December 28, 2010

Mr. Mike Mologne
Hill International, Inc.
1225 Eye Street
Suite 200 NW
Washington, D.C. 20005

Re: Indoor Air Quality Survey – Lafayette Building
811 Vermont Avenue NW, Washington D.C.

Dear Mr. Mologne:

Applied Environmental, Inc. conducted an Indoor Air Quality (IAQ) survey at the Lafayette Building, located at 811 Vermont Avenue NW, Washington, D.C. The survey was performed on December 1, 2010 and consisted of direct read measurements for carbon monoxide (CO), carbon dioxide (CO_2), temperature, relative humidity, respirable particulate, and Volatile Organic Compounds (VOCs). Visual inspections of Heating Ventilation and Air Conditioning (HVAC) systems were also performed. The survey was conducted proactively prior to renovation activities within the building.

SUMMARY

The criteria used to evaluate collected data include standards and guidelines referenced by the Occupational Safety and Health Administration (OSHA), the Environmental Protection Agency (EPA), the American Conference of Governmental Industrial Hygienists (ACGIH), the National Institute for Occupational Safety and Health (NIOSH), the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), the World Health Organization (WHO), and other applicable industry guidelines.

Survey results indicate that the air quality within the building was generally acceptable for the parameters measured. The concentrations of CO, CO_2, respirable particulate, and VOCs were within the recommended guidelines. One relative humidity measurement was slightly below the ASHRAE recommended limit but remained within the OSHA recommended range. Temperatures were generally warm throughout the building on the day of the survey with several measurements exceeding the OSHA recommended range and the ASHRAE recommended range for the winter season. Engineering personnel cited unusually warm outdoor temperatures during the morning as contributing to the warmer temperatures observed indoors.

Inspected HVAC equipment was generally clean and well maintained. Deficiencies observed were minor and include debris and rust accumulation in the condensate drip pan shared by Air Handling

Units (AHUs) 11 and 12, and dislodged air filters in some AHUs. Recommendations include replacing and securing the dislodged air filters and cleaning the condensate drip pan of AHUs 11 and 12 during the next scheduled maintenance event.

Finally, several areas of past water staining were identified on the suspended ceiling and upper walls in the penthouse. Monitoring the ceilings and walls for water intrusions during future rain events may reveal moisture pathways. If such pathways are isolated they should be eliminated.

BUILDING DESCRIPTION

The Lafayette Building is a twelve story office building reportedly constructed in the 1940s. The building has approximately 565,000 square feet including a sub-basement level, basement level, and a penthouse. The sub-basement level contains mechanical rooms, storage, and the engineering office. The basement level is a parking garage and the penthouse contains mostly mechanical space with a few occupied rooms. The building exterior consists of stone with operable windows. Interior finishing materials vary throughout the building but generally consist of plaster or drywall walls, suspended ceilings composed of spline or acoustical ceiling tiles, and concrete floors covered with carpet or tile. Hallways on the upper floors are finished with marble wall panels.

Conditioned air is provided to the Lafayette Building by perimeter induction AHU-1 through AHU-23. However, AHUs 5 through 10 and 17 through 21 were either removed or too small to require inspection.

AHU-1 serves the second floor cafeteria and rooms 211 and 212. AHUs 2 and 3 serve the south end of floors two through ten and are located in the south mechanical room with AHU-1. AHUs 11 through 16 serve the northern end of floors one through ten and are located in the north mechanical room. AHUs 22 and 23 supply the eleventh and twelfth floors and are located in the penthouse. AHU-4 serves the first floor lobby.

AHUs 1-3, 11-16, and 22-23 were inspected during the survey. AHUs 12 through 16 are located in the north mechanical room, which serves as a mixing plenum for return air. Outdoor air is introduced to each pair of AHUs via two separate ducts. One outdoor air duct provides minimal outdoor air and contains a preheat coil while the second outdoor air duct is used during economizer mode. AHUs are paired except for AHU-1 and each pair shares common return air dampers, air filters, and chilled water coils but contain separate fan chambers and supply air ductwork. Downstream of the chilled water coil, each AHU has separate intakes for return air reheating, which include a single bank of air filters, a steam coil, and individual dampers. AHUs 2 and 3 in the south mechanical room and 11 and 12 in the penthouse are paired the same as the AHUs located in the north mechanical room. However, the AHUs in the south mechanical room have return air ducted to the mixing chamber of each AHU.

On the day of the survey, outdoor air dampers ranged from minimally open to the economizer dampers 10% open at AHUs 2/3 and 11/12. Return air dampers were fully open on all AHUs and reheat return air dampers were open on AHUs 1, 13, 14, 15, 16, 22, and 23. Air filters consisted of a single bank of four inch-thick pleated panels. The air filters did not appear overloaded with particulate or debris in any of the AHUs inspected at the time of the survey. However, air filters in many of the AHUs had fallen out of the rack. These included dislodged filters from each of the common returns of AHUs 2/3, 11/12, and15/16; reheat air filters were also dislodged in AHUs 2 and 3. The upstream and downstream surfaces of the chilled water coils appeared clean with only minor particulate accumulation. The condensate drip pans were dry and contained evidence of corrosion. However, the condensate pan shared by AHUs 11 and 12 exhibited significant rust and debris. Deflectors located downstream of the condensate drip pans ranged from clean to moderately loaded with accumulated particulate. Fan box chambers were clean and dry. No evidence of microbial growth was observed in any of the inspected AHUs. Generally, the AHUs appeared to be older models and contained many cosmetic blemishes, which is consistent with the period of operation. AHU maintenance activities are reportedly completed by in-house personnel and consist of filter replacement every six months and annual coil and condensate pan cleaning.

In the penthouse, several areas of past water damage were observed on the ceiling tiles and upper walls including room 1375. The water stains did not appear wet and no evidence of suspect visible mold growth was present at the time of the survey.

SURVEY METHODOLOGY

Few legally enforceable standards exist governing the acceptable levels of airborne pollutants or other contaminants within a non-industrial building. Typically, interpretation of air sampling data obtained in IAQ evaluations is based on the guidelines and recommendations that have been developed for an indoor environment by various recognized technical associations and groups. These include the ACGIH, ASHRAE, NIOSH, WHO, EPA and the American Industrial Hygiene Association (AIHA).

Direct Read Measurements

Ambient temperature, relative humidity, CO_2, CO, and respirable particulate concentrations were measured using direct-read instruments. The CO_2 measurements were made with a portable CO_2 indicator manufactured by Metrosonics, Inc. For this unit the principle of operation for CO_2 measurements is non-dispersive infrared spectrophotometry. The unit accuracy is within ±3% of the full scale reading at 25°C, and has a resolution limit of 1 parts per million (ppm). It is capable of providing real-time CO_2 concentration, with a range of operation from 0 ppm to 5,000 ppm.

The CO measurements were made with a selective electrochemical CO sensor installed into the Metrosonics unit. The CO sensor has an accuracy at 25°C, of better than ±3% of the reading, or ±2 ppm, whichever is greater. The unit is capable of providing real time CO concentrations, during the sampling period with a range of operation of 0 ppm to 1,000 ppm.

The Metrosonics unit also measures ambient temperature with a usable range of 32°F to 140°F, with an accuracy of ±0.9°F and the ambient relative humidity from 0% to 100%, with an accuracy of ±3% at 25°C.

Respirable particulate measurements were collected using an MIE *personal* DataRAM (Personal Data-logging, Real time Aerosol Monitor), Model pDR-1000, manufactured by Monitoring Instruments for the Environment, Inc., of Bedford, Massachusetts. The operation of this direct read instrument is based on light scattering photometry, with the measurement of the intensity (irradiance) of light scattered by particles passing through the sensing area. The instrument measures both solid and liquid particles, with greatest sensitivity to particles from 0.1 to 10 micrometers (μm) in size. Concentrations from 0.001 to 400 milligrams per cubic meter of air can be measured with an accuracy of ±5% of the reading.

Total VOC measurements were performed using a portable Photo Ionization Detector (PID), manufactured by Photovac, Inc. A PID measures the concentration of airborne ionizable gases and vapors, with measurement reported in parts per million (ppm) of VOCs. The Photovac PID uses an inlet flow rate of approximately 300 ml/min and is capable of providing real-time total ionizable VOC concentrations in a range of operation from 0.5 ppm to 2,500 ppm (isobutylene equivalent). It is equipped with a 10.6 eV ultraviolet light source that generates photons able to ionize certain molecules in the gas stream. The PID is calibrated to a standard of 100 ppm of isobutylene. Its accuracy is ten percent of the reading or ± 2 ppm, whichever is greater. Isobutylene produces a medium range response in the instrument, making it a reliable standard for use when measuring average concentrations of total ionizable VOCs in sampled air. A PID does not identify specific chemical species.

SURVEY FINDINGS

A discussion of each sampling parameter and the results are presented below. A data table indicating the locations of the direct read measurements and the results is included as an Attachment 1.

Carbon Dioxide

Carbon dioxide, a product of combustion and human respiration, is a commonly used indicator of overall air quality and ventilation rates within an occupied building. The levels found in buildings are primarily a function of the rate and amount of outdoor air delivery to the occupied space, the effectiveness of air distribution within the space, and the occupancy (number of people and activity) of the space. It is generally accepted that an inadequate outdoor air supply may cause problems such as headaches and respiratory difficulties, due to a general build-up of non-specific contaminants and odors. These symptoms are typically categorized as "Sick Building Syndrome."

ASHRAE has published a recommended guideline of 1,000 ppm of CO_2 as the maximum limit for acceptable air quality in their document, *ASHRAE 62.1-2007, Ventilation for Acceptable Air Quality.*

According to the American Society for Testing and Materials, *Provisional Standard Guide for Using Indoor Carbon Dioxide Concentrations to Evaluate Indoor Air Quality and Ventilation, (PS 40-95)*, the 1,000 ppm guideline is based upon an indoor to outdoor differential of 700 ppm, and assumes an outdoor CO_2 concentration of 350 ppm. At a differential lower than 700 ppm, 80% of unadapted individuals (visitors) would find air quality acceptable (based upon non-specific contaminants, such as body odor and other bioeffluents).

According to the *OSHA Technical Manual, Chapter 6 - Indoor Air Quality Investigation* (a non-regulatory guidance document issued by OSHA Instruction CPL-2-2.20B, CH-1, November 13, 1990, for OSHA personnel conducting field surveys), NIOSH has published the following guidelines for indoor levels in their document, *Guidance for Indoor Air Quality Investigations, 1987*:

250-350 ppm	Normal Ambient Outdoor Concentrations
600 ppm	Minimal Air Quality Complaints
600-1,000 ppm	Less Clearly Interpreted
1,000 ppm	Indicates inadequate ventilation and complaints such as headaches, fatigue, and eye and throat irritation will be more widespread; 1,000 ppm should be used as an upper limit for indoor levels

These levels are only guidelines. If carbon dioxide levels exceed 1,000 ppm it does not necessarily indicate that the building is hazardous and should be evacuated. Rather this level should be used as a guideline that helps maximize comfort for all occupants."

The CO_2 concentrations within the Lafayette Building ranged from 386 ppm to 680 ppm. These concentrations are well below the maximum recommended levels published by ASHRAE and OSHA. Given the typical occupancy observed during the survey dates, these levels indicate adequate ventilation in the areas tested. The outdoor CO_2 concentrations measured at the beginning and end of the survey were 385 ppm and 416 ppm.

Carbon Monoxide

Carbon monoxide is a colorless, odorless, and tasteless gas formed during the combustion of hydrocarbon fuels. It is often encountered in garages and loading dock areas, and can be introduced into buildings by way of the ventilation system. Carbon monoxide is a simple asphyxiant to humans; when inhaled it combines with the hemoglobin of the blood to prevent oxygen transportation to the brain, heart, and other body parts. Prolonged exposure to CO can cause severe heart, brain, and circulatory damage.

Current OSHA exposure limits are 50 ppm for an 8-hour permissible exposure limit. OSHA has proposed a time-weighted average exposure limit of 35 ppm, and a ceiling level of 200 ppm, with an Immediately Dangerous to Life and Health (IDLH) level of 1,200 ppm. The ASHRAE guideline for CO is 9 ppm as an 8-hour average, or 35 ppm as a 1-hour average.

The CO concentration measured 0 ppm (undetectable) in all sampling locations. The outdoor CO concentrations were also 0 ppm on both survey dates.

Temperature and Relative Humidity
The standard *ASHRAE 55-2004, Thermal Environmental Conditions for Human Occupancy*, recommends that indoor temperatures be maintained between 73°F and 79°F during the summer/transitional season, and between 68°F and 74°F during the winter/transitional season, with relative humidity between 30% and 60%. These values are considered acceptable ranges of operative temperature and humidity for persons wearing moderate clothing and engaged in light activity, such as in a typical office setting. The standard is considered to be met if 80% of the building occupants are satisfied. The OSHA Technical Manual references a comfort range from 68°F to 76°F.

The ideal comfortable relative humidity range has been reported by ASHRAE to be 40% to 60%, as long as building materials or contents are not adversely affected. OSHA recommends humidity control within a 20% to 60% range in their technical manual for IAQ investigations. Low relative humidity can result in eye irritation and complaints of nose and throat discomfort. In addition, irritated mucous membranes can predispose susceptible individuals to the affects of certain chemical and microbiological air contaminants. High humidity levels (over 70%) can promote the growth of microorganisms on building surfaces and furnishings, and cause or contribute to microbial IAQ problems.

On December 1, 2010, temperatures measured within the Lafayette Building ranged from 72.7°F to 77.6°F. Sixteen measurements exceeded the OSHA recommended range and almost all measurements exceeded the ASHRAE recommended range for the winter season. According to the engineer present during the survey, the warmer than typical morning outdoor temperatures followed by a cold snap in the afternoon led to difficulty in maintaining comfortable temperatures indoors. The outdoor temperature measured during the morning of the survey was 64.2°F and the afternoon outdoor temperature measured 45.3°F.

Relative humidity levels indoors ranged from 28.6% to 48.9%. One measurement of 28.6% was below the ASHRAE recommended range. However, all relative humidity measurements were within the recommended OSHA range. The slightly low relative humidity measurement of 28.6% was recorded during the afternoon inside office 116. Diminished relative humidity is common indoors during the winter heating season in the Washington D.C. area. Outdoor relative humidity was measured at 89.0% during the morning and 65.2% during the afternoon of the survey date.

Respirable Particulate
Respirable particulate, which includes combustion products such as cigarette smoke, may cause irritation of the respiratory tract in individuals exposed to excessive concentrations. ASHRAE has adopted the WHO consensus guidelines, and recommends a level of concern of more than 150 micrograms per cubic meter ($\mu g/m^3$) for short-term exposure to respirable particulate generated from tobacco smoke. Short-term exposures to levels below 100 $\mu g/m^3$ of respirable particulate are considered to be of limited to no concern.

Respirable particulate concentrations ranged from 0 $\mu g/m^3$ to 62 $\mu g/m^3$ and were within the acceptable limits in all locations. The outdoor respirable particulate measured on the morning of the survey was 31$\mu g/m^3$.

Volatile Organic Compounds

The term "hydrocarbons" refers to a broad category of organic chemical materials consisting of carbon and hydrogen containing molecules, the most well known of which are solvents such as toluene, xylene, chlorinated alkenes, and benzene compounds. Volatile hydrocarbons are present in buildings as off-gassing products from construction materials, carpets, and furnishings, as well as cleaning agents, copying processes, photographic laboratories, graphics studios, and cafeterias (cooking). Recent research has also implicated ventilation systems as sources of VOCs. It should be noted that over 500 specific VOCs have been isolated in office air sampling studies (including buildings in which there were no occupant complaints).

There are no current federal standards or recommended guidelines for total hydrocarbons or VOCs in air, since such a measure represents a mixture of compounds. In 2002, ASHRAE proposed that total hydrocarbon levels in office environments should be maintained below 3 mg/m^3.

Total hydrocarbon measurements collected during the survey of the Lafayette Building were 0 ppm in all locations. No specific triggers, sources, peaks, or pathways were identified while using the instrument. The outdoor concentration measured during the morning of the survey was 0.5 ppm.

CONCLUSIONS

The direct read measurements indicate that the air quality within the building was within acceptable limits for most of the parameters measured. Carbon dioxide, CO, respirable particulate and VOCs were all within acceptable limits. One relative humidity reading was below the ASHRAE recommended range but remained within the range recommended by OSHA. Temperatures indoors were generally warm on the survey date; exceeding the OSHA recommended range and the ASHRAE recommended range for the winter season in several locations. Engineering personnel suggested that the unusually warm outdoor temperature during in the morning caused the slightly warm temperatures indoors.

The inspected AHUs were generally clean with only minor deficiencies noted. Specifically, air filters were observed dislodged from filter racks in several of the AHUs. The filters should be replaced and correctly secured. Additionally, the heavily rusted condensate drip pan shared by AHUs 11 and 12 should be cleaned of all rust debris during the next scheduled maintenance event.

Visual observations within the building revealed water stains at the ceilings and upper walls on the penthouse level. These areas should be monitored during rain events for water intrusion and repaired

as needed. Finally, no major deficiencies were identified that would be anticipated to significantly impact IAQ within the building.

If you have any questions or require further assistance, please feel free to call.

Sincerely,

Jeffrey L. Amy
Division Manager
Indoor Air Quality Services

Attachments

Ref. 1280-10-0310

ATTACHMENT 1

DIRECT READ RESULTS

applied environmental inc.

Hill International

LaFayette Building
811 Vermont Avenue, NW
Washington, D.C.

December 1, 2010

DIRECT READ RESULTS

Sampling Location	Time	Carbon Dioxide CO_2 (ppm)	Relative Humidity (%)	Temperature (°F)	Carbon Monoxide CO (ppm)	Respirable Particulate (μg/m³)	VOCs with PID (ppm)
Outdoors	9:15 a.m. 3:30 p.m.	385 416	89.0 65.2	64.2 45.3	0 0	31 -	0.5 -
Thirteenth floor, room 1375	9:52 a.m. 1:47 p.m.	387 538	48.9 41.0	74.9 73.6	3 0	10 -	0.0 -
Twelfth floor, north door 1267	9:58 a.m. 1:50 p.m.	403 512	48.6 38.5	74.8 74.0	0 0	17 -	0.0 -
Twelfth floor, west door 1233	10:03 a.m. 1:53 p.m.	386 483	46.9 37.3	73.9 74.4	0 0	11 -	0.0 -
Twelfth floor, southwest door, 1215 at the coffee table	10:07 a.m. 1:56 p.m.	397 483	46.5 38.1	74.1 74.4	0 0	11 -	0.0 -
Eleventh floor, northeast vestibule outside door of L. Evans.	10:11 a.m. 1:58 p.m.	446 491	46.9 38.7	75.5 76.3	0 0	9 -	0.0 -
Eleventh floor, north conference room 1143, center of room	10:14 a.m. 2:00 p.m.	386 513	46.0 42.1	74.1 74.2	0 0	14 -	0.0 -
Tenth floor, south door 1021, cubicle of M. Brainard	10:21 a.m. 2:06 p.m.	507 548	45.0 36.8	73.1 75.2	0 0	11 -	0.0 -
Tenth floor, northwest door 1051, office of A. Sarratt	10:36 a.m. 2:03 p.m.	436 455	44.7 39.7	74.9 74.5	0 0	33 -	0.0 -
Ninth floor, south door 925, outside office of D. Eugene	10:27 a.m. 2:11 p.m.	494 529	45.1 35.9	75.4 76.4	0 0	0 -	0.0 -

ppm = parts per million
μg/m³ = micrograms per cubic meter

1280-10-0310/1

200 Fairbrook Drive, Suite 201 • Herndon, Virginia 20170 • 703-648-0822 • Fax 703-648-0575

Hill International

LaFayette Building
811 Vermont Avenue, NW
Washington, D.C.

December 1, 2010

DIRECT READ RESULTS

Sampling Location	Time	Carbon Dioxide CO_2 (ppm)	Relative Humidity (%)	Temperature (°F)	Carbon Monoxide CO (ppm)	Respirable Particulate (μg/m^3)	VOCs with PID (ppm)
Ninth floor, north door 955, cubicle of V. Lemons	10:31 a.m. 2:14 p.m.	443 447	44.1 35.5	75.9 76.3	0 0	18 -	0.0 -
Eighth floor, northwest door 838, cubicle of D. Whitehead	10:40 a.m. 2:17 p.m.	488 581	45.5 35.5	76.7 77.4	0 0	23 -	0.0 -
Eighth floor, west door 805, office of C. Crawford	10:43 a.m. 2:20 p.m.	482 479	43.6 34.3	75.9 75.6	0 0	21 -	0.0 -
Seventh floor, east door 771, Office of E. McFadder	10:47 a.m. 2:24 p.m.	462 446	45.3 34.6	75.3 75.9	0 0	9 -	0.0 -
Seventh floor, northwest door 751, office next to S. Tata	10:52 a.m. 2:27 p.m.	454 549	43.6 37.6	75.5 75.5	0 0	25 -	0.0 -
Sixth floor, northwest door 643, office of C. Mason	10:56 a.m. 2:30 p.m.	474 556	43.9 34.9	75.6 75.8	0 0	9 -	0.0 -
Sixth floor, door 623, center of room	11:00 a.m. 2:34 p.m.	528 506	41.1 33.2	75.8 76.3	0 0	0 -	0.0 -
Fifth floor, south door 519, at microfiber station	11:03 a.m. 2:38 p.m.	477 461	41.3 32.0	76.3 76.9	0 0	21 -	0.0 -
Fifth floor, north door 540, office 538C	11:06 a.m. 2:42 p.m.	470 497	44.9 34.5	75.5 75.8	0 0	24 -	0.0 -
Fourth floor, south 419, administration desk	11:09 a.m. 2:45 p.m.	493 550	41.1 33.3	76.2 75.6	0 0	9 -	0.0 -

ppm = parts per million
μg/m^3 = micrograms per cubic meter

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December 1, 2010

DIRECT READ RESULTS

Sampling Location	Time	Carbon Dioxide CO_2 (ppm)	Relative Humidity (%)	Temperature (°F)	Carbon Monoxide CO (ppm)	Respirable Particulate (μg/m³)	VOCs with PID (ppm)
Fourth floor, north door 448, cubicle of P. Murray	11:15 a.m. 2:48 p.m.	478 517	43.4 33.4	75.3 76.4	0 0	12 -	0.0
Third floor, east door 377, cubicle of A. Daley	11:20 a.m. 2:52 p.m.	509 554	46.1 34.2	74.6 75.5	0 0	30 -	0.0 -
Third floor, southeast door 327, cubicle of B. Westman	11:24 a.m. 2:55 p.m.	518 437	41.7 33.7	75.1 72.7	0 0	15 -	0.0 -
Second floor, east Hill International Office, conference table	11:29 a.m. 2:58 p.m.	523 472	41.6 34.1	77.3 73.4	0 0	62 -	0.0 -
Second floor, south, lounge room	11:37 a.m. 3:07 p.m.	442 505	39.3 30.1	76.8 77.6	0 0	14 -	0.0 -
First floor, south door 116, cubicle of M. Shelton	11:40 a.m. 3:11 p.m.	433 466	36.7 28.6	76.1 76.8	0 0	21 -	0.0 -
First floor, north door 147, cubicle of A. Turnipseed	11:43 a.m. 3:18 p.m.	680 628	44.9 35.5	76.0 77.3	0 0	56 -	0.0 -

ppm = parts per million
μg/m³ = micrograms per cubic meter