DISTECH CONTROLS™

White Paper

Healthy and Trustworthy Educational Institutions

More than ever, ventilation has become a critical component of non-residential buildings. A defective system can have serious consequences for the health of occupants by facilitating the transmission of viruses and bacteria. Throughout this white paper, we will go through the technologies available in the market that can assist with safely reopening educational institutions.

In all aspects of our lives, we expect the spaces we occupy to be healthy and trustworthy so that we can grow, learn, work and consume with peace of mind. Even more so when it concerns the well-being of our children and the professionals that see to their development.

If we cannot ensure the health and safety of students and staff, how can we to expect parents to send their children back to school? What repercussions can we expect for children being homeschooled and secluded from social interactions.

Consider this, during the COVID-19 crisis, patients were afraid to go to the hospital for treatment for symptoms unrelated to the pandemic. As a result, the number of cases of patients who developed severe forms of illness - which are normally benign if treated promptly - increased, to the point where they became visible in medical statistics of people with a history of good health, thereby putting a strain on health systems[1].

Continued school closures risk "scarring the life chances of a generation of young people," according to an open letter published last month and signed by more than 1,500 members of the United Kingdom's Royal College of Pediatrics and Child Health (RCPCH)2.

The recent pandemic has made us aware of the importance of occupying healthy, properly ventilated buildings. It has also made us question habits and gestures previously considered harmless such as shaking hands to say hello or touching a door handle or a light switch.

The current risk will undoubtedly dissipate eventually, but a return to a measure of normality can be accelerated by providing effective and easy to implement responses to reassure occupants of non-residential buildings that their workplace or temporary residence is safe and healthy.

These measures can be classified into the two following solution types:

- Pro-active solutions that reduce the risk of contagion (deliver clean air, disinfection procedures, infection and detergent-resistant interfaces, counting / density of people to ensure social distancing is applicable, restricting access to buildings to persons not showing symptoms of contagious diseases).
- Reactive solutions that advance optimal risk management if, for various reasons, an infected person comes to visit a building (people tracking).

Finally, for these measures to have a real impact on a building's occupancy rate and for a return to normalcy (or a new normal) under the best conditions, it is important to share, in a way that respects privacy, the efforts being made to reassure occupants of a healthy environment.

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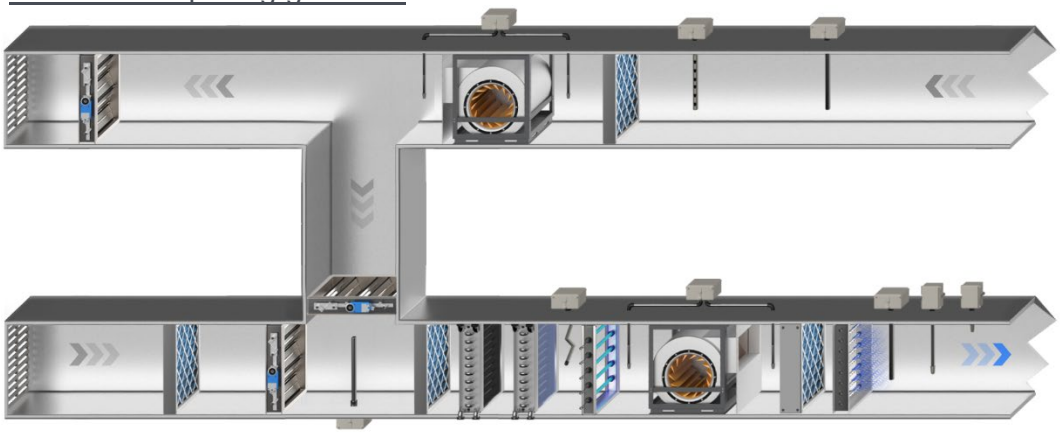
[1] The New York Times, Fear of Covid-19 Leads Other Patients to Decline Critical Treatment https://www.nytimes.com/2020/05/25/health/coronavirus-cancer-heart-treatment.html)

[2] AAAS, Science Mag, School openings across globe suggest ways to keep coronavirus at bay, despite outbreaks https://www.sciencemag.org/news/2020/07/school-openings-across-globe-suggest-ways-keep-coronavirus-bay-despite-outbreaks

Proactive Measures

Enhanced Indoor Air Quality

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (**ASHRAE)** has published a COVID-19 Building Readiness/Reopening Guideline: https://www.ashrae.org/about/news/2020/ashrae-offers-covid-19-building-readiness-reopening-guidance



Increase the Ventilation Rate

Ventilation, when used properly, allows "dilution of virus-laden aerosols, which are then extracted from the room".
Increased ventilation rates are also recommended to control airborne diseases, provided that these systems are used appropriately: without recirculating air and directing flows from clean areas to potentially contaminated areas[3].

Increase the Rate of Air Renewal

However, recommendations to provide more fresh air have technical and economical limitations. Ventilation systems are generally designed to recirculate a large quantity - e.g. 90% - of the air in the building (and therefore inject low percentages of fresh air – e.g. 10% -), which corresponds to an optimum balance of energy consumption and occupant well-being. A consequent change in these ratios can lead to very expensive system modifications and an immediate increase in energy bills.
As an illustration, for a **25000** BTU/h chiller located in a warm region (90F/32.2C), providing 55F (12.7C) for a comfortable environment at 72F (22C), the impact of energy consumption is **2.29%** for each 5% increment of the fresh air renewal rate (10% to 25% - the maximum supported by this equipment).

Outside Air Ratio	10%	25%	20%	25%	30%
Energy Consumption		+2.29%	+4.58%	+6.87%	Cooling load not supported

Increase Air Quality with HEPA filtration

A high-end ventilation system includes a HEPA (High Efficiency Particulate Air) filter (https://en.wikipedia.org/wiki/HEPA).
This standard allows high level of performance in terms of filtration (stop 99.95% of particles with a diameter greater than or equal to 0.3 µm).

[3] US National Library of Medicine, Ventilation control for airborne transmission of human exhaled bio-aerosols in buildings https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6072925/)

Although the size of the SARS-CoV-2 (Coronavirus) is almost 3 times smaller (0.12 μm) than the finest particles that can be stopped by this type of filter, a physical phenomenon called *diffusion* allows a HEPA filter to capture virtually 100% of nano particles even as small as coronavirus if they enter the air handling unit[4].

HEPA filters should be changed regularly and a differential pressure sensor placed before the filter (upstream side) and after the filter (downstream side) can be used to monitor the cleanliness of a HEPA filter.
During a pandemic, special procedures must be followed for changing HEPA filters to protect maintenance personnel.[5]

Kill Bacteria and Inactivate Viruses in HVAC Systems
There is evidence that energetic photons in UV light interact with nucleic acids (RNA and DNA) to prevent replication and make pathogens non-infectious - this process is known as thymine dimerization.

After having been exposed to a sufficient power and duration of exposure to UV-radiation, they no longer present a health risk. Bacteria are single-celled living organisms and are killed, viruses are genetic material wrapped in proteins and are inactivated[6].

Another method to prevent the spread of germs, viruses and bacteria through ventilation is to use UV lamps placed in air handling systems[7].

For economic reasons and in knowing that radiation will be contained inside ducts, it might be appropriate to use germicidal UV lamps with mercury at the 254 nm wavelength. This radiation is very close to the peak of the germicidal efficacy curve, 265 nm, which is the wavelength most lethal to microorganisms but significantly more expensive to produce than 254nm. At 254 nm, 90% of the energy generated at 265 nm is generated, which can produce the best balance of amount of UV radiation and incurred costs.

As it can represent a danger to human health, with the potential to cause skin cancer and a risk of cataracts, UV light at 254 nm use is limited. One such use of UV light at 254 nm is restricted to the inside of HVAC pipes where the necessary protection equipment and methods can be implemented. Also, since bacteria in HVAC systems is more prone to cultivate in damp environments, the ideal location to install 254 nm UV filtration systems is after the cooling coils located in the air handling systems, where condensation is more likely to happen. UV light at 254 nm may also be used to irradiate interior spaces when these spaces are unoccupied. These 254nm UV light systems may be integral with luminaires delivering visible illumination, or they may be standalone UV light systems. The key here is the proper safeguarding through controls to protect occupants in

[4] SmartAirFilters.com, Can Air Purifiers Filter Out the Coronavirus? https://smartairfilters.com/en/blog/can-air-purifiers-filter-out-the-coronavirus)
[5] Dealing With Dirty Air Filters During the COVID-19 Pandemic, https://www.achrnews.com/articles/142929-dealing-with-dirty-air-filters-during-the-covid-19-pandemic)
[6] Science Daily, Ultraviolet LEDs prove effective in eliminating coronavirus from surfaces and, potentially, air and water, https://www.sciencedaily.com/releases/2020/04/200414173251.htm)
[7] ASHRAE, technical resources, Ultraviolet Air & Surface Treatment, https://www.ashrae.org/file%20library/technical%20resources/covid-19/si_a19_ch62uvairandsurfacetreatment.pdf).

addition to special handling and maintenance instructions to protect facilities personnel. Another potential use of 254nm is through UV light systems designed for Upper Air Germicidal Ultraviolet (GUV) Light Disinfection. The design parameters for this use of 254nm is covered extensively in a Germicidal Ultraviolet (GUV) Frequently Asked Questions report by the Illuminating Engineering Society Photobiology Committee, IES CR-2-20-V1. With Upper Air GUV systems, it is possible for spaces to be occupied while 254nm is in use.

Comparison Summary of Enhanced IAQ Methods

	HEPA Filtration	**Increased ventilation rate**	**Increased air renewal rate**	**UV Filtration (**254 nm)
Pros	- Filters 99.95% of particles (0.3 µm or greater) - Safe to install in air handling units installed closer to critical environments	- Can help extract and filter contaminated airflow at a faster rate than default ventilation rates	- Greater % of fresh air in building environment leading to greater occupant productivity[6] - Less recirculated air means less risk of recirculating potential contaminants	- Up to 99.9% efficient in killing air-borne bacteria at the 254 nm wavelength (7) - Low static pressure loss (less load on AHU system than airflow options) - Ideal for use in damp environments (where viruses, bacteria and fungus tend to cultivate)
Cons	- Expensive - Requires frequent filter change-outs - Added energy costs (increased fan performance to compensate for additional static pressure)	- Could represent added noise and environmental discomfort - System imbalance possibly due to fan over-running, which could require changes to ductwork - Added energy costs due to increased airflow	- Added costs due to resizing of heating and cooling systems to account for increased load - increased load from heating and cooling systems could require upgraded fan to compensate for added static pressure of system - greater than 25% OA could possibility require semi-custom AHU (above capabilities of standard systems) - added energy of increased heating/cooling loads, increased fan load	- Increased risk of 254nm exposure by maintenance personnel when performing scheduled tasks (mitigated with proper design) - Added upfront costs of installed UVC system - Added energy costs of UVC filtration systems electrical requirements

In addition to taking steps to make sure that the air supplied by the ventilation system is healthy, it is important to provide a means by which potentially contaminated surfaces can be optimally disinfected in order to limit the risk of spreading viruses or bacteria through contact.

Pathogen Reduction

Whether gyms, classes, cafeterias, locker or staff rooms, different methods to reduce pathogens on surfaces are available:

Physical cleaning:

- The use of a cleaning team who will come to disinfect the previously occupied workspace with the appropriate detergents/germicide and methodology

UV Light disinfection:

- A new and exciting UV light disinfection technology provides an option for occupied space to be directly irradiated using 222nm far-UVC. This method - of inactivating viruses and bacteria on visible surfaces in a short period of time at energy levels that do not harm the eyes and skin when designed within appropriate parameters, allowing it to be used in occupied or unoccupied spaces[8] - will use Care222® far-UVC light disinfection[9] technology from Ushio America, Inc. (Ushio) in Acuity Brands commercial luminaires (planned for late 2020) to significantly reduce pathogens on surfaces throughout the day. Through the use of short band filters applied to a 222nm Krypton-Chlorine excimer lamp, the Care222 technology meets the American Conference of Governmental Industrial Hygienists (ACGIH®) safety guidelines for exposure to a 222nm far-UVC light source when used within appropriate parameters. These systems are designed to provide general illumination for spaces while incorporating independently modulated pulses of the filtered 222nm far-UVC light to reduce pathogens on surfaces when spaces are occupied or unoccupied. No specially trained technicians will be needed for operation.
- For example, Care222® light disinfection modules, can be integrated into luminaires. These devices operate autonomously and separately from the visible illumination systems and are designed to provide UV doses within ACGIH® safety guidelines, allowing use in occupied spaces. Also, since the Care222 modules can be used when spaces are occupied, they can operate throughout the entire day providing for reduction of pathogens as they are being introduced into the space.
- Another potential UV light disinfection technology is 405/430nm. These wavelengths technically fall into the visible portion of the electromagnetic spectrum. As such, this technology has been shown to meet visible light safety standards for occupants and will provide for reduction of certain pathogens, namely bacteria.

  All these solutions are valid, and the choice depends on the necessary periodicity and the surface to be cleaned. Combining all solutions allows for cleaning of surfaces that cannot be reached by the UV light.

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[9] All references to UV light “disinfection” are referring generally to the reduction of pathogenic bioburden and are not intended to refer to any specific definition of the term as may be used for other purposes by the U.S. Food and Drug Administration or the U.S. Environmental Protection Agency. The disinfection technology as incorporated in Acuity Brands products is not for use as or for medical devices - All trademarks referenced are property of their respective owners.

Contactless Comfort Management

Light affects concentration. Allowing educators to select the proper level of lighting within classrooms plays a monumental role in creating the optimal visual setting adapted to the activity at hand. Also, in spaces where children tend to touch everything around them, it is important to empower teachers with effective and safe tools to adapt the classroom environment.

With some of the latest generation of wall sensors and thermostats (e.g. Allure UNITOUCH from Distech Controls™), you no longer need to touch the equipment on the wall to personalize your comfort: everything can be done securely from your personal phone.

Mobile apps provided with such equipment (e.g. *my* PERSONIFY from Distech Controls) can manage all the comfort of a room from a single application available free of charge (room temperature, lights and blinds/shade). It also allows you to select predefined scenarios such as the video projection mode in a meeting room, which consists of reducing the background light to 10% and turning off all the other lights and closing the blinds.

my PERSONIFY Workplace, another mobile application from Distech Controls - which includes a link to *my* PERSONIFY that we mentioned earlier - offers all the services to simplify the life of an educational facility worker, such as comfort management (using *my* PERSONIFY), indoor positioning, way-finding, room reservation, social networks and company news, as well as easy access to the catalogue of services offered to occupants.

It allows you to limit and optimize travel within the building and avoid certain areas when moving from one place to another (it's up to the Facility Manager to choose the preferred routes to navigate the building when using the wayfinding feature).

It also makes it possible to reserve a study room from a student’s phone, thus avoiding the need to touch the screen sometimes found in front of the meeting room to reserve it at a specific time.

If you need a more personalized application - in line with your brand policy and institutional identity - it is also possible to add the comfort features offered by my PERSONIFY into your own fully customized mobile application. For example, in the higher education realm, the app could assist students throughout their journey, from enrolling, to guiding them to their next classroom and providing easy access to services such as booking study rooms and adjusting the comfort of the room from a single application.

Ensure Social Distancing can be Respected

People counting sensors are generally implemented to understand how spaces are used and to ensure that the partitioning of zones is adapted to the needs of the occupants.
In the context of a smooth return to the office, the data collected by this type of sensor (number of people per zone) can be used to ensure that the density of

people per zone allows for social distancing (or any other rule set by the building manager).
And, why not set up a restricted access system - at the discretion of the occupants, based on a maximum number of people per zone and a visual signal indicating that the zone is accessible?
In a workspace, this device will generally be considered less restrictive and more professional than an access control gate.

Thanks to thermal imaging sensors positioned in the ceiling, you will be able to check if your social distancing policy is respected by the occupant and adapt your strategy accordingly. With this technology, you do not need any agreement from your user as it respects privacy (only thermal image, no visual) and you do not need to ask each occupant to download an app.

Provide Access to Healthy Occupants Only

Although it is impossible to give the percentage of benign or asymptomatic coronavirus infections representing all regions consistently since the beginning of the epidemic, the most recent studies available give a rate of 40% to 45% of asymptomatic cases[10].

However, many asymptomatic patients also suffer from extraordinarily low blood oxygen levels, or hypoxia without even realizing it. Providing an oximeter at the entrance to the building and encouraging occupants to test their blood oxygen levels may be an effective, inexpensive way to limit asymptomatic patients from entering a building.

Infrared cameras, placed at each entrance of buildings, allow the detection of feverish people. This concerns a very limited segment of contagious people, but nevertheless remains a very interesting and affordable way to convey the message to your occupants that you care for their health and wellbeing.

[10] Statnews.com, We don't actually have that answer yet': WHO clarifies comments on asymptomatic spread of Covid-19 https://www.statnews.com/2020/06/09/who-comments-asymptomatic-spread-covid-19/)

Reactive Measures

Identify Potentially Infected Persons

Despite all the precautions we have just reviewed, there is no such thing as zero risk. There is always the possibility of a situation where, asymptomatically, individuals may have unknowingly transmitted the virus to other occupants.

In such a case, as soon as the infected person becomes aware of it, it would be advisable to warn people who have been in contact with the infected person in the last 15 days (duration can be modified). These individuals could then be asked to go and get tested in turn, and to quarantine themselves in order to prevent the spread of the virus.

In an educational institution, a potential application could be that of administrative offices and laboratories. This tractability is possible using the indoor positioning feature implemented in *my* PERSONIFY Workplace.

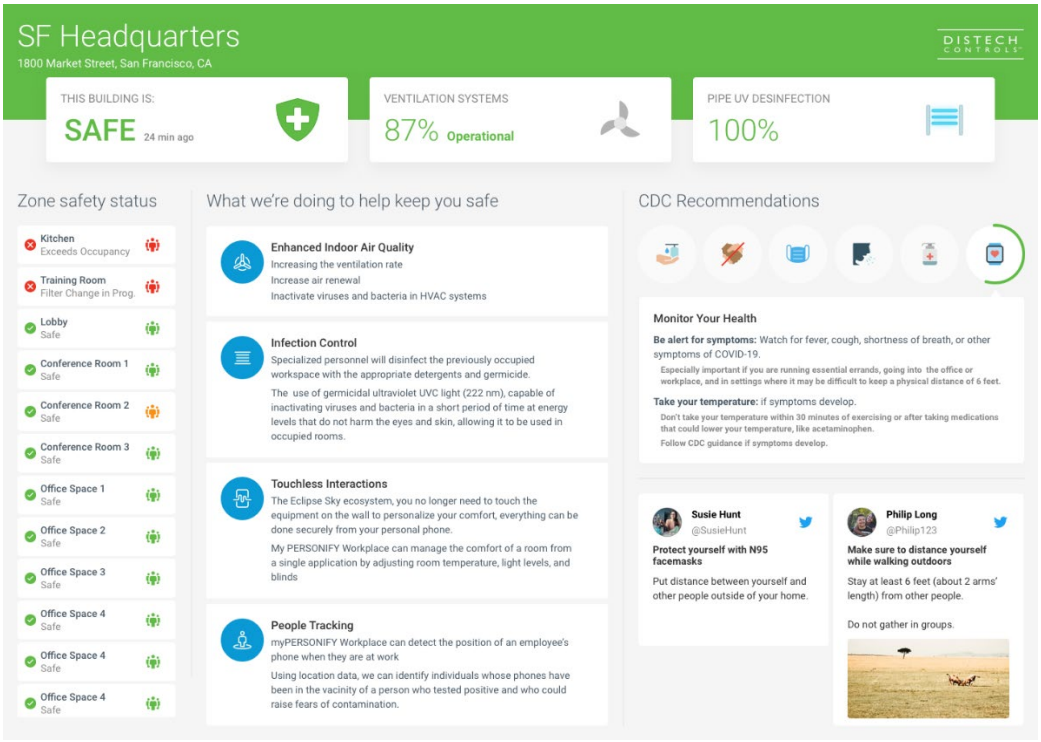
my PERSONIFY Workplace does not store any data concerning the positioning of a student or faculty member's phone while on the premises. However, the technology is available to add a software layer which would allow this data to be saved temporarily and securely. If necessary, the HR department, or whoever is responsible to maintain a safe workplace in the current framework, could therefore know the list of phones (associated to individuals who had opted-in) who had been in contact with each other.

This solution has the advantage of not only being compatible with the infrastructure of *my* PERSONIFY Workplace, but also benefiting from the accuracy of installed beacons (from 2 to 5 meters apart) which can result in an exhaustive list of people to be notified.

Open Communication

Healthy Building Dashboard

As we have seen in this brief overview of proactive and reactive measures to increase the health of commercial spaces, different solutions exist to address the various issues related to the return to offices post-COVID.
However, the real challenge is to convince building occupants that the premises are healthy and that that their return can be done in a secure fashion.



To effectively do so, the following mix of information should be provided in an easy-to-read dashboard, available at the entrance to the building or directly from the building occupant's telephone:

- procedures in place within the establishment (disinfection routine, social distancing rule, etc.)
- the status of the BMS (ventilation working optimally, air disinfection by UV lamp 254 m is operational, etc.)

Dynamic Floorplan

The digitalized floorplan in *my* PERSONIFY Workplace (which can also be integrated into dashboards) can be enhanced with a new type of POI (Point of Interest), allowing users to visualize, in real-time, information specific to a safe passage in a building based on occupancy of the premises.

In order to further respect social distancing, it is very easy to virtually add X's on desks that should not be occupied.
Digital floorplans are also an efficient way to indicate the location of health stations and their status (level of hand-sanitizer, number of available masks), and even to visually indicate surfaces that have been disinfected recently.

Conclusion

The current health crisis will end sooner or later, and it is difficult to know if, and when the next wave or pandemic will occur. This is why it is important to note that, while the measures we have outlined will serve to reassure occupants of the trustworthiness of their favorite buildings, most will also provide a healthier environment opening the door to certifications such as WELL (https://www.wellcertified.com/) which classifies buildings according to the level of well-being (health and service), and can increase the attractiveness and value of your assets.

Each building is unique, and each organization occupying all or part of a built space has specific needs. Whatever the constraints, a smooth return to public buildings including educational facilities will require adjustments in intelligent building systems; from a simple increase in the air refresh rate, to the application of all or part of the various measures we have just reviewed.

Whatever your needs are, Distech Controls' team of experts and Authorized System Integrators are here to assist you in your journey to making your building healthy and trustworthy.