

February 10, 2012

Mr. Jeffrey Klenk
Environmental Safety Specialist
Howard County Public School System
10910 Route 108
Ellicott City, MD 21043

RE: Glenwood Middle School Classroom 6 and 8
Indoor Environmental Quality Investigation
AEI Project No.: 110608

Dear Mr. Klenk,

A representative from Aria Environmental, Inc. (AEI) visited Glenwood Middle School on September 23, 2011, October 10, 2011 and November 22, 2011 in response to an indoor air quality complaint in the 8th Grade wing of the school in the vicinity of rooms 6 (faculty room) and 8 (classroom). The concern was submitted in an e-mail to the school's principal and reads in part, "I am having a terrible issue with the musty/mildew/mold in the 8th grade hall. Since returning to school, I have kept the window open in Ms. Frank's room while I am in there (it is the only way I can breathe). Today, even with the window open, I had multiple reactions - itching eyes, shortness of breath, tightening of my throat and chest. Ms. Frank turned on the air system, but it did not help at all - the windows did provide some relief, but I don't know how much longer I can keep the window open as we go into the colder weather."

On September 23, 2011, Jeffrey Klenk and Michele Twilley, DrPH, CIH visited a past area of concern (classrooms 29 and 30) and the area currently in question (classroom 8). No odor of mold or mildew was detected by the inspectors upon entry to the 8th grade hallway, classroom 8 or faculty room 6. Mr. Klenk tested the carpet with a moisture meter and found spotty moisture in rooms 6 and 8. The unit ventilator was inspected and no apparent mold or mildew growth was observed. No visual evidence of mold growth was present on the walls, book shelves, unit ventilator, ceiling tiles or above the ceiling tile.

Particle measurements were taken with an Aerocet 531 particulate monitor. The particle monitor takes a two minute averaged sample of particle concentrations in 5 size fractions (PM 1, PM 2.5, PM 7, PM 10 and total suspended particles (TSP)). ASHRAE Standard 62.1 - 2010 suggests target indoor concentrations for PM 2.5 and PM 10 of 15 µg/m³ and 50 µg/m³, respectively. These concentrations are taken from the EPA's National Ambient Air Quality Standards (NAAQS) based on annual arithmetic means. None of the PM 2.5 or PM 10 samples exceed the NAAQS.

Table 1: Particulate Matter (PM) Measured in Selected Classrooms in Glenwood Middle School on September 23, 2011

Location	PM 1 ($\mu\text{g}/\text{m}^3$)	PM 2.5 ($\mu\text{g}/\text{m}^3$)	PM 7 ($\mu\text{g}/\text{m}^3$)	PM 10 ($\mu\text{g}/\text{m}^3$)	Total Suspended Particulate ($\mu\text{g}/\text{m}^3$)
CR 30 Near Door	0.001	0.001	0.003	0.003	0.004
CR 30 Near Heater	0.001	0.002	0.002	0.002	0.002
Outdoors	0.006	0.084	0.387	0.573	1.113
CR 29	0.002	0.003	0.003	0.003	0.005
CR 6	0.002	0.004	0.010	0.011	0.027

The room air temperature ranged from 72.3-72.7°F which is acceptable for the humidity range in summer recommended to maintain thermal comfort by ASHRAE. The high temperature reported by Weather Underground (available at www.wunderground.com) on September 23, 2011 was 71°F. The outdoor relative humidity was approaching 100%. The indoor relative humidity ranged between 71.6 and 88.9 percent because windows and doors were open. The U.S. Environmental Protection Agency (EPA) recommends maintaining indoor relative humidity below 60% and ideally between 30 and 50% to prevent mold growth. The indoor humidity levels were above the recommended humidity levels for the control of mold growth.

Carbon dioxide and carbon monoxide measurements are used to assess ventilation system performance. The exhaled breath of building occupants is the main indoor source of carbon dioxide; therefore, the build-up of carbon dioxide indicates inadequate ventilation. Carbon dioxide levels were 431-588 ppm and were increasing as room occupancy increased. The concentration of concern for carbon dioxide is set by ASHRAE standard 62.1 – 2010 as 700 ppm above outdoor air (typically 350 ppm). While the US Green Building Council's Leadership in Energy and Environmental Design (LEED) Program has established 800 ppm for maintaining acceptable indoor air quality. Carbon dioxide concentrations were within the comfort parameters established by ASHRAE. Carbon monoxide is mainly attributed to incomplete combustion and was detected at concentrations between 3.1-3.4 ppm. Carbon monoxide concentrations were below the ASHRAE concentration of concern of 9 ppm.

Table 2: Temperature, Humidity, Carbon Monoxide and Carbon Dioxide Measurements in Selected Classrooms in Glenwood Middle School on September 23, 2011

Location	Temperature (°F)	Relative Humidity (%)	Carbon Monoxide (ppm)	Carbon Dioxide (ppm)
CR 30 Near Door	72.5	77.9	3.3	443
CR 30 Near Heater	72.3	77.3	3.3	440
Outdoors	69.8	96.6	3.4	431
CR 29	72.7	88.9	3.3	455
CR 6	72.5	71.6	3.1	588

A faint ozone-like odor was observed in room 6 where an electric wheelchair is stored. The student requiring the wheelchair spends time in classroom 8. The battery to the wheel chair charges overnight and over the weekend. The battery is a 2.4 Ah Nickel Cadmium (NiCd) 2 x 24 volt battery with eFix battery charger BC24025LA. The custodian noted that his eyes were bothered when he went into that room but he was unaware of the battery charging occurring in room 6.

On October 10, 2011, AEI had scheduled a return visit to the school to determine if the battery charging operation was the possible cause of the indoor air quality complaint. The visit was arranged for 6:30 am Monday morning so the battery could charge in the closed room for the weekend. Unfortunately, the room was opened by custodial staff prior to the arrival of the CIH at 6:30 am. Volumetric measurements of supply and return air were made using a TSI Balometer. The room was measured and found to be 28' long, 12' wide and 9'-4" high. The total room volume is 3,136 cubic feet. The supply air totaled 348 cubic feet per minute (CFM) and the exhaust air totaled 315.5 CFM. The room currently has 6 air changes per hour. No ozone-like odor was detected in the room.

On November 22, 2011, the concern was revisited. The weather was rainy and windy. The Wunderground.com weather station operating at Glenwood Middle School reported the weather as a high of 56°F and outdoor humidity approaching 100 percent. The distinct odor of mildew was observed in classroom 8. The carpet felt dry to the touch and indoor humidity levels were below 50%. The ventilator cover was removed and the interior was inspected. The air flowing from the ventilator seemed fresh compared to the classroom. There was no obvious accumulation of mold or mildew growth in the fins of the unit and the drip pans were dry.

The ceiling tiles had no evidence of water damage or mold growth. The ceiling was accessed in three places and no evidence of water damage or mold growth was observed. There was some discoloration on a 3 foot long section of paper backed fiberglass pipe insulation. The remaining room surfaces, furniture and equipment *appeared to be clean*. Particle measurements were repeated and were lower than the September 23, 2011 monitoring.

Table 3: Particulate Matter (PM) Measured in Selected Classrooms in Glenwood Middle School on November 22, 2011

Location	PM 1 (µg/m ³)	PM 2.5 (µg/m ³)	PM 7 (µg/m ³)	PM 10 (µg/m ³)	Total Suspended Particulate (µg/m ³)
Classroom 8	0.000	0.000	0.003	0.005	0.019
Hallway	0.000	0.000	0.005	0.005	0.014
Outside	0.000	0.000	0.005	0.006	0.013

Indoor air quality parameters of temperature, humidity, carbon monoxide and carbon dioxide were repeated. No evidence of measurements outside of comfort ranges were detected. Volatile organic compounds (VOC's) were measured using a ppbRAE 3000 photoionization detector (PID) with a 10.6 eV lamp and operated in industrial hygiene mode to identify point sources of odor causing contaminants. The measured VOC concentration in the complaint area was not significantly higher than outdoor concentrations. No gradient was detected. The measured VOC concentrations do not indicate a potential health hazard. The ozone odor was not observed in classroom 8 or the faculty prep room 6.

Table 4: Temperature, Relative Humidity, Carbon Monoxide, Carbon Dioxide and Volatile Organic Compounds (VOC) Measurements in Selected Classrooms in Glenwood Middle School on September 23, 2011

Location	Temperature (°F)	Relative Humidity (%)	Carbon Monoxide (ppm)	Carbon Dioxide (ppm)	VOC (ppb)
Classroom 8	72.3	48.2	2.6	463	110
Hallway	72.0	48.8	2.6	463	154
Outside	55.3	73.8	3.5	428	96

Conclusions and Recommendations

An obvious moldy odor was detected in classroom 8 on November 22, 2011; however, no source of mold or mildew was identified through visual inspection or through instrumentation. Furthermore, other than some speckling on the paper backed fiberglass pipe insulation above the suspended ceiling, no mold growth was observed. Carpet was noted in the September 23, 2011 to have small patches of dampness that could be contributing to odors in the classroom. Vacuuming with HEPA-equipped vacuum cleaners to remove particles including mold spores should be performed to reduce spore loads in the carpet. Use of wet methods should be avoided.

Batteries are a concern because they can release oxygen and hydrogen gas during charging. The battery manufacturer recommends a ventilation rate of 2.5 air changes per hour. More complex calculations for volumetric exhaust were presented by the manufacturer. Other guidelines for exhaust ventilation in rooms where battery charging occurs include:

- National Fire Protection Association (NFPA) 76: 1.0 CFM/SF or 336 CFM of exhaust;
- American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) 62: 1 CFM per charging ampere but not less than 6 Air Changes Per Hour or 522.5 CFM.
- Unified Facilities Code (UFC): 1.5 CFM/SF or 504 CFM of exhaust.

The measured exhaust ventilation rate in the teacher's prep room is 315.5 CFM and 6 air changes per hour which is approaching the amount called for in NFPA 76 but short of that recommended by ASHRAE 62 and UFC. We recommend finding a smaller room with exhaust ventilation that is adequate to charge the wheelchair battery.

Thank you for choosing Aria Environmental, Inc. for your indoor environmental quality needs. Please do not hesitate to contact us should you have any questions, or require additional assistance with this matter.

Sincerely,
Aria Environmental, Inc.



Michele M. Twilley, DrPH, CIH
Principal