June 18, 2019 Reference No. 11197011

Re: **Bi-Polar Ionization Study**
[redacted]

1. Introduction

GHD was requested by the [redacted] to evaluated selected indoor air quality parameters before and after the installation of a Bi-Polar Ionization system (manufactured by Global Plasma Systems) intended to improve the overall indoor air quality and reduce the required outside air intake requirements established by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). The goal was to reduce the overall energy consumption of the school while improving indoor air quality.

2. Discussion

Prior to installation of the Bi-Polar Ionization system, baseline measurements were collected on May 14, 16, and 18, 2018 from Room 302 over an approximate seven-hour day. Specifically, GHD measured the following parameters every 15 minutes:

- Ozone (measured in parts per million [PPM])
- Carbon Dioxide (measured in PPM)
- Carbon Monoxide (measured in PPM)
- Relative Humidity (measured as percent relative humidity)
- Temperature (measured in degrees Fahrenheit [°F])
- Particulates via Laser Particle Counter (measured in particles per cubic foot with particle sizes ranging from 0.03 micrometers [µm] to 10 µm).

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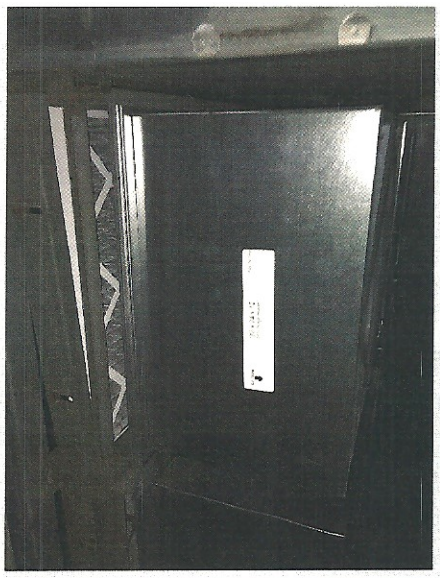
During this time, classroom students were in and out for various school activities. On Monday May 14, 2018, the class room was occupied with 17 students and two adults for 145 minutes (approximately 35% of the school day); Wednesday, May 16, 2018, was an early-release day and the room was occupied by 18 students and two adults for 187 minutes (approximately 59% of the school day), and Friday, May 18, 2018, the class room was occupied with 17 students and two adults for 130 minutes (approximately 31% of the school day). In addition, these parameters were measured outside the school, in the south parking lot, before and after each school day.

The same parameters were measured approximately one year later after the Bi-Polar Ionization system was installed (see photographs 1 through 4) and the amount of fresh air being brought into the building from the outside was reduced. On Monday May 20, 2019, the class room was occupied with 22 students and three adults for 141 minutes (approximately 34% of the school day); Wednesday May 22, 2019, the class room was occupied by 22 students and three adults for 118 minutes (approximately 28% of the school day), and Friday May 24, 2019, was an early release day and the class room was occupied by 21 students and three adults for 110 minutes (approximately 35% of the school day). In addition, these parameters were again measured outside the school, in the south parking lot, before and after each school day.

Photograph 1: Bi-Polar Ionization unit installed in the air handler.



Photograph 2: Bi-Polar Ionization unit installed in the air handler.

In addition to the aforementioned parameters described above, GHD collected an air sample in Room 302 on Wednesday May 22, 2019, for analysis of volatile organic compounds (VOCs) by Environmental Protection Agency (EPA) Method TO-15. Air from the classroom was drawn into a Summa® canister over a six-hour period and shipped to EMSL Analytical in Pineville, North Carolina, for analysis by gas chromatography/mass spectrometry (GCMS).

3. Results

Results of the measurements for each event were tabulated and averaged. Below is a comparison of the average of the three-day measurements taken before and after the Bi-Polar Ionization system was installed.

Constituent	2018	2019	% Change
Carbon Dioxide (PPM)	833.5	926	9.99
Temperature (°F)	75.1	74.4	-0.93
Relative Humidity (%)	51.3	42.4	-17.35
Carbon Monoxide (PPM)	0.0	4.1	100.00
Ozone (PPM)	0.0	0.0	0.0
Particulates (Total particles per cubic foot)			
0.3 (µm)	209617	184664	-11.90
0.5 (µm)	41052	32097	-21.81
1.0 (µm)	17231	13792	-19.96
2.0 (µm)	10972	5351	-51.23
5.0 (µm)	3840	2689	-29.97
10.0 (µm)	1501	916	-38.97

Results of the VOC sampling did not reveal any constituent above their respective National Institute of Occupational Safety and Health (NIOSH) Recommended Exposure Limits (RELs) or Occupation Safety and Health Administration (OSHA) permissible exposure limit (PEL).

4. Conclusions

As one would expect, carbon dioxide levels increased by approximately 10% as a result of decreasing the amount of fresh air being brought into the building from the outside and the temperature and relative humidity decreased. Carbon monoxide increased significantly; the cause of this increase is unknown and should be evaluated further; however, the average concentration measured during the 2019 event (4.1 parts per million [PPM]) was well below the NIOSH REL and OSHA PEL (35 PPM).

All particle sizes decreased an average of approximately 29%. This could indicate the ionization technology is reducing airborne particulates however, this result could also be due to the reduced outside air being introduced into the building. As less outside air is brought in, less particulate matter is introduced. VOCs were not measured at levels that would cause a concern within the building. This is likely due to the lack of VOC sources in educational facilities.

5. Limits of Study

This document was prepared for the exclusive use of [redacted] and was not intended for any other purpose. The observations and opinions contained herein are based upon information provided to us at the time of this document's preparation. The evaluation performed on May 14, 2019 included visual observations and assessment using instrumentation. Although an effort was made to observe all locations with potential relevance to our investigation, areas hidden from view such as ceiling, wall, and floor cavities or other inaccessible enclosures were not examined. Please note that GHD reserves the right to revise the observations and opinions above as conditions change or additional information becomes available. This document was prepared for our client's use and GHD disavows any liability for use by others.

GHD appreciates this opportunity to have assisted you with this assessment. Please contact us at 321.397.0710 if you have any questions.

Sincerely,