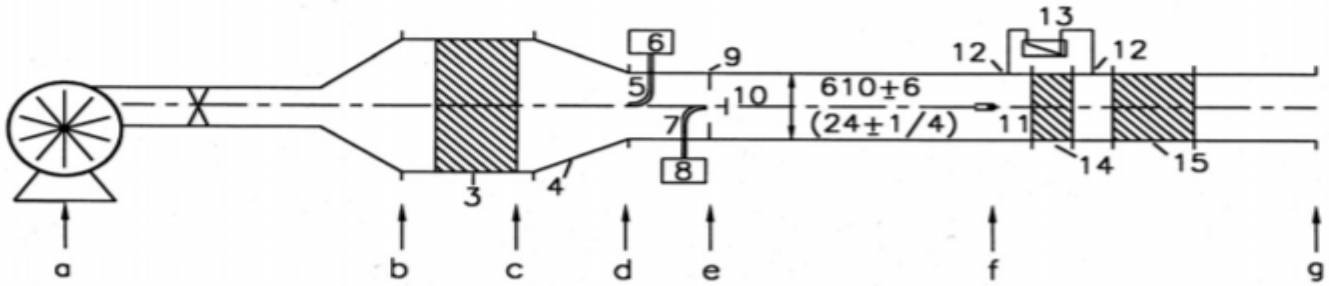


FILTER TESTING

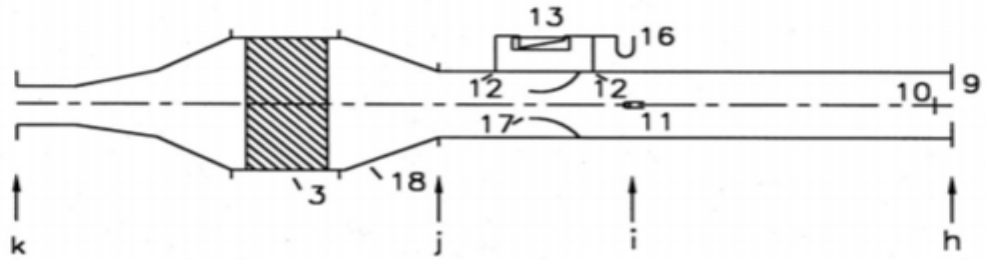
ASHRAE 52.2
Testing Apparatus



Overall View of Test Duct



Upstream Duct Detail



Downstream Duct Detail

WHAT IS A MERV RATING?

MINIMUM EFFICIENCY REPORTING VALUE

- Single number used to represent efficiency across a range of particle sizes
- Rating scale from 1-16 from lowest to highest average efficiency

Standard 52.2 Minimum Efficiency Reporting Value (MERV)	Composite Average Particle Size Efficiency, % In Size Range, µm			Average Arrestance, %
	Range 1 (0.3-1.0)	Range 2 (1.0-3.0)	Range 3 (3.0-10.0)	
1	n/a	n/a	$E3 < 20$	$A_{avg} < 65$
2	n/a	n/a	$E3 < 20$	$65 \le A_{avg} < 70$
3	n/a	n/a	$E3 < 20$	$70 \le A_{avg} < 75$
4	n/a	n/a	$E3 < 20$	$75 \le A_{avg}$
5	n/a	n/a	$20 \le E3$	n/a
6	n/a	n/a	$35 \le E3$	n/a
7	n/a	n/a	$50 \le E3$	n/a
8	n/a	$20 \le E_2$	$70 \le E3$	n/a
9	n/a	$35 \le E_2$	$75 \le E3$	n/a
10	n/a	$50 \le E_2$	$80 \le E3$	n/a
11	$20 \le E_1$	$65 \le E_2$	$85 \le E3$	n/a
12	$35 \le E_1$	$80 \le E_2$	$90 \le E3$	n/a
13	$50 \le E_1$	$85 \le E_2$	$90 \le E3$	n/a
14	$75 \le E_1$	$90 \le E_2$	$95 \le E3$	n/a
15	$85 \le E_1$	$90 \le E_2$	$95 \le E3$	n/a
16	$95 \le E_1$	$95 \le E_2$	$95 \le E3$	n/a

SOURCE: National Air Filtration Association | https://www.nafahq.org/understanding-merv-nafa-users-guide-to-ansi-ashrae-52-2/

WHAT IS A HEPA FILTER?

HIGH **E**FFICIENCY **P**ARTICULATE **A**IR

- 99.97% effective at filtering 0.3 micron particles
  - 0.3 micron particles represent the most difficult size to filter
  - Sizes both larger and smaller than 0.3 microns will be filtered at an even higher efficiency

FILTRATION EFFECTIVENESS

MERV 13 filters are **roughly 85-100% efficient** at removing potentially infectious airborne aerosol particles (1 to 5μm).

HEPA filters are **nearly 100% efficient** over this entire size range.

WHAT WOULD ASHRAE SAY?

WHAT IS THE SIZE OF THE SARS-COV-2 VIRUS, AND CAN IT BE CAPTURED BY VENTILATION FILTERS?

- Research has shown that the particle size of the SARS-CoV-2 virus is around 0.1 µm (micrometer). However, the virus does not travel through the air by itself. Since it is human generated, the virus is trapped in respiratory droplets and droplet nuclei (dried respiratory droplets) that are predominantly 1 µm in size and larger.

- ASHRAE currently recommends using a minimum MERV 13 filter
  - Which is at least 85% efficient at capturing particles in 1 µm to 3 µm size range.

- High efficiency particulate air (HEPA) filters are even more efficient at filtering human-generated infectious aerosols…
  - HEPA filters are more than 99.97% efficient at capturing airborne viral particles associated with SARS-CoV-2.

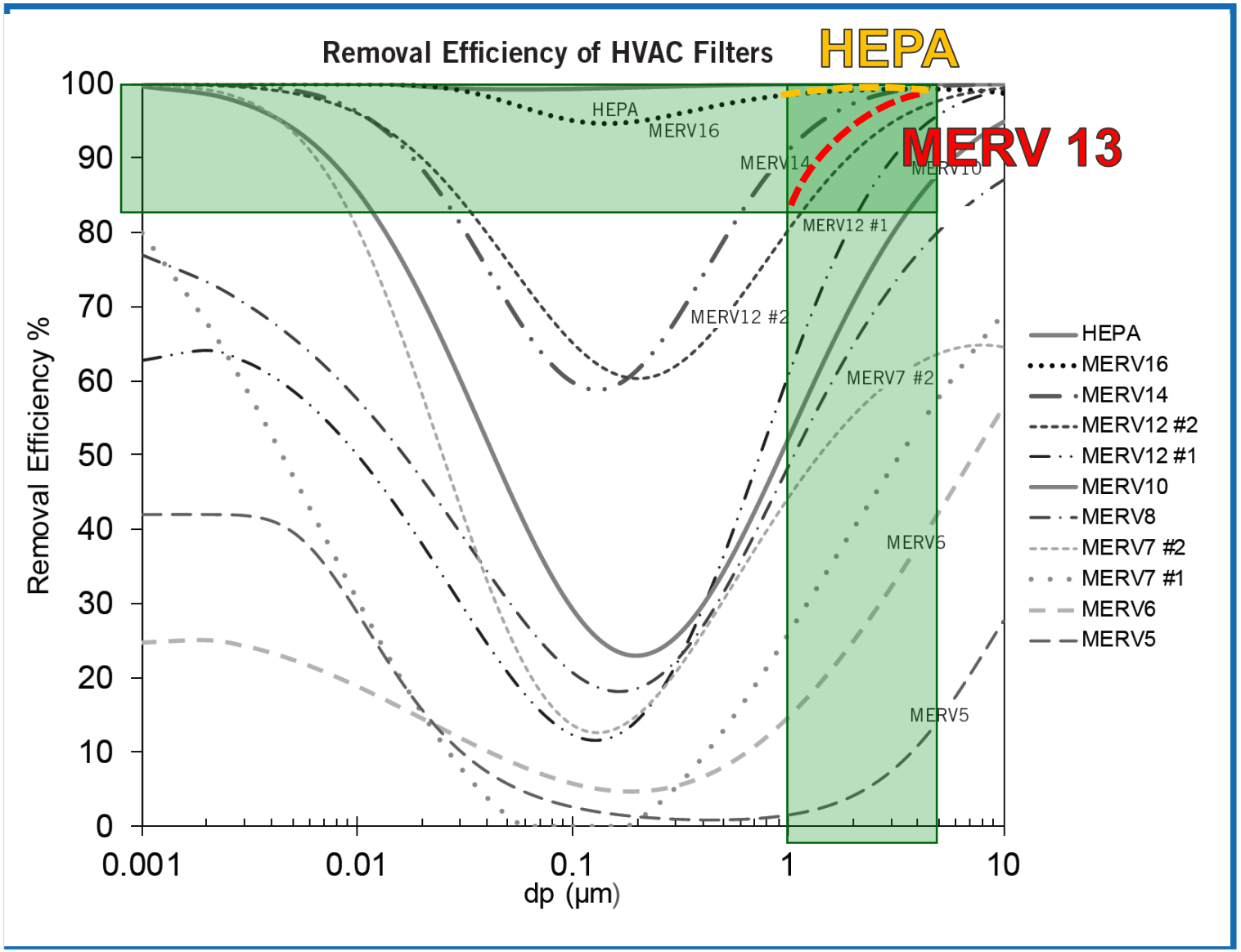
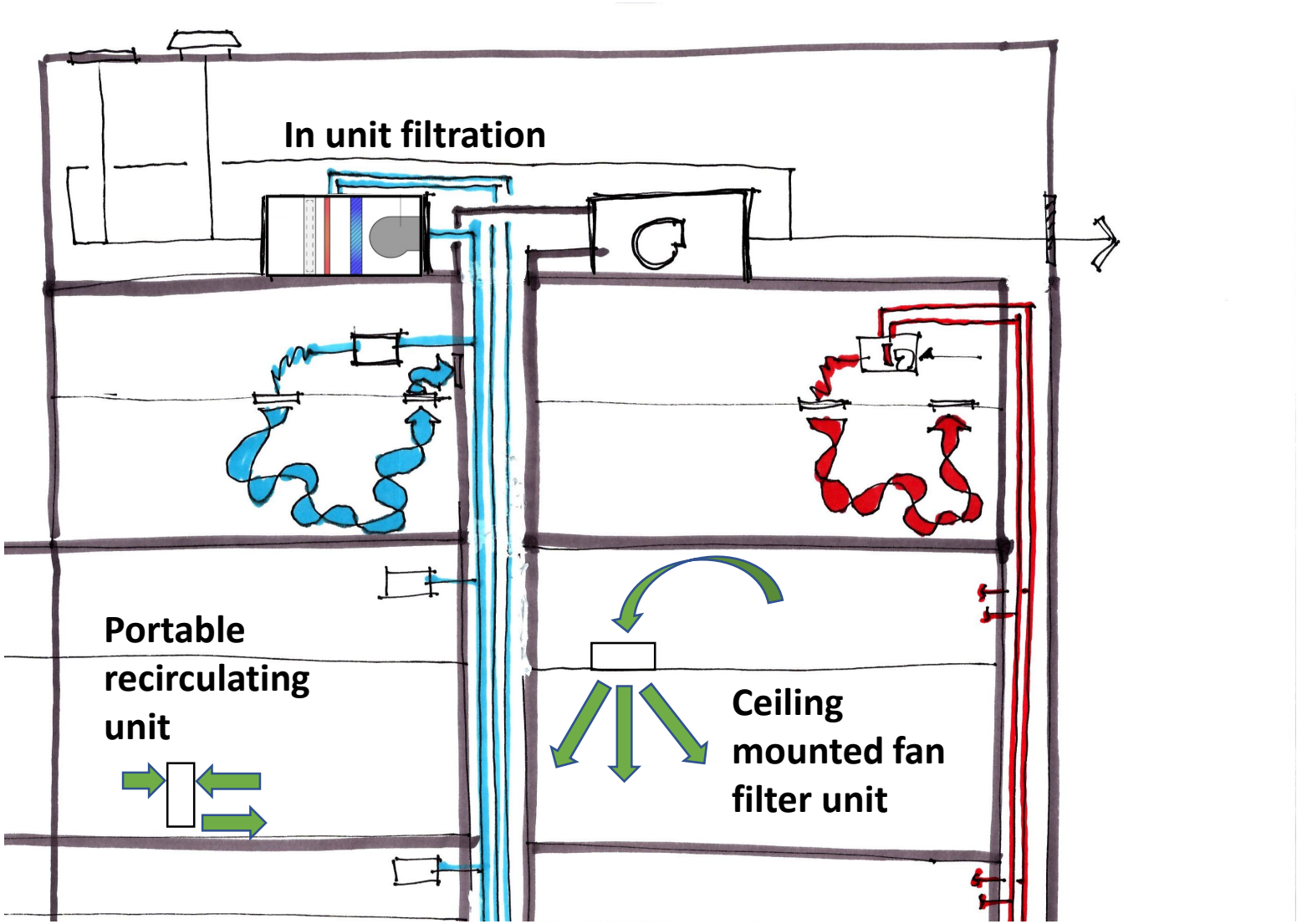


Figure 5. Typical size-resolved removal efficiency curves for new (clean) fibrous media air filters rated by the MERV metric as tested in reported in Azimi et al. (2014). Reprinted from *Atmospheric Environment*, Vol. 98, Parham Azimi, Dan Zhao, and Brent Stephens, Estimates of HVAC filtration efficiency for fine and ultrafine particles of outdoor origin, pages 337–346, copyright (2014), with permission from Elsevier.

FILTRATION APPLICATIONS


In unit filtration
Portable recirculating unit
Ceiling mounted fan filter unit

IN-HVAC FILTRATION

FILTER MOUNTING

ANGLED FILTER BANK

FLAT FILTER BANK

FILTER ARRANGEMENTS

PRE-FILTER

FINAL FILTER

	MERV 8	MERV 13	HEPA
Acceptable Velocity (FPM)	1” Deep: 350 2” Deep: 500 4” Deep: 500	1” Deep: 350 2” Deep: 500 4” Deep: 500 12” Vbank: 500	12” Standard Cap: 250 12” V-Bank: 500 12” High Cap: 600
Assumed Pressure Drop (inches)	1” Deep: .23 Initial, .46 Final 2” Deep: .31 Initial, .62 Final 4” Deep: .27 Initial, .54 Final	1” Deep: .36 Initial, .72 Final 2” Deep: .41 Initial, .82 Final 4” Deep: .36 Initial, .72 final 12” Vbank: .32 Initial, .64 final	12” Strd Cap: 1” Initial, 2” Final 2” Vbank: 1” Initial, 2” Final 12” High Cap: 1” Initial, 2” Final

SIZING CRITERIA

RECIRCULATING FILTRATION

PORTABLE UNITS

KEY CONSIDERATIONS

- Placement of recirculation HEPA filters should be as close to the contaminant source as possible to enhance capture rate of contaminants from the space.
- Additional noise may be created depending on the setting level and airflow.
- Can be used to direct airflow patterns within a space.

COVERAGE & SIZING

- 200-300 SF

FAN FILTER UNITS (FFU)

COVERAGE & SIZING

- FFUs are applied in parallel with the standard HVAC system
- They can be placed in higher density where people may congregate.
- Pulls air from the room into the above-ceiling plenum space, filters it and returns it to the room

The Pharmaseal FFU is a fan-powered option of the Pharmaseal filter housing. In addition to the industry leading features of the Pharmaseal, the FFU option has the following features:

1. Electronic Fan Speed Adjustment

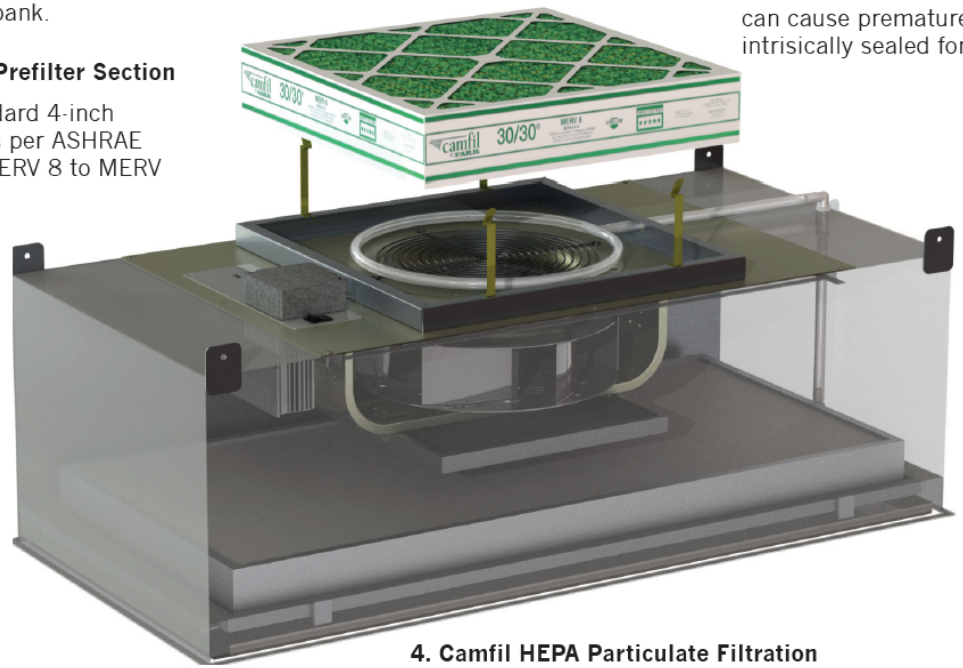
Pharmaseal FFUs can be speed-adjusted individually, by zones or as a large bank.

2. Integrated 30/30® Prefilter Section

Accepts industry standard 4-inch deep air filters. MERVs per ASHRAE Standard 52.2 from MERV 8 to MERV 14 are available.

3. All-Welded Housing Construction

Pharmaseal housing is guaranteed to be leakfree to 3" w.g.



4. Camfil HEPA Particulate Filtration

Camfil prefilters and Megalam HEPA filters ensure optimum performance and the lowest total cost of ownership.

5. Solid Air/Aerosol Diffuser Plate

The proprietary air/aerosol diffuser assembly ensures adequate dispersion of filter challenge for filter testing and/or room certification. The challenge is spread evenly across the face of the filter so that filters can be scan tested. It also ensures uniformity of airflow through the filter.

6. Backward Inclined Fan

High efficiency, low noise, high air volume delivery fan.

7. Electronically-Commutated Fan Motor

Electronically-Commutated (EC) fan motors are highly efficient during operation. EC motors magnetically "lock" when turned off and do not rotate freely which can cause premature bearing failure. Fan motor is intrisically sealed for system integrity.

ENERGY IMPLICATIONS

$$\frac{cfm_2}{cfm_1} = \frac{rpm_2}{rpm_1}$$

CFM varies **DIRECTLY** with rpm change

$$\frac{P_{S2}}{P_{S1}} = \left(\frac{rpm_2}{rpm_1}\right)^2$$

Static pressure varies with the **SQUARE** of the rpm change

$$\frac{bhp_2}{bhp_1} = \left(\frac{rpm_2}{rpm_1}\right)^3$$

Horsepower varies with the **CUBE** of the rpm change

THE FAN LAWS

THE MATH

THE FAN'S FULL-LOAD DESIGN CONDITIONS WITH MERV 8 FILTERS ARE:

2000 RPM	2000 CFM
1.5 in.w.c total SP	5.0 bhp

REPLACING THE EXISTING MERV 8 FILTER WITH A MERV 13 INCREASES THE TOTAL SP FROM 1.5 TO 1.72 IN. W.C.:

- What is the new required fan **RPM** with a MERV 13 filter?
- What is the new required **brake horsepower**?
- What would the impact of a **HEPA filter** be?

$$rpm_2 = \sqrt{\frac{P_{s2}}{P_{s1}}} \cdot rpm_1$$

$$rpm_2 = \sqrt{\frac{1.72}{1.5}} \cdot 2000$$

$$rpm_2 = 1.07 \cdot 2000$$

$$rpm_2 = 2{,}140$$

WHAT IS THE REQUIRED FAN RPM WITH MERV 13 FILTERS?

$$bhp_2 = \left(\frac{rpm_2}{rpm_1}\right)^3 \cdot bhp_1$$

$$bhp_2 = \left(\frac{2140\ rpm}{2000\ rpm}\right)^3 \cdot 5.0\ bhp$$

$$bhp_2 = (1.07)^3 \cdot 5.0\ bhp$$

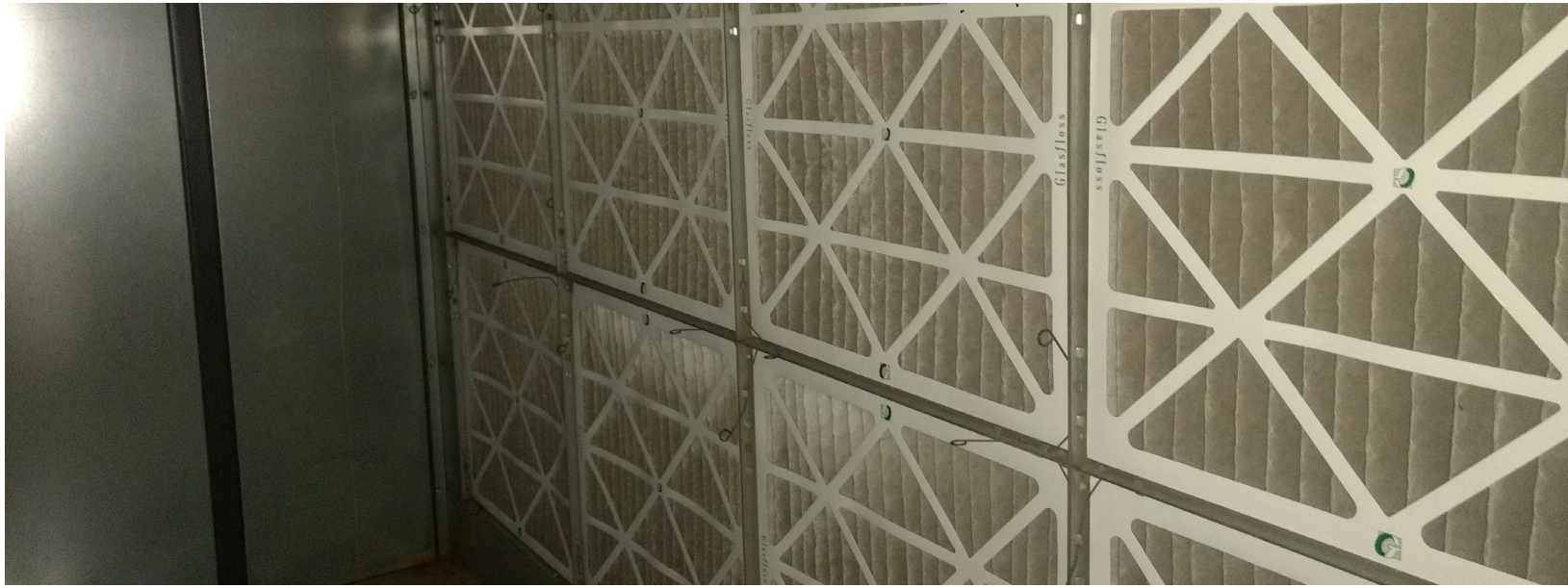
$$bhp_2 = 6.13\ bhp$$

WHAT IS THE NEW BHP AT THIS NEW RPM?

$$rpm_2 = 3266$$

$$bhp_2 = 21.77$$

WHAT IF WE DID THE SAME BUT WITH A HEPA FILTER?



CASE STUDY

QUIZ TIME

+

5 MINUTE BREAK

AIRBORNE MITIGATION: UV

HENDERSON ENGINEERS | HENDERSON BUILDING SOLUTIONS

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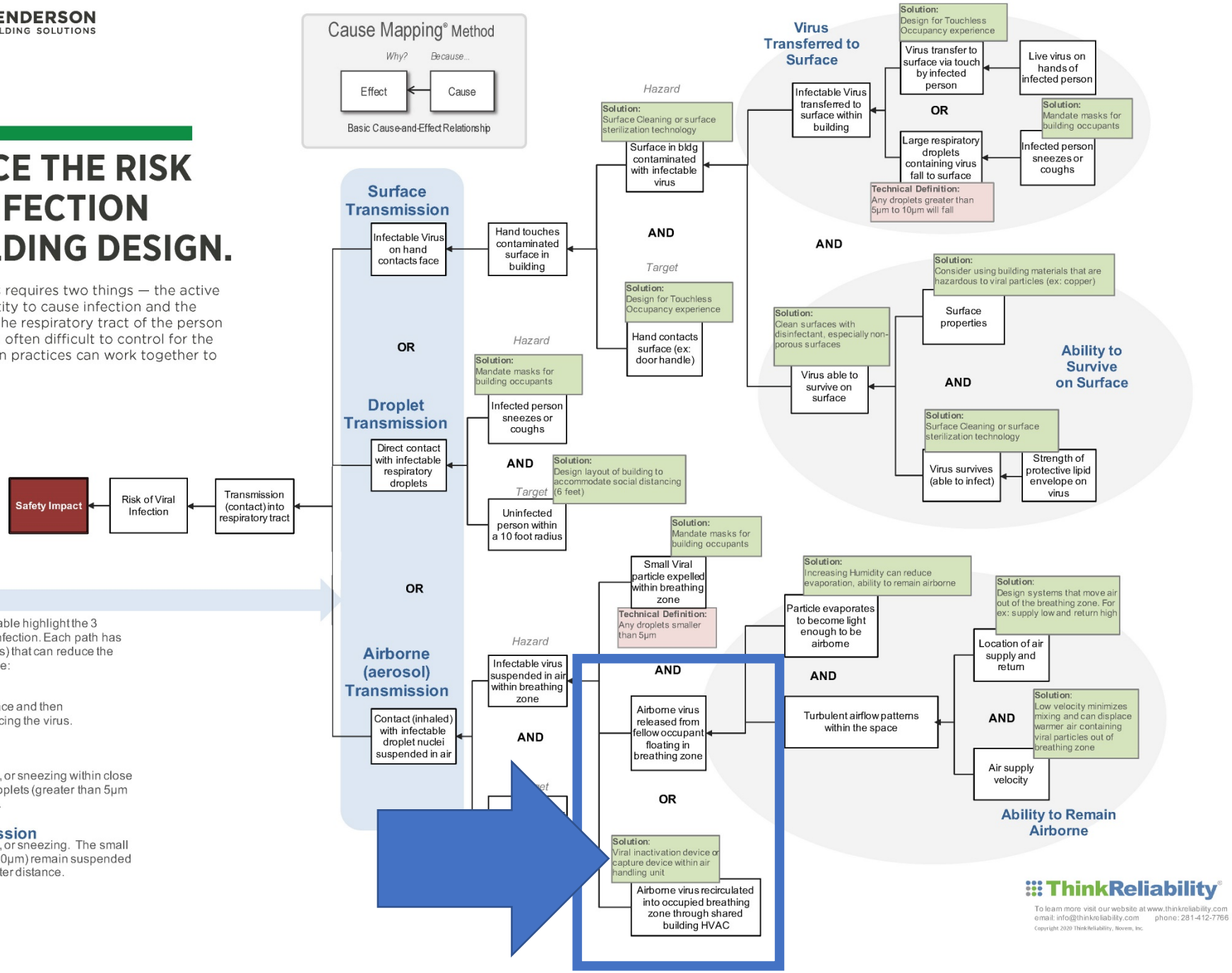
HOW TO REDUCE THE RISK OF COVID-19 INFECTION THROUGH BUILDING DESIGN.

Transmission of COVID-19 in buildings requires two things — the active virus being present in sufficient quantity to cause infection and the transmission of that active virus into the respiratory tract of the person being infected. In public buildings, it's often difficult to control for the presence of the virus, but good design practices can work together to reduce the overall risk of infection.



3 Transmission Paths

Using the Cause Map diagram we are able highlight the 3 potential transmission paths of a viral infection. Each path has different control opportunities (Solutions) that can reduce the risk of transmission. The 3 paths include:

Surface Transmission

A person touches a contaminated surface and then inadvertently touches their face introducing the virus.

Droplet Transmission

An infected person is talking, coughing, or sneezing within close contact of others. Large Respiratory droplets (greater than 5µm to 10µm) makes direct contact to infect.

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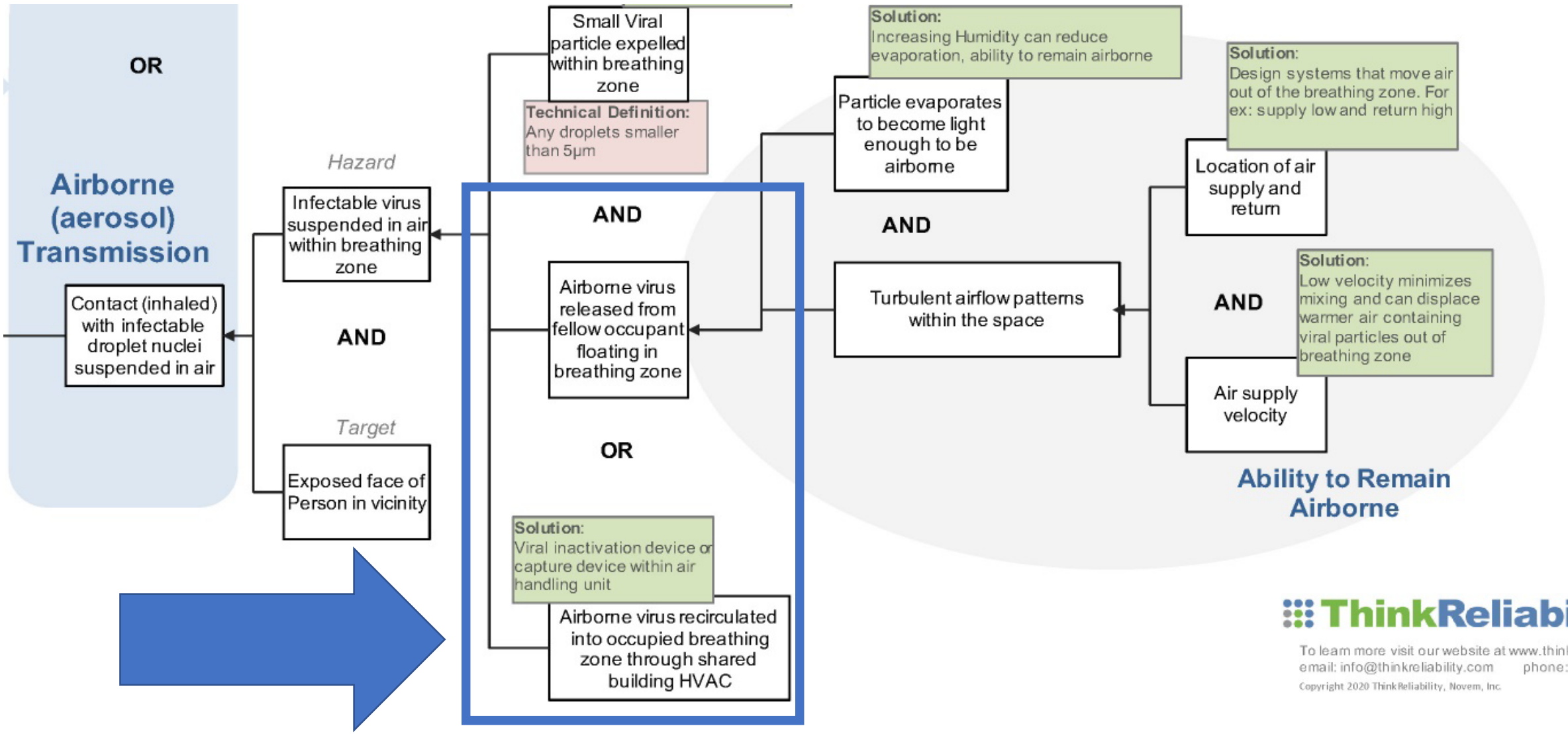
An infected person is talking, coughing, or sneezing. The small respiratory droplets (less than 5µm to 10µm) remain suspended in air for a period of time and over greater distance.

ThinkReliability
To learn more visit our website at www.thinkreliability.com
email: info@thinkreliability.com phone: 281-412-7766



UV EFFECTIVENESS

Early evidence suggests that in-duct UVc systems can effectively reduce active viral load by greater than 90% in a moving air stream in a single pass when sized appropriately.

LOGIC TEST FOR UVC EFFECTIVENESS

1. SARS-COV-2 is susceptible to Uvc light
2. UVc can kill similar viruses in an airborne application
3. Preliminary testing on SARS-COV-2 shows inactivation at very low doses

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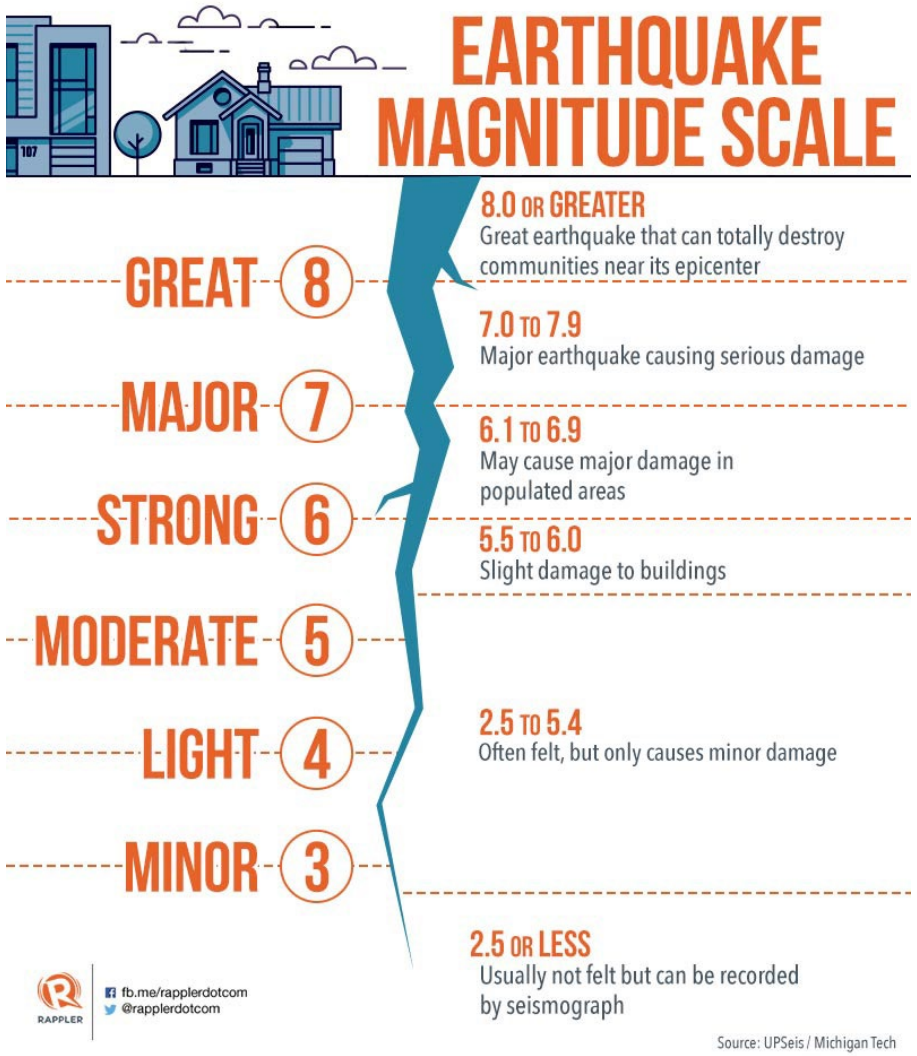
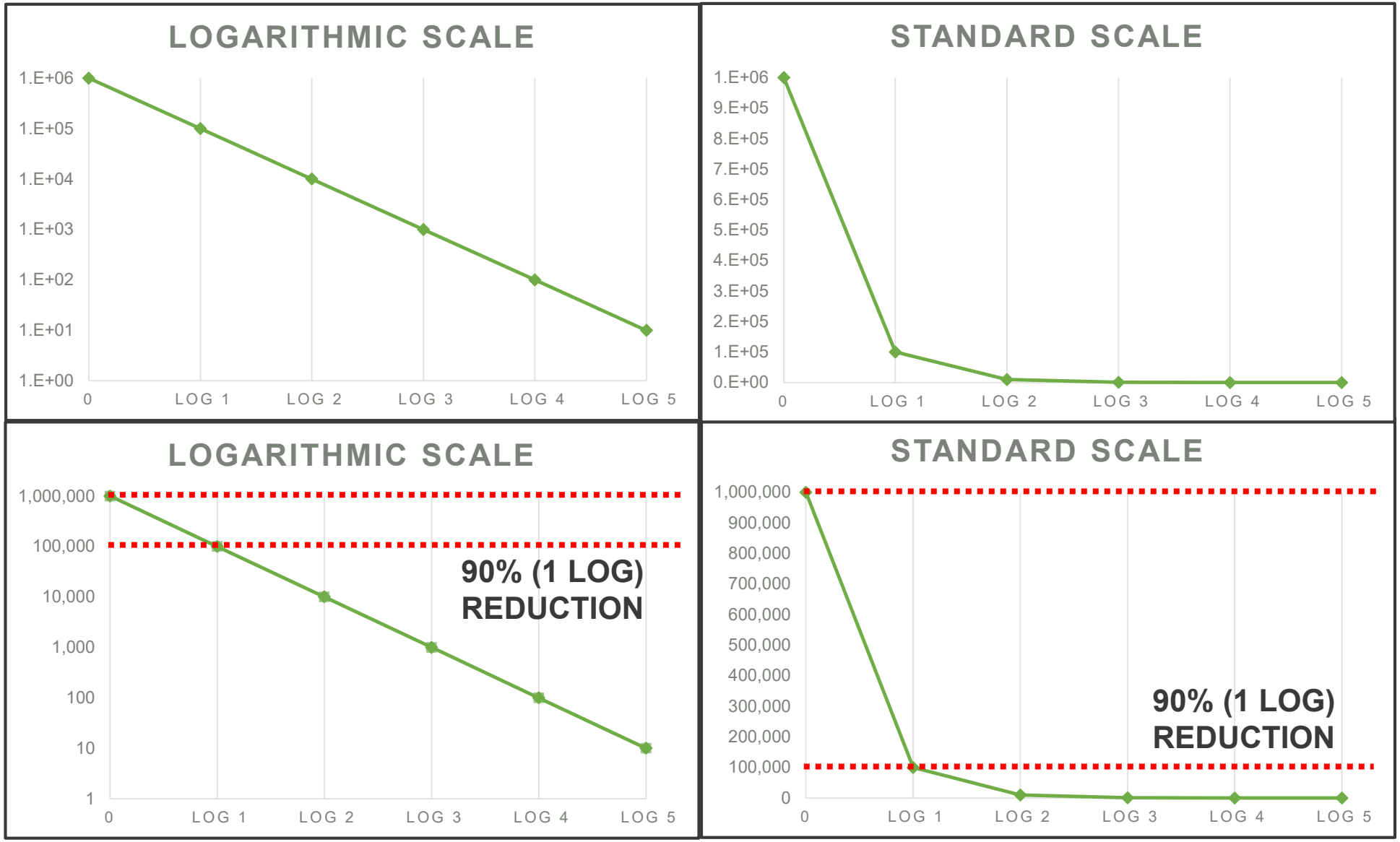
AN ASIDE ABOUT SCALES…

- **Log Reduction** → 10-fold (one decimal) or 90% **reduction**

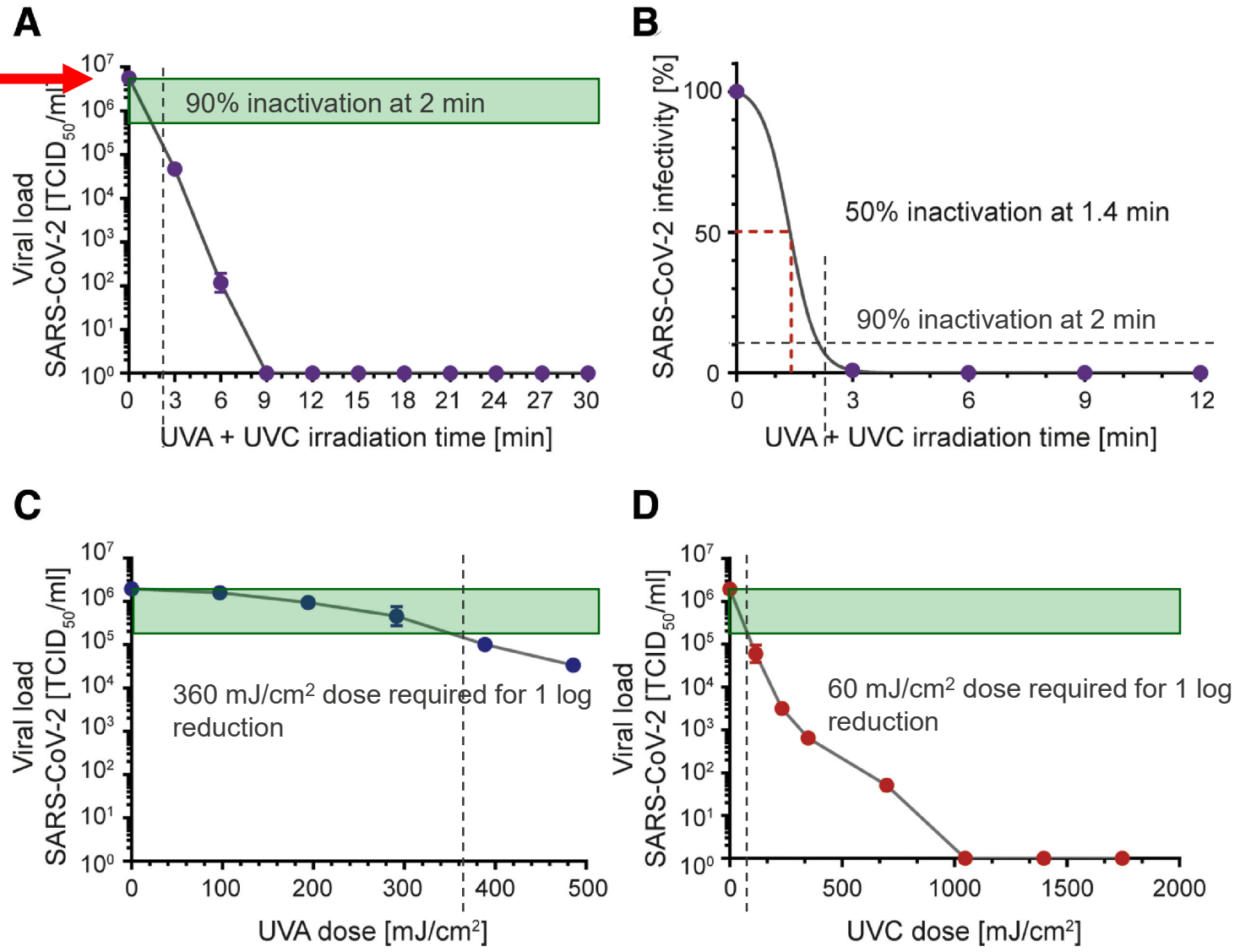
- **1-Log Reduction would reduce** the number of bacteria 90%
  - 100 bacteria reduced to 10 or 10 reduced to **1**




LOGARITHMIC SCALE
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
0
LOG 1
LOG 2
LOG 3
LOG 4
LOG 5
STANDARD SCALE
1.E+06
9.E+05
8.E+05
7.E+05
6.E+05
5.E+05
4.E+05
3.E+05
2.E+05
1.E+05
0.E+00
0
LOG 1
LOG 2
LOG 3
LOG 4
LOG 5
LOGARITHMIC SCALE
1,000,000
100,000
10,000
1,000
100
10
1
90% (1 LOG) REDUCTION
0
LOG 1
LOG 2
LOG 3
LOG 4
LOG 5
STANDARD SCALE
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
90% (1 LOG) REDUCTION
0
LOG 1
LOG 2
LOG 3
LOG 4
LOG 5

VIRAL REDUCTION OF SURFACE APPLICATION OF UVA AND UVC

Very high concentration representative of viral load in terminal COVID patient



SOURCE: American Journal of Infection Control | https://www.ajicjournal.org/article/S0196-6553(20)30756-2/fulltext

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Biological Inactivation Efficiency of HVAC In-Duct Ultraviolet Light Devices

UVC Device	Lamps	Measured Dosage [a] (μW-s/cm²)	Power (w)	Airborne Inactivation Efficiencies (%)		
				Spore form of bacteria (*B. atrophaeus*)	Vegetative form of bacteria (*S. marcescens*)	Virus (MS2 bacteriophage)
Abracair, LLC	12	447 (376 – 550)	6480 – 6720	6.9	99.8	59
American Ultraviolet Corporation ACP-24/HO-4	4	582 (490 – 716)	169	9	≥99.96 [b]	75
Atlantic Ultraviolet Corporation AeroLogic Model AD24-4	4	295 (249 – 363)	94	0	≥99.8 [b]	46
Dust Free Bio-Fighter 4Xtreme, Model 21	1	247 (208 – 304)	53	4	99	39
Lumalier ADPL-60-8	8	3180 (2678 – 3914)	568	40	≥99.98 [b]	82
Novatron, Inc. BioProtector BP114i	6	> 42,342 (35,656 – 52,113)	748	≥99.9[b]	≥99.94[b]	≥99.9 [b]
Sanuvox Technologies Inc. UV Bio-Wall 50 Outwardly Projecting Air Purifier	5	16,439 (13,843 – 20,223)	944	93	≥99.97 [b]	99
Steril-Aire, Inc. Model SE1 VO with GTS 24 Emitter	6	19,826 (16,696 – 24,401)	421	96	≥99.96 [b]	99
UltraViolet Devices, Inc. Altru-V V-Flex	12	7,651 (6,443 – 9,416)	755	71	≥99.98 [b]	98

[a] The systems were run at 0.93 m³/sec (1970 CFM), except for the Novatron device, which was run at 0.14 m³/sec (300 CFM).
[b] These values are based on the upper 95 percent confidence limit for the mean downstream count of the test organism. There were no downstream counts measured.

Relatively high dosage of UVC

SOURCE: United States Environmental Protection Agency | https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=NHSRC&address=nhsrc/si/&dirEntryId=233212

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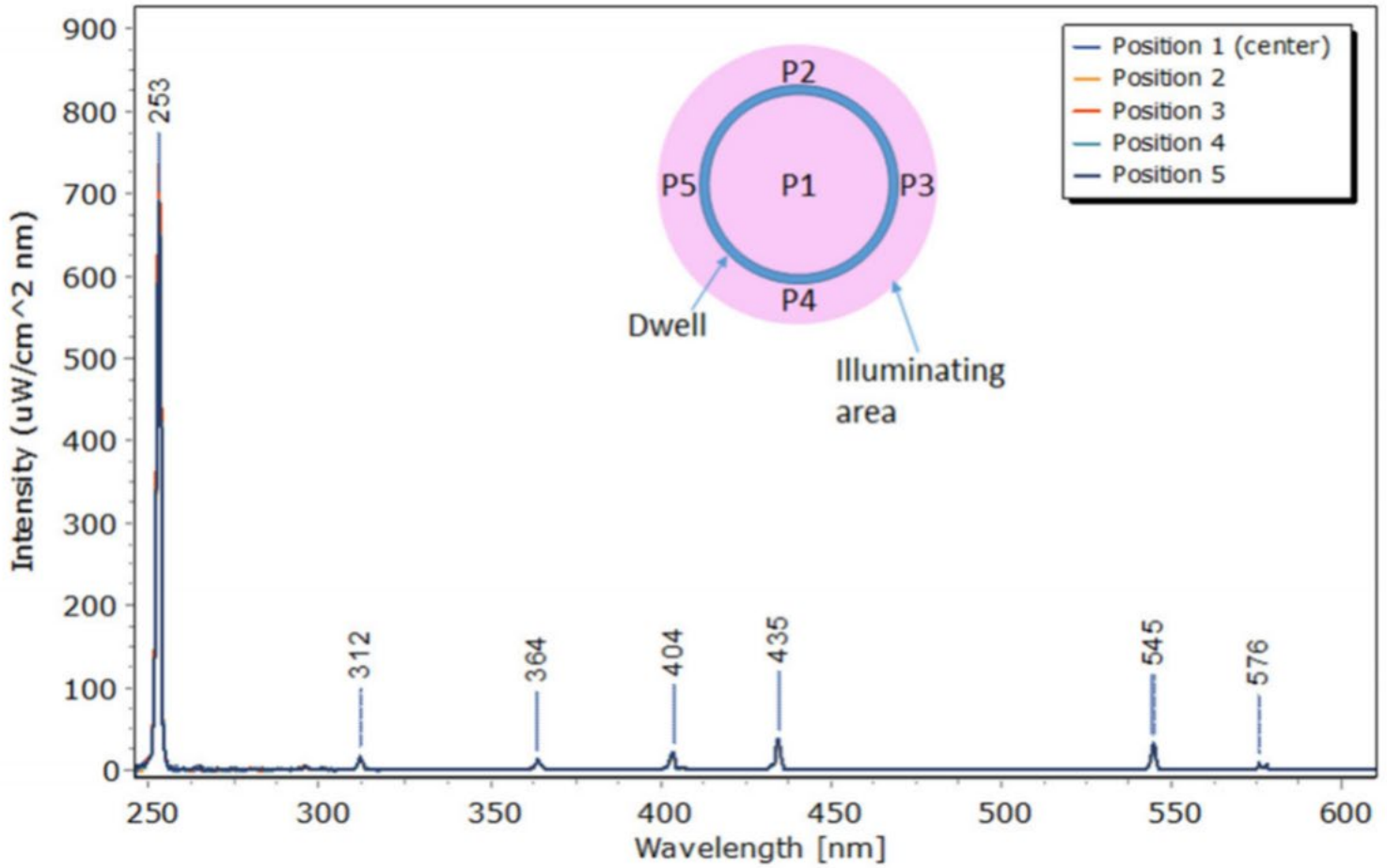
OUTPUT OF UV LAMP USED IN EXPERIMENT



Total output of 1084 μW-s/cm^2 concentrated at 253 nm

SOURCE: medRxiv Preprint | https://www.medrxiv.org/content/10.1101/2020.06.05.20123463v2.full.pdf

OUTPUT OF UV LAMP USED IN EXPERIMENT

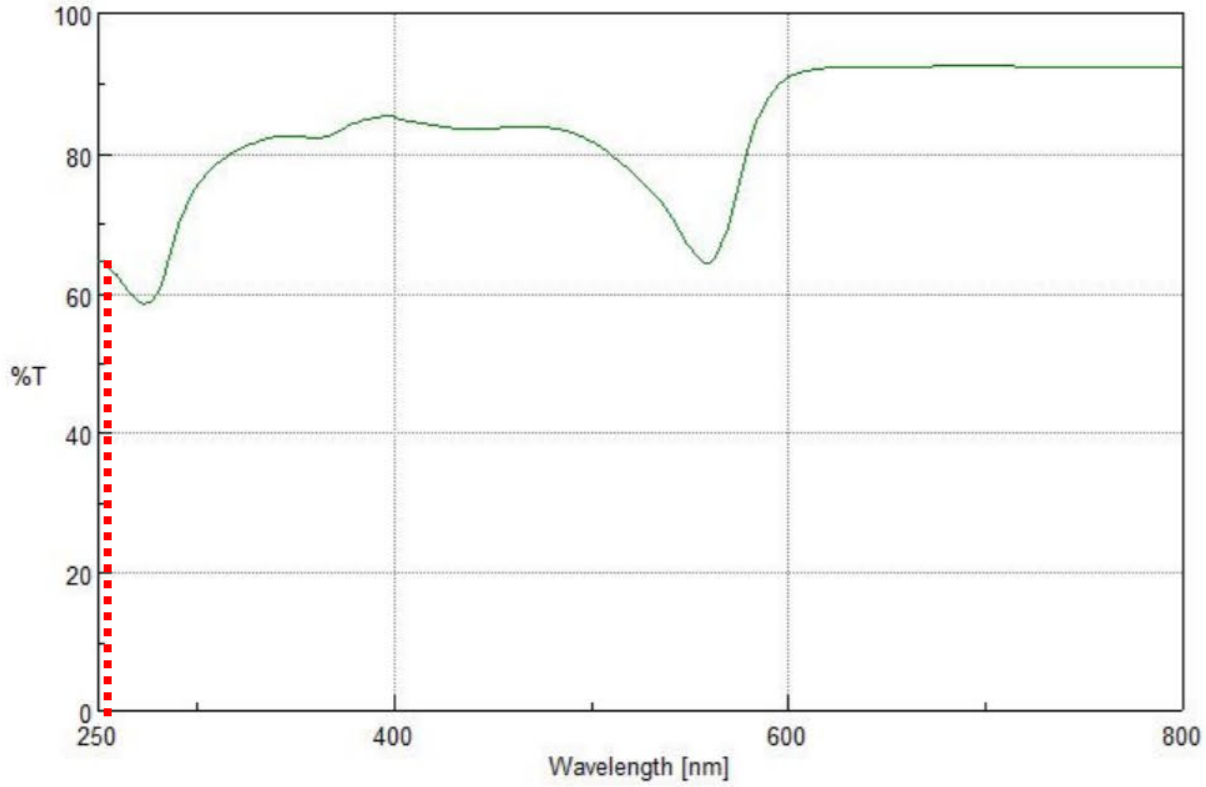
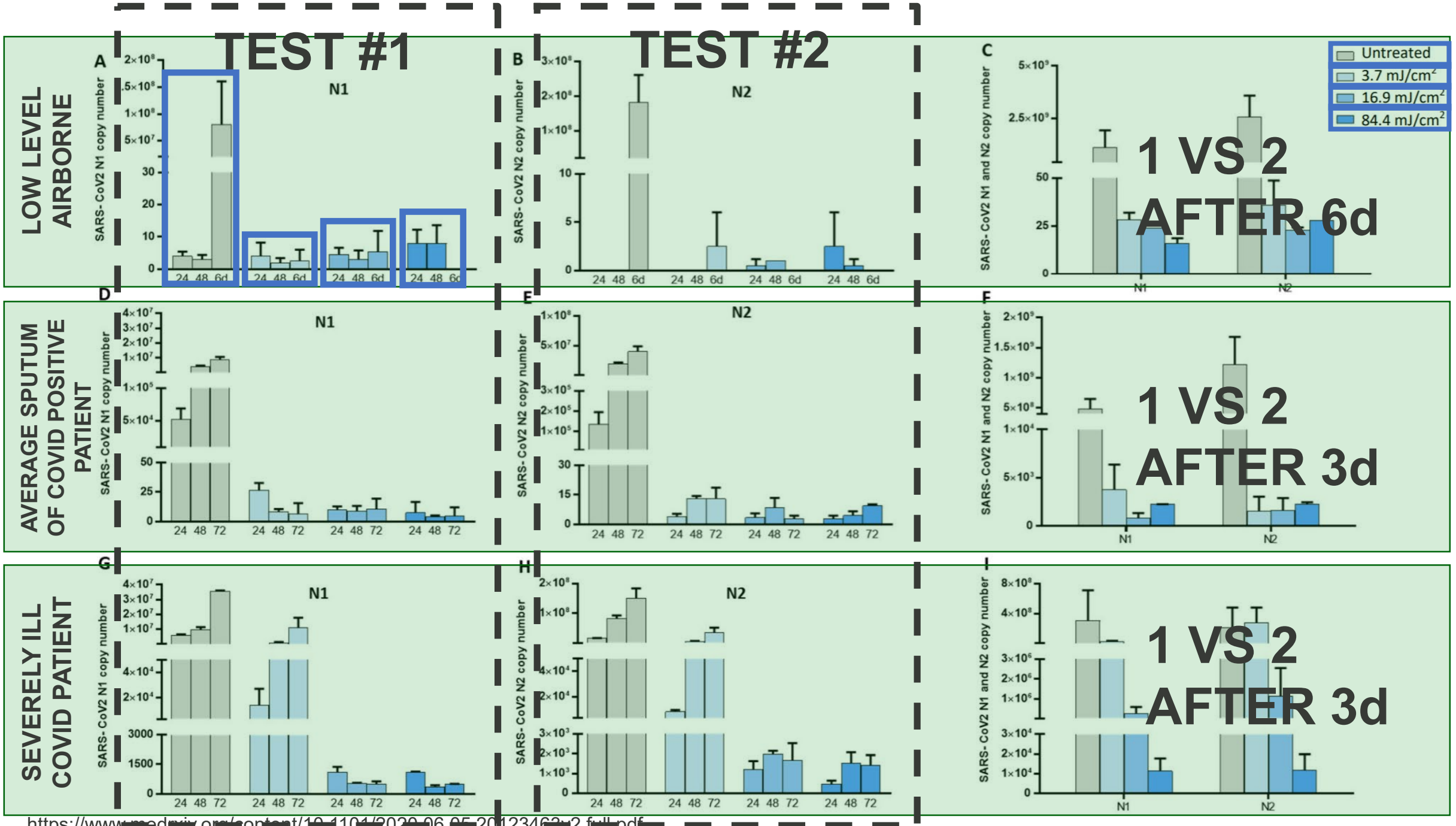
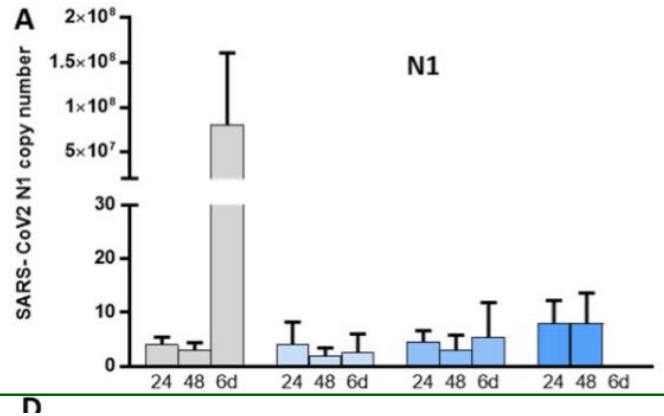


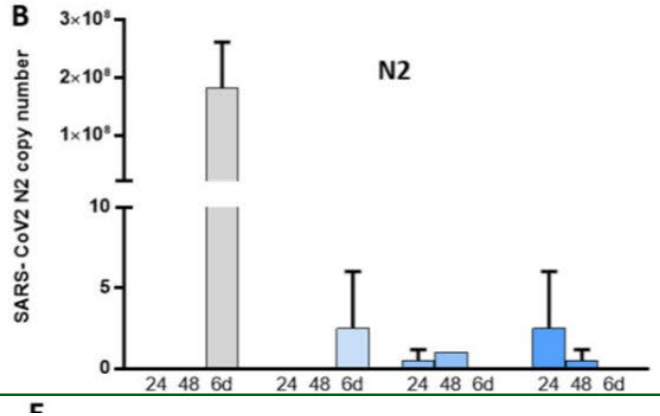
Figure S2. UV-vis transmission spectrum of the Dulbecco's Modified Eagle's Medium (DMEM) in a 1 mm quartz cuvette.

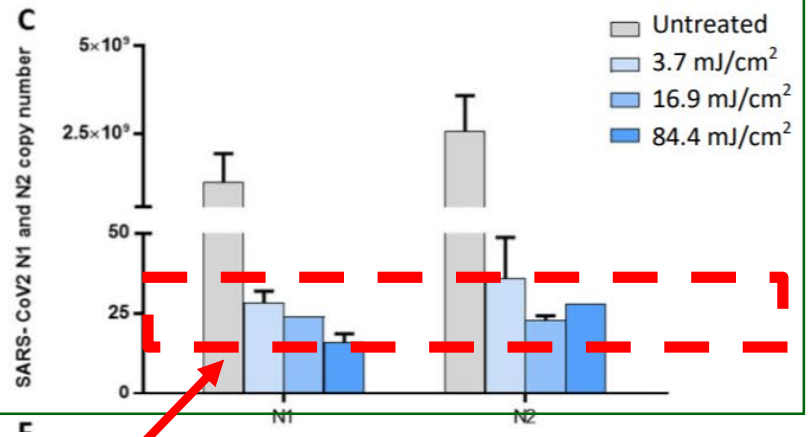
SOURCE: medRxiv Preprint | https://www.medrxiv.org/content/10.1101/2020.06.05.20123463v2.full.pdf



LOW LEVEL AIRBORNE







TEST #1

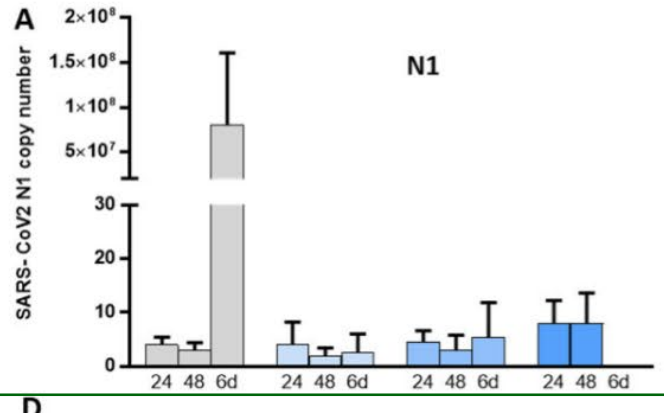
TEST #2

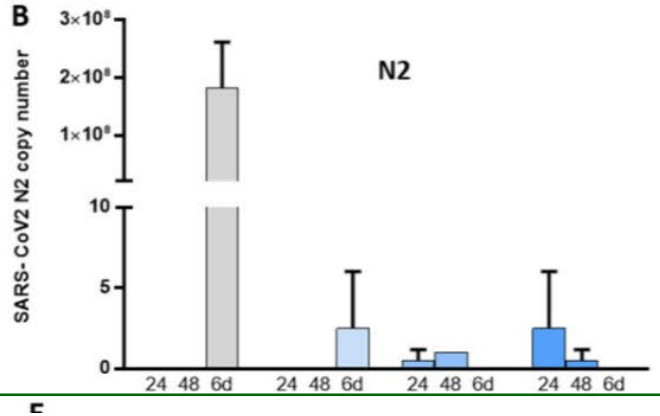
1 VS 2 AFTER 6d

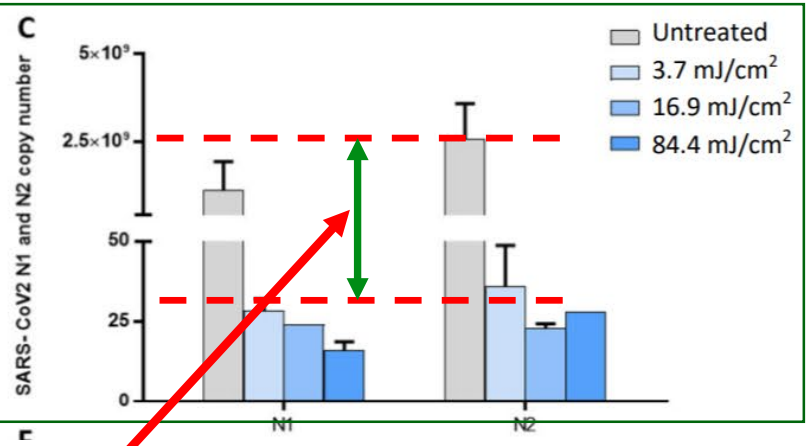
Very similar levels of active virus growth after 6 days at all UVc exposure rates!

https://www.medrxiv.org/content/10.1101/2020.06.05.20123463v2.full.pdf

LOW LEVEL AIRBORNE







TEST #1

TEST #2

1 VS 2 AFTER 6d

There is an 8 log difference in the treated samples vs. the untreated samples after 6 days. Essentially <u>any</u> UVc exposure inactivated the virus and prevented it from regrowing.

https://www.medrxiv.org/content/10.1101/2020.06.05.20123463v2.full.pdf

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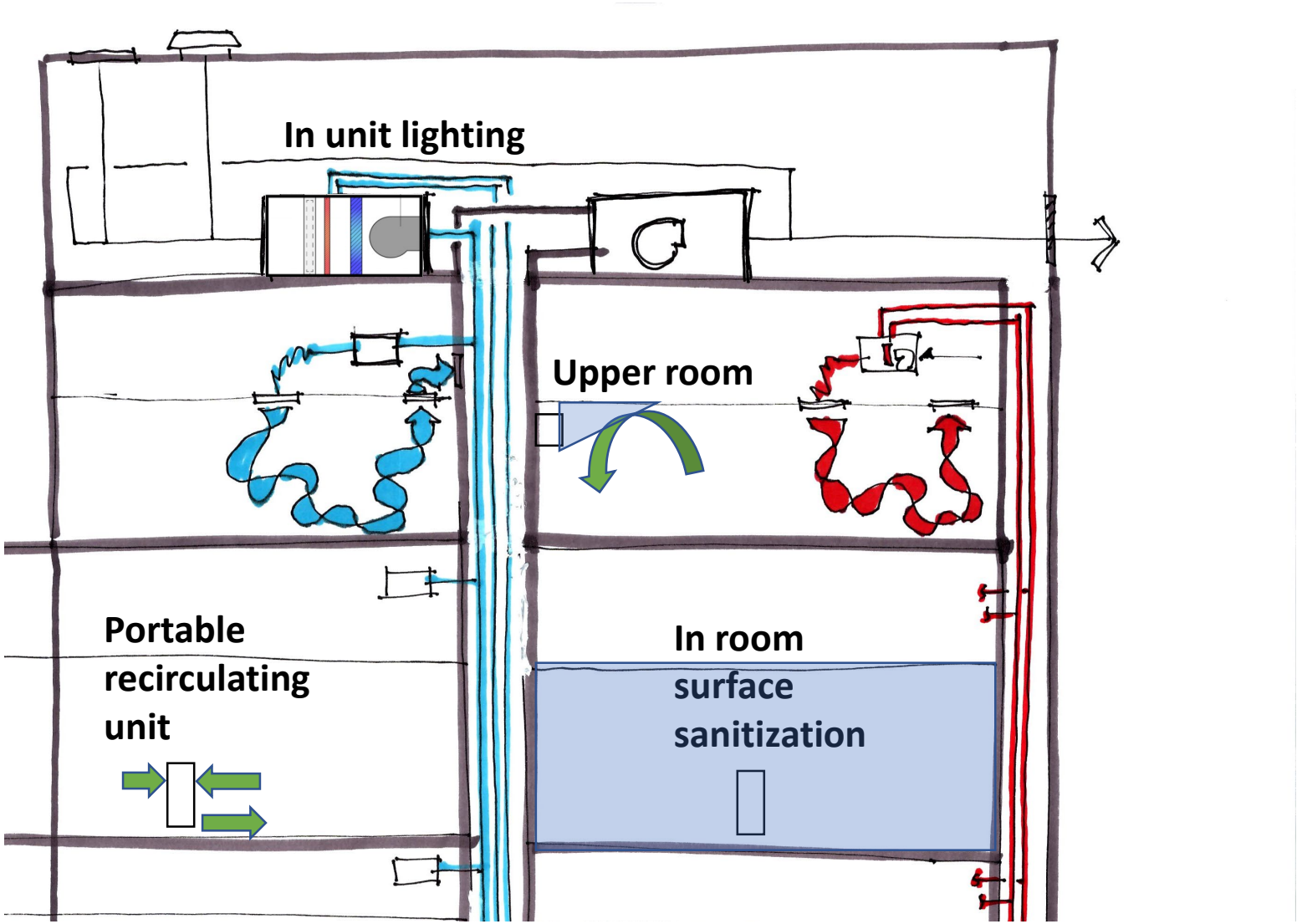
UV APPLICATIONS


In unit lighting
Upper room
Portable recirculating unit
In room surface sanitization

UPPER ROOM

UPPER ROOM

OPERATION

- Designed to treat the air and avoid direct contact with occupants
- Airflow patterns must bring contaminants into the upper room

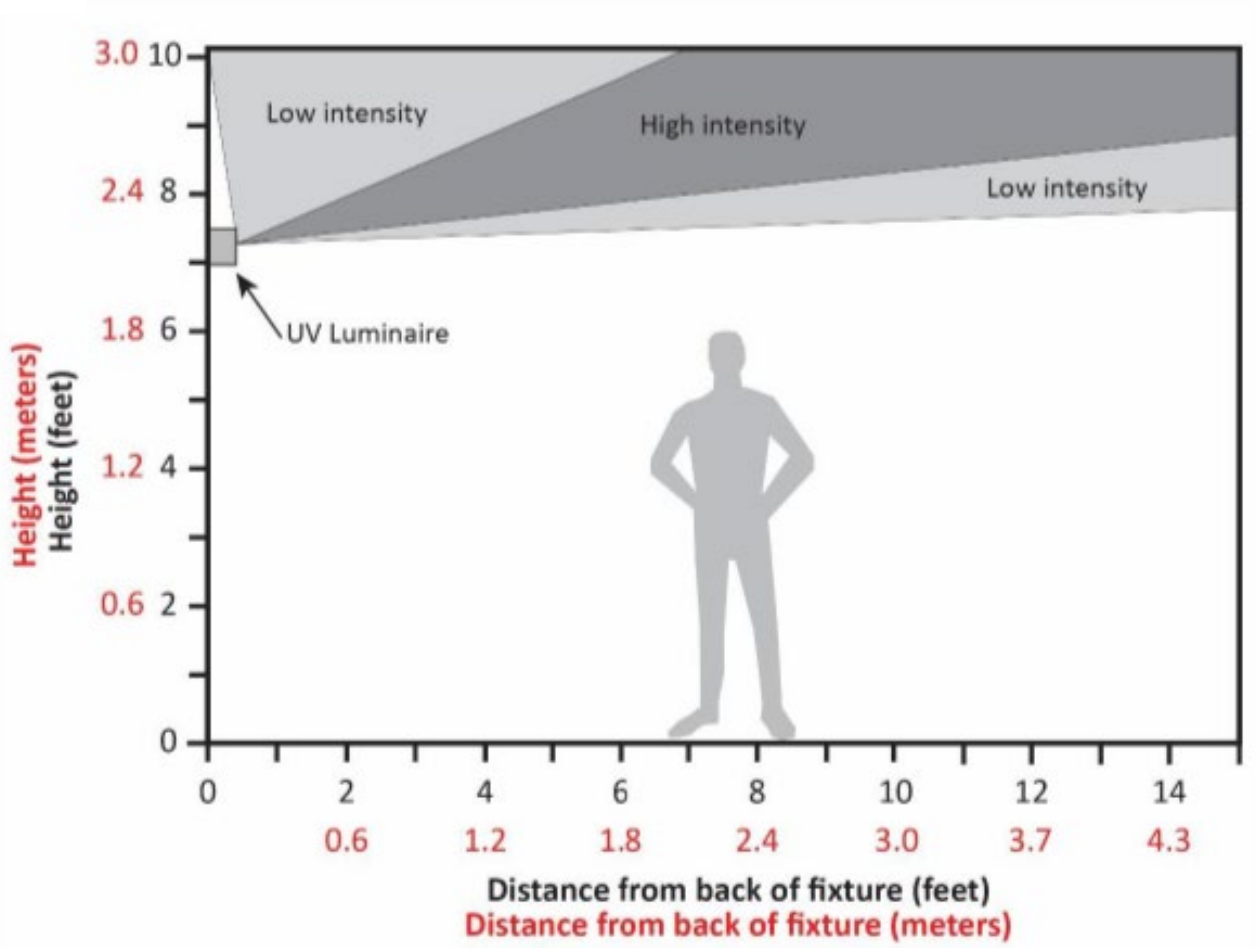


Figure 3-1. Upper-air GUV installation.

Upper Air TB/RAM/CM/ICR Series Germicidal Solutions

Solutions

- Healthcare Solutions
- OR Packages
- Mobile Room UVC
- Handheld/Surface
- UVC Dosimeter™
- Upper Air
- Why UVC for Healthcare
- Why American Ultraviolet for Healthcare
- FAQs about UVC
- Contact

Resources

Mobile Room UVC Germicidal Solutions (PDF Document)

Download

Folleto en Español

TB, RAM, CM and ICR Upper-Air Series in-room air treatment fixtures are designed specifically for continuous upper air UVC irradiation that helps decontaminate the environment around the patient. These trusted fixtures have been successfully used to control the spread of airborne microorganisms and bio-aerosols in hospitals, prisons, clinics and government buildings since 1960. The fixtures incorporate adjustable louvers that safely direct UVC energy above contact level (7+ feet) with occupants, ensuring TB/RAM/CM/ICR fixtures disinfect the air in occupied rooms.

TB Upper-Air Series

The TB Upper-Air Series is available in three sizes (providing 100, 200 and 300 square feet of coverage), and operate from 110-277 VAC at 50 or 60 Hz, allowing installation flexibility to accommodate virtually any room or building layout. Multiple fixtures can be used to cover areas larger than 300 square feet. TB Upper-Air Series fixtures are designed for easy access lamp changes (simply unscrew two thumbscrews on the sides and drop the hinged louver down for easy lamp access). TB Upper-Air Series lamps are rated for two-year continuous operational life with approximately 20% drop in UVC output at end of lamp life.

RAM Upper-Air Series

The RAM Upper-Air Series features dual lamp configurations with fan motors pulling the air through the stainless steel housing. This fixture is available in two high output lamp sizes (14" or 36"), with two voltage options (115 or 230VAC), allowing installation flexibility to accommodate virtually any room or building layout. RAM Series fixtures are also designed for easy access lamp changes (simply unlatch the cover). RAM Series lamps are rated for two-year continuous operational life with approximately 20% drop in UVC output at end of lamp life.

CM 15 Upper-Air Corner Mount Series

CM 15 Upper-Air units are designed to mount in corners of rooms where TB Series units are not desirable. A single CM 15 unit can cover 75-100 square feet, depending on the application. The CM 15 is easily accessed for lamp replacement (simply remove a single fastener on the top of the unit and slide off the louver). CM 15 lamps are rated for 9 ,000 hours effective lamp life (approximately one-year).

Benefits

- Improves Indoor Air Quality (IAQ) by reducing

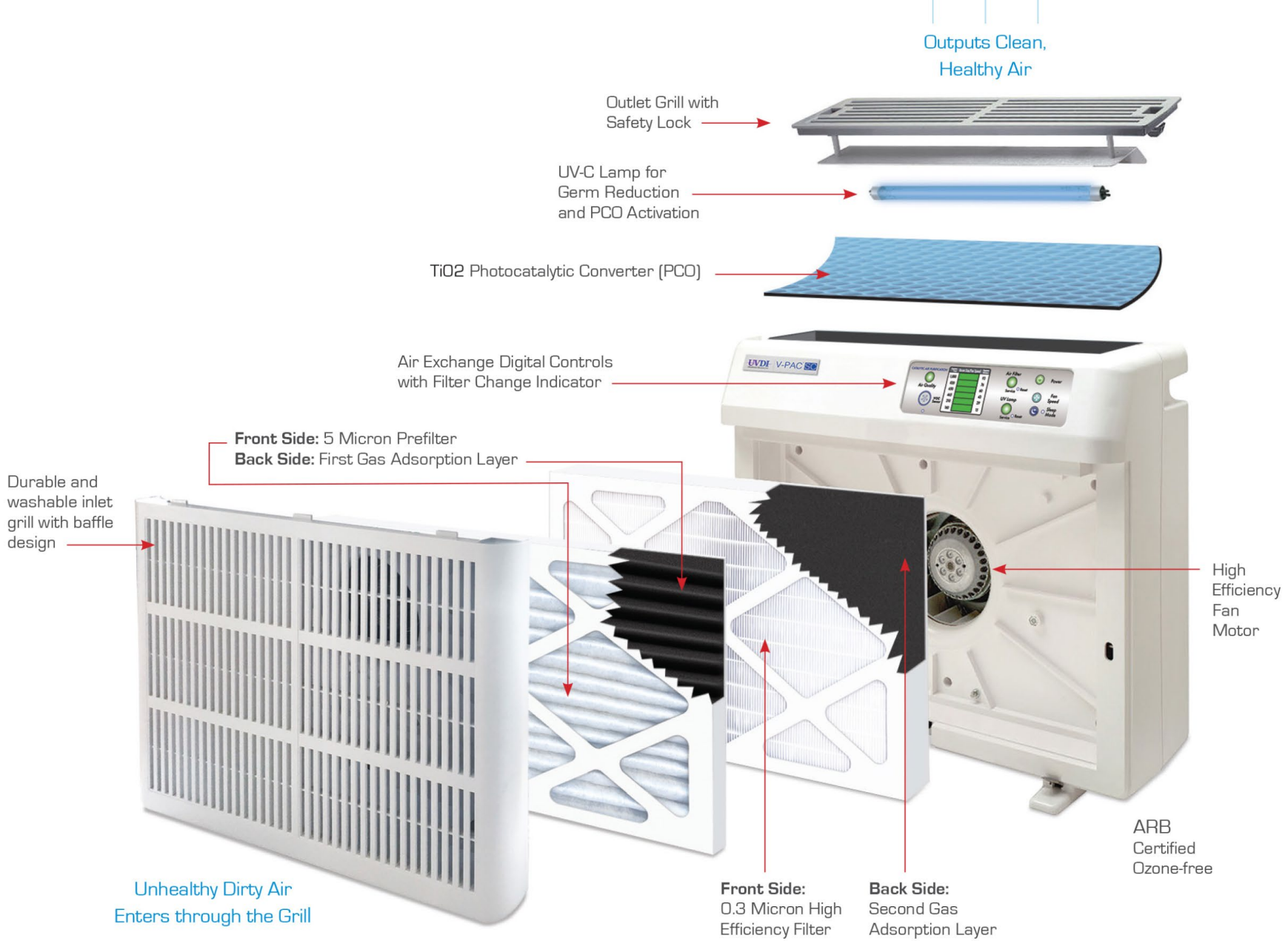
IN ROOM UNITS

IN ROOM APPLICATIONS

OPERATION

- Visibile UV must be shielded from occupants
- Can be used to treat surfaces or recirculated air

SOURCE: UVDI



UVDI – V-PAC SC UNIT

IN HVAC SYSTEM

IN HVAC

PLACEMENT

- ASHRAE Ch 62 recommends downstream of cooling coil
  - Air velocity is lower inside AHU vs in duct which increases exposure time in kill zone

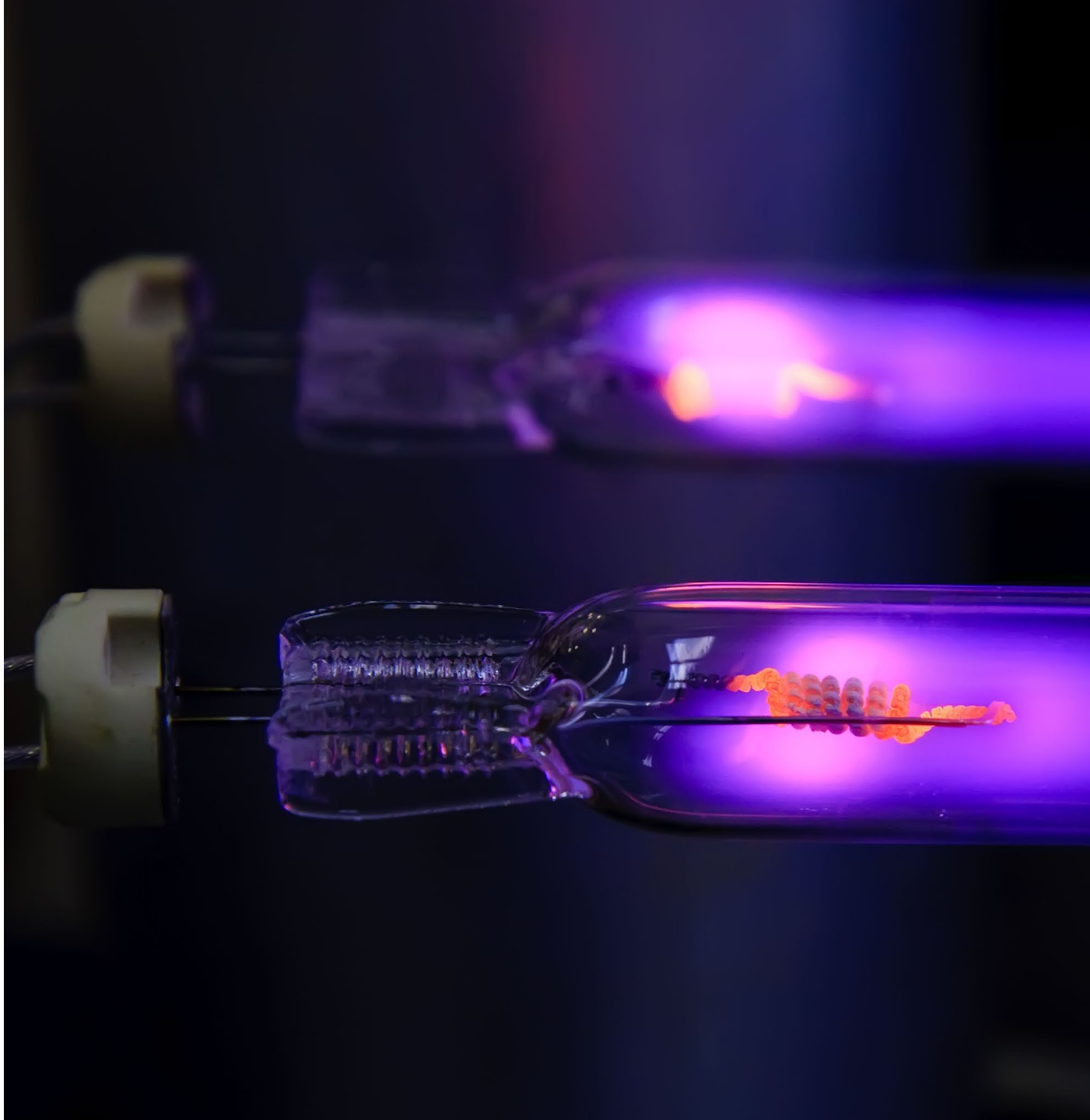
NEED TO KNOW

- Identify the virus/bacteria being targeted
- Targeted kill rate
- Kill zone distance (visibility to light)
- Velocity in kill zone
- Air temperature and humidity in kill zone
- Material reflectivity

SOURCE: UVDI

LAMP QUALITY

- All lamps are not created equal
  - Bulb temperature
  - Lamp life
  - Power needs
  - Output
  - Impact on ambient temperatures
  - Cost



QUIZ TIME

+

5 MINUTE BREAK

HENDERSON ENGINEERS | HENDERSON BUILDING SOLUTIONS

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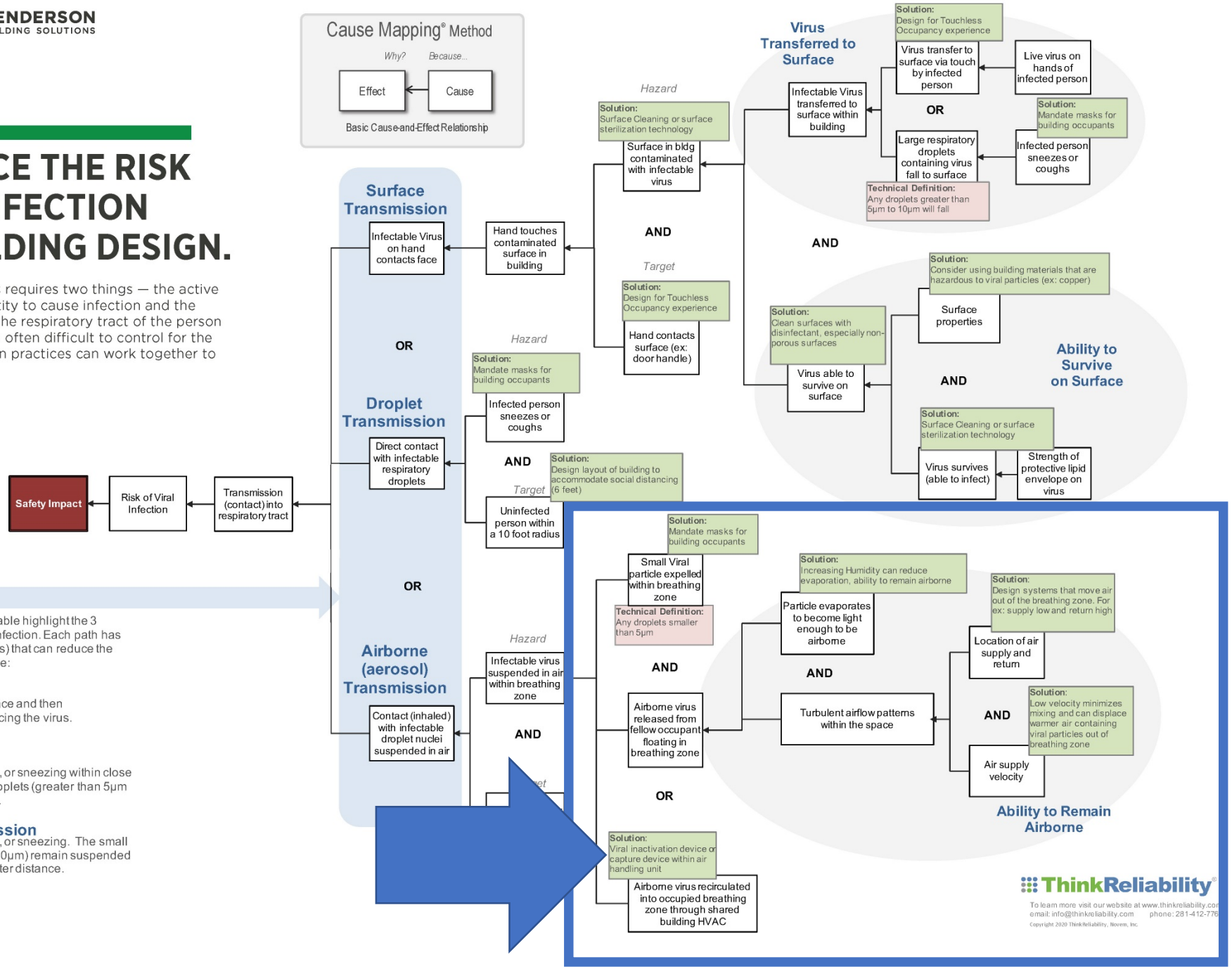

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REVIEW OF SESSION 2

- Increasing outside air ventilation rates can effectively reduce the recirculation risk – but it can be difficult to implement and comes with an energy penalty
- MERV 13 filters are between 85-100% effective at removing potentially infected particles from recirculated air
- HEPA filters approach 100% effectiveness but often require too much pressure drop for a retrofit application
- UVc lighting can effectively reduce active virus in a moving airstream

THANK YOU

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Arron Cooper PE | Director of Arkansas Operations
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