BU URBAN-Energize Andover Memorandum

To: Andover Public Schools and the Town of Andover
From: Catherine Connolly
Date: July 31, 2020
RE: Classroom Analysis for Carbon Dioxide and Temperature in Andover High School

Introduction

The purpose of this memorandum is to inform the Town of Andover and Andover Public Schools about the results of a classroom carbon dioxide and temperature analysis conducted in Summer 2020. The scope of this work included a collaboration between Energize Andover and Boston University Graduate Program in Urban Biogeoscience and Environmental Health to perform an exploratory analysis using the monitoring data within the school HVAC system. An intern at Energize Andover and a PhD student collaborated to analyze the live monitoring data to compile into a report and usable format for future data processing as needed by the community stakeholders. The results have been summarized in supporting documentation with tables, graphs, and references for school ventilation and health impacts. These applications of this project are important during 2020 with the presence of an airborne infectious virus as ventilation and engineering controls are recommended to reduce infection transmission risk.

Research Question & Methodology

The objective of this project was to develop a weekly report available for the Town's use to investigate classrooms in Andover High School (AHS) with potential issues related to temperature or carbon dioxide (CO_2). These two parameters influence student thermal comfort (i.e. a room may be too hot or too cold and may change with season) and affect ventilation and indoor air quality, which have been shown to impact cognition, attention, and academic performance in students. The data were collected from real-time sensors within many of the classrooms at AHS which continuously monitor temperature and CO_2 during the school day (7AM-3PM). These data were processed through the Town of Andover data repository to identify rooms with potential sensor issues (i.e. same value all day or low CO_2 values below outdoor concentrations), problems with temperature control, and high CO_2 concentrations above recommended standards. Indicators for the issues within the rooms were flagged and documented in the data processing to identify rooms with sensors in need of attention by Facilities. Descriptive statistics were also run to calculate the percent of time in each room spent above a recommended threshold, 1000 ppm CO_2, and the primary statistical parameters, mean, standard deviation, median, minimum, and maximum for both temperature and CO_2. The data presented are for a single week, February 3-7, 2020 while students occupied the school and during a colder season with minimal expectation of window opening.

Key Findings

Classroom Temperatures

Most AHS classrooms were identified as having temperature controlled within an adequate range for this analysis during early February 2020. No classrooms were too hot, rather most identified rooms had some measurements that were too cold below 65 ºF.

Classroom CO_2 Concentrations

For the CO_2 analysis, most rooms reported concentrations well above 1000 ppm at some point in the school day, with many rooms sustaining high CO_2 levels for the majority of the day. There was heterogeneity between floors with the third floor having overall higher CO_2 concentrations, whereas the

second floor reported more sensor issues related to constant values all day throughout the week and low CO_2 values below ambient background levels. For recorded classrooms without aforementioned exclusions related to constant or consistently low values, the average CO_2 concentration was 981 ppm, the median was 953 ppm, and the range was from 230 ppm to 2569 ppm. The attached AHS CO_2 Classroom Summary Tables Document for specific room numbers with different issues and summary statistics for more detailed information.

Recommendations & Next Steps

This analysis and collaboration between students at Energize Andover and the BU URBAN Program has concluded that there are many classroom ventilation systems and sensors in Andover High School in need of attention and evaluation by the School and Town Facilities. Rooms with probable sensor issues were identified, which merit the attention of Facilities to investigate and replace these if needed. For the rooms with high CO_2 concentrations, we recommend that Facilities evaluate the dampers as part of the Demand Control Ventilation to confirm the individual unit ventilators are functioning properly. **The Town of Andover has access to an enormous amount of continuously monitored data that can be used to implement changes with a focus on indoor air quality, ventilation, and occupant health, creating an opportunity for the Town to be a leader in this space for other municipalities in Massachusetts.** After necessary changes and inspection of the ventilation system, the CO_2 and temperature sensor data should be reevaluated to confirm the CO_2 levels decrease when the classrooms are occupied, as determined by the Massachusetts DESE guidelines for the 2020-2021 academic year. There are potential ancillary benefits of reducing infectious disease risk transmission with additional control measures, such as increased filtration and higher percent of outdoor air being ventilated into the classroom spaces. These benefits are important at this time due to the COVID-19 pandemic and potential for airborne spread of the SARS-CoV-2 virus, but specific recommendations are out of scope for this project. Resources from different agencies are provided in supplementary materials. For complete evaluation of best engineering practices, it is recommended to allocate funding and to work with an environmental consulting firm to determine the best protocols to reduce and control infectious disease spread in indoor spaces using known recommendations from ASHRAE, EPA, and other agencies to make the right decisions for this community.

Closing

The key findings of this project indicate Andover High School classrooms with temperature and CO_2 sensor issues, rooms that are too hot or cold based on thermal comfort, and rooms with high concentrations of CO_2, many of which are sustained for large portions of the school day. Attached reports, tables, and graphs visually display the rooms indicated in this memorandum by both the Energize Andover high school intern (Jade Nair) and the BU PhD student (Kate Connolly). The data demonstrate classrooms and sensors in need of attention by Facilities and the School to improve the indoor air quality and ventilation in classrooms with multiple health benefits for students, teachers, and staff that occupy AHS throughout the day. Government agencies (EPA, CDC) and other organizations (i.e. ASHRAE) are available as published resources, outlined in the Appendix, for schools to use to evaluate and improve their ventilation systems. The primary focus of this analysis was on the classroom environmental parameters, all of which have been summarized in this memorandum and in supporting documentation.