District of Columbia Public Schools Air Quality Report Guidance

In alignment with guidance from the Centers for Disease Control (CDC) and DC Health, DCPS buildings have received HVAC building automation scheduling changes to increase ventilation and filtration upgrades. Furthermore, all DCPS classrooms and large bathrooms have HEPA filtration and UV-C non-visible disinfection lights in place. Classroom units are mobile to allow for teacher flexibility, and bathroom units are fixed in the ceiling. DCPS buildings are equipped with indoor air quality sensors that are continuously monitoring air quality in our schools. The results of the readings are being sent directly to an independent platform where the Department of General Services (DGS) utilizes a third-party vendor, Setty and Associates, to monitor events to be addressed by the facilities staff. These air quality sample size measurements help provide a profile of the air in the school, which help us understand how well ventilated our buildings are and how well the filtration is working. In addition, we are calculating a probability infection risk index for a typical classroom at each school.

Why Focus on Carbon Dioxide (CO_2) and Particulate Matter?

Throughout the public health emergency, we have learned more and more about how COVID-19 is transmitted and the importance of CO_2 and particulate matter. While we know that in some circumstances surfaces can be contaminated, COVID-19 typically spreads when an infected person breathes out droplets and very small particles that contain the virus.[1]

In alignment with these principles, and in accordance with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards, we have focused our efforts on indoor air quality and the metrics most associated with mitigating the risk of COVID-19 transmission, CO_2 and particulate matter. CO_2 is measured as a proxy for ventilation. Monitoring CO_2 levels allows us to understand how well our buildings are being ventilated and address any issues as they arise. Seeing the readings shows us that the strategies we put in place to increase ventilation are working.

Carbon Dioxide (CO_2)

Carbon dioxide is a natural component of air in buildings caused by the respiration of occupants. The amount of CO_2 in a given air sample is shown in *parts per million* (ppm). Nationally, we typically see around 380-450 parts per million carbon dioxide in the outside air, but higher levels of outdoor CO_2 concentrations can be found in urban environments where there is more vehicle traffic and density.

[1] How Coronavirus Spreads | CDC

Indoor concentrations of CO_2 are typically driven by the ambient outdoor CO_2 level, CO_2 produced by people, occupant time within a space and how well ventilated the spaces are. People exhale carbon dioxide—the average person's breath contains about 35,000 to 50,000 ppm of CO_2. These rates vary based on the variables of gender, level of physical activity, body mass and age. Ventilation is used to dilute and remove the CO_2 that is generated by the occupants. It is expected, normal, and safe to see spikes in CO_2 levels as people enter and occupy spaces.

We are reporting on the monthly average CO_2 levels for each building, the peak reading of CO_2 in the building, and if any elevated level events occurred (above 1100ppm) of CO_2 are sustained for more than 90 minutes. Peaks are expected as classrooms fill up with occupants but tracking if the elevated levels are cleared tell us if the ventilation systems are doing their job. It is important to note that while we are tracking 1100 ppm as an elevated level, prolonged exposure to 5,000 ppm is recognized as the occupational safety standard, which can lead to drowsiness and drops in productivity. For the last 6 months of monitoring, there are no events of elevated CO_2 for longer than 90 minutes.

Particulate Matter

According to the Environmental Protection Agency (EPA), particulate matter is the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope. $PM^{2.5}$, which are fine inhalable particles, have diameters that are generally 2.5 micrometers and smaller. The size of 2.5 micrometers is about 30 times smaller than the diameter of human hair. A majority of $PM^{2.5}$ is generated from outdoor conditions such as smoke, exhaust and pollen.

Particulate matter in the $PM^{2.5}$ range is one of the primary modes of transmission for airborne pathogens. By filtering our air for $PM^{2.5}$ particulate matter, we have the correlating effect of filtering the air for airborne pathogens. Our interventions with the MERV-13 and HEPA filters in the buildings are designed to filter out $PM^{2.5}$ from the air. Understanding the readings of $PM^{2.5}$ helps us understand how well our filters are working in the buildings.

In the reports we are tracking any events, or elevated readings, of $PM^{2.5}$ above 55.5µg/m^3, which is recognized by the AirNow division of the EPA as the acceptable threshold level for the monitoring of $PM^{2.5}$.

Air Quality Scores

Looking at the CO_2 levels in our buildings allows us to create a score for each building and compare that to our district-wide baseline. The CO_2 levels will vary greatly school by school and classroom by classroom, but what we are monitoring is the reduction rate of the CO_2 near the ambient CO_2 levels in the DC area. This is a clear indication that airflow is occurring. It is expected that air should return to normal ambient CO_2 levels 60 to 120 minutes after peak occupancy.

Infection Risk Index based on Wells-Riley

The Wells–Riley model[2] has been extensively used for quantitative infection risk assessment of respiratory infectious diseases in indoor premises. Utilizing the Wells-Riley equation, we can generate the probability of infection for an average classroom in each school based on current operations, ventilation, time of occupancy, number of infectors, total number of occupants, effective air change rates, quanta generation of occupants, and air cleaners. Our calculations are based on a scenario in which one student is infected and generating airborne infectious particles, or quanta.

Overview of Calculation Parameters for the Wells-Riley Model

The infection risk index has been created based on averages within each school that pertain to both population and classroom sizes. The risk index provides a probability of infection from airborne viruses. While there is no instance in which a guarantee can be made that no one will be infected by a virus in a common space like a classroom, there are operational and HVAC system changes that reduce the airborne concentration of viruses and thus, the risk of infection.

The following are the key business rules used for the data included in the Wells-Riley infection risk calculation presented in this report:

- Typical classroom square foot area is utilized for each school
- Each school's average class size is used for the mean of scheduled class enrollment counts
- Classes with the same room, term and period are combined, as the assumption is they are sharing spaces
- Average exposure time applied is three hours at the elementary level and two hours at the secondary level, based on standard schedules and typical student rotations
- Non-instructional components of the schedule are excluded from averages
- Non-classroom locations are excluded from the calculation

[2] The Wells-Riley model is a model developed to estimate the probability of the airborne transmission of infectious diseases developed by William F. Wells and Richard L. Riley. The model makes predictions for the probability that a susceptible person becomes infected in the case that one or more infected individuals are sharing a room.

In addition, the model takes into consideration the HVAC interventions currently in place that are quantifiable, such as the outside air rates, filtration levels and the utilization of UV-C.

It is important to note that the calculation does not account for additional safety precautions in place at DCPS such as the required use of face masks, sanitation procedures and social distancing. The calculation also does not account for vaccination status. These additional layers of protection will help to lower the overall probability of infection beyond the Wells-Riley prediction.

This risk index model is an estimate used solely for predictions. The index does not depict actual risk for the multiple reasons outlined above, nor should the infection risk index be used as a substitute for following CDC protocols.