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Visit To: East Carolina University
Brewster Building A-Wing
East 10th Street Greenville NC

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Reason for Visit: Review HVAC systems and operations

On August 26, 2021, Rick Langley, Medical Consultant with the NC Division of Public Health, Occupational and Environmental Epidemiology Branch, Phill Lewis, ECU Assistant Director of Environmental Health & Safety, Bill Koch ECU Associate Vice Chancellor of Campus Safety and Auxiliary Services, EHS), Ray Schmit, Engineer with ECU Facilities Services and David Lipton, CIH, Industrial Hygiene Consultant with the NC Division of Public Health, Occupational and Environmental Epidemiology Branch performed a survey of the indoor environment in the A Wing of the Brewster Building in Greenville NC. The purpose was to evaluate the design and operation of the heating ventilation and air conditioning (HVAC) systems, understand upgrades and modifications proposed by the University, and evaluate any visibly obvious conditions that could have an impact on the indoor environment.

Brewster Building is a complex of four independent wings (A, B, C, and D) that surround a central courtyard and are connected by breezeways. The survey was limited to the A-Wing, because of other health concerns among faculty who have offices in the A wing where the spend they majority of time while on campus. Brewster A-Wing a rectangular building that runs parallel to the north side of East 10th Street. The A-wing contains administrative offices and professors' offices of departments History, Geography, Philosophy, Political Science, Sociology, Economics, Religious Studies, and the Center for Women's Studies Program.

Brewster A wing is a four-story building with concrete slab-on grade foundation and exterior cavity walls. The exterior walls are brick veneer, and structural concrete masonry walls. There is a built-up low slope roof, replaced in 1993. Interior partition walls are separated by paper faced gypsum board (drywall). Floor coverings in hallways are terrazzo on the ground floor and vinyl composition tile on the other floors. Offices have vinyl composition tile floors and carpet. The floors appeared in good condition. There are an estimated 160 office spaces in the building. On the survey date there were around 25 people working in the building. Occupancy rates may change as professors come and go throughout the day and as the university resumes more normal operations as the COVID-19 pandemic changes.

There are no indoor connections between the A-wing and other wings in the Brewster complex. The other wings contain classrooms and other student facilities including the Testing Center, and the Innovation Early High School. It is our understand that no chemistry laboratories or other facilities that stored or used chemical products have ever been present in Brewster. It is also our understanding that there have never been dry cleaners or other facilities adjacent or nearby that could be related to vapor intrusion.

Both public water supply and wastewater services are provided by the Greenville Utilities Commission. Water fountains in the building have been replaced by modern water fountains/filling stations equipped with filters.

According to the ECU Library Special Collections at the Joyner Library, construction of Brewster was completed in 1970 with several interesting design elements. Stairway exits from each floor in each wing discharge into the courtyard. The courtyard can be isolated from the outside by sets of closable steel gates, still present today.

Another design element is very narrow windows surrounded on the top and sides by stone "shutters". Reportedly, narrow windows were part of the design to prevent someone from climbing into or out of windows. The stone "shutters" narrow the field of view so that someone outside would need to be directly in front of a window to see inside. Windows appear to be openable and appear to be the original 1970's single pane windows with aluminum frames.

Some speculations for these design elements include protecting the structure from student unrest of the 1960's or that the windows and "shutters" were intended for passive energy savings. It is my understanding that the Brewster was one of the first buildings at ECU intentionally designed for mechanical cooling.

Heating Ventilation and Air Conditioning (HVAC)
For its age, Brewster has sophisticated HVAC systems. Each floor has an independent HVAC system with air handlers and supply ducts that supply conditioned air to offices and rooms on each floor. On each floor, mechanical rooms are located near the west end of the A-Wing. They appeared to be in good order, clean and well kept. HVAC equipment and air ducts have exterior insulation. There were no obvious signs of loose/friable or insulation.

Bathrooms are near the center of each hallway with exhaust ventilation by a central system with exhaust ducts that discharge to a roof mounted fan.

Three thermostats control temperature on each floor, one at the east end, the center and west end of the building. As each central hallway serves as a return air plenum, offices have grills cut into the doors to promote air flow into the hallways. Return air intakes to bring air into mechanical systems are at the west end of each floor.

Belt driven continuously operating constant volume fans pulls return/outdoor air through a bank of Minimum Efficiency Value Rating (MERV) 8 filters and then pushes air across a "cold deck" a "hot deck" and a "mixing deck" before air is pushed through air ducts to the occupied spaces.

The mechanical rooms can act as plenums to allow introduction of outdoor air. The outdoor air intakes are located near the northwest wall of the A wing facing into the courtyard. Outdoor air intakes are equipped with dampers that open or close to vary the amount of outdoor air introduced into the mechanical rooms. No obvious sources of pollutants appeared to be near outdoor air intakes. An additional set of intakes and dampers are located just downstream of the main return duct in the mechanical rooms. These dampers can be opened and closed to allow for introduction and mixing of return air and outdoor air. On the survey date both outdoor air dampers and return/mixing dampers were also closed.

A closed-circuit hot water loop supplies hot water for the "hot deck" (heating coils). Hot water is generated by a steam-to-water heat exchanger. Steam is supplied from a central steam plant. Both water temperature and flow rate in the hot water loop can be controlled.

A closed-circuit chilled water loop supplies chilled water for the "cold deck" (cooling coils). Chilled water is generated by a water-to water heat exchanger connected to a central chilled water system. It is my understanding the chilled water temperature cannot be controlled but flow rate of chilled water through the cooling "deck" can be varied to control discharge air temperature. Air from the hot deck and cold deck are mixed through a damper system in the "mixing deck" to satisfy space temperature requirements.

Currently outdoor air dampers, outdoor/return air dampers, hot deck dampers, cold deck dampers, and mixing deck dampers are pneumatically controlled. Thermostats and sensors send signals to a compressed air system of copper or plastic piping connected to actuators that move damper positions to vary the amount of air flowing through various components of the systems. Damper position can be verified by looking at the position of the actuator. Gauges must manually read to measure water temperature and water flow rate through hot and cold decks.

The plan is to upgrade damper controls to electrically operated motors and to install electric sensors to monitor their positions. Damper controls, sensors, and thermostats will be integrated into a Building Automation System (BAS). Technicians can use the BAS to monitor operational status and change operating parameters of components from remote locations. Thresholds can be set to send signals to technicians when sensors indicate anomalies. The BAS should increase energy efficiency, ease maintenance, and better control space temperature.

Discussion

A limitation of the system design is that only three thermostats control temperature on each floor. Centrally located thermostats may not be represent the temperature in each office. Another limitation is no humidity control. To prevent high humidity in the building, outdoor air intakes are closed during periods when outdoor dew points are high enough to bring excess moisture into the systems.

People's temperature preference also varies. Drafts from air flow are known to affect thermal comfort. In some offices, either intentionally or unintentionally, office furniture has been placed so that occupants are under a draft of air. Sometimes occupants have installed home-made devices to block or divert drafts at their workstations. In other cases, supply air has been diverted to blow air toward windows to prevent condensation on poorly insulated windows during the winter. Generally, it is not recommended to block air flows as a change in one location may affect air flow in other locations. When a change in air flow direction is needed for comfort or other reasons, directional diffusers are a better choice than blocking air flow.

The maintenance staff have equipment to measure air flow into offices for comparison against design specifications and do so when there are occupant complaints. However, it is my understanding that there has not been a complete testing and balancing analysis for each floor and the entire building since it was commissioned. Since there have been no major changes in equipment, how air is distributed, or layout of spaces, the value of a complete testing and balancing analysis may be limited.

Although the pandemic guidance is to install HVAC filters with a Minimum Efficiency Value Rating (MERV) of 13 to achieve the best filter efficiency, least cost, and lowest resistance air flow in the system, ECU staff have selected to stay with MERV 8 Filters. The ASHRAE recommendation for MERV 13 filters notes that installing more efficient filtration comes with costs: "increasing filter efficiency leads to increased pressure drop which can lead to reduced air flow through the HVAC system, more energy use for the fan to compensate for the increased resistance, or both. If a MERV 13 filter cannot be accommodated in the system, then use the highest MERV rating you can." In Brewster A-wing based on the age of equipment, constant volume fans, the way that air is distributed through the building, and the occupancy patterns, costs to accommodate MERV 13 filters seem to outweigh benefits.

Another pandemic recommendation is to increase outdoor air by opening outdoor air intakes. On the survey date outdoor air intakes were closed, which would be an appropriate choice under hot and humid conditions and reduced occupancy. I obtained data temperature and humidity data for the week prior to the survey at the Pitt County Airport from Station Scout a service of the State Climate Office of North Carolina. The average daily dew point temperature was approximately 72.6°F (range 71.6°F to 73.3°F) with an average daily difference between the minimum and maximum dew point temperature of 3.6°F (range1.8°F to 4.8°F). For the same period the average hourly temperature was about 80°F with a range of 70°F to 90°F. These are extremely humid conditions, the most humid conditions that occur in Greenville on an annual basis as measured by dew point temperature. Dew point temperature represents the temperature at which air has 100% relative humidity. Water condenses on surfaces cooler than the dew point temperature of the surrounding air. The dew point temperature can be used to calculate the partial pressure of water vapor in air or the absolute humidity, the mass-to-volume concentration of water vapor in air (milligrams of water vapor per cubic meter of air).

According to the Station Scout, in the Greenville area, over the last 10 years the highest average daily dew points have always occurred in late August and early September. In addition, under these conditions maintaining humidity control in the building is more important than introducing additional outdoor air.

The cooling load for a building is a combination of exterior heat loads (outdoor conditions) and indoor loads from people and inanimate sources (lights, computers, and other equipment). The total cooling load for a building is a combination of the energy required for sensible cooling (reduction in temperature) and latent cooling (energy required to dehumidify the air). Designers calculate expected cooling loads by considering interior, exterior, sensible, and latent cooling loads under specified conditions. At the time of the survey outdoor sensible heat loads (temperature) were most likely within design parameters, latent heat loads (humidity) were at or exceeded design conditions and interior heat loads were less than design conditions. Under these circumstances in systems controlled by temperature only, introducing additional outdoor could lead to loss of humidity control.

Phil Lewis spot checked carbon dioxide levels around the building. The carbon dioxide level was consistently around 600 parts per million parts of air (ppm), well within the recommended guidance of no more that 400ppm greater than outdoors. Baseline outdoor air carbon dioxide concentration is expected to be about 400ppm. Carbon dioxide levels in a building are a result of outdoor air exchange and the occupant density. Old casement windows and other building features are likely to allow more infiltration and exfiltration of outdoor air than occurs in modern well sealed buildings. Given the extremely high outdoor dew point temperature and the low occupancy density the decision to keep outdoor air intakes closed to assure humidity control is an appropriate choice.

When outdoor conditions become cooler and less humid (as measured by dew point), opening outdoor air intakes to take advantage of "free" cooling and "free dehumidification" makes sense. The ventilation system in Brewster becomes an air-side economizer. When outdoor conditions are favorable a duct/damper arrangement allows introduction of outdoor air to reduce or eliminate the need for mechanical cooling. In our climate use of an economizer needs to account for both outdoor temperature and humidity to maintain humidity control inside the building. As outdoor conditions become dryer and milder and the number of occupants in the building increase, opening dampers to bring in more outdoor air would make sense to promote health and comfort, reduce odors, and to reduce energy costs from mechanical cooling. BAS and electrical controls will provide greater flexibility to meet changing conditions.

From the viewpoint of controlling infectious aerosols, the Brewster A-wing has a directional (displacement) ventilation system. This means the general air flow pattern is from offices into the hallways, from cleaner air to less clean air. While in an office, an occupant would be on the clean side of the general airflow pattern which would tend to reduce their exposure to infectious aerosols generated by other people in the building.

Recommendations

As this survey was connected to a report of a cancer concerns among occupants in the building, ECU should proceed with a survey of Brewster for Asbestos Containing Materials (ACM), by a North Carolina accredited asbestos inspector. Although ECU has a robust asbestos management plan, a thorough survey of Brewster for the presence and condition of ACM will further enhance their program. Accredited asbestos inspectors should be required to follow the Model Asbestos Accreditation Plan published by the EPA for inspections and preparation of reports.

Custodial services for Brewster are provided by ECU employees. Records about chemicals used in the building may be available as far back as 1986 when the Occupational Safety and Health Administration Hazard Communication Standard 1910.1200 became effective. Under this standard labels and material safety data sheets for chemical products used in the building were to be made available for the purposed of providing information to employees about workplace chemical hazards and procedures to protect themselves.

Overall, we found no obvious conditions that could have negative impacts on the indoor environmental quality of Brewster A wing. A previous inspection, survey and monitoring of Brewster A-Wing Staff from the ECU Office of Environmental Health & Safety in during the period of June-to August 2019. did not find obvious conditions that could have negative impacts on the indoor environment.

I hope information in this report will be useful to you. Good industrial hygiene practices were used to conduct this survey and make appropriate recommendations. Nothing should be assumed concerning other conditions or areas. Please contact me at (919) 707-5961 for references, clarification, assistance in implementing the recommendations contained in this report, or for any other questions or concerns.

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