

## GTE NO3 HVAC study

### Objectives:

An infield evaluation of the GTE HVAC units as to measurable results and overall impact to indoor air quality in a typical commercial setting.

### Location:

1501 Lehigh St. testing suite

**Project start:** 6/21/21 to 6/25/21

**Conducted by:** Keith Roe, CIE/CMC, Advanced IAQ Solutions, Inc

### Testing Environment:

Room 203 is a two room finished commercial suite of about 1240 sq.ft with painted drywall ceilings and walls , used carpeting and a suspended ceiling. It is serviced by a 4 ton Trane 1600 CFM RTU with (2) 20"x30"x2" filters. The system was designed for MERV 8 in line filters. The economizer is primarily closed allowing about a 10% fresh air introduction. During the testing, the door into the 12' x 14' interior office was left open. Doors to the connecting hallway were always closed. When in a continuously operating mode, this AHU unit provided up to 9 air turns per hour. A new MERV 13 filter was installed in the HVAC unit prior to testing. The thermostat was set to maintain a 73 degree temperature inside the suite.

### Location of the HVAC unit:

A single NO3 unit was installed in the 24" vertical metal supply drop that extends horizontally across the suite for approx. 20' supplying conditioned air to 9 ceiling mounted supply grilles. There are 3 ceiling mounted return grilles. This unit was operating continuously.

### Definitions of Technology:

The HVAC unit contains ARC (Active Radiant Catalysis) which is the GTE proprietary form of UVC-PCO. That is the use of a broad-spectrum UV lamp that is encased in a quad-metallic catalyst containing 15x the exposure surface than similar UVC devices. This produces continuous air/ surface disinfectant with purifying hydroxyl emissions through a continuous AOP (advanced oxidation process). Combined with BPI technology, negative ions are also produced in a continuous streaming process into the indoor environment. This also creates an electrostatic charge to the harmful particulates, causing them to drop out of the breathing space. This unit contains a UV glass bulb that is reported to produce *no* measurable ozone emissions from UV bulb when in use.

### Sampling/Monitoring Protocols Used:

#### 1. Spore Trap Mold Testing:

150 liter air samples were taken before the installation (day 1), during ( Day 3), and at the end of the testing (day 5) in the room 203, in the adjacent hallway( indoor control) and outside( outside baseline) . These samples were analyzed by AEML Labs using Microscopy for total spore count identified by each mold genus. (see Addendum A for further testing details). It is standard protocol to take both an indoor control and outdoor control when performing spore trap testing.





**2. Particle Impactor Sampling:**

These air samples were taken daily within the room 203, on days 1, 3 and 5 in the same locations in the center of the room. These samples were sealed, refrigerated and submitted to Focus Labs within 1 hour for incubation, culture and identification of total detectable *viable* mold spores that are capable of reproduction given the necessary moisture and growth host. The lab followed ISO 14698, protocol 023. (see Addendum A for further sampling details)

**3. Surface Sampling: Swab sample method**

These surface samples were taken simultaneously with the air samples on days 1,3 and 5. The dusty surface of the same supply register was sampled for 4 sq.in. using a sterile Stuart transport swab. These swabs were sealed and refrigerated and submitted to Focus Labs within 1 hour. They were incubated and analyzed for total CFU (colony forming units) for both mild and bacteria. The lab followed ISO 14698, protocol 023. (further detail in Addendum A)

**4. TO-15-Summa type VOC sampling**

This testing method allows the identification of parts per trillion of certain volatile organic compounds and look at unknown compounds and make tentative identifications if newly formed compounds are present. This test was performed prior to the testing and on day 5 of the testing.

**5. TVOC (Total Volatile Organic Compounds) and Formaldehyde (HCHO) gas monitoring:**

Using a newly calibrated TemTop model LKC-1000 a laser multi-functional detector with a high precision electrochemical sensor that can transform the concentration of pollutants in the air into visual data, readings were taken daily during the project. The TVOC reading that this unit provides is representative of multiple airborne compounds that were present simultaneously and are reported in mg/m<sup>3</sup> allowing low levels to be detected and reported. A VOC PID meter was used to report the VOC levels present in ppm.

HCHO (formaldehyde), a common indoor contaminant used in many products and disinfectants, was also monitored daily and the readings are part of the integrated results and are reported separately but part of the TVOC component reported by the TemTop Meter. These total results were reported in mg/m<sup>3</sup>. (milligram per cubic meter) providing very low detection levels.

**6. PM2.5, PM10.0**

These are inhalable particle matter (PM) not a single pollutant, but a mixture of many chemical species. It is a complex mixture of solids and aerosols comprised of small droplets of liquid, dry solid fragments, and solid cores with liquid coatings. Those with a diameter of 10 microns or less (PM10) are inhalable into the lungs and can induce adverse Health effects. *Fine* particle matter is defined as particles that are 2.5 microns or less in diameter and comprises a portion of the PM10. These levels are regulated by an OSHO standard of exposure in the workplace. These were measured daily using a calibrated TemTop model LKC-1000 laser detector with a high precision electrochemical sensor.

**7. Respirable (dust) Particle Counts:**

Airborne particle sizes are measured in microns. Usually particle size is designated as the average diameter in microns. Particles less than 10 microns in diameter can get deep into your lungs and some may even pass into your bloodstream. Smaller particles ( 1-3 microns) diffuse deeply into your lungs tissue, depositing in the alveoli by a number of mechanisms including diffusion, sedimentation and electrostatic effects.





Using a recently calibrated Extech VPC300 Video Particle Counter, particle sizes 0.3, 0.5, 1.0, 2.5, 5.0 and 10.0 microns were measured daily the project.

## 8. Activated Oxygen ( O<sub>3</sub> )

Using an Aeroqual portable ozone monitor, the ozone levels were monitored daily and were able to be reported at levels from 1 to 100 ppb. The current TLV TWA is .1 ppm.

### Preparation for testing:

Prior to the beginning of the testing period, the carpets were vacuumed using a HEPA filtered brush head vacuum and horizontal surfaces were cleaned. Then for 24 hours the suite was flushed with outside air through the RTU with the fresh air economizer open and without filters so that outside ubiquitous molds would be introduced.

After the flushing, during a second 24 hour period the suite was “seeded” with an additional contaminants. Mold and bacteria were introduced from inoculated MEA and TSA agar plates.

VOC sources from two scented liquid cleaners, Simple Green and Citrus Cleaner that both contain Limonene were introduced into the room environment from 4 saturated sponges.

### Findings:

#### 1. Mold Spore Trap Test Results

Reference AEML report #325831, dated 6/21/21. (initial sampling)

These air samples were taken prior to the operation of the HVAC unit and testing.

Sample #32696563, the outside spore total was reported for that day at 1,6130 s/m<sup>3</sup>. (spores /cubic meter)

Sample #32696566, Room 203 at 6,360 s/m<sup>3</sup>, *approximately 5x greater than the outside control.*

Sample 32696542, (inside control) hallway was reported at 1,147 s/m<sup>3</sup>, approx. 29% lower than outside.

Reference AEML report # 325981, dated 6/23/21

These air samples were taken the 3rd day of the project.

Sample # 32696602, the outside spore count was reported on that day at 2,793 s/m<sup>3</sup>.

Sample # 32696543, *Room 203 was reported at 0 s/m<sup>3</sup>, a 100% reduction from the initial levels.*

Sample # 32481941, *Hallway was reported at 40 s/m<sup>3</sup>, approx. 1.5% of the outdoor control.*

Reference AEML report # 326355, dated 6/25/21, 5th day of testing

Sample # 32696591, outside was reported at 633 s/m<sup>3</sup>.

Sample # 32696597, room 203 was reported at only 87 s/m<sup>3</sup>, approx. 14.0% of the outside level.

Sample # 326965585, Hallway was reported at 40/m<sup>3</sup>, approx. 5.8% of the outside level.

#### **Overview:**

*A 100% reduction of airborne mold spores was reported by day 3 with the outside control increasing from the initial levels by 61%. Sustained low levels of mold spores were reported with an 86% reduction compared to the outside level reported on day 5.*

## 2. Particle Impactor Air Sampling





Reference: FOCUS Labs

Test Reference number: 212032, dated 6/21/21.

A total of 406 cfu (colony forming units) of airborne viable mold was reported.

A total of 259 cfu of airborne viable bacteria was reported.

Test reference number: 212052, dated 6/23/21

A total of 6 cfu of airborne viable mold was reported.

A total of 7 cfu of viable airborne bacteria was reported.

*This was a reduction of > 99.5% for mold and 97% for bacteria.*

Test Reference number: 212082, dated 6/25/21

A total of 0 cfu of viable mold was reported.

A total of 11 cfu of viable bacteria was reported.

*This was a total removal of viable mold from the air and a reduction > 95% for bacteria.*

### 3. Surface Sampling

Reference: FOCUS Labs

Test Reference number 212031, dated 6/21/21

A total number of 140 cfu of viable surface molds were reported.

A total number of 200 cfu of viable surface bacteria were reported.

Test Reference number 212051, dated 6/21/21

A total number of 70 cfu viable surface mold was reported, *a 50% reduction.*

A total number of 30 viable surface bacteria was reported, *an 85% reduction.*

Test Reference number 212080, dated 6/25/21

A total number of 120 cfu of mold was reported on this day, *a reduction of 14.7%*

A total number of 20 cfu of bacteria was reported, *a reduction of 90%.*

### 4. TO-15 results

Reference EMSL report # 492100356 dated 6/21/21, the TVOC level reported at that time with this collection method was comprised of 18 separate compounds totaling 600 ug/m<sup>3</sup>. The primary compound identified was Ethanol at 290 ug/m<sup>3</sup>, D-limonene was reported at 31 ug/m<sup>3</sup>, isopropyl alcohol reported at 110 ug/m<sup>3</sup>.

Reference EMSL report # 492100363, dated 6/23/21, the TVOC level reported was comprised of only 4 separate compounds totaling 930 ug/m<sup>3</sup>. Isopropyl alcohol was the primary compound at 830 ug/m<sup>3</sup> vs 110 ug/m<sup>3</sup> initially. This compound has a 2.9 to 16.2 hour half-life. Since this highly volatile compound is found in the 2" square sanitizing wipe used to sanitize the bioaerosol equipment used that day and time for the needed air turns per hour was not possible, least, this total needs to be adjusted to the initial level found after the 24-hour flushing of the testing area. That adjusted total is now 210 ug/m<sup>3</sup>.

**An overall reduction of 65%.** There was 0 D- limonene and 73 ug/m<sup>3</sup> of Ethanol reported.

These 4 reported compounds were also present in the initial testing now at reduced levels. *No new compounds were reported.*

Reference EMSL report # 4921100371, dated 6/25/21, the TVOC level reported was 1,012 ug/m<sup>3</sup> comprised of 8 separate compounds. Two new compounds were reported, Methyl Methacrylate at 2.8 ug/m<sup>3</sup> and Pentane at 7.5 ug/m<sup>3</sup>. Isopropyl Alcohol was reported at 910 ug/m<sup>3</sup>, the *adjusted total* for lack of sufficient half-life is set at 110 ug/m<sup>3</sup>. The adjusted TVOC level becomes 212 ug/m<sup>3</sup>, very similar to the 3 day level indicating a *low VOC level had been sustained.*





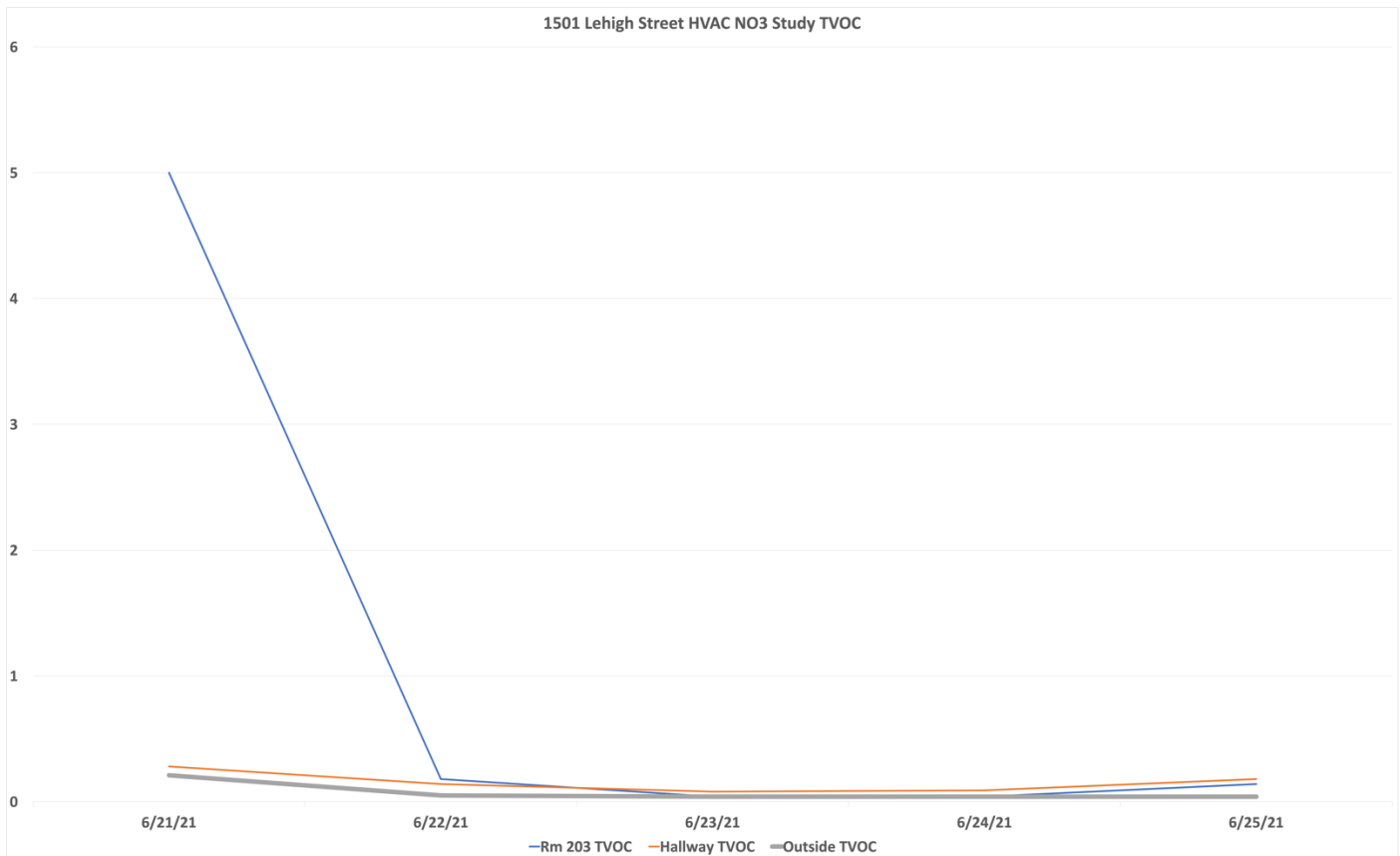
**5. TVOC and HCHO reading results:**

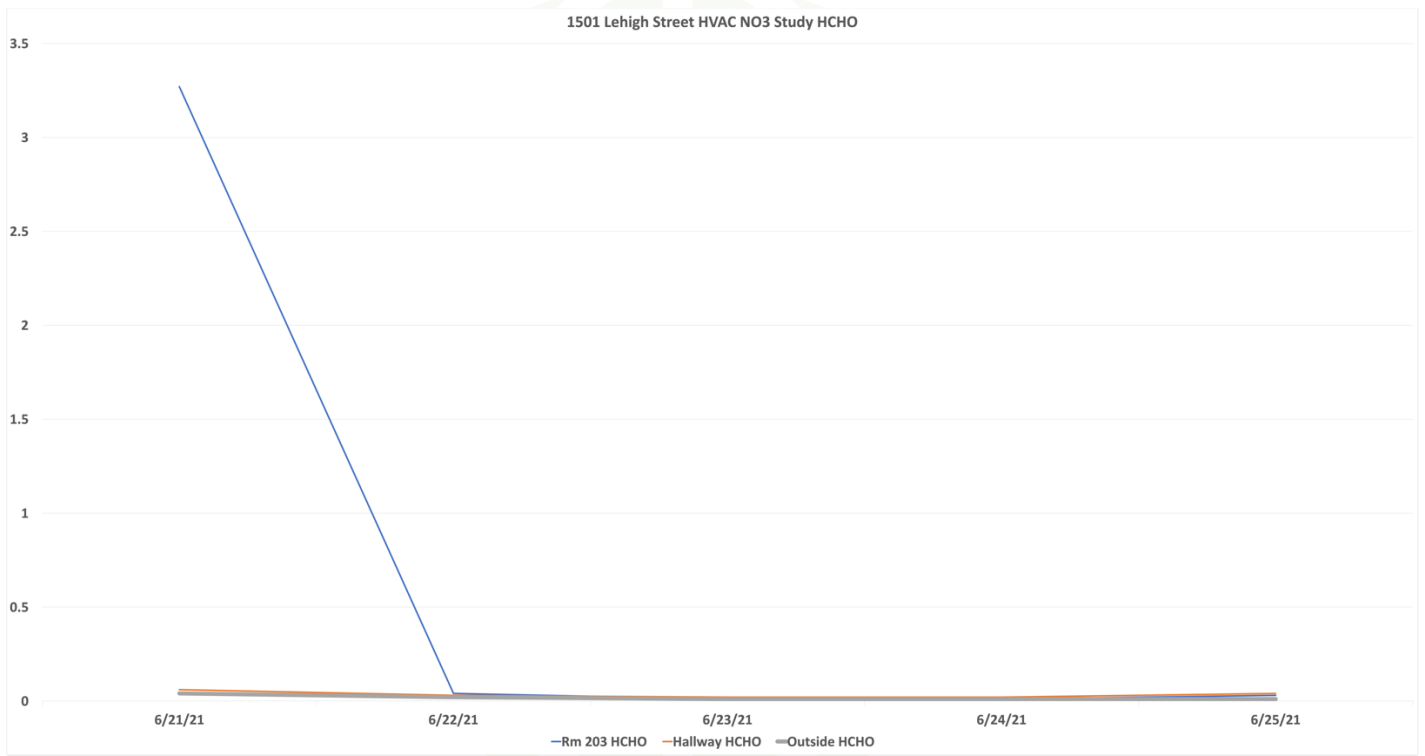
On 6/21/21, the TVOC readings in room 203 were reported at an elevated level of .7 ppm / 5.00 mg/m<sup>3</sup>. compared to the outdoor level reported at 0.0 ppm/ 0.21 mg/m<sup>3</sup>. The indoor hallway at 0.0 ppm / .028 mg/m<sup>3</sup>. *This condition in Room 203 would be best described as “odor present, irritation or discomfort possible”.*

*From 6/22/21 to 6/25/21, 0 ppm of TVOC was reported. From 6/22/21 to 6/28/21 the TVOC levels ranged between .04 to .14 mg/m<sup>3</sup>, consistently lower than the hallway levels. An overall reduction of > 99%.*

On 6/21/21 the HCHO level ( formaldehyde) in suite 203 was reported at 3.27 mg/m<sup>3</sup> compared to .06 mg/m<sup>3</sup> in the hallway and .04 mg/m<sup>3</sup> outside.

From 6/21/21 to 6/25/21 the HCHO levels in room 203 were reported at levels between .01 to .04 mg/m<sup>3</sup>, *Reflecting a > 99.9% reduction.*



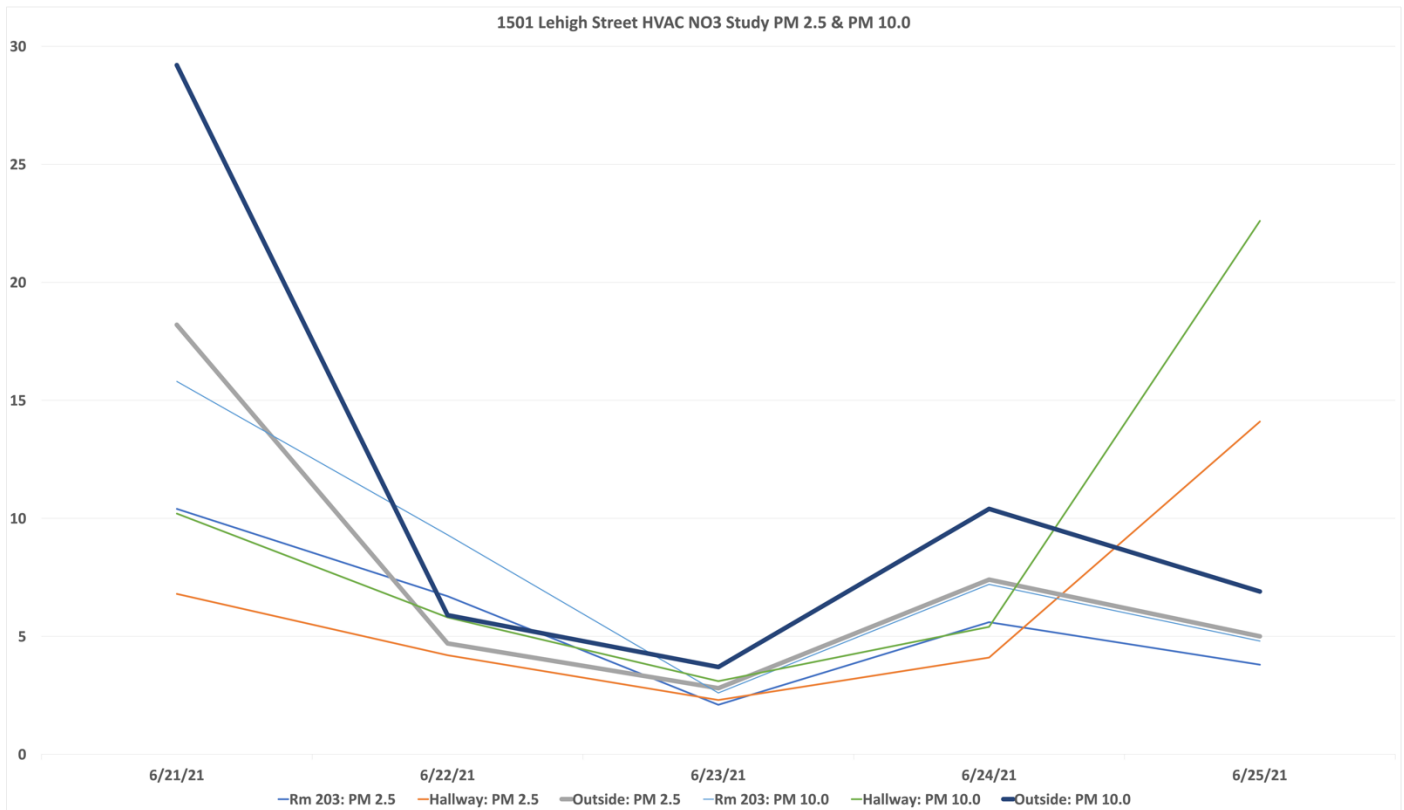




### 6. PM 2.5/PM 10.0

On 6/21/21, The PM levels inside Rm. 203 were reported for 2.5PM at 10.4 ug, (micrograms), 10.0 PM at 15.8 ug.

By 6/22/21 the levels had decreased to 6.3 and 9.3 respectively, *approx. a 61% reduction*. Those levels were *further reduced* over the remaining 3 day period and remained consistently lower to the 5<sup>th</sup> day.





**7. (Respirable) Particle Dust Count Results:**

On 6/21/21, The collective total of the 6 particle sizes in room 203 totaled 29,064 micron sized particles, approx. 61% less than the outside counts recorded at 50,102. The inside counts remained *below the outdoor levels* throughout the 5 day monitoring period.

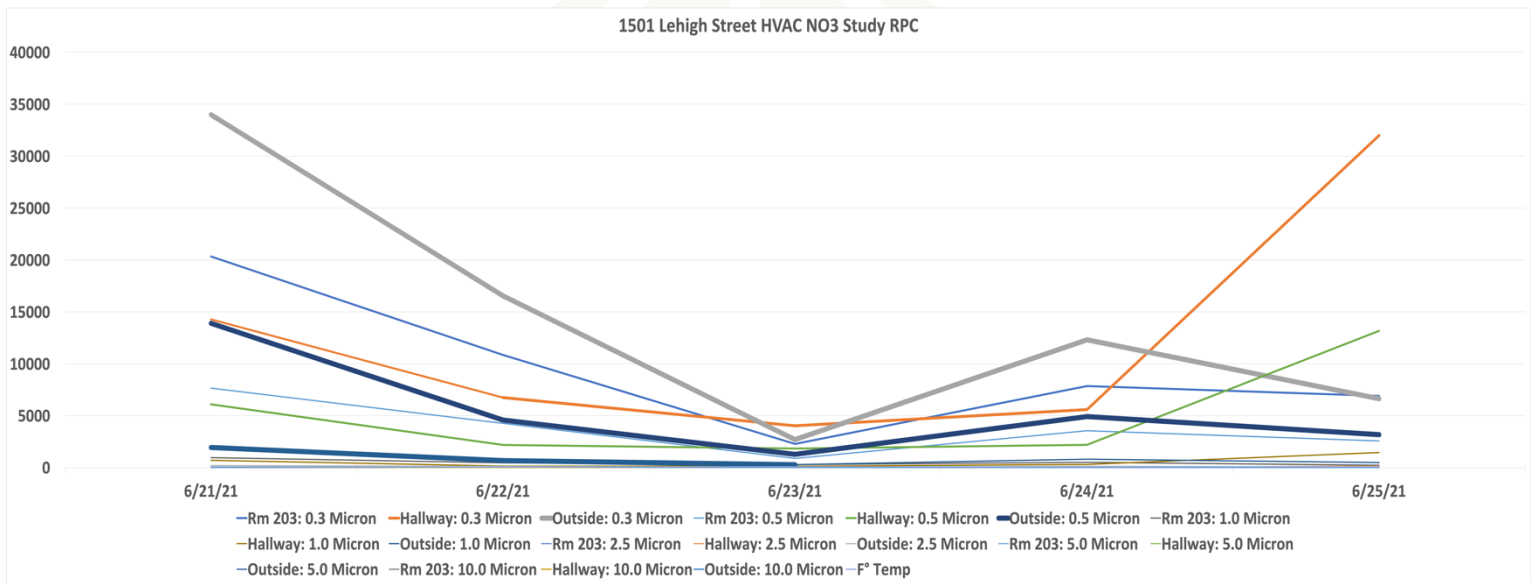
The daily collective totals in 203 were as follows:

Day 2: 15,631 microns vs 22,013 outside, 32% less.

Day 3: 3,494 microns, *a further reduction of 88%*, vs 4,326 microns outside.

Day 4: 11,986 microns vs 18,232 outside, 34% less than outside.

Day 5: 9,738 microns vs 10,392 outside, 6% less than outside.







### 8. Ozone (O3)

Daily readings were recorded of the Ozone levels. The current TLV for ozone exposure is .1 ppm. TWA/TLV Indoor Levels 0.0 ppm for the first 4 days and .034 ppm vs .046 ppm. on the 5<sup>th</sup> day.

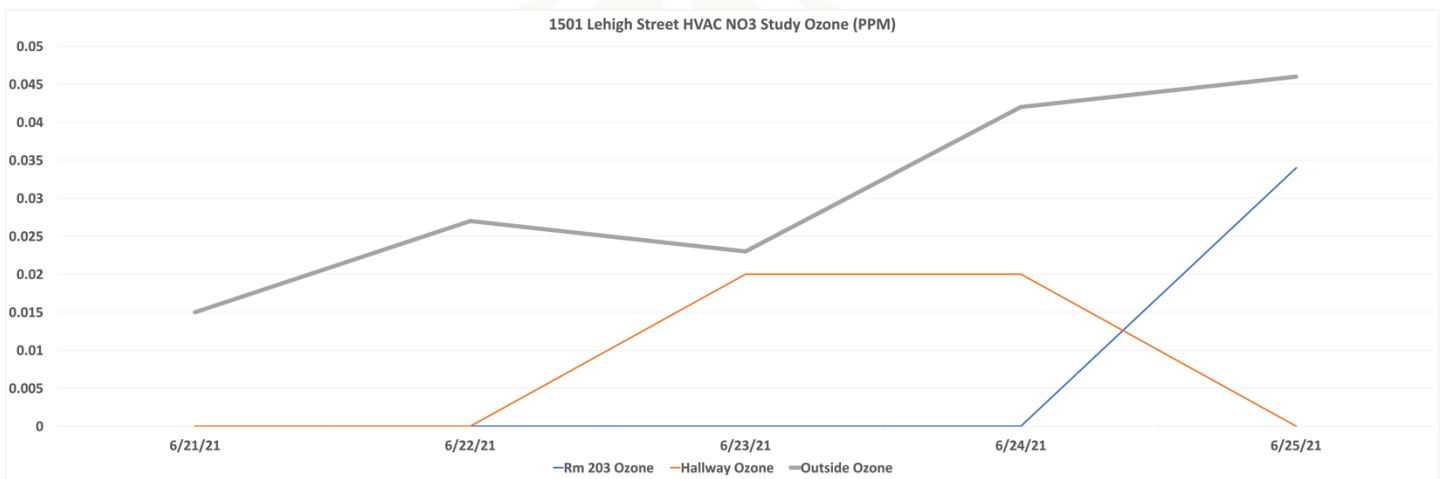
Day 1- 0.0 ppm. inside (Room 203), 0 ppm. outside

Day 2- 0.0 ppm inside, .027 ppm outside

Day 3- 0.0 ppm. inside, .023 ppm outside

Day 4- 0.0 ppm. inside, .042 ppm outside

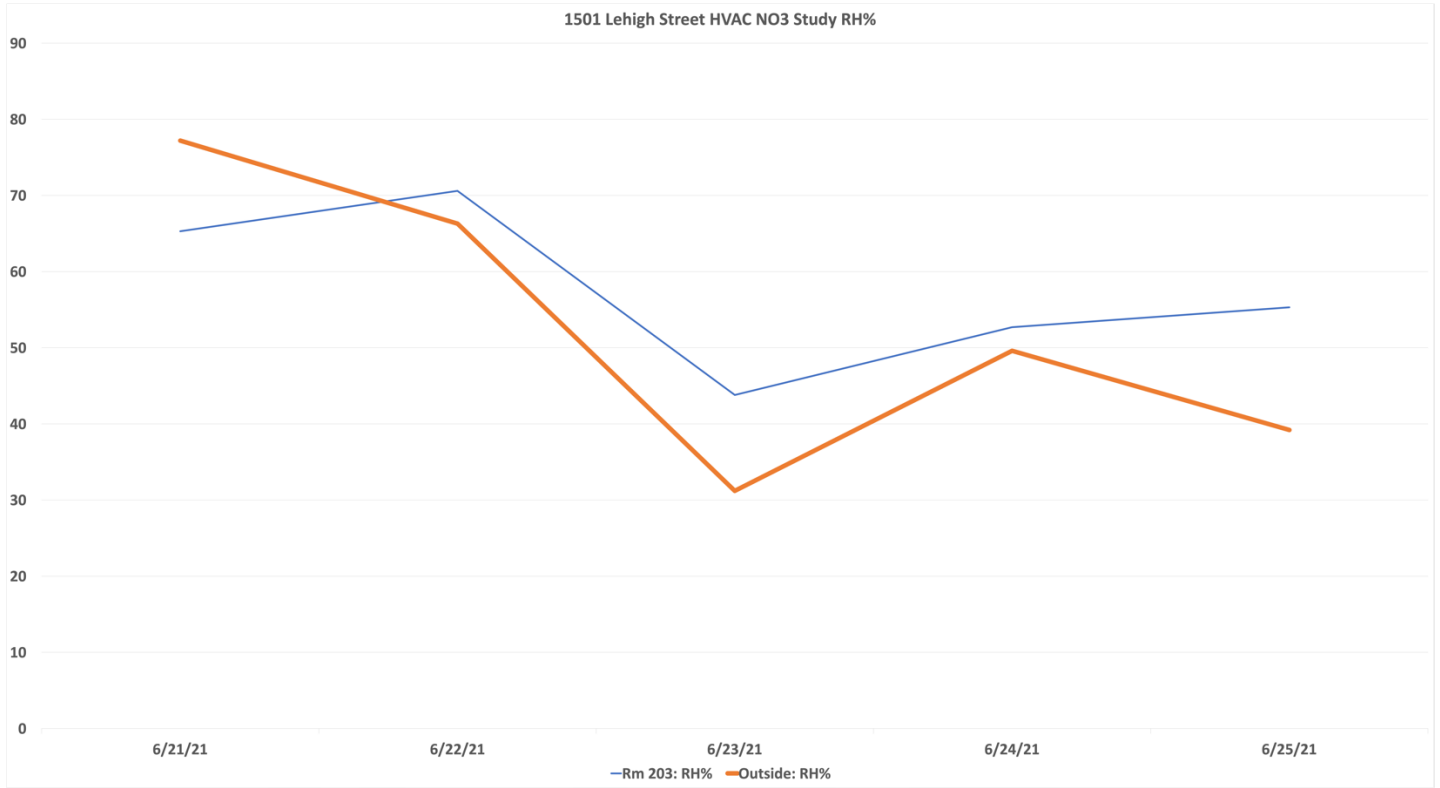
Day 5- .034 ppm inside, .046 ppm outside





**8. RH%**

Inside RH% ranged between 43.8 % to 70.6%, which had no detectable impact on the results recorded.



**Summary of Observations:**

It is my observation that this in- duct HVAC unit does provide a rapid and significant reduction of the typical contaminants tested. The levels achieved and maintained were far below any known standard or established TLV. It is my considered opinion, that this sustained condition would not be typical or possible without the continuous use of this product.





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