INDOOR AIR QUALITY ASSESSMENT

Worcester Trial Court
Superior Court Clerk's Office
225 Main Street
Worcester, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health
Indoor Air Quality Program
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Background/Introduction

At the request of Mike Lane, Administrative Office of the Trial Court, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality (IAQ) concerns in the Superior Court Clerk's Office (SCCO) at the Worcester Trial Court (WTC), 225 Main Street, Worcester, Massachusetts.

On December 7, 2012, a visit to the SCCO to conduct an IAQ assessment was made by Mike Feeney, Director of BEH's IAQ program. He was accompanied by Mr. Lane. The WTC is a three-story building that was constructed in 2007. The SCCO is located on the first floor. The building was constructed with "energy conserving features integral to the design of the HVAC [heating, ventilating and air-conditioning] system..." (EOAF, 2012). Windows throughout the building are not openable.

Methods

Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 7565. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Sampling for total volatile organic compounds was performed using a mini-RAE 2000 photoionization detector. BEH staff performed a visual inspection of building materials for water damage and/or microbial growth.

Results

The SCCO has approximately 20 employees and can be visited by up to several hundred people daily. Tests in the SCCO were taken during normal operations, and results appear in Table 1

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels in the SCCO were below 800 parts per million (ppm) in all areas surveyed during the assessment, indicating adequate air exchange in the building. Some areas were empty or sparsely populated during the assessment; carbon dioxide levels would be expected to be higher with increased occupancy.

Mechanical ventilation is provided by air-handling units (AHUs) which provide 100 percent fresh air. Fresh air is drawn into the AHUs through an air intake on the roof and is delivered to occupied areas via ceiling-mounted air diffusers. Fresh air is introduced into office space at low velocity. As reported by WTC facilities staff, air flow velocity from fresh air supply vents was reduced due to employee complaints of the sensation of excessive air flow at workstations. While fresh air supply is adequate based on carbon dioxide measurements, the air feels somewhat stagnant in the office space. Due to the low velocity, the effect of air flow sweeping normally-occurring environmental pollutants produced by occupants and office equipment is reduced. However, if any respiratory irritants are present or used in the space, these materials tend to linger which may cause irritation to the eyes, nose and respiratory system of occupants (see “Other Concerns” section of this report, below).

Exhaust air is drawn into ductwork via grilled vents and returned to the mechanical room. Similarly, the reduction in exhaust vent flow will allow normally-occurring environmental pollutants to linger within office space. It was noted that one location in the SCCO had coffee makers, toaster ovens and a microwave oven in a hallway lacking dedicated exhaust ventilation. Cooking-related pollutants can be irritating to the eyes, nose and respiratory system. It is recommended that these types of devices are located in areas that were designed for cooking purposes and are equipped with exhaust ventilation.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

Minimum design ventilation rates are mandated by the Massachusetts State Building Code (MSBC). Until 2011, the minimum ventilation rate in Massachusetts was higher for both occupied office spaces and general classrooms, with similar requirements for other occupied spaces (BOCA, 1993). The current version of the MSBC, promulgated in 2011 by the State Board of Building Regulations and Standards (SBBRS), adopted the 2009 International Mechanical Code (IMC) to set minimum ventilation rates. **Please note that the MSBC is a minimum standard that is not health-based**. At lower rates of cubic feet per minute (cfm) per occupant of fresh air, carbon dioxide levels would be expected to rise significantly. A ventilation rate of 20 cfm per occupant of fresh air provides optimal air exchange resulting in carbon dioxide levels at or below 800 ppm in the indoor environment in each area measured.

MDPH recommends that carbon dioxide levels be maintained at 800 ppm or below. This is because most environmental and occupational health scientists involved with research on IAQ and health effects have documented significant increases in indoor air quality complaints and/or health effects when carbon dioxide levels rise above the MDPH guidelines of 800 ppm for schools, office buildings and other occupied spaces (Sundell et al., 2011). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix A.

Temperature readings in the SCCO on the day of the assessment ranged from 73ºF to 75ºF, which were within the MDPH recommended comfort guidelines. The MDPH recommends

that indoor air temperatures be maintained in a range of 70ºF to 78ºF in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the SCCO ranged from 19 to 24 percent, which was below the MDPH recommended comfort range in all areas surveyed. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Staff on the ground floor reported that a flood had moistened gypsum wall board (GW) in the hallway and office space. According to building occupants, the carpet was not removed during the remediation effort. The US Environmental Protection Agency and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials (carpeting, ceiling tiles, etc.) be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. As reported by WTC facilities staff, the location of the water damage was dried with fans. BEH staff examined the wall and adjacent wall cavity and could not observe any water damage.

In the corner near the damaged GW described above, a musty odor was detected by BEH staff. The source of the musty odor was determined to be paper records that were stored on a

shelf (Picture 1). These records were moved into the SCCO from a previous location which did not have climate-controlled records storage. Water-damaged paper and book bindings can be a medium for mold growth.

Plants were noted in several areas (Picture 2); some were located on carpeting, which has become stained from spilled water. Plants should be properly maintained and be equipped with drip pans made of a non-porous material. Drip pans should be cleaned and inspected periodically to prevent mold growth. Plants should be located away from ventilation sources to prevent aerosolization of dirt, pollen or mold.

Other IAQ Evaluations

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present indoors, BEH staff obtained measurements for carbon monoxide and PM2.5.

Carbon Monoxide

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice

resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. On the day of the assessment, outdoor carbon monoxide concentrations were measured not detectable. No levels of carbon monoxide were detected inside the building during the assessment (Table 1).

Particulate Matter (PM2.5)

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits to particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per

cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA established a more protective standard for fine airborne particles. This more stringent PM2.5 standard requires outdoor air particle levels be maintained below 35 $\mu g/m^3$ over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 10 $\mu g/m^3$ (Table 1). Indoor PM2.5 levels ranged from 4 to 6 $\mu g/m^3$ (Table 1), which were below the NAAQS PM2.5 level of 35 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur indoors can generate particulate during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system, use of stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Volatile Organic Compounds

Indoor air concentrations can be greatly impacted by the use of products containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs.

In an effort to determine whether VOCs were present in the SCCO, air monitoring for TVOCs was conducted. An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND. No measureable levels of TVOCs were detected in the SCCO (Table 1). Please note, that the TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use TVOC-containing products and the presence of other sources.

Cleaning and sanitization products were observed in some rooms (Table 1). These products contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Cleaning products should be properly labeled and stored. In addition, a Material Safety Data Sheet (MSDS) should be available at a central location for each product in the event of an emergency. Consideration should be given to providing staff with building issued cleaning products and supplies to prevent any potential for adverse chemical interactions between residues left from cleaners.

Air deodorizers were observed in some areas. Air deodorizers contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Many air fresheners contain 1,4-dichlorobenzene, a VOC which may cause reductions in lung function (NIH, 2006). Furthermore, deodorizing agents do not remove materials causing odors, but rather mask odors that may be present in the area.

Containers of hand sanitizer were observed in the building. Hand sanitizer products contain ethyl alcohol and fragrances, both of which can be eye and respiratory irritants to some individuals (Betco Corporation, 2007; Birchwood Laboratories, Inc., 2007; B4 Brands by AMA, 2006; Georgia-Pacific Consumer Products, 2007). According to MDPH recommendations

concerning the flu, protection from flu virus can be achieved by either washing your hands often with soap and water or using alcohol-based hand gel (Appendix B).

Other Conditions

Food, food containers and food preparation equipment were observed in a number of areas (Picture 3). Stored food attracts insects and rodents, as do crumbs or food waste in trash cans. Rodent infestation can result in indoor air quality related symptoms due to materials in their wastes. Mouse urine contains a protein that is a known sensitizer (US EPA, 1992). A sensitizer is a material that can produce allergic symptoms (e.g., running nose or skin rashes) in sensitive individuals following repeated exposures. A three step approach is necessary to eliminate rodent infestation:

1. removal of the rodents;
2. cleaning of waste products from the interior of the building; and
3. reduction/elimination of pathways/food sources that are attracting rodents.

To eliminate exposure to allergens, rodents must be removed from the building. Please note that removal, even after cleaning, may not provide immediate relief since allergens can exist in the interior for several months after rodents are eliminated (Burge, 1995). A combination of cleaning, increases in ventilation, and filtration should serve to reduce rodent-associated allergens once the infestation is eliminated.

Of note is the number of locations that contain significant amounts of cardboard (Picture 4). Cardboard is manufactured from a variety of chemicals which can off-gas and be a source of irritation to the eyes, nose and respiratory system. In addition, heavily bound books (e.g., law books) can also be a source of irritating odor from the glues and inks used in printing and

binding. Having a large amount of books stored/shelved in occupied space can be a cause of respiratory irritation to occupants.

Finally, occupants expressed concerns the condition of carpeting and carpet cleaning in several areas throughout the building. Carpets are cleaned periodically using a broom and dust pan. Carpeting should be cleaned using a vacuum equipped with a high efficiency particle arrestance (HEPA) filter to reduce airborne particulate. In addition, the Institute of Inspection, Cleaning and Restoration Certification (IICRC), recommends that carpeting be cleaned annually or semi-annually in high traffic areas (IICRC, 2005).

Conclusions/Recommendations

The ventilation system in the building provides adequate fresh air for the SCCO. However, due to the low velocity of the air flow, various normally-occurring pollutants will tend to linger within the office. Occupant comfort can be increased by increasing the airflow velocity from the HVAC system, including the exhaust, as well as limiting the number of potential sources of respiratory irritants in this office. In view of the findings at the time of the assessment, the following is recommended:

1. Increase the velocity of the HVAC system exhaust vents to help draw pollutants from the office space.
2. Examine the feasibility of reconfiguring fresh air supply vents in this office space to direct airflow away from office occupants so that the “sweeping effect” can aid in the dilution of normally-occurring environmental pollutants.
3. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to

minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters and brooms on carpeting. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

4. Reduce the number of plants in the office space. Those that remain should be equipped with drip pans that are made of a non-porous, cleanable material. Examine drip pans periodically for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary. Move plants away from ventilation sources.
5. Consolidate all reference books into an unoccupied room within the office.
6. Move all food preparation activities into the kitchen.
7. Move cardboard and other supplies into an area that is not occupied as office space.
8. Implement the principles of integrated pest management (IPM) to rid the building of pests. Activities that can be used to eliminate pest infestation may include the following activities.
    a. Rinse out recycled food containers. Seal recycled containers with a tight fitting lid to prevent rodent access.
    b. Remove non-food items that rodents are consuming.
    c. Stored foods in tight fitting containers.
    d. Avoid eating at work stations. In areas were food is consumed, periodic vacuuming to remove crumbs is recommended.

e. Regularly clean crumbs and other food residues from toasters, toaster ovens, microwave ovens, coffee pots and other food preparation equipment.

f. Examine each room and the exterior walls of the building for means of rodent entry and seal them. Holes as small as ¼″ are enough space for rodents to enter an area. If exterior doors do not seal at the bottom, install a weather strip as a barrier to rodents.

g. Reduce harborages (such as cardboard boxes) where rodents may reside.

1. Refrain from using air fresheners and deodorizers to prevent exposure to VOCs.
2. Consider providing staff with building-issued cleaning products.
3. Consider cleaning carpeting annually or semi-annually in soiled/high traffic areas as per the recommendations of the Institute of Inspection, Cleaning and Restoration Certification (IICRC). Copies of the IICRC fact sheet can be downloaded at: http://cleancareseminars.net/?page_id=185 (IICRC, 2005)
4. Refer to resource manual and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings; these materials are located on the MDPH's website: www.mass.gov/dph/iaq.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989.

B4 Brands by AMA. 2006. Avant Original™ Instant Hand Sanitizer Materials Safety Data Sheet. B4 Brands by AMA., Nixa, MO.

BETCO Corporation. 2007. Clario Foaming Alcohol Instant Hand Sanitizer Material Safety Data Sheet. BETCO Corporation, Toledo, OH.

Birchwood Laboratories, Inc. 2007. Hand Wipe Take Alongs Materials Safety Data Sheet. Birchwood Laboratories, Inc., Eden Prairie, MN.

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

Burge, H.A. 1995. Bioaerosols. Lewis Publishing Company, Boca Raton, FL.

EOAF. 2012. "New Downtown Worcester Trial Court". Massachusetts Executive Office of Administration and Finance, Property Management and Construction web page. http://www.mass.gov/anf/property-mgmt-and-construction/design-and-construction-of-public-bldgs/current-and-completed-projects/court-projects/new-downtown-worcester-trial-court.html.

Georgia-Pacific Consumer Products. 2007. Cormatic® High Capacity Instant Hand sanitizer Material Safety Data Sheet. Georgia- Pacific Consumer Products, Atlanta, GA

IICRC. 2005. Carpet Cleaning FAQ 4 Institute of Inspection, Cleaning and Restoration Certification. Institute of Inspection Cleaning and Restoration, Vancouver, WA.

MDPH. 1997. Requirements to Maintain Air Quality in Indoor Skating Rinks (State Sanitary Code, Chapter XI). 105 CMR 675.000. Massachusetts Department of Public Health, Boston, MA.

NIH. 2006. Chemical in Many Air Fresheners May Reduce Lung Function. NIH News. National Institute of Health. July 27, 2006. http://www.nih.gov/news/pr/jul2006/niehs-27.htm

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 2011. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations, 8th edition. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Sundell. 2011. Sundell, J., H. Levin, W. W. Nazaroff, W. S. Cain, W. J. Fisk, D. T. Grimsrud, F. Gyntelberg, Y. Li, A. K. Persily, A. C. Pickering, J. M. Samet, J. D. Spengler, S. T. Taylor, and C. J. Weschler. Ventilation rates and health: multidisciplinary review of the scientific literature. *Indoor Air*, Volume 21: pp 191–204.

US EPA. 1992. Indoor Biological Pollutants. US Environmental Protection Agency, Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, research Triangle Park, NC. EPA 600/8-91/202. January 1992.

US EPA. 2001. Mold Remediation in Schools and Commercial Buildings. US Environmental Protection Agency, Office of Air and Radiation, Indoor Environments Division, Washington, DC. EPA 402-K-01-001. March 2001.

US EPA. 2006. National Ambient Air Quality Standards (NAAQS). US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. http://www.epa.gov/air/criteria.html.

Picture 1

Water-Damaged Books on Shelf in Main Office

Picture 2

Plants in Main Office

Picture 3

Food Preparation Area in Office

Picture 4

Cardboard Stored in Cubicle

Location: Worcester Trial Court, Superior Court Clerk's Office **Indoor Air Results**

Address: 225 Main St. Worcester, MA **Date: 12/7/2012**

Table 1

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (ppm)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
Background (Outdoors)	402	ND	41	48	ND	10					
1008 east	482	ND	75	22	ND	4	2	N	Y	Y	Plants
1008 northeast	464	ND	73	24	ND	4	2	N	Y	Y	Photocopier
1008 northwest	485	ND	75	20	ND	6	2	N	Y	Y	Ammonia cleaner
1008 southeast	460	ND	75	22	ND	4	0	N	Y	Y	Plants
1008 southwest	439	ND	75	20	ND	6	1	N	Y	Y	Photocopier
1008 west	446	ND	75	20	ND	6	1	N	Y	Y	
1241	471	ND	75	20	ND	5	0	N	Y	Y	Door open
1242	453	ND	75	21	ND	5	0	N	Y	Y	
1243	465	ND	75	20	ND	4	0	N	Y	Y	Door open

ppm = parts per million µg/m^3 = micrograms per cubic meter ND = non-detect

Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Location: Worcester Trial Court, Superior Court Clerk's Office **Indoor Air Results**

Address: 225 Main St. Worcester, MA **Date: 12/7/2012**

Table 1 (continued)

Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (ppm)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
1244	463	ND	74	20	ND	5	0	N	Y	Y	Storage of records
1247	416	ND	73	21	ND	5	0	N	Y	Y	
1251	446	ND	74	19	ND	5	0	N	Y	Y	
1252	470	ND	73	19	ND	5	0	N	Y	Y	Plant
1253	460	ND	73	20	ND	5	0	N	Y	Y	
1256	471	ND	73	20	ND	4	0	N	Y	Y	Plant
Foley	440	ND	73	21	ND	5	0	N	Y	Y	Cardboard odor
Hearing room	529	ND	75	21	ND	5	1	N	Y	Y	
Kitchen	531	ND	75	21	ND	5	0	N	Y	Y	
Main lobby	486	ND	73	23	ND	6	20+	N	Y	Y	

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Location	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	Temp (°F)	Relative Humidity (%)	TVOCs (ppm)	PM2.5 (ug/m^3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Intake	Exhaust	
Storage	437	ND	74	21	ND	6	0	N	Y	Y	Cardboard odor
Storeroom	456	ND	74	21	ND	6	0	N	Y	Y	Cardboard odor
Waiting area	434	ND	74	20	ND	4	0	N	Y	Y	
Zona	474	ND	74	21	ND	5	0	N	Y	Y	

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