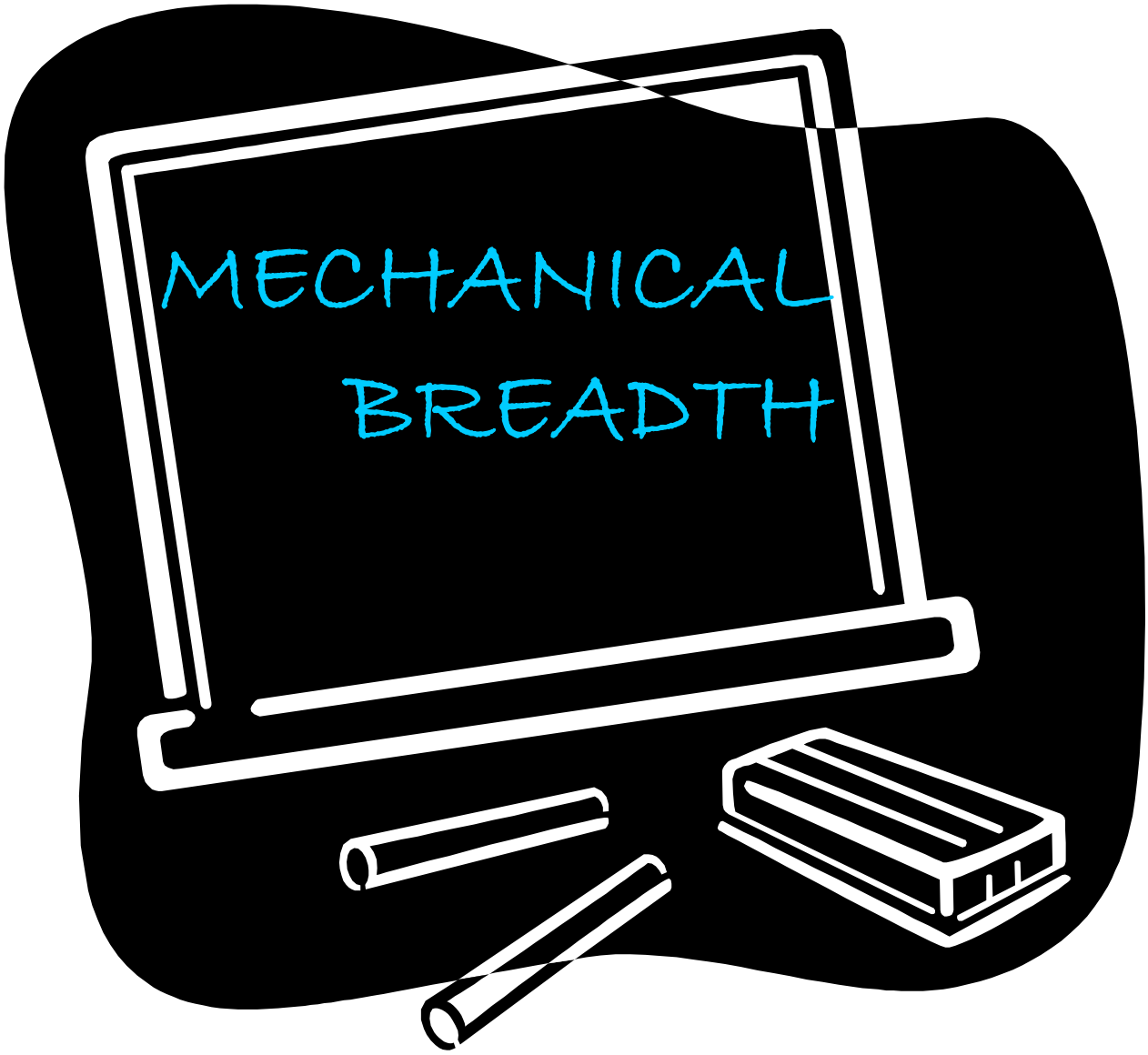

MECHANICAL
BREADTH


LORD STIRLING COMMUNITY SCHOOL

3.0 Mechanical Breadth Analysis: Introduction

Following the theme of total indoor air quality, the Mechanical Depth Analysis of this report is concerned with Indoor Air Quality. A major dilemma facing elementary schools across the country is mold growth in the building's Heating Ventilating and Air Condition (HVAC) system. Wherever there is cooling in a building's air conditioning system, there will be moisture due to condensation and the opportunity for mold growth. Mold accumulation on air filters, cooling coils, drip pans, and ductwork contribute to the spread of hypersensitivity diseases such as asthma throughout the building.

Three traditional methods used to combat mold proliferation in HVAC systems are source control, ventilation, and air cleaning. Source control deals with dehumidification of the source air via desiccant dehumidification. Source control alone is not 100% effective due to its inability to control condensation within the Air Handling Units (AHUs). The second method, ventilation, applies filters to the systems outdoor and recirculated air. The use of both fixed and portable filters are not effective if the contamination occurs within the AHU itself. Air cleaning, the third method, introduces high quality and properly maintained filters throughout the system. However, this method does not prevent mold growth on drain pans and coils. The most effective method for fighting microbial growth in HVAC systems and a focus of this study is Ultraviolet Energy in the 260-nanometer frequency in the "C" wavelength (UVC).

How does UVC work?

The "C" wavelength is effective at combating microbes by altering the DNA of the molecule causing cell death or making reproduction impossible. By targeting the DNA of micro organisms and rendering them unable to reproduce, UVC energy virtually removes all surface mold growth, airborne mold spores, viruses, and bacteria.

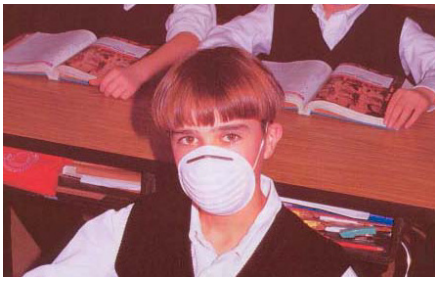
www.steril-aire.com

Does UVC work?

Many case studies have been completed on the effectiveness of UVC emitters in HVAC equipment. One such case, "The Effectiveness of Germicidal UV Radiation for Reducing Fungal Contamination within Air Handling Units" completed by researchers at Tulsa University published in the August 2001 edition of the *American Society of Microbiology*, investigated the effects if UVC emitters used on one floor of a four story office building with visible mold growth. Each floor of the office building is serviced by separate air handlers. AHUs on one floor were outfitted with UVC emitters. The control floor was not. Measurements of mold concentration in HVAC systems of each floor were taken before and after a 9 month period of operation. After nine months, there was a significant reduction in mold concentration. In another study published in *Engineered Systems*, vol. 15 #4, Ioloni elementary school in Honolulu, Hawaii, implemented a UVC system in one of the buildings air handling units and hired an independent testing laboratory to compare the before and after mold counts of the UVC outfitted AHU. The before reading, measured in colony forming units per milliliter, averaged 2087 cfu/ml; the after readings, measured 26 cfu/ml. In a few days, the reading was decreased by 99.8%!

3.0 Mechanical Breadth Analysis: Introduction (continued)

Why UVC in Schools?



Engineered Systems, Vol. No. 4, April 1998

Another case study, "UVC Goes to School," by Roger Sampler, implementation of UVC emitters was responsible for a "20% drop in absenteeism among students and a 50% drop among teachers" at the Crescent Avenue Christian Preschool in Beuna Park, California from 2002 to 2004. Along with reduced absenteeism, UVC emitters hold many other advantages for schools. The germicidal effect on a variety of microorganisms, from bacteria, to mold, to viruses, drastically cut down absenteeism due to illness, increase productivity due to better indoor air quality, and reduce operational and maintenance costs for HVAC systems. In another case study, "UVC Sheds New Light on School Mold Problems," by James Freeman, (*HPAC Engineering*, May 2001), the Rizzuto elementary school in Texas noticed that after the implementation of UVC emitters throughout the HVAC system the energy management system (EMS) began to throttle back on chilled-water usage. With a comparison to it's slightly smaller twin, the Jaine Reed Elementary School, the Rizzuto school chiller plant was supplying chilled water 2-7 degrees warmer and saving much more than 9% in energy costs despite the fact that Rizzuto is 12,000 square feet larger, has longer hours, and is operating with its original 15 year old chiller plant while Jaine Reed had just replaced two chiller units.

For this mechanical report, an exploration will be made into the implementation of a UVC system for the Lord Stirling Community School. Since UVC emitters work at a higher efficiency with a dehumidification system, the implementation of enthalpy wheels will also be explored.

3.1 Mechanical Breadth Analysis Intent

- To explore the possibility of incorporating a dehumidification method in the existing HVAC system
- To recommend a UVC system to be installed into the school's ductwork, air handling units, and fan coil units

3.2 Mechanical Breadth Analysis: Dehumidification

The components of interest for this breadth analysis for the current HVAC system of the Lord Stirling Community School are 5 roof top air handling units (AHU-1 through 5) servicing five separate areas, fan-coil units used throughout the schools to condition the air in classrooms, and heat recovery units servicing only the fan-coil units. Due to the presence of heat recovery units, further dehumidification measures are necessary for the fan-coil units. Therefore, the remainder of the dehumidification study will focus on the air handling units. The design of the dehumidification system is based on design data found in 2001 ASHRAE Fundamentals Handbook.

- 95.6 DB, 75.6 WB for Newark, New Jersey for the design day in July.

Below is a chart describing the operating characteristics of the five air handlers and its corresponding space:

Unit Number	Space	CFM	HP
AHU-1	Stage	4205	3
AHU-2	Auditorium	7200	5
AHU-3	Gymnasium	9300	7.5
AHU-4	Administrative Offices	1920	1
AHU-5	Cafeteria	8755	7.5

For each space, outdoor air and exhaust requirements were studied to determine if the installation of an enthalpy wheel is possible. Due to the mechanics of an enthalpy wheel, if there is no reverse stream (exhaust air) then the wheel will not turn, and therefore, not work. Only two of the air handlers received exhaust air. These were AHU-3 and AHU-4, servicing the gymnasium and the administrative offices. Below is a summary of the supply air, outdoor air, and exhaust air amounts for each unit.

Unit Number	Space	CFM	HP	SA (cfm)	OA (cfm)	EA (cfm)
AHU-3	Gymnasium	9300	7.5	9300	2250	1640
AHU-4	Administrative Offices	1920	1	1920	785	785

For the two air handlers, two enthalpy wheels were selected. Efficiency was calculated for each wheel and used to calculate and estimate the cost savings per year. The results were used to determine if implementation of the system would be beneficial due to the high cost of enthalpy wheels. The two wheels and their corresponding efficiencies for latent and sensible loads are provided below.

AHU-3

Latent Efficiency = (input DB temp – output DB temp)/ (input DB temp – exhaust DB temp)
= 68.6%
Sensible Efficiency = (input WB temp – output WB temp)/ (input WB temp – exhaust WB temp)
= 52.8%

AHU-4

Latent Efficiency = 74.8%
Sensible Efficiency = 70.3%

3.2 Mechanical Breadth Analysis: Dehumidification (continued)

After calculating the efficiency, bin data was calculated for Newark, NJ using BMPlus and data was inserted a spreadsheet to analyze cost effectiveness with an assumed flat utility charge of 0.35 per KWH. Final results showed that together, the enthalpy wheels can save close to $7,000 per year which is significant for a school. Assuming that this was a very lax estimate, the value will be cut in half to say that the two wheels will save $3500 per year, effectively paying back the cost of the wheels in two years. Actual spreadsheets can be viewed in Appendix F: Supplemental Mechanical Data, at the end of this report. The addition of two enthalpy wheels will add two motors, one 0.5 HP and one .01 HP, to Distribution Panel 3. See the Electrical Depth section for Mechanical Changes made to the power distribution system.

3.3 Mechanical Breadth Analysis: UVC Emitters

Technical data provided by Steril-Aire, GE lighting, and Advance Transformer can be viewed in Appendix F: Supplemental Mechanical Data at the end of this report. Each 36" UVC emitter and ballast requires .16 Ampere to operate. Each fan-coil unit requires one Fan-kit (one fixture), and each air handler requires 5 fixtures. Regular maintenance for the UVC emitters involves a strict adherence to a 12 month change out of all lamps. After 12 months, the UVC energy loses more than 50% of its effectiveness, and it is strongly recommended to replace all the lamps annually to maintain system efficiency. See the Electrical Depth section for Mechanical Changes made to the lighting panels for the building.

3.4 Mechanical Breadth Analysis Summary

The improvement of the indoor air quality for the Lord Stirling Community School with UVC emitters is a win-win opportunity for students, faculty, and maintenance personnel.

Indoor Quality: UVC energy attacks microbe DNA and kills or inactivates surface and airborne microorganisms that trigger allergy and asthma symptoms

Reduced Absenteeism: By attacking bacteria and viruses at a molecular level, UVC energy prevents the spread of infectious diseases, therefore reducing time due to illness for students and faculty

Reduced Maintenance: Constant cleaning of coils, drain pans, and plenums eliminate costly cleaning programs and time consuming cleaning schedules allowing the system to rapidly pay itself back in maintenance savings

Energy Savings: Constant cleaning of the HVAC system virtually doubles the life of the mechanical equipment and lowers the HVAC energy costs by improving the heat transfer

The final mechanical recommendation for the Lord Stirling Community School includes UVC emitters in all five air handling units and in all fan-coil units, and two enthalpy wheels added to AHU-3 and AHU-4. It is important to note that UVC emitters are only a component in an effective indoor air quality strategy and work in conjunction with filters and dehumidification. It is not the intent of this report to state that UVC emitters will eliminate the need for other filtration methods, only that it strongly improves the HVAC performance.