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IAQ Consulting Excellence Since 1980

October 31, 2008

Emilio Galanda
Vice President
ING Investment Management
230 Park Avenue
New York, NY 10017

Dear Mr. Galanda:

230 Park Avenue, 15th Floor
LEED™ CI Version 2.1 Credit EQ 3.2

This letter provides documentation of indoor air quality (IAQ) test procedures conducted by Healthy Buildings International, Inc. (HBI) for ING Investment Management at 230 Park Avenue, New York, NY. These procedures are in pursuit of LEED Commercial Interiors (CI) Version 2.1 EQ Credit 3.2 Indoor Air Quality (IAQ) Testing Before Occupancy. This sampling was conducted on the fifteenth floor on October 23, 2008. Inspection and sampling confirmed that this space satisfies all requirements for LEED CI Version 2.1 EQ3.2 credit.

LEED CI 2.0 lists two distinct procedures for earning this point, through a two-week flush-out period duly documented by the engineer or architect or an IAQ testing procedure. The IAQ testing procedure was used in this case to obtain the one credit. This report, the LEED Template, laboratory analysis reports, accompanying field notes and calibration data should be sufficient verification that the IAQ proceedure to obtain EQ 3.2 has been successful.

To obtain the credit the following criteria must be met:

- Measurements must be prior to occupancy.
- During normal occupied hours.
- With the building ventilation system set at a minimum.
- With the building ventilation system operated at the minimum outside air flow rate for the occupied mode throughout the duration of testing.
- The areas must have interior finishes installed, including but not limited to millwork, doors, paint, carpeting and acoustic tiles as well as non-fixed furnishings are required to be in place for the testing.
- For each area served by a separate ventilation system, the number of sampling points must not be less than one per 25,000 ft^2, or each contiguous floor area, whichever is larger, and included areas with the least ventilation and presumed source strength.

- Air samples must be collected from 4 to 7 ft. off of the floor to represent the breathing zone of occupants.
- Air quality testing must be completed for a minimum of four hours to methods that meet or are equal to the methods specified in the EPA Compendium of Methods for the Determination of Air Pollutants in Indoor Air EPA/600/4-90/010 for the pollutants listed below:

CONTAMINANT	MAXIMUM CONCENTRATION	SAMPLING METHOD USED BY HBI
Formaldehyde	50 parts per billion	NIOSH 2016 equal to EPA Method IP-6A
Particulates (PM 10)	50 micrograms per cubic meter	EPA IP-10A
Total Volatile Organic Compounds (TVOC)	500 micrograms per cubic meter	EPA IP-1B
* 4-Phenylcyclohexene	6.5 micrograms per cubic meter	EPA Method IP-1B
Carbon Monoxide	9 parts per million but not greater than 2 ppm above outdoor levels	EPA IP-3A

*Testing for 4-Phenylcyclohexene is only required if carpets and fabrics with Styrene Butadiene (SB) latex backing material are installed as part of the base building. However, since HBI doesn't have information on the material, samples are collected with the TVOC tests.

The renovated floor space was approximately 16,000 square feet in area and ventilated by two main air handling units: Fan 3 and Fan 15. Fan 3 served the east perimeter units, while Fan 15 supplies the interior zones. The perimeter systems are constant volume and the interior zones are variable air volume. In addition, there are two fan coil units controlled by local thermostats that provide additional cooling to the perimeter offices. The air handling units were in very good condition and were operating normally. The outdoor air intake dampers were approximately 15-20% open in Fan 3 and Fan 15's dampers were open 10-15% open during our four hour testing period.

All furnishings, including floor covering, millwork, wall coatings, acoustical tiles, etc., were installed before our scheduled testing periods. To comply with the LEED testing requirements described above, we collected one sample set. A walk through test for TVOCs and formaldehyde was completed with an electronic instrument to determine if there was a worse case area since ventilation to all areas was relatively equal. The 15F NE perimeter office of M. Heitz registered the highest formaldehyde and VOC readings with an electronic instrument, so this area was identified as the non-random sampling point. The sampling period for all samples was at least 4 hours to comply with LEED requirements.

Formaldehyde

Sources and Health Effects of Formaldehyde

Formaldehyde is a colorless, organic compound of carbon, hydrogen and oxygen having the formula HCHO. It is used extensively in industry in the production of synthetic urea and urea-formaldehyde resins, which themselves are widely used as adhesives in making particle board, laminates, plywood and other wood products. Many adhesives and glues also contain this compound, including some used for carpets and wallpaper coverings, and another widely used product containing formaldehyde is urea-formaldehyde foam insulation. Formaldehyde is also used as a flame retardant for fabrics. Other sources include bulk stored paper products, some cosmetic products, combustion processes including smoking, and atmospheric photochemical smog.

Thus, the potential for formaldehyde products to be present in building air is considerable. Its main nuisance value arises from the fact that it can vaporize or "out-gas" from building materials at room temperatures and contaminate the air we breathe. The rate of evaporation is determined by the concentration of "unbound" formaldehyde in the products, the air temperature and relative humidity, and the ventilation rate.

Airborne formaldehyde can cause acute irritation to those exposed. The degree of discomfort and the concentrations of formaldehyde that trigger a response vary from person to person. Most people sense its odor at a concentration of 0.5 parts per million (ppm), though sensitized persons react at far lower concentrations. Symptoms of exposure include severe irritation of the eyes, nose, throat and respiratory passages, and coughing, nausea and headaches. It exacerbates the condition of those suffering from bronchial asthma. High concentrations of 50 - 100 ppm can cause serious injuries to those exposed, such as pneumonitis or even death. Formaldehyde has been shown to be an animal carcinogen and it is listed as a suspect human carcinogen.

Of particular concern is that prolonged exposure, even to low levels of formaldehyde, can cause sensitization to some people. Typically, these individuals develop allergic type reactions to it and their sensitivity increases thus rendering them susceptible to even lower concentrations of airborne formaldehyde in the future. This can result in a situation where such sensitized persons cannot even tolerate levels that are lower than all permitted exposure standards, levels at which the bulk of the occupants find perfectly acceptable. Where formaldehyde gas is found in elevated levels (above 0.75 ppm), measures such as “baking out” buildings using carefully controlled operation of their heating systems, or the use of absorbent filters installed in the air supply and return systems along with increased air ventilation and circulation have been used in the past to reduce the levels of this potentially harmful gas with varying levels of success.

Pertinent Standards and Concentrations - Formaldehyde

LEED Requirement per October 8th 2002 Interpretation	0.05 ppm = 50 parts per billion (ppb).
ACGIH (STEL)	0.3 ppm (Short Term Exposure Limit)
OSHA (PEL)	0.75 ppm 8 hour TWA
OSHA (STEL)	2.0 ppm 15 minutes exposure
ASHRAE Guideline (1/10 PEL)	0.075 ppm 8 hour TWA
NIOSH (STEL)	0.10 ppm (15 min for sensitized persons)
WHO	<0.05 ppm (Limited or no concern)
WHO	>0.1 ppm (Concentrations of concern)

Sampling and Analysis of Building Air for Formaldehyde Content

Objective: To measure the levels of formaldehyde gas present and compare with standards.

Method: Air sampling with a calibrated air pump at approximately 200 mLPM connected to collection tube specifically constructed for formaldehyde collection with an ozone scrubber. The sampling interval was 4 hours or more. The samples were analyzed using NIOSH 2016, which is equal to EPA IP-10A.

Results:

Location	Formaldehyde Concentration (ppm)
15F NE Perimeter Office, M. Heitz	< 0.006 ppm

Conclusions

The LEED compliance criterion derived from the State of Washington Standard is 0.05 ppm (50 ppb), well below the current OSHA industrial Permissible Exposure Level (PEL) for formaldehyde gas as defined by OSHA of 0.75 ppm or 75 ppb.

On the days of our test, the levels detected were well below this LEED compliance criterion and are therefore considered very satisfactory.

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Particulates

Airborne Particle Weights

The dust that has the most impact on the health of the people exposed is that fraction of the total airborne dusts that is in the size range that can be drawn directly into a person's lungs during normal breathing activity. This fraction of the airborne dusts is called the Respirable Suspended Particulate (RSP) and is measured as the mass (weight) in micrograms per cubic meter ($\mu g/m^3$) of air. Traditionally, researchers have arbitrarily set their own cut-off point for the RSP fraction; some use 2.5 microns as the upper size limit, many others quote 3.5 and even 5 microns. However, in 1991 the International Standards Organization - European Standardization Committee (ISO/CEN) defined a protocol setting the cut-off point at 4 microns for RSP.

Currently there are no defined standards in the USA for RSP levels in the indoor air of non-industrial environments. However, in 1984 a World Health Organization (WHO) working group identified that concentrations of less than 100 micrograms per cubic meter ($\mu g/m^3$) of air were of limited or of no concern. Only when the values exceed 150 $\mu g/m^3$ are they considered to be concentrations of concern. However in this case LEED is requiring a more stringent level to the EPA PM-10 standard where all particulates below 10 microns in particle size are collected and weighted and must be <50 $\mu g/m^3$.

Airborne Particle Weights — Pertinent Standards

LEED Requirement (PM-10)	50 $\mu g/m^3$
ASHRAE Std 62-2001 (RSP)	75 $\mu g/m^3$, annual average *, 260 $\mu g/m^3$, 24 hr. average
OSHA PEL (RSP)	5,000 $\mu g/m^3$, 8 hr. TWA
ACGIH TLV (RSP)	10,000 $\mu g/m^3$, 8 hr. TWA
EPA NAAQS (RSP)	50 $\mu g/m^3$, annual average,* 150 $\mu g/m^3$, 24 hr. average
WHO (ETS Particulate)	<100 $\mu g/m^3$, of limited or no concern

Weighing of Particulate to PM-10 Standard in Building Air

Objective: To assess the weight of airborne particles at or less than 10 microns in size at random locations of the building and compare with available standards.

Method: Air sampling with a calibrated air pump at approximately 10 LPM using a Model 200 PEM impactor with 10 μm cut point onto a pre-weighted filter and weighing of the filter on a calibrated laboratory balance after running for a minimum of 4 hours. This is comparable to NIOSH 0500, NIOSH 0600 and is equal to EPA IP-10A.

Results:

Location	PM-10 Particulate ($\mu g/m^3$)
15F NE Perimeter Office, M. Heitz	< 41 $\mu g/m^3$

Conclusions

This result is below the LEED recommended acceptable upper limit for airborne PM- 10 particles of 50 micrograms per cubic meter of air and, therefore, is satisfactory.

TVOC and 4-Phenylcyclohexene

An organic chemical is one that contains the element carbon (C), which is vital to all living forms on the earth. Organic chemicals that volatilize at moderate temperatures are described as volatile organic compounds and many of these compounds are released by "off-gassing" from materials such as furnishings, wall, floor and ceiling materials, adhesives, and cleaning compounds. In fact, volatile organic compounds are released from diverse sources including:

Human and pet perspiration, body wastes

- House plants, insects, and microbes
- Wood products, binders, preservatives, and scents
- Insulation material
- Fabrics - clothing, furnishing, dry cleaning residues
- Paints, solvents, adhesives, hobby materials
- Combustion - fires, smoking, cooking
- Health-care products - sprays
- Cleaning products - disinfectants, detergents, pesticides
- Contaminants in outdoor air.

In commercial buildings, there are multiple sources of these compounds, especially immediately following construction since so many concentrated sources of these compounds are present, and are subsequently released, from glues, adhesives, cleaning agents, waxes etc. Thus it is common to find elevated levels immediately after use of these products but as the following table demonstrates, many routine operations conducted in the course of normal business activities may also lead to the release of such chemicals.

Common Volatile Organic Compounds in Indoor Air and their Sources

Compound	Uses	Possible Source In Indoor Air
Aliphatic hydrocarbons	Solvents for oils, waxes, lacquers, varnishes	Wood stains, lacquers, and polyurethane coatings
Benzene	Manufacture of dyes, organic chemicals and solvent for waxes, oils, varnishes etc	Waxes, polishers, cleaning compounds, caulking compounds, adhesives (wall paper, tiles etc), paints, carpets, smoking
Carbon tetrachloride	Solvent for oils, lacquers, varnishes, dry-cleaning fluid	Old fire extinguishers, stain removers, paint removers
Chloroform (Trichloromethane)	Solvent for fats, waxes, resins. Cleaning agents, also for water chlorination	Excess water chlorination, cleaning agents, new or newly cleaned fabrics, some printers
Dichlorodifluoromethane R-12	Refrigerant, aerosol propellant	R-12 refrigerant leak, aerosol sprays
Ethyl benzene	Solvent for resins, paints	Paints, polyurethane, waxes and furniture polish, some copy machines & printers, caulks, adhesives (carpets)
Limonene	Solvent, waxes, glues, varnishes, wetting and	Cleaning agents, waxes, polishes

Compound	Uses	Possible Source In Indoor Air
	dispersing agent	
Methylene Chloride (Dichloromethane)	Solvent, degreaser and cleaning agents	Cleaning compounds, water based adhesives, paint strippers
4-Phenylcyclohexene	Component of latex carpet backing	New carpets
Tetratchloroethene Perchloroethylene (Tetrachloroethylene)	Solvent, especially for degreasing metals and dry-cleaning fluid	Dry cleaning operations, degreasers, rust removers, Some printers & fax machines
Styrene (Vinyl benzene)	Manufacture of synthetic rubber, plastics, resins	Jointing compounds, carpets, adhesives (tiles & carpets)
Trichloroethylene (Trichloroethene) (TCE)	Solvent for tars, waxes, polishers, oils, runner, paints. Used as degreaser and dry cleaner	Dry cleaned fabrics, degreasers, emitted by some computer and fax machines,
1,1,1 trichloroethane (Methyl chloroform)	Metal cleaning and plastic mold cleaner	Wood paneling, cleaning agents
Toluene (Methyl benzene)	Solvent for paints, lacquers, waxes, and polishers, also gasoline additive	Paints, cleaning agents, polishes, jointing compounds, caulks, water based adhesives, wallpapers, carpets, tile adhesives, linoleum
Xylene	Industrial solvent esp. for dyes, polyester fibers	Adhesives, wallpapers, lacquers, glues

VOCs originate from hundreds of different sources and literally thousands of different chemicals are involved. Fortunately, however, they are normally present in very dilute concentrations in the air, usually only measurable in parts per million (ppm) or parts per billion (ppb). However, the fact that there are usually dozens of different chemicals present at the same time in the air of a typical office may raise problems with respect to the comfort and/or health effects of the occupants. In assessing these compounds there are three factors of concern:

First is the concern of odors. Next the possibility that specific VOCs, or mixtures of VOCs cause irritation. Finally, there are the health risks due to toxic effect of the compounds involved, either singly or in combination.

When dealing with low concentrations of volatile organic compounds no agency has set standards for mixtures of these compounds in the indoor air. Common sense does suggest that such mixtures may well have a different effect from exposure to a series of individual compounds because there may well be interactions between chemicals that can either neutralize some and/or exacerbate others. With regard to the effects of such mixtures of VOCs on building inhabitants, much of the best research has been completed in Denmark. Perhaps the best-known pioneer in this field is Lars Molhave, MD, from Aarhus University, Denmark. In an attempt to identify a practical, low cost method for assessing the effects of total VOCs, or TVOCs, Molhave developed a classification of four grades of TVOC concentrations and HBI has adopted that classification with the slight modification in which we have extended the “comfort

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range” from 200 µg/m^3 up to 500 µg/m^3 based on our own experience. This 500µg/m^3 concentration is also the standard recommended by the State of Washington, which is the most stringent standard in the USA, and it is the standard adopted by the US Green Building Council in their LEED™ rating system.

Tentative Dose Response to TVOCs

Grade	Airborne TVOC concentration (µg/m^3)	Symptoms	Effects
A	<500	No irritation or discomfort	The comfort range
B	500-3,000	Irritation and discomfort possible if other exposures interact	The multifactorial exposure range
C	3,000-25,000	Exposure effect and probable headache possible if other exposures interact	The discomfort range
D	>25,000	Additional neurotoxic effects other than headache may occur	The toxic range

When assessing the significance of the concentration of 4-phenylcyclohexene, LEED has adopted the State of Washington guideline of 6.5 µg/m^3. Other guidelines for specific VOCs are as follows:

Health Effects (Individual VOCs)	1/10th TLV (ASHRAE)
Suggested Irritation Guideline	1/40th the TLV (8-hr TWA)
Effects of Mixtures of VOCs (TVOCs)	500µg/m^3 (Modified Molhave’s table)

Testing of Building Air for 4-phenylcyclohexene and Total VOCs

Test: Sampling and analysis of volatile organic compounds.

Objective: To estimate the amounts of volatile organic compounds present in the building air.

Method: Air sampling using Multibed Sorbent Tubes. After collection the tubes are heat desorbed into a cold trap with subsequent analysis by capillary gas chromatography and mass spectroscopy. This method follows EPA Method IP-1B.

Results:

Location	4-Phenylcyclohexene (µg/m^3)	Total VOCs (µg/m^3)
15F NE Perimeter Office, M. Heitz	< 1.9 µg/m^3	124 µg/m^3

Conclusions

During the testing, the sum of all the VOCs detected in the area test was well below the LEED requirement of 500µg/m^3 and therefore meet the requirement for LEED certification.

Looking at the levels of 4-phenylcyclohexene detected we noted it did not exceeded the detection limits of 1.0 µg/m^3 and were thus well under the LEED requirement of 6.5 µg/m^3; in essence there was no indication that there was any 4-phenylcyclohexene present in any area tested.

Carbon Monoxide

Health Effects and Guidelines

Carbon monoxide (CO) is a colorless, odorless gas that is produced by the incomplete combustion of carbon containing fuels. Oil, gasoline, diesel fuels, wood, smoke and coal are the main sources with small amounts produced by burning cigarettes.

Carbon monoxide poisoning is a form of asphyxiation. Normally, oxygen in the lungs is absorbed into the blood due to oxygen's affinity for the hemoglobin (Hb) in the blood. The oxygen binds itself to the hemoglobin to form oxyhemoglobin (OHb), this oxygen rich blood is then carried around the blood stream to the body tissues. In a similar way, if carbon monoxide is present it also bonds with the hemoglobin to form carboxyhemoglobin (COHb) and this precludes the hemoglobin from bonding with oxygen. Unfortunately, the carbon monoxide is estimated to be about 200 times more reactive than oxygen, so when both are present most of the active sites of the hemoglobin are taken up by the carbon monoxide.

The effect of carbon monoxide exposure is usually described in terms of the percentage of carboxyhemoglobin in the blood (% COHb). Continuous exposure to carbon monoxide at a concentration of 30 ppm leads to a COHb level of about 5%; continuous exposure at 20 ppm equates to a COHb of 3.7% and continuous exposure at 10 ppm equates to a COHb blood level of 2%. Note "continuous exposure" is important, if for example an individual is exposed to 30 ppm CO, it takes about 4 hours for the COHb blood content to build to about 4% and a further 4 hours to reach the 5% level. For this reason, some agencies have accepted a far higher concentration as a ceiling for exposure, e.g. NIOSH who set a 200 ppm ceiling for exposure, a ceiling being a level that shall not be exceeded at any time. Other recommended permissible exposure limits are:

Pertinent Standards and Concentrations	
ASHRAE Std 62.1-2004	9 ppm (8 hour average)
NAAQS	35 ppm (1 hour average)
ACGIH TLV	25 ppm (8 hour TWA)
NIOSH	35 ppm (8 hour TWA)
OSHA PEL	50 ppm (8 hour TWA)
NIOSH	200 ppm (ceiling limit)
NAAQS	9 ppm (8 hour average)
LEED	9 ppm (4 hour average)

The symptoms of carbon monoxide exposure include headaches, drowsiness, nausea, upper respiratory complaints, chest pain, impaired judgment, and death from asphyxiation. Levels as low as 2.5% COHb have been found to aggravate the symptoms of angina. However, no adverse health effects have been reported when the concentration of COHb has been below 2%. For this reason, HBI adopts the 9 ppm concentration of carbon monoxide as the recommended guideline for office areas since at this concentration the blood level of COHb should never reach 2%.

Carbon monoxide measurements were electronically recorded for the 4 hour period of testing with a calibrated instrument containing and electrochemical sensor meeting EPA IP-3A standards.

Testing of Building Air for Carbon Monoxide

Location	CO Range found (ppm)	CO Average reading (ppm)
Outdoors	0.9-1.8 ppm	1.2 ppm
15F NE Perimeter Office, M. Heitz	0 ppm	0 ppm

Conclusions

These results are all below the LEED recommended acceptable upper limit for carbon monoxide. The LEED upper limit is described as 9 ppm or 2 ppm above the outdoor levels. The highest indoor average was 0 ppm on the day of testing and the levels meet requirements acceptable to LEED.

Summary

Indoor air quality testing conducted in accordance with LEED criteria on the fifteenth floor of the building found each constituent tested to be within the parameters required. In our opinion, this floor qualifies for LEED Credit EQ 3.2.

We have attached a copy of a completed LEED CI Version 2.0 EQ 3.2 Option B template on HBI letterhead as well as field notes, forms, instrument calibrations, copies of carbon monoxide data and laboratory analysis reports as supporting data.

If you have questions about this report, please contact me at 973-394-1330 or dtyler@hbiamerica.com.

For Healthy Buildings International, Inc. (HBI),

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