APPENDIX O

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June 24th 2003

Mr. Brian Schiltz
Project Engineer
TG Construction, Inc.
119 Standard Street
El Segundo, CA 90245-3833

Dear Mr. Schiltz,

This letter provides documentation of indoor air quality (IAQ) procedures conducted by TG Construction for the Inland Empire Utilities Agency new headquarters in Chino, California. These procedures are in pursuit of LEED IEQ Credit 3.2., to develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and pre-occupancy phases of two buildings (A and B).

In LEED 2.0 two distinct procedures are prescribed for earning this point, through a two-week flush-out period duly documented by the engineer or architect, and/or a testing procedure. The testing procedure can be modified according to a request for interpretation granted by USGBC on October 8th 2002. The interpretation requires the following procedure:

Conduct a baseline indoor air quality testing procedure that randomly selects sampling points for every 25,000 square feet, or for each contiguous floor area, whichever is larger, to measure the maximum concentration levels for the chemical contaminants listed below:

Chemical Contaminant	Maximum Concentration	Reference Standard
Carbon Dioxide (CO_2)	530 parts per million *	ASHRAE 62-1999
Formaldehyde	50 parts per billion	State of Washington IAQ Standard
Particulates	150 $\mu g/m^3$	EPA National Ambient Air Quality Standard
TVOC	500 $\mu g/m^3$	State of Washington IAQ Standard
4-PCH	6.5 $\mu g/m^3$	State of Washington IAQ Standard

*This measurement is required only if the building is regularly occupied during the testing. Measured differential between indoor and outdoor conditions is based on occupancy type as defined by ASHRAE 62-2001. Maximum concentration differential in parts per million = 10,300 / ventilation rate per occupant in cubic feet per minute.

For each building area where the maximum concentration limits are exceeded conduct a partial building flush-out, for a maximum of two weeks, then retest the indoor air quality levels to indicate the requirements are achieved.

This letter records the results of the testing procedure in these buildings, the location of readings that did not meet these criteria initially, and the results of the repeat testing. The initial Testing of Buildings A and B was completed May 27th 2003, and the parameters required to be retested were completed after an approximate two week flush-out period on June 13th 2003.

Results:

May 27th 2003 Testing

No	Location	4-Phenylcyclohexene (μg/m³)	Total VOCs (μg/m³)
1	Building A	<3.1	580
2	Building B	<2.8	242

June 13th 2003 Testing

No	Location	4-Phenylcyclohexene (μg/m³)	Total VOCs (μg/m³)
1	Building A	4.4	122

CONCLUSION

During the first round of testing the sum of all the VOCs detected in Building A was slightly higher than the LEED criteria of 500 μg/m³ though Building B was found to be well below this criterion. This required that Building A be retested. We retested this parameter in Building A during the second round of testing and found the level to be well inside the LEED compliance level. They are therefore now both considered satisfactory.

Looking at the levels of 4-phenylcyclohexene detected we noted that none of them exceeded the the LEED requirement of 6.5 μg/m³; these very low levels are unlikely to cause adverse health effects in normally healthy occupants.

Summary

Indoor air quality testing conducted in accordance with LEED criteria at the Inland Empire Utilities Agency buildings found each constituent tested to be within the parameters required. Both buildings in our opinion qualify for LEED Credit 3.2.

If you have any questions about this report please call me at (949) 340-1111.

Sincerely,

S Turner

Simon Turner
Director, Western Region

Cc Marc Cohen, CTG Inc.

Carbon Dioxide

None of the floor plates tested was occupied during the testing or the retesting, so in accordance with the LEED interpretation, carbon dioxide testing is not required in these instances.

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 excessively high 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
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)
HBI's recommended guidelines for typical commercial offices	0.075 8 hour TWA

(HBI also advises occupants that sensitized individuals may react at 0.05 ppm)

Sampling and Analysis of Building Air for Formaldehyde Content

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

Method: Direct Reading Meter.

Results:

May 27th 2003 Testing

Building A

Location	Formaldehyde Concentration (ppm)
WC open cube area	0.215
NW perim office	0.190
EC open cube area	0.225
SE perim office	0.190
SC open office area	0.205
NE open office area	0.130
SW interior office	0.220

Building B

Location	Formaldehyde Concentration (ppm)
WC open cube area	0. 195
NC perim office	0.255
SE open cube area	0.225
SW large open conf area	0.190
SC dining area	0.205
NWC open office area	0.130
NE interior office	0.215

June 13th 2003Testing

Building A

Location	Formaldehyde Concentration (ppm)
WC open cube area	<0.010
NW perim office	0.010
EC open cube area	0.015
SE perim office	<0.01
SC open office area	<0.01
NE open office area	<0.01
SW interior office	0.020

Building B

Location	Formaldehyde Concentration (ppm)
WC open cube area	0.010
NC perim office	0.020
SE open cube area	0.025
SW large open conf area	<0.01
SC dining area	<0.01
NWC open office area	0.010
NE interior office	<0.01

CONCLUSIONS

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

On the initial day of our tests the levels detected in both buildings were above this LEED compliance criterion and were therefore retested after the flushout period. At the second round of testing levels were dramatically lower, well inside the LEED and OSHA compliance level. They are therefore considered satisfactory.

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. This International Standard has been adopted by HBI. Sampling measurements to this standard are achieved by removing the larger airborne size fraction using a 10 mm nylon cyclone at a flow rate of 1.7 liters per minute then calculating the mass of the RSP fraction with an approved measuring device.

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 $\mu g/m^3$ they are considered to be concentrations of concern. LEED has accepted the EPA National Ambient Air Quality Standard of 150 $\mu g/m^3$ as the criterion for acceptability.

Airborne Particle Weights — Pertinent Standards

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

*Annual averaging regulates cumulative exposures over a one year period and says little about day to day exposures. It is entirely possible to exceed a 150 μg/m^3 (24 hr) average on several occasions and still achieve a 50 μg/m^3 annual average. Thus, for regulating day to day exposures the 150 μg/m^3 (24 hr) standard is more appropriate and, in some circumstances, may be more stringent. Similarly, short duration sampling times of typically 1 - 5 minutes may exceed an 8 hr TWA, but this does not mean that the TWA value has necessarily been breached.

Measurement Techniques for RSP

The three techniques routinely used by researchers are a) gravimetric analysis, in which the particle size cut-off can be specified by the user; b) Piezo microbalances supplied by the manufacturer with a defined particle size cut-off; and c) aerosol mass monitors based on light scattering principles, such as the "DustTrak" monitors made by TSI Incorporated, St Paul, MN, which are supplied with a size cut-off and flow rate matching the ISO/CEN standard of 4 microns. Because of the differences in size cut-offs, cyclone types, flow rates and basic measurement principles between these various techniques, it is difficult to make direct comparisons between the results obtained from each method.

The instrument used for RSP measurements in these buildings was the DustTrak Aerosol Monitor model 8520. For use in monitoring non-industrial indoor airborne dusts the factory calibration standard based on the Arizona Test Dust Standard was used. Thus any comparison of HBI results with other instrument results from the same sampled areas must first ensure that such other instruments employ the same cut-off point for RSP of 4 microns, have the same cyclone design, and use a similar sampling rate.

Weighing of Respirable Suspended Particulate (RSP) in Building Air

Objective: To assess the weight of respirable airborne particles at random locations in occupied areas of the building and compare with available standards.

Method: Short-term air sampling and weighing of particles by real-time electronic aerosol mass monitor.

Results:

May 27th 2003 Testing

Building A

Location	Respirable Suspended Particulates (µg/m^3)
WC open cube area	173
NW perim office	157
EC open cube area	87
SE perim office	107
SC open office area	116
NE open office area	77
SW interior office	87

Building B

Location	Respirable Suspended Particulates (µg/m^3)
WC open cube area	133
NC perim office	68
SE open cube area	101
SW large open conf area	95
SC dining area	104
NWC open office area	154
NE interior office	61

June 13th 2003 Testing

Building A

Location	Respirable Suspended Particulates (µg/m^3)
WC open cube area	23
NW perim office	29
EC open cube area	30
SE perim office	21
SC open office area	41
NE open office area	26
SW interior office	35

Building B

Location	Respirable Suspended Particulates (µg/m^3)
WC open cube area	36
NC perim office	30
SE open cube area	23
SW large open conf area	27
SC dining area	17
NWC open office area	19
NE interior office	19

CONCLUSIONS

Some of the initial testing results in both buildings were above the LEED recommended acceptable upper limit for airborne respirable particles of 150 micrograms per cubic meter of air although the mean levels were below this value. We nevertheless retested this parameter in both buildings during the second round of testing and found levels to be well inside the LEED compliance level. They are therefore considered 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, laquers, varnishes, dry-cleaning fluid	Old fire extinquishers, 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 dispersing agent	Cleaning agents, waxes, polishes
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) (PCE) or "PERC"	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 (Dimethyl benzene)	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. Commonsense 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 range" from 200 $\mu g/m^3$ up to 500 $\mu g/m^3$ based on our own experience. Moreover, LEED's criteria of 500$\mu g/m^3$ is based on the State of Washington Standard.

Tentative Dose Response to TVOCs

Grade	Airborne TVOC concentration ($\mu g/m^3$)	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 $\mu g/m^3$. 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)	Molhave's table (see above)

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.

APPENDIX P

LEED Indoor Environmental Quality

PROJECT: INLAND EMPIRE UTILITIES AGENCY HEADQUARTERS - CHINO
PREPARED BY: CTG ENERGETICS, Inc. DATE: 23 October 2003

LOW EMITTING MATERIALS: Adhesives and Sealants
IEQ.CO4.1 Points Achieved: 1

This is a listing of all indoor adhesive and sealant products used on the project as represented by the General Contractor.

Adhesive VOC levels compared to SCAQMD Rule 1168 Effective (2/2001)
Sealant VOC levels compared to BAAQMD Regulation 8 Rule 51

Adhesives

Product	Category	VOC Content (g/l)	SCQMD Limit (g.l)
Liquid Nails Heavy Duty Construcion and Remodeling Adhesive	Multi-Purpose Adhesive	70	70
Chapco SafeSet 7	Vinyl Flooring Adhesive	0	50
Re:Source Technologies Grid Set Green Glue 2000	Indoor Carpet Adhesive	0	50

Sealants

Product	Category	VOC Content (g/l)	BAAQMD Limit (g.l)
Re:Source Technologies Re:Seal 4800	Architectural Sealant	None	250
Collins and Aikman C-36 Floor Primer	Architectural - Non-Porous Primer	None	250
Pecora AC-20 + Silicone Caulk	Architectural Sealant	31	250
OSI HM-270 Construction Silicone Sealant	Architectural Sealant	40	250
USG Sheetrock Acoustical Sealant	Architectural Sealant	65	250