The following guidance is developed as healthcare facilities prepare for COVID patients, and is based on input from ASHE, ASHRAE Technical Committee for Healthcare and ASHRAE/ASHE Standard 170 Committee.

This guidance represents personal opinions and ASHRAE and ASHE are not responsible for the use or application of this information. Please contact Michael.sheerin@tlc-eng.com **(Chair ASHRAE Standard 170) for questions.**

March 25, 2020

COVID 19 GUIDANCE

Latest Update

- 3/25 Update
  - Add s23 : Explain Passive Isolation
  - Revise s29 : Add Hazard Note
- 3/21,22 Update
  - Add s20-22 : Keep it Simple Approach and Aerobiology of COVID 19
  - Add s25 : HEPA / N95 Filter Efficiency Information
  - Revised s33-34: Further Explanation re Fan Coils and other Room Recirculating Systems
  - Add s42 : Recommendation regarding VAV Airflow

Acknowledgements

- This information wouldn't exist without the shared expertise of many people. We are grateful to the following and apologize if we missed anyone herein:

- Jonathan Flannery, ASHE

- Traci Hanegan, Coffman Eng – Chair ASHRAE Tech Comm for Healthcare

- ASHRAE Standard 170 Committee especially Kevin Scarlett / John Williams (Wash State), Ken Mead, and Richard Hermans.

- TLC Engineering Solutions Healthcare Center of Excellence Team including Aaron Johnson, Mark Costello, Jeff Stone and Ben Roseborough along with COO Jim Ferris and EVP Bob Danner

Experts Across the Country

1. COVID 19 in Perspective
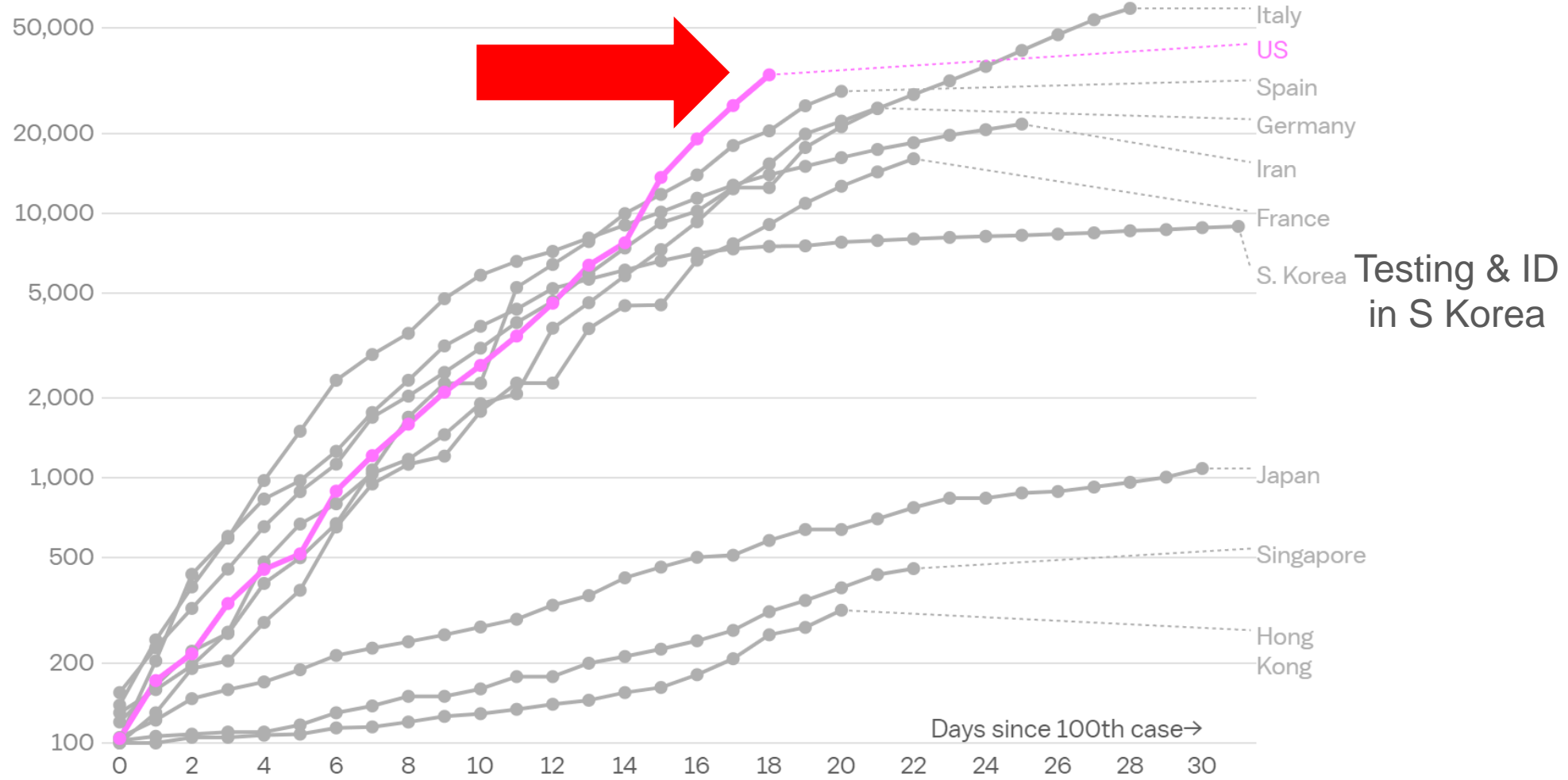
Tweet

James Fell ✔
@BodyForWife

Months from now, if we're lucky, the extreme measures being taken now to limit the spread of COVID 19 may seem like they were an overreaction, because relatively few people died.

That's the point. That's why we're doing it.

8:08 PM · 3/12/20 · Twitter Web App

Number of confirmed coronavirus cases, by days since 100th case

Hover for exact value or individual country

Point of Rapid Expansion

Testing & ID in S Korea

Italy
US
Spain
Germany
Iran
France
S. Korea
Japan
Singapore
Hong Kong

Days since 100th case→

Note: Chart is in log scale to mimic the exponential rate at which the virus spreads

Source: Vox analysis of Center for Systems Science and Engineering at Johns Hopkins University data, through March 22; Financial Times
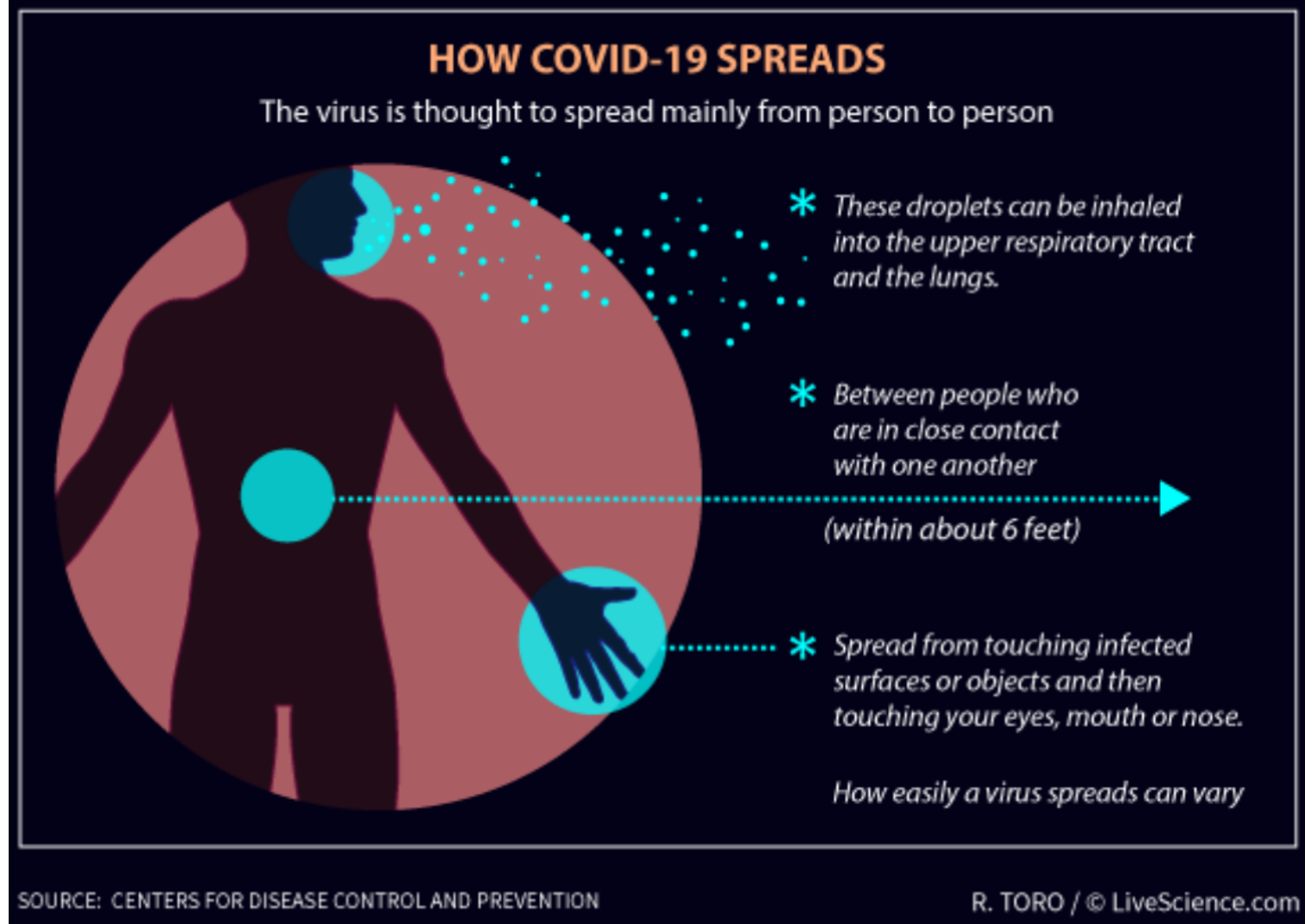
Perspective

- True number of cases in an area are vastly under-counted due to quantity of undiagnosed and untested patients. They may still arrive at the hospital.

- Two ways to estimate "true" number of cases *:

  - # of Reported Cases x 10-20

  - # of COVID Deaths x 400

* tomaspueyo/coronavirus-act-today-or-people-will-die-f4d3d9cd99ca

Perspective

- COVID 19 is viable on surfaces for 2-3 days

- COVID 19 is viable aerosolized for at least 3 hours

HOW COVID-19 SPREADS

The virus is thought to spread mainly from person to person

* These droplets can be inhaled into the upper respiratory tract and the lungs.

* Between people who are in close contact with one another

(within about 6 feet)

* Spread from touching infected surfaces or objects and then touching your eyes, mouth or nose.

How easily a virus spreads can vary

SOURCE: CENTERS FOR DISEASE CONTROL AND PREVENTION

R. TORO / © LiveScience.com

Perspective

- Transmission rate appears comparable but higher than influenza

- 25% of cases transmitted while asymptomatic (first 24-48 hrs)

- But…<u>most contagious </u>when they are most symptomatic (sickest) – like in a hospital !

COVID-19 death rate in countries with confirmed deaths and more than 5,000 cases

COUNTRY	# CASES	# DEATHS	DEATH RATE	
Italy	63,927	6,077	9.51%	
Iran	23,049	1,812	7.86%	
Spain	33,089	2,207	6.67%	
UK	6,726	336	5.00%	
France	20,123	862	4.28%	
China*	81,496	3,274	4.02%	
Switzerland	8,547	118	1.38%	
South Korea	8,961	111	1.24%	
US	43,214	533	1.23%	
Germany	29,056	123	0.42%	

Data as of 7:30 pm EST on March 23, 2020.   *Mainland China and Hong Kong

Source: Johns Hopkins

INSIDER

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Perspective

- At risk populations frequently become more severe cases

- 15% of infected require <u>oxygen interventions</u>

- 3-4% mortality rate* vs 0.1% for influenza   (<u>30x higher</u>)

- 80 yrs and older mortality rate is near 15% (70 = 8%, 60 = 3%)

- Nursing home / Assisted Living residents at <u>high</u> risk

* If healthcare system becomes overwhelmed. Have been contained to approx. 1.0% mortality when rigourously managed (testing, quarantined, treatment regimes). (Still 10x higher)

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Recent Info

- Young Folks May Unknowingly Have COVID and Spread COVID

Coronavirus cases (%) in South Korea and Italy by age groups
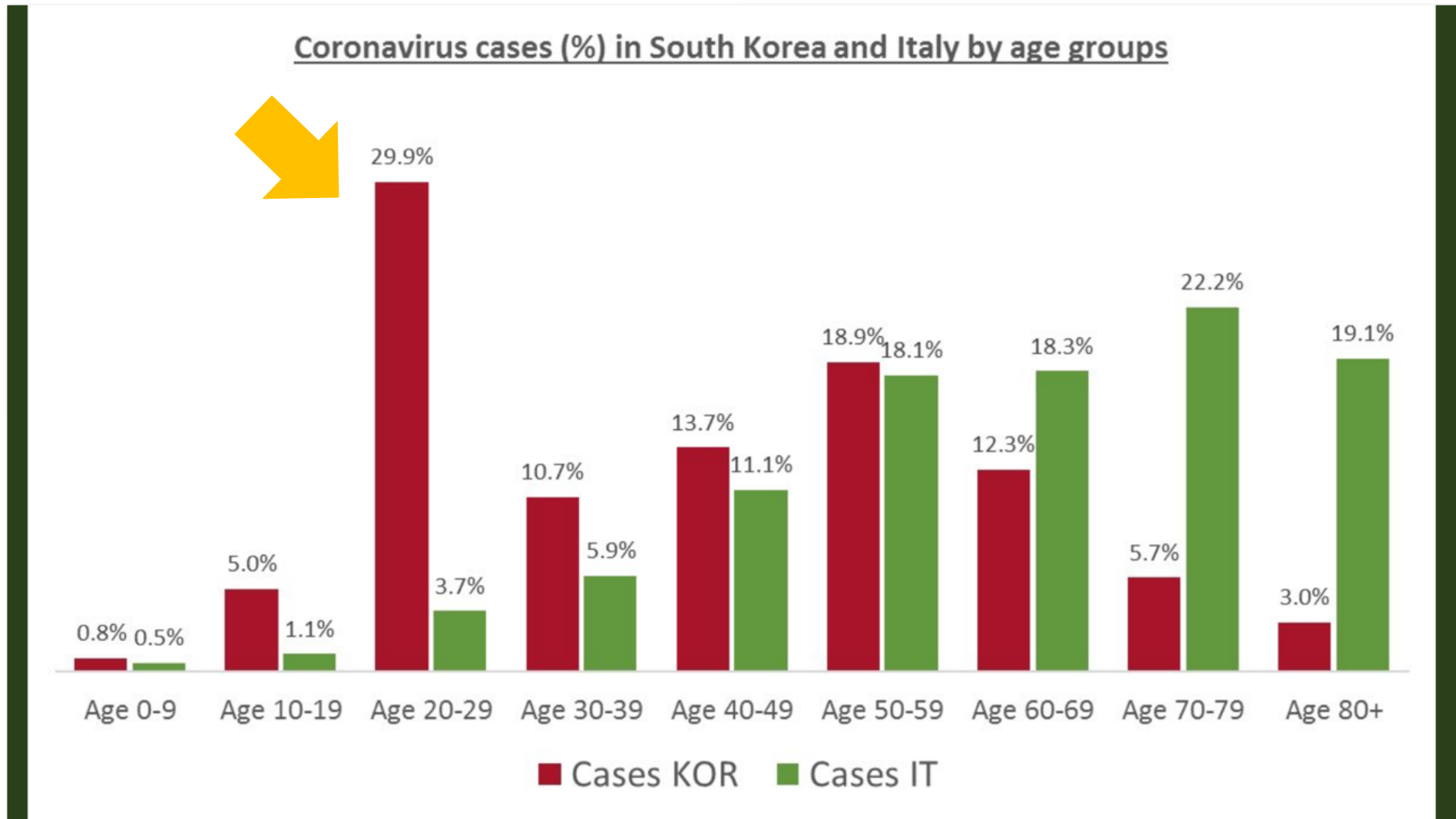
Perspective

- As this is normal flu season, and snowbird season in FL, most hospitals are running at higher capacity presently. COVID influx will stretch normal conditions and may overcome their capacity. Without strategies and alternatives, patient needs will not be met.

- Hospitals have Airborne Infectious Isolation (A.I.I.) Rooms, generally 1-2 per patient floor or suite. These rooms would normally be used for suspected COVID patients, along with other infectious conditions such as Tuberculosis.

- As numbers increase, too few A.I.I. rooms may be available to house suspected COVID patients.

Perspective

- The general course of growth from suspected cases to a high number of cases is commonly shorter than the time frame for treatment and release of "first in" patients, so it is important to recognize that <u>committing A.I.I. rooms to patients limits future flexibility</u>.

- CDC is recommending that A.I.I. rooms be used <u>only</u> for COVID <u>patients undergoing aersol generating procedures</u> (AGP).

  - Work With Clinicians to Manage A.I.I. Room Use

- Examples of AGP are positive pressure ventilation (BiPAP and CPAP), endotracheal intubation, airway suction, high frequency oscillatory ventilation, tracheostomy, chest physiotherapy, nebulizer treatment, sputum induction, and bronchoscopy.

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Perspective

- CDC has provided recent guidance that "facilities could consider <u>designating entire units</u>" to care for known or suspected COVID patients. These units would be staffed with dedicated healthcare personnel to limit exposure risk.

- Clinicians have advocated against cohorting suspected and confirmed patients in the same unit / suite, to avoid the potential for conversion. Coordinate with your clinical staff on this matter.

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Perspective

- In order to manage patient influx, congestion, and to control the risk of exposure to healthcare workers, <u>hospitals are restricting access to Emergency Dept to ambulatory patients only, and designating a specific area in ED for respiratory cases</u>.

- Persons Under Investigation (PUI) capable of self care are triaged outside the ED, either through drive-through or walk up screening stations set up in tent or temporary space, and advised to continue home care until results are available.

- Many Nursing Homes and Assisted Living Facilities have implemented protective measures including checking staff (before every shift) and visitors for flu-like conditions, temperature and travel history (required in FL). In hard-hit Seattle, they are restricting visitors to a resident room or halting visits altogether.

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2. Action Plan

The Design and Construction Industry can help our communities get prepared:

• Share the Knowledge and Info

• Answer Questions and Be a Resource

• Be Available to Help When Asked

• Be Positive and Reassuring

2. Action Plan

Main Steps for Health Facility Operators:

• Verify Performance of Existing Airborne Infectious Isolation Rooms

• Verify Performance of Emergency Department HVAC System

• Secure all HEPA UNITS

3. Implementation

Our primary function and expertise in preparation for COVID 19 is advising on HVAC systems, configurations, and modifications to support the safe segregation of suspected and confirmed patients within controlled air environments, whether true isolation or modified alternative arrangements, as best suits their needs.

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Basics

- General Parameters:

    - Do No Harm

    - System Arrangement Should Protect Workers

    - System Arrangement Should Protect Other Patients

    - Airflow from Clean to Less Clean

Aerobiology

- COVID 19 Patients Will Typically Have Respiratory Conditions

- Virus Most Commonly Spread Through Droplets - Contact Exposures

- Aerosolized Virus Is a Limited but Possible Vector of Transmission*

- Recognize That Virus May Be Aerosolized During Toilet Flush

*https://www.livescience.com/coronavirus-can-spread-as-an-aerosol.html

Aerobiology & What You Should Do

- HVAC Systems Can Protect Healthcare Workers and Instill Confidence By Providing Safe Environment for their Interactions with Most Contagious Patients and Reduce Exposure When Patients Discharge Contaminants During Procedures.

- Basic Approaches:

  - A.I.I. Rooms Require 12 Air Changes, Air Exhausted Directly (see Std 170)

  - Establish Solutions Beyond A.I.I. Rooms as Needed:

  - Air Changes Dilute Contaminant Level (See CDC info below re AirCleaning)

  - Exhaust Removes Contaminants

  - Filtration Removes Contaminants

  - Negative Relative Pressure Helps Contain Contaminants

Basics – KEEP IT SIMPLE

- Resource Management:
  - Recognize That You Have Limited Time, So Focus Your Efforts
  - Do Not Waste Time, Mental Energy, or Dollars Without Clear Goals & Plan
- Set Goals:
  - Work With Clinicians
  - Establish Minimum Standards
  - Define Key Areas and Designated Rooms, Suites
  - Maintain Life Safety Protections
  - Make a Floor Plan / Map – Ensure Everyone Knows

Basics

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Passive Isolation

- As Prescribed in CDC Guidance*

- <u>Most Basic</u> Approach

  - One Patient per Room

  - Close the Door

  - Implement Related CDC Safety Protocols

- Work with Clinicians, Anticipate Patient Load and Establish Layered Approach As Needed

  * https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fhcp%2Finfection-control.html

Basics

Layered Approach

Hospitals Should Be Aware of the Clinical Modes:

- Normal mode - Follow CDC Guidelines

  - Clinical Plan May Limit A.I.I. Rooms to Patients Receiving AGP

- Small Scale Surge Capacity Mode –May Be Asked to Create Additional Dedicated A.I.I. or Temporary Patient Observation/Segregation Rooms with HEPA and negative pressure.

- Large Scale Surge Capacity Mode – May Be Asked to Establish Dedicated Ward/Suite(s) and Establish Protocols with Clinical and Environmental Action Plans

- Inform Clinicians that Temporary Patient Observation/Segregation areas are not True A.I.I. Rooms.

Basics - HEPA

- When We Refer to a "HEPA Unit":

  - Portable HEPA Machine

  - Pre-Assembled System

  - Ad Hoc Assembly

    - HEPA Filter in Frame, Preferably Bag In/Out But As Needed/Available

    - Off Shelf Exhaust Fan and Associated Power

    - Sealed Connections, Rack or Wheel Mounted

HEPA Filters

- Yes the Virus particles can be .1 micron or smaller.
- Infectious Patient airborne discharges (cough/sneeze) are typically greater than .1 micron as virus is passed on/in liquid/mucous !
- HEPA is <u>at least</u> 99.97% effective for .3 micron particles (see chart)
- HEPA is an effective tool for contaminant removal.

N95 Mask Filters

- N95 require fit testing and a competent pulmonary efficiency.
- N95 are TESTED with .3 micron particles.
- N95 is certified to filter <u>at least</u> 95% of airborne particles.
- N95 is an effective tool for worker protection.

Basics - HEPA


Basics
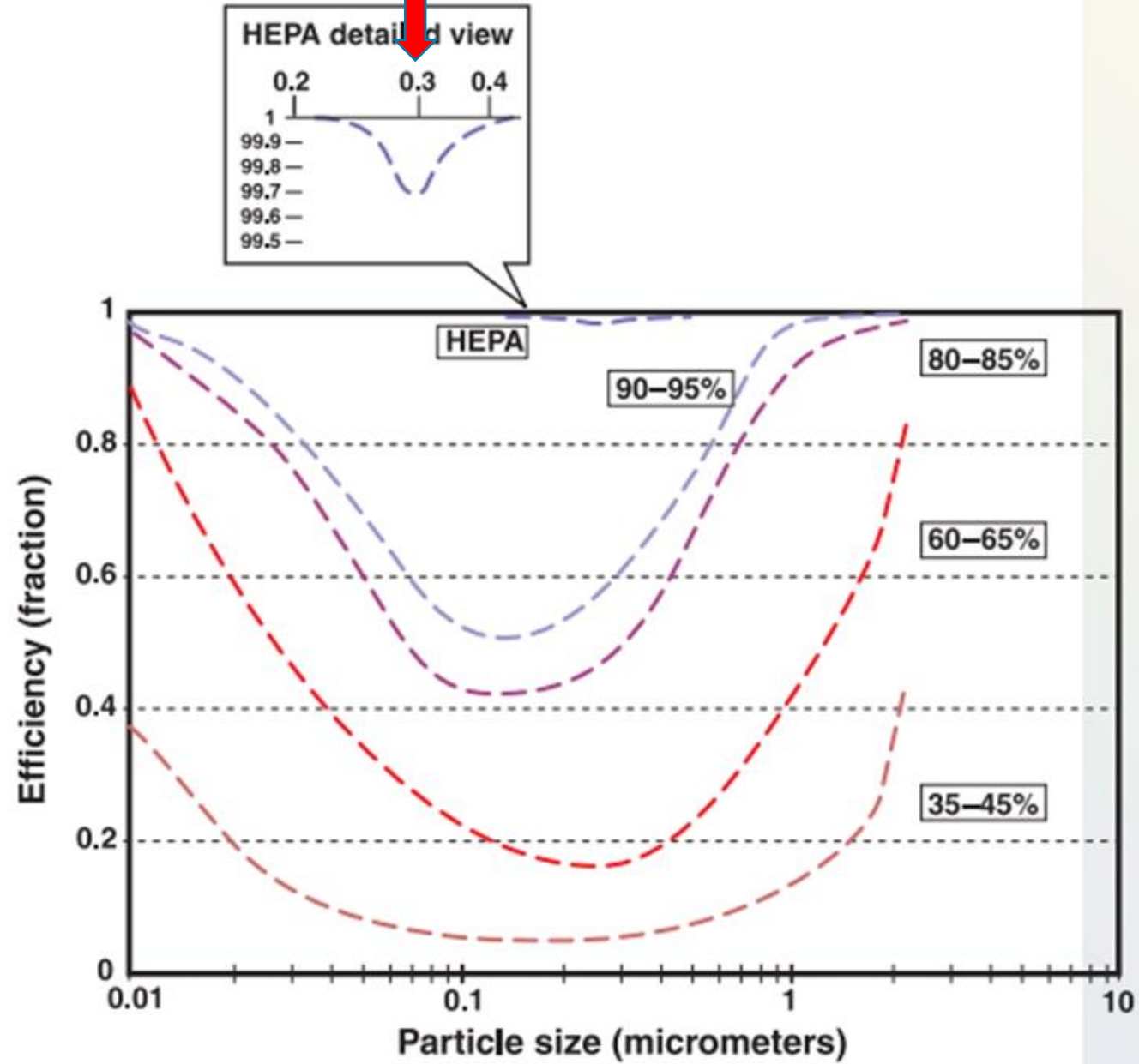
Warning – Intensive Care Unit (ICU)

- ICU Rooms May Be Positive Pressure** – Verify and Address !

  - Designate Specific Room(s) or Area(s)

  - Proactively Review and Modify Test and Balance as Needed

  - Consider System Level, Once Through Air Approach Described Below

  - Recognize That Changing the Outdoor Air Amount Might Impact Building Pressure Balance and Also Create Humidity Issues if Unmanaged

  *Was Code Defined and Common Practice for Many Years

Patient Room

VARIETY OF APPROACHES – EVALUATE WHAT WORKS BEST FOR YOUR CONDITION(S)

Consider:
-Door Closer
-Ability to Monitor Room Pressure
-Limit Patient Transfers
-Ventilate and Terminal Clean Before Re-Use

AII ROOM
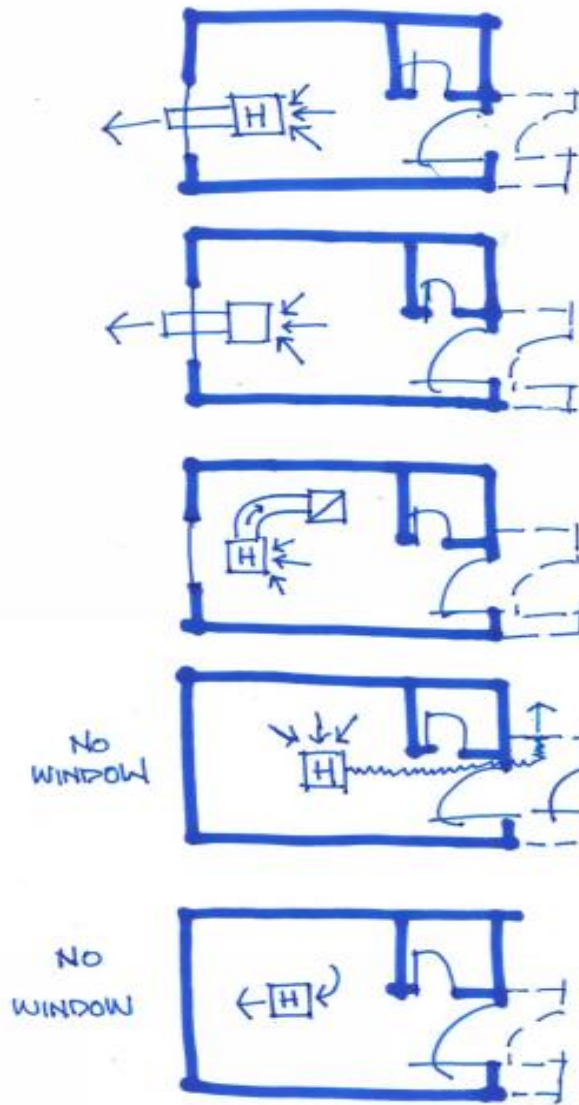
OPTION 1.
COMPLIANT W/ CDC, ASHRAE, FGI

OPTION 2.
IN ROOM HEPA, DISCHARGING DIRECTLY TO EXTERIOR.

OPTION 3.
IN ROOM FAN (NON-HEPA) DISCHARGING DIRECTLY TO EXTERIOR. -OR- USE EXISTING TLT ROOM EXHAUST.

OPTION 4.
IN ROOM HEPA DISCHARGING TO RETURN. MUST BALANCE SYSTEM TO PREVENT DOWN STREAM AFFECTS

OPTION 5.
HEPA UNIT SCRUBS AIR FROM ROOM AND DISCHARGES TO CORRIDOR. NEED TO RELIEVE PRESSURE FROM CORRIDOR.

NO WINDOW

OPTION 6.
HEPA UNIT RECIRCULATES AIR IN ROOM AFTER SCRUBBING. NOT NEGATIVE, SUPPLY SHOULD BE COVERED TO PREVENT + PRESSURE.

NO WINDOW

* RETURNS SHOULD BE COVERED IN ALL OPTIONS (EXCEPT #1)

* MAINTAIN 25' DISTANCE FROM FINAL DISCHARGE POINT & OPENINGS INTO BUILDING.

Hazard:
-Notify Healthcare Workers That HEPA Units Can Not be Turned Off Once in Place As May Result in Unsafe Condition with Room Becoming Positive Pressure to Corridor.
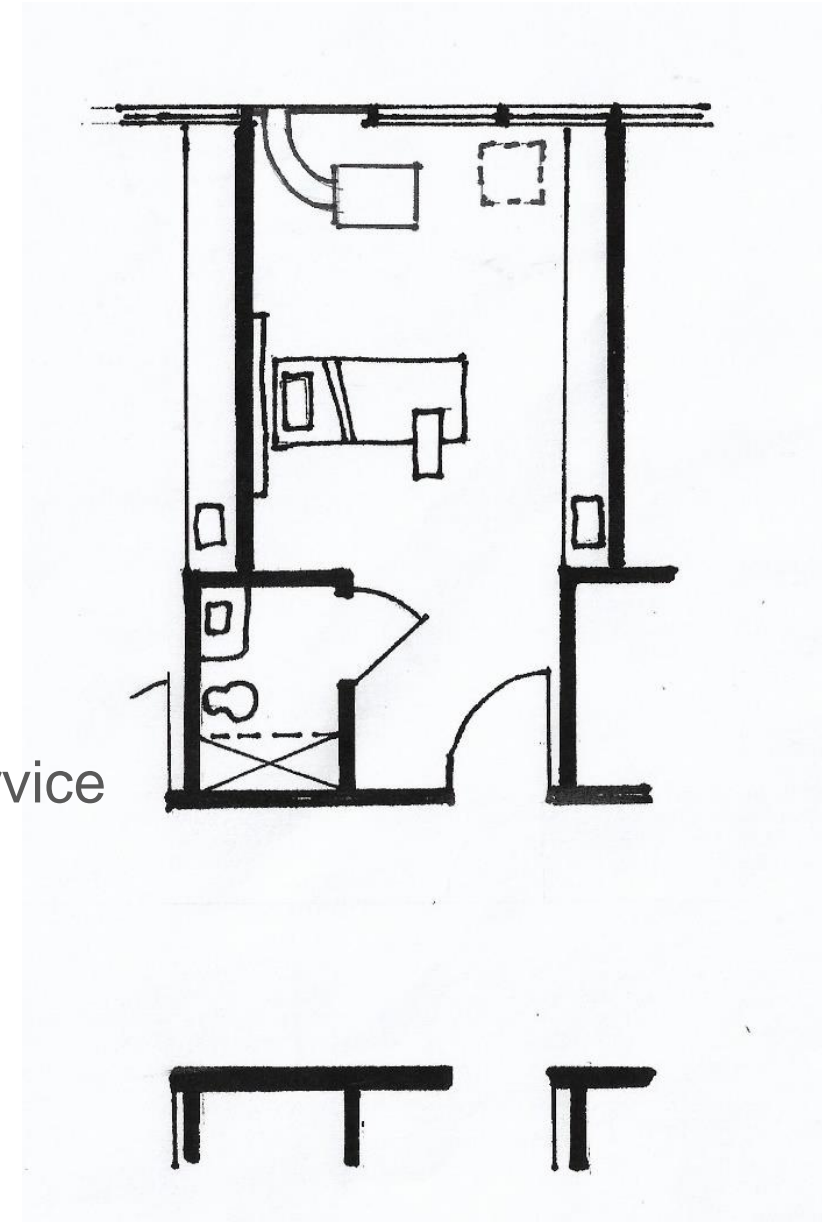
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Examples - Patient Rooms

SMALL SCALE SURGE

HEPA to Outside

- Single patient room with dedicated bathroom
- Seal off return air grill in patient room
- Place HEPA filtered negative air machine in patient room
- Duct through exterior to outside
  - Remove window and enclose opening
- Keep door to patient room closed
- Verify negative pressure prior to placing room in service and monitor negative pressure while in service
- Limit patient transport and patient transfers
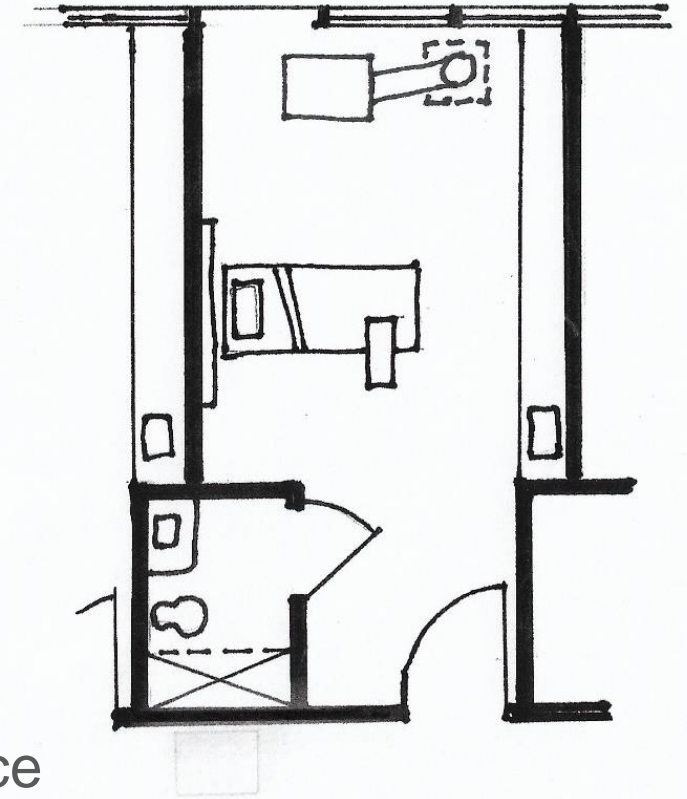- Terminal cleaning after ACH removes potentially infections particles

Examples - Patient Rooms

SMALL SCALE SURGE

HEPA to Return

- Single patient room with dedicated bathroom
- Place HEPA filtered negative air machine in patient room
- Duct to return air grill
  - Seal off remaining part of return air grill
  - Verify impact that this will have to the overall air handling system – choosing rooms closest to the air handler may reduce impact
- Keep door to patient room closed
- Verify negative pressure prior to placing room in service and monitor negative pressure while in service
- Limit patient transport and patient transfers
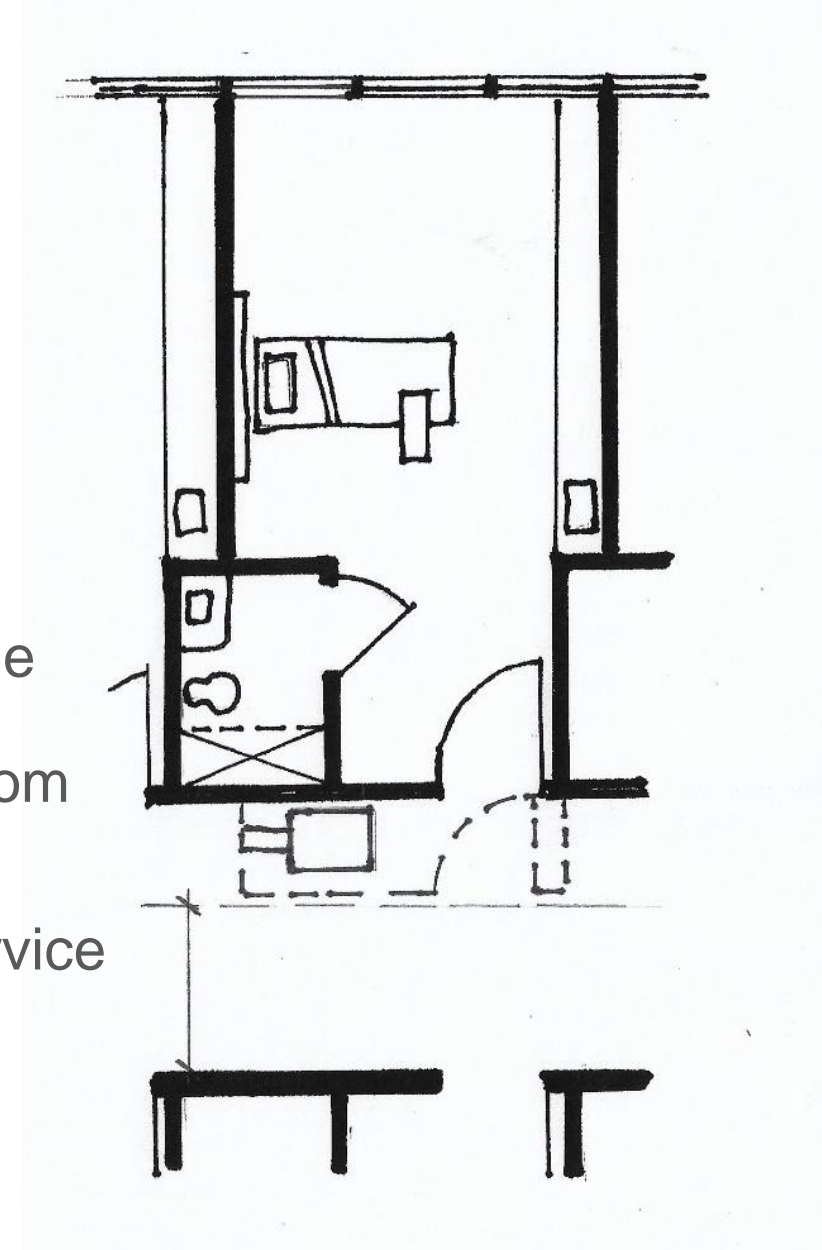- Terminal cleaning after ACH removes potentially infections particles

Examples - Patient Rooms

SMALL SCALE SURGE

HEPA to Corridor
- Single patient room with dedicated bathroom
- Create "airtight" vestibule to patient room
  - Need minimum 5'-0" egress clearance in the corridor
- Seal off return air grill in patient room
- Place HEPA filtered negative air machine in vestibule
- Duct through vestibule to corridor
- Keep door to vestibule closed but door to patient room open
  - Verify that patient room door is not a rated fire door!
- Verify negative pressure prior to placing room in service and monitor negative pressure while in service
- Limit patient transport and patient transfers
- Terminal cleaning after ACH removes potentially infections particles

Example – Patient Room

OPTION 7

HEPA FILTERED UNIT

DISCHARGE TO RETURN SYSTEM

PROTECTIVE PORTABLE ISOLATION TENT

# Warning – Room Recirculating Units

Avoid Use for COVID Patients IF YOU CAN

- IF YOU MUST:
  - Consider Option 7 (previous slide) as Best Approach
  - If No Other Option Than Using RR Unit, Then <u>Increase Room Exhaust</u>
    - Create Negative Relative Pressure to Corridor
    - May Be Accomplished By Adding Supplemental Local Exhaust Fan per Room
    - Consider System Level Approach By Increasing Gen'l/Toilet Exhaust Airflow
    - Consider Means of Sanitizing RR Unit Between Patients – Peroxide Fog, Other?
    - Deep Decontamination of RR Unit's Coil After Event Is Over

What Are Room Recirculating Units?

- Variety of In-Room Cooling/Heating Units

  - Fan Coil Units
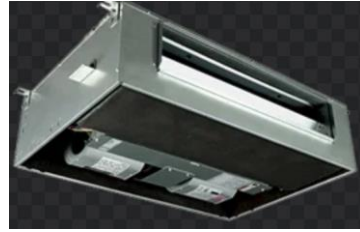
  - Heat Pump Units

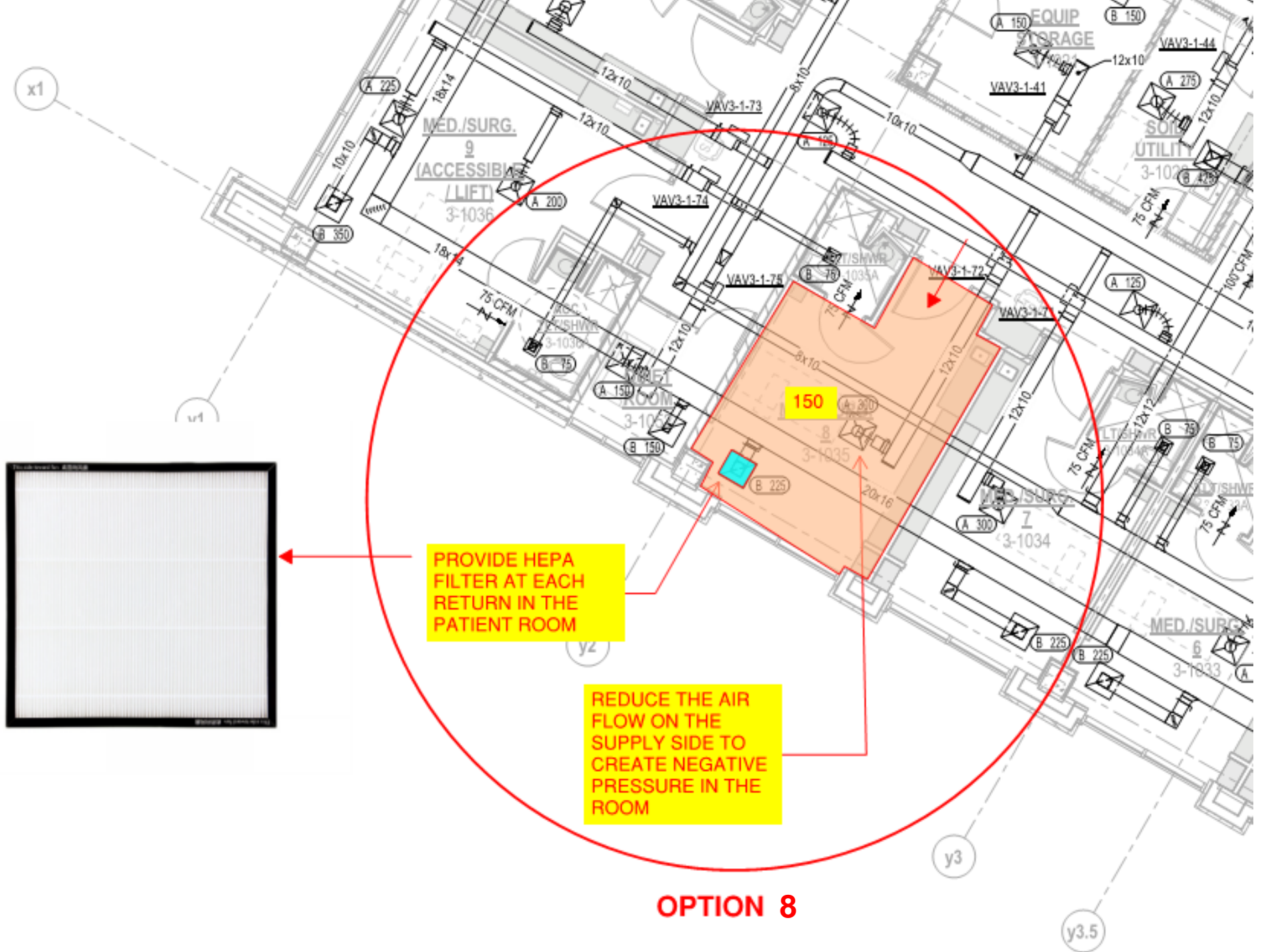 - Packaged Terminal Air Conditioner (PTAC)

  - DX and Mini-Split DX Units

  - Special Case: Induction Units (Seek Expert Guidance)

  - Special Case: Active Chilled Beam (Seek Expert Guidance)

- RR Unit Typically Has <=6 ACH Air Changes, Minimal Filtration

Example – Patient Room

PROVIDE HEPA FILTER AT EACH RETURN IN THE PATIENT ROOM

REDUCE THE AIR FLOW ON THE SUPPLY SIDE TO CREATE NEGATIVE PRESSURE IN THE ROOM

OPTION 8

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Example – Patient Room

OPTION 3 FOR LIMITED SELECT ROOMS
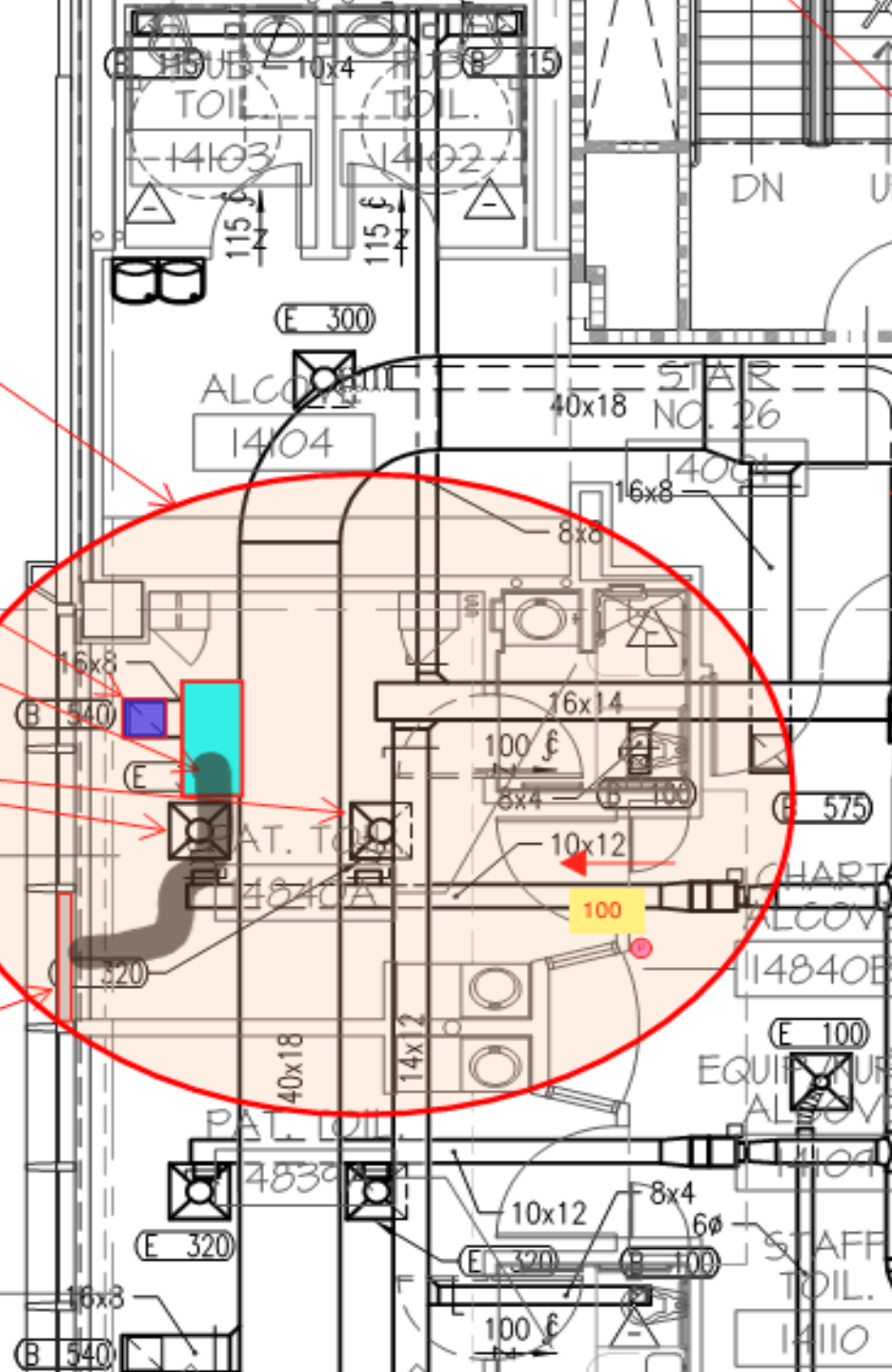
TYPICAL ALL PATIENT ROOMS

BLANK OFF RETURN

HEPA NEGATIVE PRESSURE UNIT BALANCE FOR 400 CFM

REBALANCE EXISTING DIFFUSERS 200 CFM

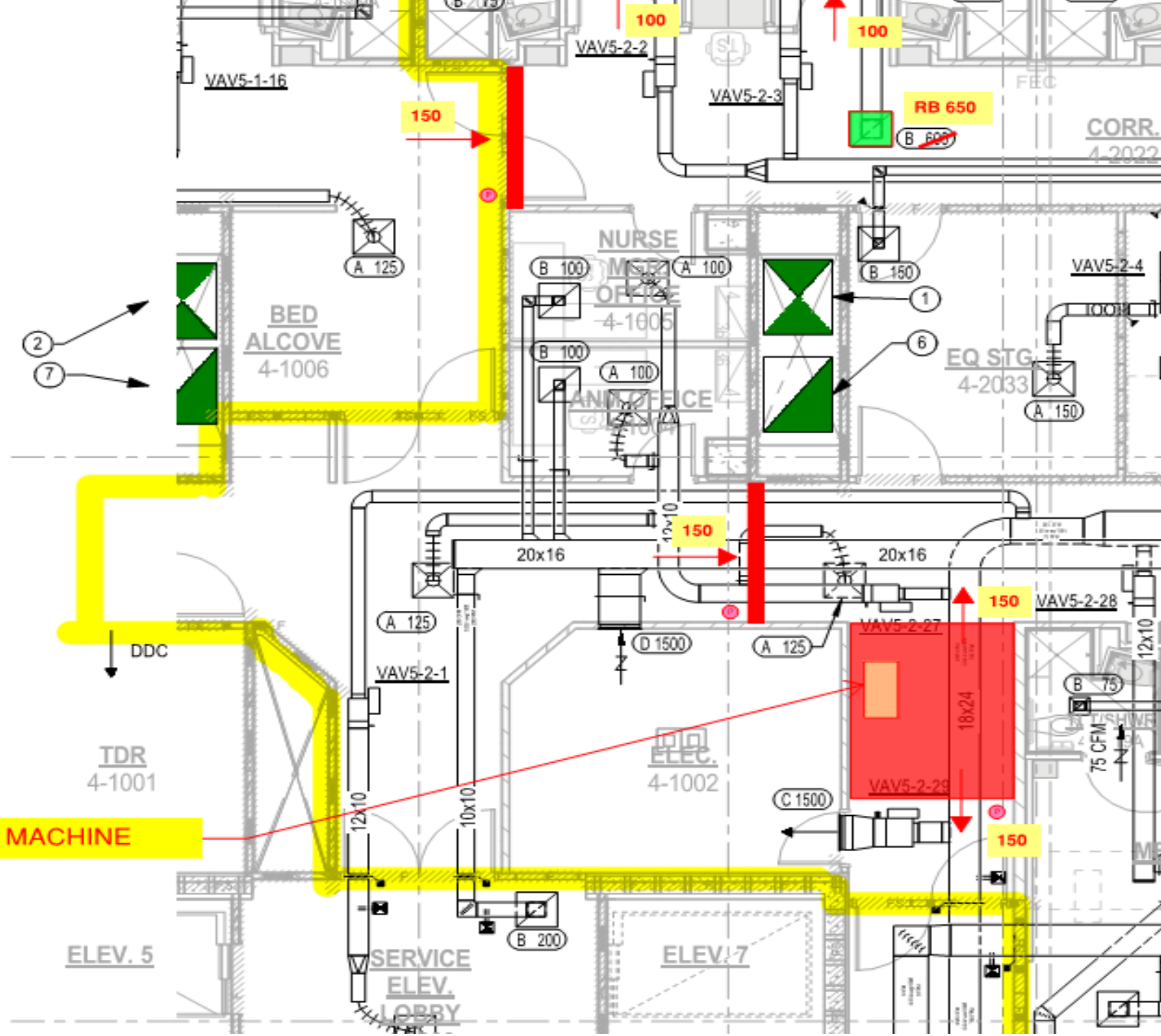REMOVE EXISTING GLASS AND PROVIDE DISCHARGE FOR NEGATIVE PRESSURE UNIT
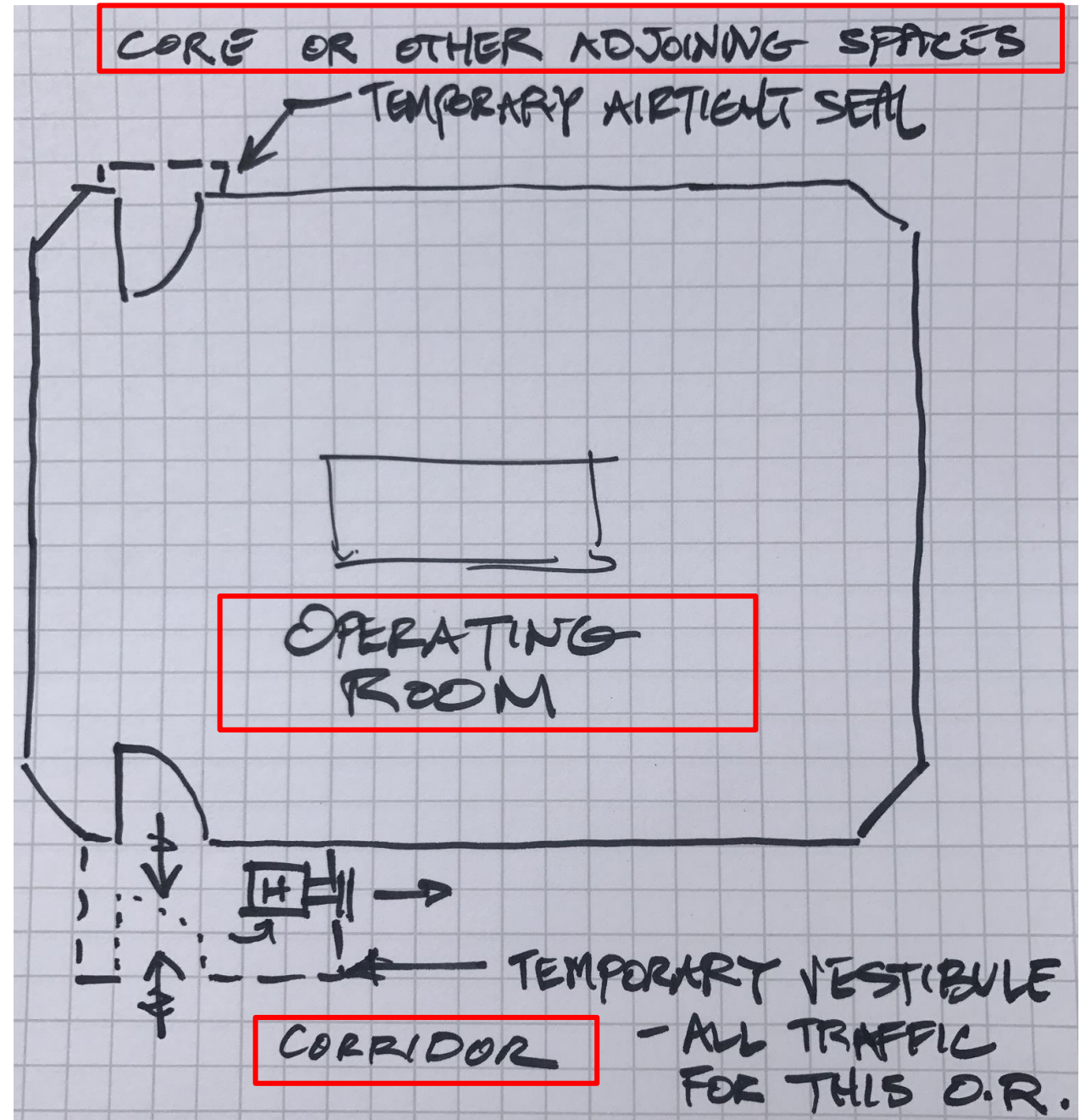
Control Vestibule

Operating Room – COVID Patient

- Avoid Use for COVID Patients IF YOU CAN

- See Resources Link for Add'l Info

- IF YOU MUST:

  - Recommend Intubation in Operating Room

  - Use Negative Pressure Operating Room IF YOU HAVE (UNLIKELY)

  - Recommend Creating Temporary Vestibule in lieu of Creating a Negative Pressure OR

  - Creates Buffer Zone of Negative Pressure, but Maintains OR Cleanliness

  - Recommend Consider Dedicating an Operating Room for COVID
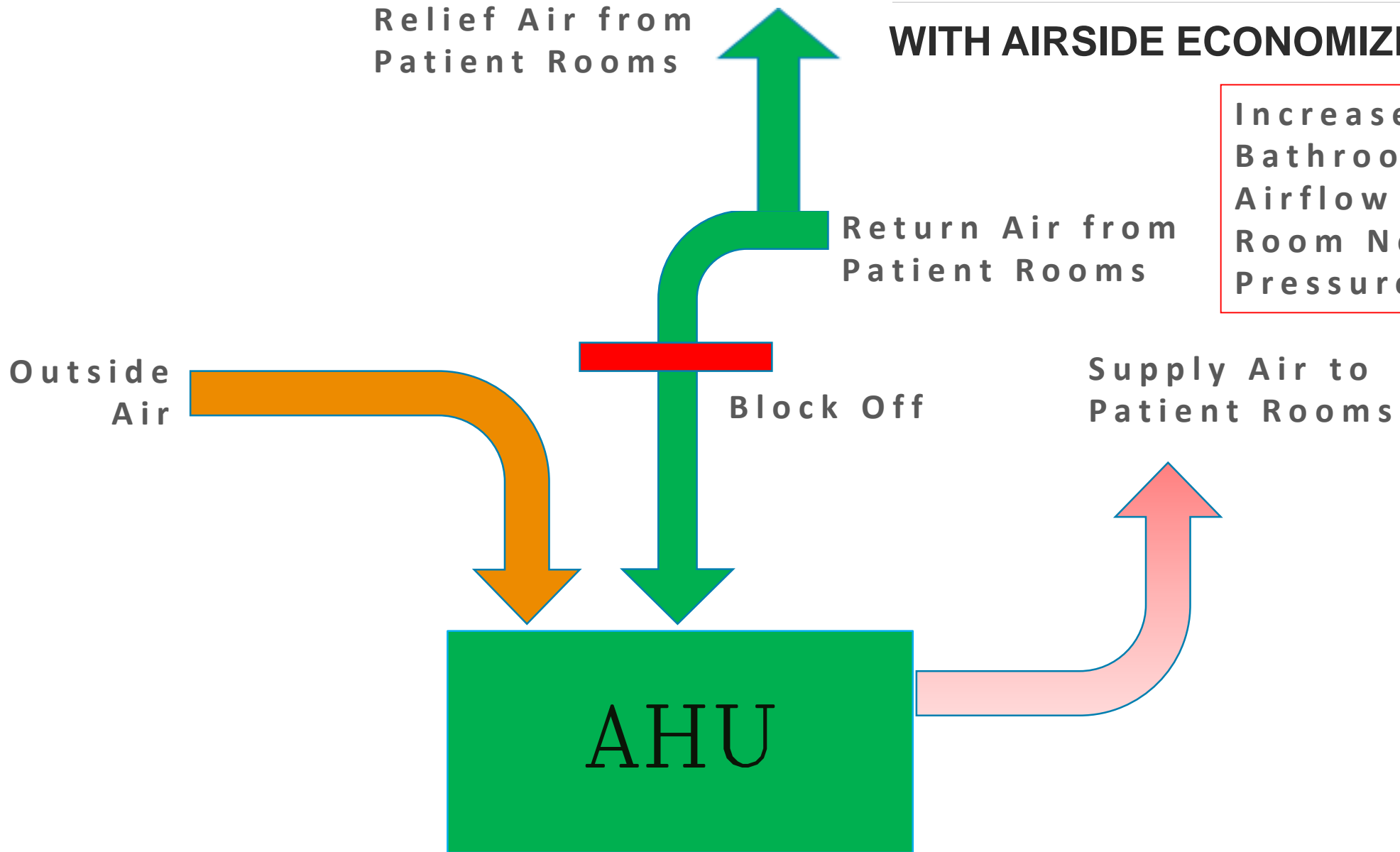
Basics

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Operating Room – COVID Patient

- **Temporary Vestibule**

- **HEPA unit in vestibule to create negative zone**

- **Seal other entries**

NO AIRSIDE ECONOMIZER

HVAC – Once Through Air

Temp Exhaust
Air from
Patient Rooms

Block Off

Outside
Air

Pre-Conditioned
Outside Air

Return Air from
Patient Rooms
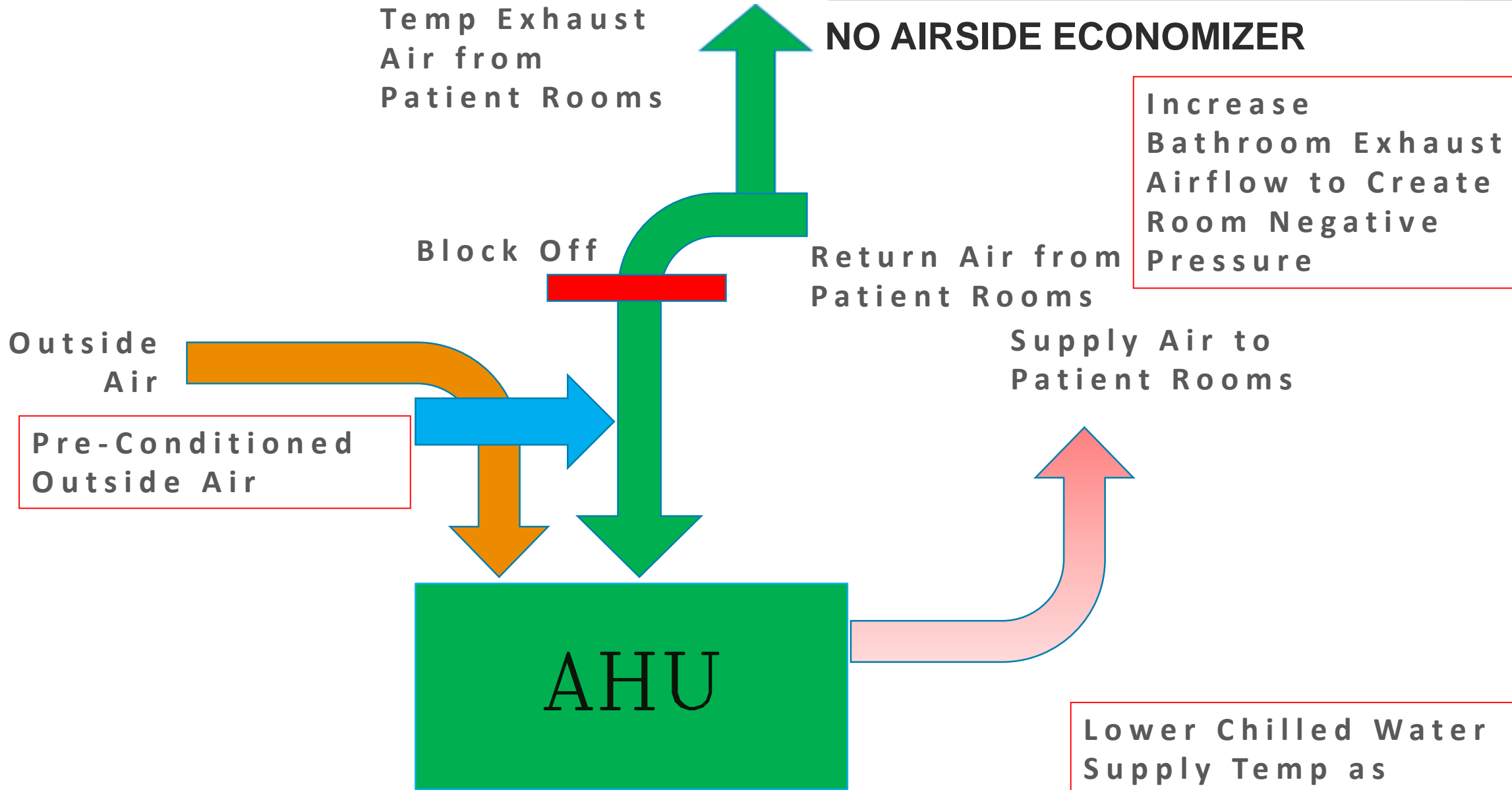
Increase
Bathroom Exhaust
Airflow to Create
Room Negative
Pressure

Supply Air to
Patient Rooms

AHU

Lower Chilled Water
Supply Temp as
Needed for Humidity
Control / Capacity

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Recommended – Variable Air Volume

- Recognize that VAV Systems Will Vary Airflow Quantity

- IF HOUSING COVID Patients in Area Served by VAV System:

  - Recommend <u>Resetting Minimum Airflow Setting to Match Maximum</u>

  - Why? Varying Air Flow Will Hamper Air Balance Goals of COVID Area

  - Fixed Air Changes Will Permit Stable Air Balance of COVID Area

  - May Result in Increased Cooling, Reheat Consumption

Basics

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Warning – HVAC System Consideration

- IF YOU HAVE A HEAT WHEEL/ENERGY RECOVERY (ERV)
  - Must Address How Exhaust from COVID Patient Rooms is Handled
  - Could Contaminate These Components
  - May Have Cross-Contamination Concerns
  - Either Incorporate HEPA or Discharge Directly, Not to Heat Wheel/ERV
  - Evaluate How Airflow Reduction May Result in Cool/Heat Capacity Issue
- IF YOU HAVE A ONCE THROUGH SYSTEM ALREADY
  - VERIFY IF YOU HAVE A HEAT WHEEL/ENERGY RECOVERY
  - See Above Notes

Basics

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Further Considerations

- Emergency Department

  - Coordinate with Clinical Team. Many Hospitals Are Implementing Access Management Plans That Limit Occupancy of Patient Waiting, Including Off-Site Triage Protocols.

  - Evaluate Air System Operation and Alternative Measures

    - Example: Convert Open Bay or Trauma Room with Use of HEPA Recirculation Unit to Multiple Patient Station

    - Example: Convert AHU Temporarily to Once Through Air System; Supplement Make Up Air Needs with Temporary A/C As Needed

    - Have a Contingency / Fall-Back Plan

- Temporary Spaces – Evaluate HVAC Needs & Arrangements

Perspective

Further Considerations

- <u>Ventilate the Room</u> and Terminal Clean before Re-use

- Follow CDC Air Change Clearance Rates:

Table B.1. Air changes/hour (ACH) and time required for airborne-contaminant removal by efficiency *		
ACH § ¶	Time (mins.) required for removal 99% efficiency	Time (mins.) required for removal 99.9% efficiency
2	138	207
4	69	104
6+	46	69
8	35	52
10+	28	41
12+	23	35
15+	18	28
20	14	21
50	6	8

Perspective

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4. Other Factors

- Infrastructure

- Code Compliance

- "Flatten the Curve"

- PPE Guidance

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Infrastructure

- Assume increased demand for oxygen therapy. Assess bulk oxygen capacity and top off; develop a re-filling plan if already frequent.

- Coordinate with biomedical regarding stores of O2 hoses, masks, humidifiers and portable oxygen cylinders. ECMO has been needed for severe cases.

- Considering the possibility of being short-staffed in the future, consider run-testing and re-fueling emergency generator system.

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Code Compliance

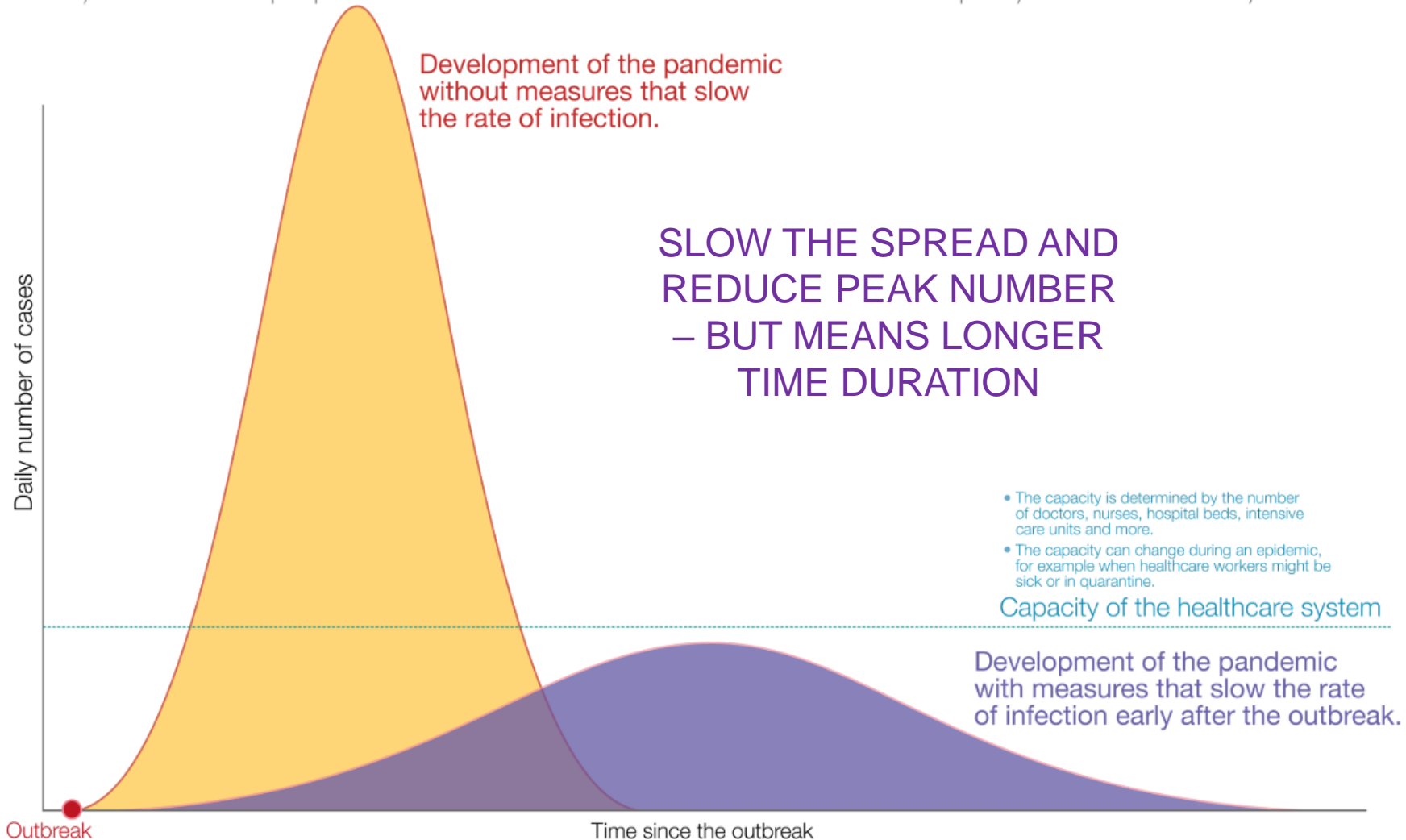- Coordinate with State and Local Authorities

- Seek Guidance / Reach Out for Help

- Take Appropriate Action Based on Circumstances

- Reminder to Document the Action Plan and Alterations in Place.

- Develop Interim Life Safety Measures as applicable

- Upon Cessation of Cases: Establish Disinfection Plan Before Returning HVAC System to Normal Operation (Grilles, Duct, Air Handler)

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Flatten the Curve

In the outbreak of an epidemic *early* counter measures are important

Their intention is to 'flatten the curve': to lower the rate of infection to spread out the epidemic.
This way the number of people who are sick at the *same time* does not exceed the capacity of the healthcare system.

Our World in Data

Development of the pandemic without measures that slow the rate of infection.

SLOW THE SPREAD AND REDUCE PEAK NUMBER – BUT MEANS LONGER TIME DURATION

- The capacity is determined by the number of doctors, nurses, hospital beds, intensive care units and more.
- The capacity can change during an epidemic, for example when healthcare workers might be sick or in quarantine.

Capacity of the healthcare system

Development of the pandemic with measures that slow the rate of infection early after the outbreak.

Daily number of cases

Outbreak

Time since the outbreak

Based on the Centers for Disease Control and Prevention
OurWorldinData.org – Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the author Max Roser

Other Factors

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PPE Guidance

- Refer to CDC Guidance on PPE Use

  https://www.cdc.gov/coronavirus/2019-ncov/hcp/respirators-strategy/index.html

  - Especially Note the Banners at Bottom of Webpage
- Consider Re-Use : Silicone Half Mask with N95
- Double Glove Increases Protection When Re-Using Gear

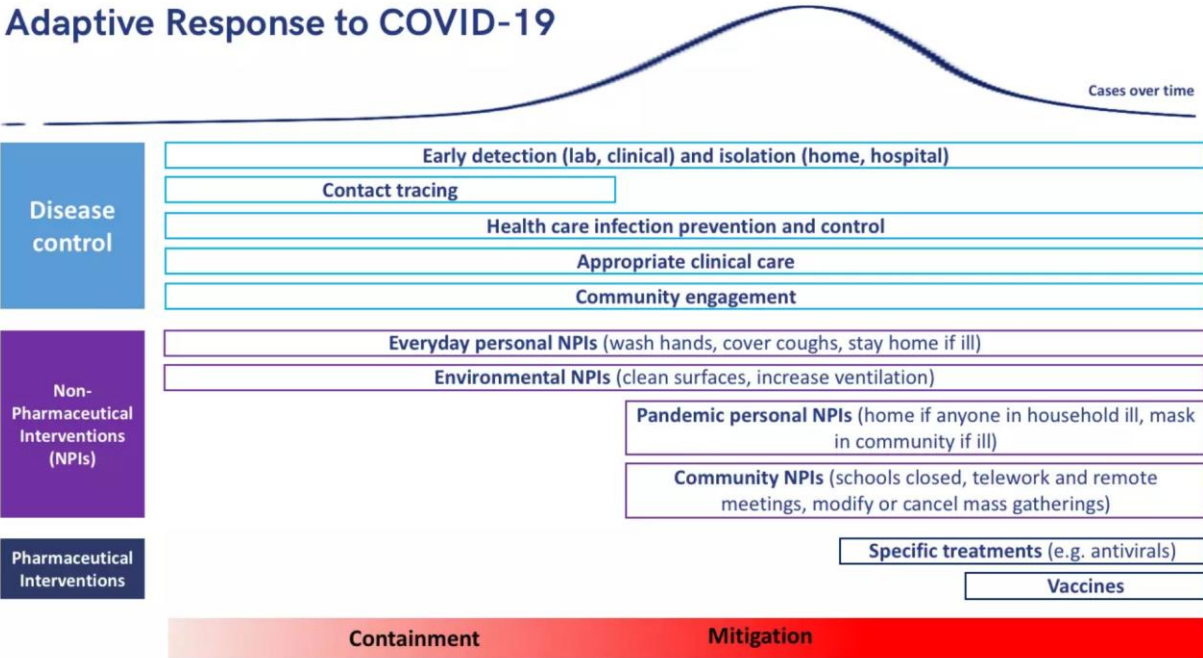Conventional Capacity Strategies

Contingency Capacity Strategies

Crisis Alternate Strategies

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Additional Resources

- Operating Room Guidance

  - https://anesthesiology.pubs.asahq.org/article.aspx?articleid=2763456

- Aerobiology

  - https://jamanetwork.com/journals/jama/fullarticle/2762692

- Patient Demand Modeling

  - https://penn-chime.phl.io/

  - https://preventepidemics.org/c insights/#adaptive-response-t

Adaptive Response to COVID-19

Geography

COVID-19: U.S. at a Glance*

- Total cases: 15,219
- Total deaths: 201
- Jurisdictions reporting cases: 54 (50 states, District of Columbia, Puerto Rico, Guam, and US Virgin Islands)

* Data include both confirmed and presumptive positive cases of COVID-19 reported to CDC or tested at CDC since January 21, 2020, with the exception of testing results for persons repatriated to the United States from Wuhan, China and Japan. State and local public health departments are now testing and publicly reporting their cases. In the event of a discrepancy between CDC cases and cases reported by state and local public health officials, data reported by states should be considered the most up to date.

Cases of COVID-19 Reported in the US, by Source of Exposure*†

Travel-related	337
Close contact	321
Under investigation	14,561
Total cases	15,219

Geography

Present Geographic Impact
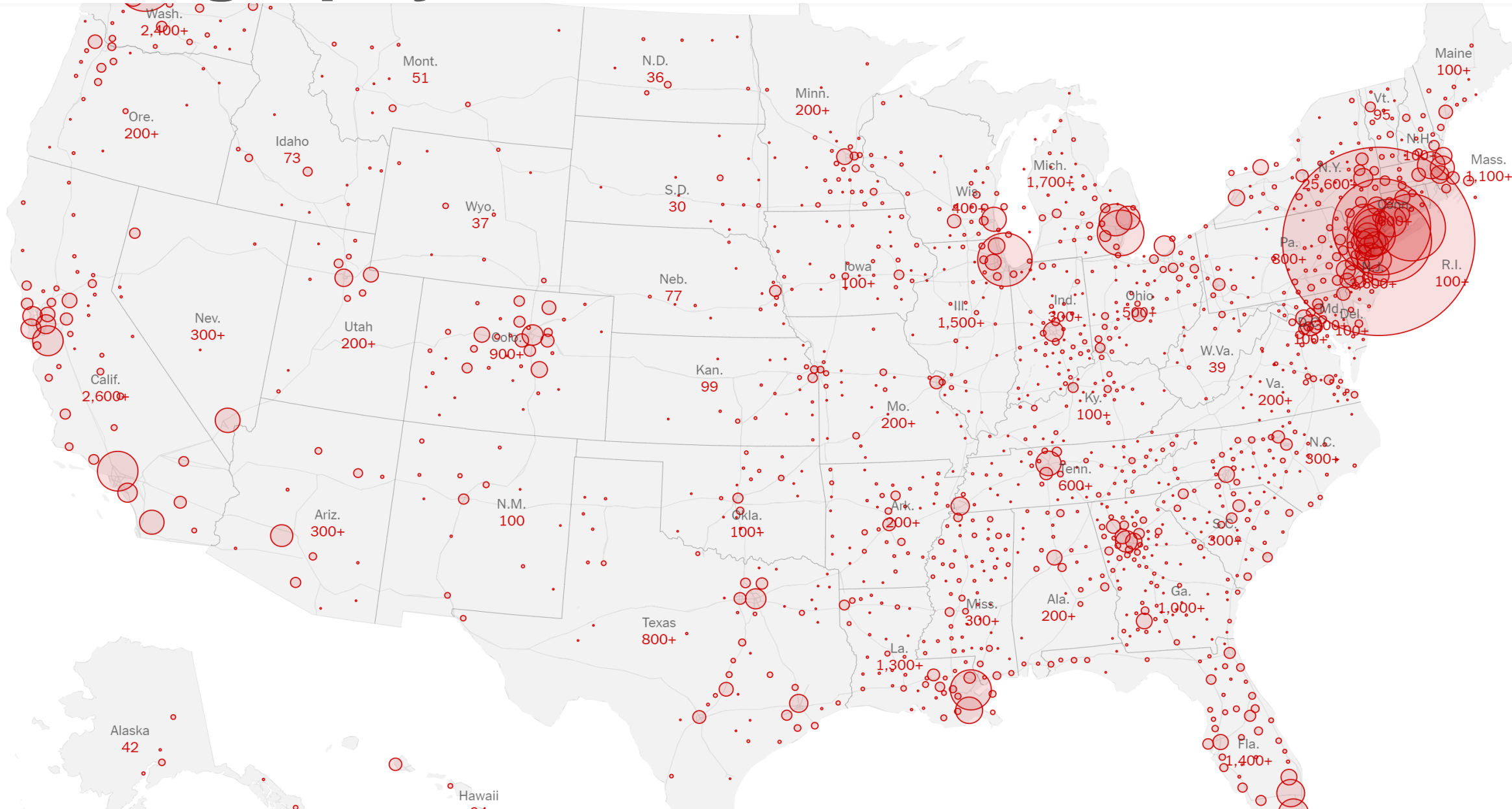
COVID 19 GUIDANCE

Need Help? Have Questions?

Contact:

Michael.sheerin@tlc-eng.com

QUESTIONS?