nbi new buildings institute

Reopening Office Buildings:

Creating a Healthy Environment for Occupants and the Planet

White Paper Prepared By:

Webly Bowles, AIA
Cathy Higgins
New Buildings Institute

March 2021

The David and Lucile Packard Foundation Headquarters | Los Altos, California
Photo: Jeremy Bittermann

Table of Contents

This white paper provides an overview and summary of the multiple building systems that affect occupants' return to a safe indoor air environment, their energy use implications, and recommendations for best practices. Included is *Retrofit and Reopening Recommendations for Offices*—a checklist resource for facility managers and owners.

The Banner Bank Building | Boise, ID
Credit: HDR Architecture, Inc.

Office Building Reopening: Minimizing Viral Spread

Building energy use is a significant part of carbon emissions and, as such, a core contributor to the climate that enabled the advancement of the COVID-19 pandemic. The energy use in buildings also increases emissions from fossil-fueled generation that affect nearby residents' air quality and respiratory systems—making them even more vulnerable to airborne infections.[1]

The public is turning our attention indoors, where industrialized nations spend 90% of their time and where most COVID-19 cases are contracted. Creating healthy environments is essential as employees return to the office, but the interventions needed to create healthy spaces also greatly impacts energy use and contributes to climate impacts from that energy production and use. This paper shares the strategies being used to minimize the virus's spread indoors while reopening office buildings.

What We Know About COVID-19 in Buildings

Scientists have established that the virus that causes COVID-19 (SARS-CoV-2, herein referred to as "the virus") is transmitted via contact, respiratory droplet transmission (and other bodily explants), and airborne particles.[2] Fomite, or viral transmission via surfaces to humans, is considered minimal. World Health Organization (WHO) recommends frequent hand hygiene and limited touching of surfaces. Other recommendations include physical distancing, proper respiratory etiquette, and avoiding crowded, confined, and enclosed spaces with poor ventilation. The risk of transmission between unshielded occupants depends on the viral potency of the infected individual and their expulsion of droplets/aerosols, the proximity, and duration in contact with others.

Building ventilation and air filtration is crucial to minimize human-to-human viral transmission.

Polices, space design, ventilation, and related mechanical system factors and settings in office buildings need attention and action for safe re-occupancy. The WHO recognizes that COVID-19 can spread through aerosolized particles, particularly in an indoor setting with poor ventilation.[3] With live virus particles found within 16 feet of the human source, building ventilation and air filtration is crucial to minimize human-to-human viral transmission.[4]

However, proper environmental conditions can be controlled in most buildings. When spaces can control temperature and relative humidity, the virus decays and reduces infection potential. Increased temperature and relative humidity cause a minor deterioration of the virus. Combined with additional airflow, the risk of viral transmission is significantly reduced.[5] Understanding the virus' favored environment can help building operators understand how to minimize those conditions.

1 The relationship between buildings, climate and the spread of disease is discussed in this February 2021 blog by Webly Bowles, **Buildings' Impact on Pandemics**

2 Centers for Disease Control and Prevention, October 2020, **Scientific Brief: SARS-CoV-2 and Potential Airborne Transmission**

3 World Health Organization, July 2020, **Coronavirus disease (COVID-19): How is it transmitted?**

4 University of Flordia August 2020, **A Question of Physics**

5 Bukhari & Jameel, March 2020, **Will Coronavirus Pandemic Diminish by Summer?**

Creating a Pandemic-free Work Environment

These ventilation strategies alone can increase building energy use by 24% per square foot.

Many offices closed at the start of the pandemic, knowing that minimizing human contact and controlling indoor ventilation can curtail viral spread within buildings. Some offices are opening due to necessity, and they are quickly updating spaces to mitigate the spread of the virus. The reopening recommendations and the ability to follow them has not always been clear.

Building managers, or operators, have referenced and implemented ASHRAE guidelines, resulting in additional energy consumption to protect occupants.[6] These ventilation strategies alone can increase building energy use by 24% per square foot.[7] The temporary rise in energy may be necessary to protect the occupants, though building owners should look for opportunities to create climate-friendly buildings to minimize the potential for future pandemics.[8]

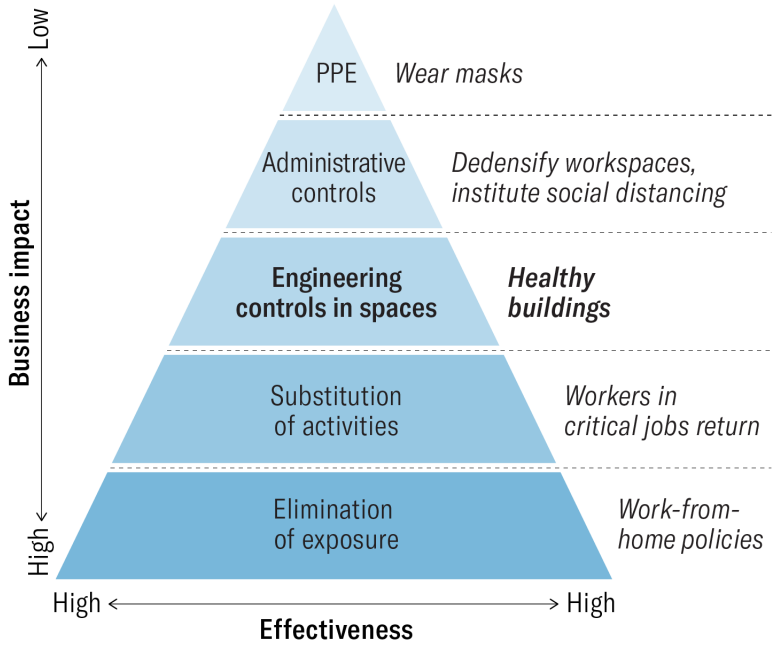
Businesses have three main areas of influence for returning staff to offices:

1 Workplace Policies

2 Space Alterations

3 Mechanical Adjustments

Phase-in plans for reopening allow businesses to slowly get these areas addressed and employees back to the office in a controlled manner. Once a community is virus-free, or vaccines are available and widely administered, staff can be united again. The content within this paper provides a technical narrative on the three areas of re-occupancy influence and recommended actions. Appended to this white paper is the *Retrofit and Reopening Recommendations for Offices: A Quick Checklist,* a brief overview and a checklist for reopening. Additional resources can be found within this white paper.



Credit: Allen, Macomber, https://hbr.org/2020/04/what-makes-an-office-building-healthy

6 ASHRAE, Coronavirus (COVID-19) Response Resources from ASHRAE and Others

7 Arons September 2020, Technology + Technique

8 Bowles Februry 2021, Buildings' Impact on Pandemics

1 Workplace Policies

Building and business owners can update policies and recommend strategies to encourage proper hygiene and minimize occupant contact. Office policies may include allowing vulnerable employees to work from home, or encouraging all employees to work from home, specifically when sick with any contagious illness. When in the office, require masks/face shields, implement physical distancing rules, offer physical barriers between employees, provide handwashing stations and personal protection equipment (PPE) options. Other policies may limit/eliminate travel, eliminate share amenities, disallow personal fans, and increase cleaning regimens, specifically high-touch surfaces. All employees should be made aware of the new policies. When employees feel safer in their work environments, they are more productive employees.[9]

2 Space Alterations

Most staff are interested in working from home 2-3 days per week, and as they return to their offices, they are looking for changes to protect them.

A Gensler study found that only 12% of U.S. workers want to work from home full time.[10] Most staff are interested in working from home 2-3 days per week, and as they return to their offices, they are looking for policy updates and changes in the physical space to protect them. Assigned seating and 1-2 occupancy offices are expected to be a standard feature. As more office real estate is made available due to some companies working remotely 100% of the time employers can expand their square footage and offer more space per employee. Additional space is also necessary to separate and reconfigure visitor spaces from staff space, minimizing exposure from others. The expansion of entries and waiting rooms can provide space for guests to physically distance or provide space for temperature or other pre-entry screening.

Space adjustments may be minor, such as assigning one-way hallways, installing no-touch entries and fixtures, rearranging workstations, and adjusting electrical and mechanical configurations to match. Many people are wary of touching common surfaces, though transmission is minimal from fomites. Keyless entries, touchless buttons, faucets, and flush fixtures may become more common to reduce the spread of viruses. Workstations should be spaced out further to physically distance coworkers; when ventilation rates are increased, viruses travel from one person to the next before the virus falls to the ground or becomes aerosolized and removed through filtration. Staggering desks to minimize employees sitting in the same ventilation air currents can minimize the transfer of the virus.

3 Mechanical Adjustments

No one can ensure zero risk of contracting the virus. Multiple mechanical strategies can support a lower risk office environment.

Healthy indoor environmental quality is necessary to offer safer environments and prevent the spread of viruses. However, no one can ensure zero risk of contracting the virus. Multiple mechanical strategies can support a lower risk office environment. Unfortunately, many of these strategies increase building energy consumption, a necessary risk for maintaining occupant health. Unoccupied buildings provide an opportunity to retrofit existing buildings with systems that meet occupant health needs when they return to the office while also reducing energy consumption.

CONTROLS

Building automation controls frequently offer an opportunity for energy savings. Remotely adjusting controls as occupancy changes offers energy saving potential. Indoor temperature, humidity, and ventilation can be

9 Evans, May 2020, COVID-19 Virtual Town Hall: Mental Health and Sanitation of COVID-19 Facilities

10 Gensler, May 2020, Back to the Office: Return Strategies for the Workplace and Office Buildings

At a minimum, buildings should be evaluated to ensure the ventilation system can meet ASHRAE 62.1 and that spaces do not have stagnant air pockets.

modified to reduce the potential for viral spread. Colder spaces support the viability of the virus, while environments above 65°F see virus decay.[11] As building occupancy decreases, the active heating must increase to adjust for internal loads. The Pacific Northwest National Laboratory (PNNL) modeled a Denver, Colorado school to study the energy impact on a lower occupancy.[12] The annual heating demand increased by 0.14 kBtu per square foot. As the temperature increased, so did the annual energy consumption.

Maintaining the space relative humidity between 40% and 60% is an ideal range.[13] Humidification may be necessary for dryer climates, and in the winter. Increasing indoor humidity in cold climates can advance the production of condensation, inviting additional building complications such as bacterial and mold growth, leading to building material decay and occupant health concerns.

Continuously moving air reduces stagnant areas where the virus may reside in higher quantity and allows for high quality filtration to collect and trap virus particles. ASHRAE recommends disabling demand-controlled ventilation (DCV) to provide a steady air supply, though it may not be necessary for all scenarios. Spaces should be flushed with outdoor air two hours before and after occupants enter and leave a space or building. A custom sequence of operations can be set up to allow both scenarios, depending on the space configuration, occupancy, and system controls.

VENTILATION/EXHAUST

When it comes to moving and diluting the virus in the air, proper ventilation is critical. Researchers dispute that increasing air changes per hour (ACH) above ASHRAE 62.1 and Title 24 reduce the potency of the virus in the air, though it is considered standard in hospital design.[14, 15] Providing 100% outside air is also contested but regarded as good practice. At a minimum, buildings should be evaluated to ensure the ventilation system can meet ASHRAE 62.1 and that spaces do not have stagnant air pockets.

Agreed upon recommendations include: Discourage directly recirculating air without filtration; Starting occupant-level ventilation strategies two hours before occupants enter and two hours after occupants vacate; Considering the direction of air airflow current and air moving directly from one person to the next; Directly exhausting rooms where contaminates might be higher, such as bathrooms, breakrooms, and dining areas; Cleaning heating and cooling coils to optimize heat transfer. Any changes to ventilation and exhaust should be coordinated with space planning considerations.

ENERGY IMPACTS

However, these commonly agreed upon strategies require more energy, specifically in environments with more extreme temperatures. Some strategies may not be possible with current equipment or arrangements, as an example, increasing outside air (OSA) from 20% to 90% may double the required chilled water, the coil pressure drop, and the amount of cooling source.[16] Doubling the required ventilation can increase a building's site energy use intensity (EUI)

11 Bukhari & Jameel, March 2020, Will Coronavirus Pandemic Diminish by Summer?

12 Fernandez, Xie, Katipamula, Zhao, Wang, Corbin, May 2017, Impacts of Commercial Building Controls on Energy Savings and Peak Load Reduction

13 ASHRAE, October 2020, Epidemic Taskforce: Building Readiness

14 ASHRAE, December 2020, Epidemic Taskforce: Healthcare

15 Pantelic, Tham August 2012, Assessment of the mixing air delivery system ability to protect occupants from the airborne infectious disease transmission using Wells-Riley approach

16 ASHRAE, February 2021, Epidemic Taskforce: Building Readiness

by 12% while delivering 100% OSA may further increase the total energy consumption.[17] Combined with enhanced ventilation rates, HVAC systems are more costly to operate. Systems may not have the required capacity to meet the OSA requirements, and other considerations, such as a leaky envelope, may apply, requiring more energy to meet the guidelines.

FILTERS

High quality air filters, both inside ventilation systems and standalone room filters, can capture virus particles, depending on the filter's quality. Minimum Efficiency Reporting Value (MERV) 13 filter, or higher, can remove particles associated with the virus. MERV 13, or higher, filters will not work with all ventilation systems, and similar to ventilation, system-specific design must be considered. Quality filters require higher air velocity to force air through the filter, thus using more energy and putting stress on fans and ducts. Air filters should be cleaned or replaced frequently since a dirty air filter can consume 15% more system energy, burn out fans, and lead to early HVAC system failure.[18]

Freestanding high-efficiency particulate air (HEPA) filters offer an alternative when ventilation systems cannot accommodate a quality filter capable of removing small particles. HEPA filters can be moved from space to space for personal use. When combined with adequate ventilation or an operable window, the duo can be a temporary substitute for a quality HVAC system.

Lease and Liability Considerations

Other considerations should be addressed before altering workplaces to address COVID-19.

Lease Provisions. If buildings are leased and not owned, tenants may not have the ability to make necessary workplace adjustments. Lease provisions may address energy-specific requirements, including energy consumption, temperature setpoints, equipment maintenance requirements, hours of operation, overtime usage, energy improvement cost-share provisions, and more. When temperature setpoints are not in the lease, some cities have requirements that regulate building setpoints and minimum ventilation requirements for buildings during specific hours.[19, 20]

Unoccupied Alterations. Altering the ventilation system in an occupied building could lead to litigious action due to breach of contract/lease violation. In the future, cities are likely to include variances to address unforeseen events. In the case of absentee owners or property managers, they may not change building operations for vacant buildings—leaving previous settings in place either due to general inattention to the property status or apprehension of how building schedules, setpoints, and reduced ventilation changes might lead to mold, Legionella disease, and other maintenance issues when reoccupying the space. These concerns can be overcome through thoughtful facility management, leading to reduced energy consumption in unoccupied buildings.

The Psychology of Safety

Employers should also pay special attention to their employee's feelings of safety around re-occupancy as they plan a building for reopening. If employees do not feel safe in a building, they will not perform to the best of their abilities. Toxic work environments, pending layoffs, or fear of getting

17 Benne, Griffith, Long, Torcellini, Crawley, Logee, April 2009, Assessment of the Energy Impacts of Outside Air in the Commercial Sector

18 U.S. Department of Energy Maintaining Your Air Conditioner

19 City of Chicago, 2020, Municipal Code Chapter 14

20 City of New York 2009, Health Code Article 131

The Banner Bank Building | Boise, ID
Credit: HDR Architecture, Inc.

If employees do not feel safe in a building, they will not perform to the best of their abilities. Giving as much certainty as possible will go a long way in helping to reduce COVID-19 anxiety.

sick puts stress on employees, distracting them from their tasks and making them more suspectable to getting sick. When staff do not feel safe, they will often look for new opportunities.

Giving as much certainty as possible will go a long way in helping to reduce COVID-19 anxiety. Employers should provide information and plans for ensuring employee health, implement safety measures and ask employees to contribute by following guidelines and policies. Employers and building managers will need to frequently communicate the strategies implemented and post signage. Each employee will have different needs, offering control over their space allows them to make personal adjustments for comfort and health through: individual fixture level lighting control, automated shades with personal controls, temperature controls, personal air filters, and cleaning products. Once these strategies are implemented, employees often perform better and take less sick time.

Maintaining healthy employees reduces organization costs from sick time and employee turnover, and attracts new talent. Communicating COVID-19 prevention strategies with employees and prospects alike, tells occupants that the office is a safe space to work, and the employer cares about its employees.

Re-entering offices can be done safely. Businesses can use workplace policies, space alterations, mechanical adjustments, and employee engagement to return to a safer office. How strategies are implemented will depend on the community and building capabilities. By implementing COVID-19-safe strategies, not only will workplaces be healthier during the pandemic reopening, but post-pandemic.

---

nbi new buildings institute

623 SW Oak St., 3rd Floor
Portland, OR 97205
503 761 7339

New Buildings Institute (NBI) is a nonprofit organization driving better energy performance in buildings. We work collaboratively with industry market players—governments, utilities, energy efficiency advocates and building professionals—to promote advanced design practices, innovative technologies, public policies and programs that improve energy efficiency and reduce carbon emissions. We also develop and offer guidance and tools to support the design and construction of energy efficient buildings. Learn more at newbuildings.org

This paper was partly supported through the California Energy Commission EPIC project “Leading in LA”.