



Exponent
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May 30, 2017

Lynn M. Beekman, Esq.
Fagen Friedman & Fulfroost LLP
1525 Faraday Avenue, Suite 300
San Diego, California 92008

VIA ELECTRONIC MAIL: lbeekman@f3law.com

Subject: Volatile Organic Compound (VOC) Emissions from Select Installed Carpet Tiles,
Bridgeport Elementary School
23670 Newhall Ranch Road, Valencia, California
Exponent Project No. 1703766.000

Dear Ms. Beekman:

Exponent conducted an indoor air quality investigation at Bridgeport Elementary School in Valencia, California, on Sunday, May 7, 2017. We issued a report to you titled "Indoor Air Quality Investigation, Bridgeport Elementary School, 23670 Newhall Ranch Road, Valencia, California" dated May 23, 2017, (further referred to as the "IAQ Report") outlining the results, findings, and recommendations from our investigation. In the IAQ Report, we recommended that additional emissions testing be conducted on carpet tile samples that we collected during our original inspection. We obtained four representative carpet tile samples from different classrooms at the school and submitted them to a laboratory for emission testing. The objective of this investigation was to identify volatile organic compounds (VOCs) that may be contributing to odors within the classrooms.

This letter includes a summary of our findings, study methods, and our findings. The laboratory report from Berkeley Analytical Associates is provided in Attachment A. Representative photographs are provided in Attachment B and are referenced in this report.

Summary

We obtained four carpet tile samples from four classrooms at the Bridgeport Elementary School on May 7, 2017. Three carpet tile samples were collected from rooms with noticeable odors, staining, and/or the obvious presence of moisture; the fourth carpet tile sample was collected from a classroom where these conditions were absent. The samples were submitted to Berkeley Analytical Associates for emission chamber testing following standard procedures and analysis

for volatile organic compounds (VOCs). Based on the results of the testing, we found detectable levels 2-ethyl-1-hexanol and other VOCs that are likely contributing to the odors within the classrooms. This finding is supported by articles in the scientific literature. Chamber emission rates of VOCs (in particular 2-ethyl-1-hexanol) tracked the intensity of the odor observations we made during our inspection on May 7, 2017. The emission rates reported in this letter were obtained during emission testing in a controlled chamber at a laboratory. They are presented as a relative comparison between samples and may not be reflective of actual emissions from installed carpet tiles within the classrooms. The findings in this letter do not alter the conclusions presented in Exponent's May 23, 2017 IAQ Report.

Study Methods

Collection of Representative Carpet Samples

Four bulk carpet samples were obtained from four classrooms, as follows:

- Three (3) carpet tile samples were collected from rooms with noticeable odors, staining, and/or the obvious presence of moisture when the carpet tile was lifted. Carpet tiles were obtained from classrooms: A11, A76, and C1, as shown in Photos 1, 2, and 3, respectively. These samples are further referred to as the "impacted" samples.
- One (1) carpet tile sample was collected from classroom A10 (Photo 4), where there were no noticeable odors, staining, and/or the obvious presence of moisture when the carpet tile was lifted. This sample served as a point of comparison for three of the impacted samples.

Samples were obtained by cutting an approximate one square foot section of each tile using metal shears. Prior to cutting the sample, the underside of the carpet tile was inspected. The sample was cut from the section where obvious staining was heaviest in cases where this condition was present or where strong odors were perceived beneath the carpet tile. After cutting, each sample was carefully and tightly wrapped in multiple layers of aluminum foil to limit off-gassing. The wrapped samples were then photographed, placed in dedicated plastic bags, uniquely labeled, logged on a chain-of-custody form and transported to Berkeley Analytical Associates in Richmond, California. During transit, the samples were kept in a cool (room temperature) dry location. The gap in the larger carpet tile that remained in the classroom was carefully covered using aluminum foil to restrict any off-gassing from the exposed concrete slab into the classrooms until a new tile could be installed (Photo 5). We understand that carpet tiles that were cut as part of this sampling were replaced prior to the start of the school day on the morning of May 8, 2017, by school district employees.

Chamber Testing

Samples submitted to Berkeley Analytical Associates were subjected to emission testing following the American Society of Testing Materials (ASTM) D 5116 titled, “Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products.” During this emission testing, the carpet samples were trimmed to fit within the chamber and placed on a metal grate. The metal grate was intended to allow VOCs to emit from both the top surface and bottom surface that are in contact with the concrete slab. This configuration was intended to allow for off-gassing from the bottom surface of the carpet tile to increase the likelihood that VOCs would be sufficiently present in the chamber air and available for detection and identification by the laboratory. Therefore, the values presented do not represent emissions of the installed product. The chamber was kept under controlled conditions (i.e., temperature, humidity, ventilation rate) for a period of 24 hours. After a 24-hour period, air samples were collected and analyzed for VOCs according to U.S. Environmental Protection Agency (U.S. EPA) Compendium Method TO-17. Both individual and total VOC emission rates were reported. Samples were also collected and analyzed for acetaldehyde and formaldehyde following ASTM D5197. Background samples were also collected to determine if any chemicals were present in the chambers prior to commencing the testing. More details regarding the chamber testing conducted by Berkeley Analytical Associates are provided in Attachment A.

Findings

The VOCs and their detected emission rates in the air collected from the chamber are presented in Table 1. In addition, we have provided general perceptions of odor, presence of moisture, and/or presence of staining beneath the carpet tile, as outlined in the IAQ Report.

Table 1. Summary of 24-Hour Chamber Emission Rates (in $\mu\text{g}/\text{m}^2\text{-hour}$)

Chemical	Sample ID:	A76-1B	A11-1B [a]	C1-1B	A10-1B [b]
1,2-Propanediol (Propylene glycol)		13.2	10.5	8.1	ND
1-Butanol		65.9	11.5	ND	ND
1-Heptanol		ND	ND	ND	10.9
1-Nonanol		ND	ND	ND	18.8
1-Octanol, 3,7-dimethyl-		ND	ND	ND	32.4
1-Udecanol		ND	ND	ND	6.2
2-(hexyloxy) ethanol		ND	ND	5	ND
2-Ethyl-1-hexanol		959.9	74.7	5.6	12.3
2-Propanone (acetone)		13.5	4.5	9.1	ND
Acetic acid		6.4	7	ND	9.6
Benzaldehyde, 4-methyl-		9	ND	ND	ND
Benzoic Acid		ND	4.6	ND	ND
C8 Alcohol		ND	ND	ND	5.3
Caprolactam		ND	18.2	17.5	32.7
Decanal		4.6	45.5	ND	ND
Ethanone,1-cyclopentyl-		6.8	ND	ND	ND
Ethylene glycol		10.7	25.4	ND	ND
Hexanal		5.6	ND	ND	ND
Nonanal		ND	123.7	4.5	ND
Nonanoic acid		ND	24.8	ND	ND
Octanal		ND	14.7	ND	ND
Unidentified Compound		ND	ND	ND	17.8
TVOCs		1193	270	49	159
May 7, 2017, Inspection Observations					
Staining under carpet observed:		Yes	Yes	Yes	No
Moisture under carpet:		Yes	Yes	Yes	No
Odor under carpet:		Yes	Yes	Yes	No

Notes

The emissions presented in this table were obtained during emission testing in a controlled chamber at a laboratory and may not be representative of actual emissions from installed carpet tiles within the classroom.

Notes (continued)

[a] Acetone and nonanal detected in background sample.

[b] Acetone, decanal, and nonanal detected in background air.

ND = not detected.

$\mu\text{g}/\text{m}^2\text{-hour}$ = micrograms per square
meter per hour (emission factor)

As shown in Table 1, the VOC detected with the highest emission rates is 2-ethyl-1-hexanol. This compound has been identified in the indoor air of buildings where carpet tile backing or glue is degrading in the presence of moisture under alkaline conditions.^{1,2} Based on this emission testing, it is likely that the cause of the odor in the classroom is associated with low concentrations of 2-Ethyl-1-hexanol and other hydroxyl-group containing compounds (i.e., alcohols) detected in the emission testing under certain conditions (e.g., low or no ventilation). As previously stated, the emissions presented in Table 1 were obtained during emission testing in a controlled chamber at a laboratory and may not be representative of actual emissions from installed carpet tiles and resultant air concentrations within the classroom. As presented in the IAQ Report, a variety of low level VOC detections were reported in the classrooms, with all being well below health based comparison values.

The relative emission rates of VOCs between the carpet tile samples were further supported by observations made during our May 7, 2017, inspection and described in our IAQ Report. More specifically, odor perception at the time of our inspection mirrors the relative magnitude of the reported VOC emission rates. That is, stronger odors were noted when the carpet tiles were lifted in A76 relative to A11 and C1. In room A10, no odors, staining, or moisture were noted under the carpet tiles. Emission rates for 2-ethyl-1-hexanol generally followed this trend with the emission rate highest for the A76 sample and decreasing in the other samples that generally mirrored our odor perceptions. Further, elevated concentrations of VOCs were measured using a handheld photoionization detector (PID) under the carpet tile in room A76 relative to the other rooms.

Based on the indoor air sampling at the school and as outlined in the IAQ Report, the cause of the odor in some of the classrooms appears to be related to the moisture under the carpets and the VOCs described above. A variety of chemicals were detected in the indoor air samples collected within the classrooms on May 7, 2017, and all were at very low concentrations.

¹ Gunilla Wieslander PhD , Anders Kumlin & Dan Norbäck PhD (2010) Dampness and 2-Ethyl-1-hexanol in Floor Construction of Rehabilitation Center: Health Effects in Staff, Archives of Environmental & Occupational Health, 65:1, 3-11.

² As described in the IAQ report, 2-ethyl-1-hexanol was not detected in the indoor air samples collected at the school on May 7, 2017, indicating that classroom occupants are not being exposed to it at reportable levels. Although there are no published regulatory health-based exposure standards for 2-ethyl-1-hexanol, the odor threshold concentrations for this chemical are well below concentrations associated with sensory irritation, as reported in Gunilla et al. (2010).

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The findings outlined in this letter do not alter the conclusions made in the IAQ Report.

Limitations

This assessment was limited to the samples collected from rooms A76, A11, C1, and A10 and their condition that existed on May 7, 2017. The bulk carpet tile sampling reflected the conditions that existed at the time of this evaluation, and such conditions may be different at other times.

Exponent investigated specific issues relevant to the evaluation as provided by the client. Therefore, the scope of services performed during this assessment may not adequately address the needs of others, and any re-use of or reliance on this report or the findings, conclusions, or recommendations presented herein is at the sole risk of the user. If any errors in this report are discovered, please notify us so that we can respond to any concerns.

If you have any questions or require any additional information, please contact me via phone at 510-268-5077.

Sincerely,



Michael Posson, M.P.H., CIH
Managing Scientist

Attachment A: Berkeley Analytical Associates Laboratory Reports (4)
Attachment B: Photographs

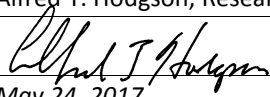
Attachment A

Berkeley Analytical Associates Laboratory Report

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815 Harbour Way South, Suite 6
Richmond, CA 94804-3614
Ph. 510-236-2325; Fax 510-236-2335
E-mail info@berkeleyanalytical.com

Building Product VOC Emission Factors

Customer & Building Product Sample Information

Report Certification	
Report number	096-071-01A-May2417
Report date	May 24, 2017
Certified by (Name/Title)	Alfred T. Hodgson, Research Director
Signature	
Date	May 24, 2017

Standard	
Test method	ASTM D 5116-10 (Small Chamber)

Customer Information	
Manufacturer or organization	Exponent, Inc.
City/State/Country	Oakland, CA
Contact name/Title	Mike Posson
Phone number	510-387-7695

Product Sample Information*	
Manufacturer (if not customer)	Same as above
Product name / Number	24"x24" Carpet Tile - Installed / A76-1B
Product CSI category	Other (99 10 00)
Customer sample ID	not provided
Manufacturing location	not provided
Date sample manufactured	not provided
Date sample collected	May 7, 2017
Date sample shipped	May 11, 2017
Date sample received by lab	May 12, 2017
Condition of received sample	No observed problems
Lab sample tracking number	096-071-01A
Conditioning start date & duration (if applicable)	None
Chamber test start date & duration	May 15, 2017; 1 days (24 hours)
Total test start date & duration	May 15, 2017; 1 days (24 hours)

*Chain-of-custody (COC) form for product sample is attached to this report

Test Method for Building Product Samples

Test Specimen Preparation – Cut a test specimen from the received sample leaving top and bottom surfaces exposed. The emission factor calculations are based on the top surface of 17.8cm*17.8cm. Photographs of the tested specimen are given later in this report. The test results presented herein are specific to this item.

Test Protocol Summary* – This VOC emission test was performed following the guidance of [ASTM Standard Guide D 5116](#). If required by the test, chemical sampling and analysis for VOCs were performed following [U.S. EPA Compendium Method TO-17](#). If required, sampling and analysis for low molecular weight aldehydes were performed following [ASTM Standard Method D 5197](#). The product specimen was prepared from the supplied product sample. If conditioning was required, the specimen was placed directly into the conditioning environment and maintained at controlled conditions of air flow rate, temperature and relative humidity for the specified period. At the end of this period, the specimen was transferred directly to a small-scale chamber. If conditioning was not required, the specimen was placed directly into the small-scale chamber. The chamber conditions for the test period are summarized in Table 1. Air samples were collected from the chamber at one or more specified elapsed times. Samples for the analysis of individual VOCs and TVOC, as required, were collected on multisorbent tubes containing Tenax-TA backed by a carbonaceous sorbent. Samples for the analysis of low molecular weight aldehydes, as required, were collected on treated DNPH cartridges.

Analyses of target chemicals and chemical groups were performed using the following procedures as required. Note: The target chemicals and chemical groups selected for the test (Table 2) determined which procedures were used. VOC samples were analyzed by thermal desorption GC/MS. TVOC was calculated using toluene as the calibration reference. Individual VOCs (iVOCs) were quantified using multi-point (4 or more points) with calibration curves prepared with pure standards, unless otherwise noted. iVOCs without pure standards were quantified based on their total-ion-current responses using toluene as the calibration reference. Formaldehyde and acetaldehyde were analyzed by HPLC and quantified using multi-point (4 or more points) calibration curves. The analytical instruments and their operating parameters used for these analyses are described in Appendix A.

Availability of Data – All data, including but not limited to raw instrument files, calibration files, and quality control checks used to generate the test results will be made available to the customer upon request.

Table 1. Chamber conditions for test period

Parameter	Symbol	Units	Value
Tested specimen exposed area	A _S	m ²	0.032
Chamber volume	V _C	m ³	0.067
Loading ratio	L	m ² /m ³	0.473
Avg. Inlet gas flow rate & Range	Q _C	m ³ /h	0.067 (0.064-0.070)
Avg Temperature & Range		°C	23.1 (22-24)
Avg Relative humidity & Range		%	52 (45-55)
Test period duration		h	24
Earlier air sampling time(s)		h	none

*All standards identified in this section are included in Berkeley Analytical's scope of ISO/IEC17025 accreditation, Testing Laboratory TL-383, International Accreditation Service, www.iasonline.org

VOC Emission Test Results

Target Chemicals – The target chemicals and chemical groups selected for this test are listed in Table 2.

Table 2. Target chemicals and chemical groups and applicable sampling and analytical method standards

Chemical/Chemical Group	CAS No	Standard
TVOC	--	EPA TO-17
Formaldehyde	50-00-0	ASTM D 5197
Acetaldehyde	75-07-0	ASTM D 5197
iVOCs	--	EPA TO-17

Chamber Background Concentrations – Background concentrations of target chemicals and chemical groups measured at time zero are reported in Table 3. Reported chamber concentrations are background corrected.

Table 3. Chamber background VOC concentrations at time zero. Only target chemicals and chemical groups that were detected in the chamber background are listed

Chemical/Chemical Group	CAS No	Chamber Conc (µg/m ³)
Acetaldehyde	75-07-0	LQ
Formaldehyde	50-00-0	LQ
TVOC	--	LQ

VOC Emission Test Results, Continued

Emitted VOCs – Individual VOCs (iVOCs) detected in the test above lower limits of quantitation are reported in Table 4. All iVOCs with pure standard calibrations are listed first. iVOCs quantified using toluene as the reference standard are listed next; identifications of these compounds are considered tentative.

Table 4. iVOCs detected above lower limits of quantitation in chamber air sample

Chemical	CAS No	Surrogate?*
1-Butanol	71-36-3	
Ethylene glycol	107-21-1	
2-Propanone (acetone)	67-64-1	
Hexanal	66-25-1	
1,2-Propanediol (Propylene glycol)	57-55-6	
2-Ethyl-1-hexanol	104-76-7	
Decanal	112-31-2	
Acetic acid	64-19-7	Yes
Ethanone, 1-cyclopentyl-	6004-60-0	Yes
Benzaldehyde, 4-methyl-	104-87-0	Yes

*"Yes" response indicates iVOC quantified using toluene as the calibration reference; all other iVOCs quantified using pure standards

VOC Emission Test Results, Continued

VOC Chamber Concentrations and Emission Factors – The chamber sample was analyzed for TVOC and the iVOCs listed in Table 4. The emission factors for TVOC and iVOCs were calculated from the chamber parameters, the measured quantity of the test specimen and the chamber concentrations. Chamber concentrations and emission factors for iVOCs and TVOC are listed in Table 5 and Table 6, respectively.

Table 5. Measured chamber concentrations and calculated emission factors for iVOCs

Chemical/Chemical Group	Elapsed Time (h)	Chamber Concentration ($\mu\text{g}/\text{m}^3$)	Emission Factor ($\mu\text{g}/\text{m}^2\text{-h}$)
1,2-Propanediol (Propylene glycol)	24	6.2	13.2
1-Butanol	24	31.0	65.9
2-Ethyl-1-hexanol	24	452.0	959.9
2-Propanone (acetone)	24	6.3	13.5
Acetic acid	24	3.0	6.4
Benzaldehyde, 4-methyl-	24	4.2	9.0
Decanal	24	2.2	4.6
Ethanone, 1-cyclopentyl-	24	3.2	6.8
Ethylene glycol	24	5.1	10.7
Hexanal	24	2.7	5.6

Table 6. Measured chamber concentrations and calculated emission factors for TVOC

Chemical/Chemical Group	Elapsed Time (h)	Chamber Concentration ($\mu\text{g}/\text{m}^3$)	Emission Factor ($\mu\text{g}/\text{m}^2\text{-h}$)
TVOC	24	562	1193

Photographs of Tested Product Specimen

Photo Documentation – The product sample specimen is photographed immediately following specimen preparation and prior to initiating the test. Typically, the top and bottom faces of the specimen are photographed. Bottom faces may show a stainless steel plate or other substrate if required by the test.



Definitions

Table 7. Definitions of parameters

Parameter/Value	Definition
CARB TAC	Toxic Air Contaminant (TAC) on California Air Resources Board list, with toxic category indicated
CAS No.	Chemical Abstract Service registry number providing unique chemical ID
Chamber Conc.	Measured chamber VOC concentration at time point minus any analytical blank or background concentration for empty chamber measured prior to test. Lower limit of quantitation (LQ) or reporting limit for individual VOCs is 2 µg/m ³ unless otherwise noted
CREL	Chronic non-cancer Reference Exposure Level established by Cal/EPA OEHHA (http://www.OEHHA.ca.gov/air/allrels.html)
Emission Factor	Mass of compound emitted per unit area per hour (calculation shown below). Reporting limits for emission factors are established by LQ or reporting limit for chamber concentration and specimen area tested
Formaldehyde & acetaldehyde	Volatile aldehydes quantified by HPLC following ASTM Standard Method D 5197. LQs for formaldehyde and acetaldehyde are 1 µg/m ³ and 1.6 µg/m ³ , respectively
Individual VOC (iVOC)	Quantified by thermal desorption GC/MS following EPA Method TO-17. Compounds quantified using multi-point calibrations prepared with pure chemicals unless otherwise indicated.
LQ	Indicates calculated value is below its lower limit of quantitation
Prop 65 list	“Yes” indicates the compound is a chemical known to cause cancer or reproductive toxicity according to California Safe Drinking Water Toxic Enforcement Act of 1986 (Proposition 65)
TVOC	Total Volatile Organic Compounds eluting over retention time range bounded by n-pentane and n-heptadecane and quantified by GC/MS TIC method using toluene as calibration reference. LQ for TVOC is 20 µg/m ³
“na”	Not applicable
“<”	Less than value established by LQ

Equations and Comments

Equations Used in Calculations – An emission factor (EF) in $\mu\text{g}/\text{m}^2\text{-h}$ for a chemical in a chamber test of a building product sample is calculated using Equation 1:

$$\text{EF} = (Q_c(C - C_o)) / A_s \quad (1)$$

where Q_c is the chamber inlet air flow rate (m^3/h), C is the VOC chamber concentration ($\mu\text{g}/\text{m}^3$), C_o is the corresponding chamber background VOC concentration ($\mu\text{g}/\text{m}^3$), and A_s is the tested specimen exposed area (m^2).

Comments: Odor investigation test and tested per worst case exposure leaving both surfaces and edges exposed.

END OF REPORT

BERKELEY ANALYTICAL
815 Harbour Way South, Suite 6
Richmond, CA 94804-3614

Appendix A
Analytical Instruments & Operating Parameters

Table A1. Description of analytical instrument components

Component	Description
HPLC	1260 Infinity Quaternary LC, G1314F VW Detector, Agilent
Analytical column	Poroshell 120 EC-C18, Agilent
Column dimensions	2.1 mm x 100 mm
Thermal desorber	Unity / TD100, Markes International, Ltd.
Gas chromatograph	Model 7890A, Agilent
Analytical column	DB-624, J&W Scientific
Column dimensions	1 µm film, 0.18 mm ID, 20 m
Mass spectrometer	Model 5975C MSD, Agilent

Table A2. HPLC operating parameters for analysis of formaldehyde and acetaldehyde

Parameter	Value
Solvent A	65/35% H ₂ O/Acetonitrile
Solvent B	100% Acetonitrile
Flow rate	0.3 mL/min
End time	11 min
Detector wavelength	360 nm

Table A3. Thermal desorption GC/MS parameters used for analysis of iVOCs and TVOC

Parameter	Value
Thermal desorption	
Tube desorb temperature	285 °C
Trap temperature	-5 °C
Trap desorb temperature	300 °C
Trap desorb split ratio	10:1
Gas chromatograph	
Initial temperature	40 °C
Initial temperature time	6.0 min
Final temperature	225 °C
Final temperature time	3 min
Mass spectrometer	
Low scan mass, <i>m/z</i>	30 amu
High scan mass, <i>m/z</i>	450 amu
Scan rate	3.42 Hz

CHAIN OF CUSTODY RECORD/SAMPLE ANALYSIS REQUEST FORM

Project Name / Number: 1703766 000 Sampling Date: 5/7/2017

Ship To: Berkeley Analytical
815 Harbor Way
Richmond, CA 94804

Lab Contact: Al Hodgson
 Phone: 510-236-2325
 E-mail: mposson@exponent.com

SAMPLERS: Mike Posson

Exponent Contact: Mike Posson
 Direct Phone: 510-387-7695
 Email: mposson@exponent.com

Office Location:
 Farmington Hills, MI (248) 324-9100
 Menlo Park, CA (650) 326-9400
 Oakland, CA (510) 268-5000
 Other: _____

Sample No.	Time	Vol(L)	Fungi: Spore Trap Analysis	Fungi: Direct Microscopic Exam	Culturable Fungi: Std. Quant. Analysis	Fungi: w/Pen. and Asp. Speciation	24-hr. ULL-EMSAW Test (ASTM D5116)	Matrix	Area	Remarks / Sample Location
A76-1B	N/A	M/A					X	B		Per Estimate # 170510-2
A11-1B	↓	↓								
A10-1B	↓	↓								
C1-1B	↓	↓								

MATRIX CODE: BC = Biocassette ST = Spore Trap
 B = Bulk T = Tape
 D = Dust SW = Swab

OTHER: please identify code: _____

PRIORITY: Standard Rush Next Day 2-Day Same Day (Extra Fee)
 Due Date: _____

Shipped Via: FedEx UPS Courier Hand Other: _____

Condition of Samples Upon Receipt: _____

Custody Seal Intact: Yes No None

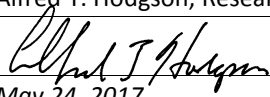
Relinquished by: Michael Posson Date/Time: 5/11/17 @ 1345 Received by: F. MASRI Date/Time: 5/12/17

Relinquished by: _____ Date/Time: _____ Received by: _____ Date/Time: _____

BERKELEY ANALYTICAL
815 Harbour Way South, Suite 6
Richmond, CA 94804-3614
Ph. 510-236-2325; Fax 510-236-2335
E-mail info@berkeleyanalytical.com

Building Product VOC Emission Factors

Customer & Building Product Sample Information

Report Certification	
Report number	096-071-02A-May2417
Report date	May 24, 2017
Certified by (Name/Title)	Alfred T. Hodgson, Research Director
Signature	
Date	May 24, 2017

Standard	
Test method	ASTM D 5116-10 (Small Chamber)

Customer Information	
Manufacturer or organization	Exponent, Inc.
City/State/Country	Oakland, CA
Contact name/Title	Mike Posson
Phone number	510-387-7695

Product Sample Information*	
Manufacturer (if not customer)	Same as above
Product name / Number	24"x24" Carpet Tile - Installed / A11-1B
Product CSI category	Other (99 10 00)
Customer sample ID	not provided
Manufacturing location	not provided
Date sample manufactured	not provided
Date sample collected	May 7, 2017
Date sample shipped	May 11, 2017
Date sample received by lab	May 12, 2017
Condition of received sample	No observed problems
Lab sample tracking number	096-071-02A
Conditioning start date & duration (if applicable)	None
Chamber test start date & duration	May 15, 2017; 1 days (24 hours)
Total test start date & duration	May 15, 2017; 1 days (24 hours)

*Chain-of-custody (COC) form for product sample is attached to this report

Test Method for Building Product Samples

Test Specimen Preparation – Cut a test specimen from the received sample leaving top and bottom surfaces exposed. The emission factor calculations are based on the top surface of 17.8cm*17.8cm.

Photographs of the tested specimen are given later in this report. The test results presented herein are specific to this item.

Test Protocol Summary* – This VOC emission test was performed following the guidance of ASTM Standard Guide D 5116. If required by the test, chemical sampling and analysis for VOCs were performed following U.S. EPA Compendium Method TO-17. If required, sampling and analysis for low molecular weight aldehydes were performed following ASTM Standard Method D 5197. The product specimen was prepared from the supplied product sample. If conditioning was required, the specimen was placed directly into the conditioning environment and maintained at controlled conditions of air flow rate, temperature and relative humidity for the specified period. At the end of this period, the specimen was transferred directly to a small-scale chamber. If conditioning was not required, the specimen was placed directly into the small-scale chamber. The chamber conditions for the test period are summarized in Table 1. Air samples were collected from the chamber at one or more specified elapsed times. Samples for the analysis of individual VOCs and TVOC, as required, were collected on multisorbent tubes containing Tenax-TA backed by a carbonaceous sorbent. Samples for the analysis of low molecular weight aldehydes, as required, were collected on treated DNPH cartridges.

Analyses of target chemicals and chemical groups were performed using the following procedures as required. Note: The target chemicals and chemical groups selected for the test (Table 2) determined which procedures were used. VOC samples were analyzed by thermal desorption GC/MS. TVOC was calculated using toluene as the calibration reference. Individual VOCs (iVOCs) were quantified using multi-point (4 or more points) with calibration curves prepared with pure standards, unless otherwise noted. iVOCs without pure standards were quantified based on their total-ion-current responses using toluene as the calibration reference. Formaldehyde and acetaldehyde were analyzed by HPLC and quantified using multi-point (4 or more points) calibration curves. The analytical instruments and their operating parameters used for these analyses are described in Appendix A.

Availability of Data – All data, including but not limited to raw instrument files, calibration files, and quality control checks used to generate the test results will be made available to the customer upon request.

Table 1. Chamber conditions for test period

Parameter	Symbol	Units	Value
Tested specimen exposed area	A _S	m ²	0.032
Chamber volume	V _C	m ³	0.067
Loading ratio	L	m ² /m ³	0.473
Avg. Inlet gas flow rate & Range	Q _C	m ³ /h	0.067 (0.064-0.070)
Avg Temperature & Range		°C	23.4 (22-24)
Avg Relative humidity & Range		%	51 (45-55)
Test period duration		h	24
Earlier air sampling time(s)		h	none

*All standards identified in this section are included in Berkeley Analytical's scope of ISO/IEC17025 accreditation, Testing Laboratory TL-383, International Accreditation Service, www.iasonline.org

VOC Emission Test Results

Target Chemicals – The target chemicals and chemical groups selected for this test are listed in Table 2.

Table 2. Target chemicals and chemical groups and applicable sampling and analytical method standards

Chemical/Chemical Group	CAS No	Standard
TVOC	--	EPA TO-17
Formaldehyde	50-00-0	ASTM D 5197
Acetaldehyde	75-07-0	ASTM D 5197
iVOCs	--	EPA TO-17

Chamber Background Concentrations – Background concentrations of target chemicals and chemical groups measured at time zero are reported in Table 3. Reported chamber concentrations are background corrected.

Table 3. Chamber background VOC concentrations at time zero. Only target chemicals and chemical groups that were detected in the chamber background are listed

Chemical/Chemical Group	CAS No	Chamber Conc (µg/m ³)
2-Propanone (acetone)	67-64-1	4.2
Acetaldehyde	75-07-0	LQ
Formaldehyde	50-00-0	LQ
Nonanal	124-19-6	2.1
TVOC	--	LQ

VOC Emission Test Results, Continued

Emitted VOCs – Individual VOCs (iVOCs) detected in the test above lower limits of quantitation are reported in Table 4. All iVOCs with pure standard calibrations are listed first. iVOCs quantified using toluene as the reference standard are listed next; identifications of these compounds are considered tentative.

Table 4. iVOCs detected above lower limits of quantitation in chamber air sample

Chemical	CAS No	Surrogate?*
1-Butanol	71-36-3	
Ethylene glycol	107-21-1	
Caprolactam	105-60-2	
2-Propanone (acetone)	67-64-1	
1,2-Propanediol (Propylene glycol)	57-55-6	
Octanal	124-13-0	
2-Ethyl-1-hexanol	104-76-7	
Nonanal	124-19-6	
Decanal	112-31-2	
Acetic acid	64-19-7	Yes
Benzoic acid	65-85-0	Yes
Nonanoic acid	112-05-0	Yes

*"Yes" response indicates iVOC quantified using toluene as the calibration reference; all other iVOCs quantified using pure standards

VOC Emission Test Results, Continued

VOC Chamber Concentrations and Emission Factors – The chamber sample was analyzed for TVOC and the iVOCs listed in Table 4. The emission factors for TVOC and iVOCs were calculated from the chamber parameters, the measured quantity of the test specimen and the chamber concentrations. Chamber concentrations and emission factors for iVOCs and TVOC are listed in Table 5 and Table 6, respectively.

Table 5. Measured chamber concentrations and calculated emission factors for iVOCs

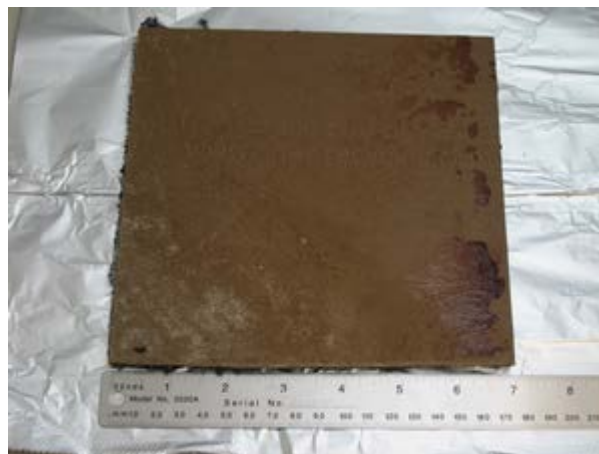
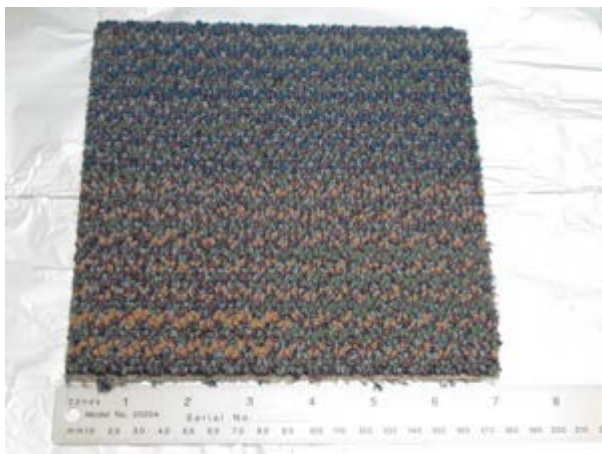
Chemical/Chemical Group	Elapsed Time (h)	Chamber Concentration ($\mu\text{g}/\text{m}^3$)	Emission Factor ($\mu\text{g}/\text{m}^2\text{-h}$)
1,2-Propanediol (Propylene glycol)	24	4.9	10.5
1-Butanol	24	5.4	11.5
2-Ethyl-1-hexanol	24	35.2	74.7
2-Propanone (acetone)	24	2.1	4.5
Acetic acid	24	3.3	7.0
Benzoic acid	24	2.2	4.6
Caprolactam	24	8.6	18.2
Decanal	24	21.4	45.5
Ethylene glycol	24	12.0	25.4
Nonanal	24	58.3	123.7
Nonanoic acid	24	11.7	24.8
Octanal	24	6.9	14.7

Table 6. Measured chamber concentrations and calculated emission factors for TVOC

Chemical/Chemical Group	Elapsed Time (h)	Chamber Concentration ($\mu\text{g}/\text{m}^3$)	Emission Factor ($\mu\text{g}/\text{m}^2\text{-h}$)
TVOC	24	127	270

Photographs of Tested Product Specimen

Photo Documentation – The product sample specimen is photographed immediately following specimen preparation and prior to initiating the test. Typically, the top and bottom faces of the specimen are photographed. Bottom faces may show a stainless steel plate or other substrate if required by the test.



Definitions

Table 7. Definitions of parameters

Parameter/Value	Definition
CARB TAC	Toxic Air Contaminant (TAC) on California Air Resources Board list, with toxic category indicated
CAS No.	Chemical Abstract Service registry number providing unique chemical ID
Chamber Conc.	Measured chamber VOC concentration at time point minus any analytical blank or background concentration for empty chamber measured prior to test. Lower limit of quantitation (LQ) or reporting limit for individual VOCs is 2 µg/m ³ unless otherwise noted
CREL	Chronic non-cancer Reference Exposure Level established by Cal/EPA OEHHA (http://www.OEHHA.ca.gov/air/allrels.html)
Emission Factor	Mass of compound emitted per unit area per hour (calculation shown below). Reporting limits for emission factors are established by LQ or reporting limit for chamber concentration and specimen area tested
Formaldehyde & acetaldehyde	Volatile aldehydes quantified by HPLC following ASTM Standard Method D 5197. LQs for formaldehyde and acetaldehyde are 1 µg/m ³ and 1.6 µg/m ³ , respectively
Individual VOC (iVOC)	Quantified by thermal desorption GC/MS following EPA Method TO-17. Compounds quantified using multi-point calibrations prepared with pure chemicals unless otherwise indicated.
LQ	Indicates calculated value is below its lower limit of quantitation
Prop 65 list	“Yes” indicates the compound is a chemical known to cause cancer or reproductive toxicity according to California Safe Drinking Water Toxic Enforcement Act of 1986 (Proposition 65)
TVOC	Total Volatile Organic Compounds eluting over retention time range bounded by n-pentane and n-heptadecane and quantified by GC/MS TIC method using toluene as calibration reference. LQ for TVOC is 20 µg/m ³
“na”	Not applicable
“<”	Less than value established by LQ

Equations and Comments

Equations Used in Calculations – An emission factor (EF) in $\mu\text{g}/\text{m}^2\text{-h}$ for a chemical in a chamber test of a building product sample is calculated using Equation 1:

$$\text{EF} = (Q_c(C - C_o)) / A_s \quad (1)$$

where Q_c is the chamber inlet air flow rate (m^3/h), C is the VOC chamber concentration ($\mu\text{g}/\text{m}^3$), C_o is the corresponding chamber background VOC concentration ($\mu\text{g}/\text{m}^3$), and A_s is the tested specimen exposed area (m^2).

Comments: Odor investigation test and tested per worst case exposure leaving both surfaces and edges exposed.

END OF REPORT

BERKELEY ANALYTICAL
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Richmond, CA 94804-3614

Appendix A
Analytical Instruments & Operating Parameters

Table A1. Description of analytical instrument components

Component	Description
HPLC	1260 Infinity Quaternary LC, G1314F VW Detector, Agilent
Analytical column	Poroshell 120 EC-C18, Agilent
Column dimensions	2.1 mm x 100 mm
Thermal desorber	Unity / TD100, Markes International, Ltd.
Gas chromatograph	Model 7890A, Agilent
Analytical column	DB-624, J&W Scientific
Column dimensions	1 µm film, 0.18 mm ID, 20 m
Mass spectrometer	Model 5975C MSD, Agilent

Table A2. HPLC operating parameters for analysis of formaldehyde and acetaldehyde

Parameter	Value
Solvent A	65/35% H ₂ O/Acetonitrile
Solvent B	100% Acetonitrile
Flow rate	0.3 mL/min
End time	11 min
Detector wavelength	360 nm

Table A3. Thermal desorption GC/MS parameters used for analysis of iVOCs and TVOC

Parameter	Value
Thermal desorption	
Tube desorb temperature	285 °C
Trap temperature	-5 °C
Trap desorb temperature	300 °C
Trap desorb split ratio	10:1
Gas chromatograph	
Initial temperature	40 °C
Initial temperature time	6.0 min
Final temperature	225 °C
Final temperature time	3 min
Mass spectrometer	
Low scan mass, <i>m/z</i>	30 amu
High scan mass, <i>m/z</i>	450 amu
Scan rate	3.42 Hz

CHAIN OF CUSTODY RECORD/SAMPLE ANALYSIS REQUEST FORM

Project Name / Number: 1703766 000 Sampling Date: 5/7/2017

Ship To: Berkeley Analytical
815 Harbor Way
Richmond, CA 94804
Lab Contact: Al Hodgson
Phone: 510-236-2325
E-mail: mposson@exponent.com

SAMPLERS: Mike Posson

Exponent Contact: Mike Posson
Direct Phone: 510-387-7695
Email: mposson@exponent.com
Office Location:
[] Farmington Hills, MI (248) 324-9100
[] Menlo Park, CA (650) 326-9400
[X] Oakland, CA (510) 268-5000
[] Other:

Analyses Requested

Table with columns for various analyses: Fungi: Spore Trap Analysis, Fungi: Direct Microscopic Exam, Culturable Fungi: Std. Quant. Analysis, Fungi: w/Pen. and Asp. Speciation, 24-hr. UL-EMSAW Test (ASTM D5116), Matrix, Area.

Table with columns: Sample No., Time, Vol(L), Matrix, Area, Remarks / Sample Location. Rows include A76-1B, A11-1B, A10-1B, C1-1B.

MATRIX CODE: BC = Biocassette, B = Bulk, D = Dust, ST = Spore Trap, T = Tape, SW = Swab. OTHER: please identify code:

PRIORITY: [X] Standard [] Rush [] Next Day [] 2-Day [] Same Day (Extra Fee) Due Date:

Shipped Via: [X] FedEx [] UPS [] Courier [] Hand [] Other: Condition of Samples Upon Receipt: Custody Seal Intact: [] Yes [] No [] None

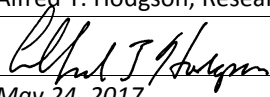
Relinquished by: Michael Posson Date/Time: 5/11/17 Received by: F. MASRI Date/Time: 5/12/17

Relinquished by: Date/Time: Received by: Date/Time:

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Building Product VOC Emission Factors

Customer & Building Product Sample Information

Report Certification	
Report number	096-071-03A-May2417
Report date	May 24, 2017
Certified by (Name/Title)	Alfred T. Hodgson, Research Director
Signature	
Date	May 24, 2017

Standard	
Test method	ASTM D 5116-10 (Small Chamber)

Customer Information	
Manufacturer or organization	Exponent, Inc.
City/State/Country	Oakland, CA
Contact name/Title	Michael Posson
Phone number	510-387-7695

Product Sample Information*	
Manufacturer (if not customer)	Same as above
Product name / Number	24"x24" Carpet Tile - Installed / A10-1B
Product CSI category	Other (99 10 00)
Customer sample ID	not provided
Manufacturing location	not provided
Date sample manufactured	not provided
Date sample collected	May 7, 2017
Date sample shipped	May 11, 2017
Date sample received by lab	May 12, 2017
Condition of received sample	No observed problems
Lab sample tracking number	096-071-03A
Conditioning start date & duration (if applicable)	None
Chamber test start date & duration	May 15, 2017; 1 days (24 hours)
Total test start date & duration	May 15, 2017; 1 days (24 hours)

*Chain-of-custody (COC) form for product sample is attached to this report

Test Method for Building Product Samples

Test Specimen Preparation – Odor investigation test, cut a 17.8 cm x 17.8 cm piece from received field collected carpet sample then placed it into chamber as is with all surfaces exposed. Exposed area is based on one surface. Sample also has adhesive residual on its backer side. Photographs of the tested specimen are given later in this report. The test results presented herein are specific to this item.

Test Protocol Summary* – This VOC emission test was performed following the guidance of ASTM Standard Guide D 5116. If required by the test, chemical sampling and analysis for VOCs were performed following U.S. EPA Compendium Method TO-17. If required, sampling and analysis for low molecular weight aldehydes were performed following ASTM Standard Method D 5197. The product specimen was prepared from the supplied product sample. If conditioning was required, the specimen was placed directly into the conditioning environment and maintained at controlled conditions of air flow rate, temperature and relative humidity for the specified period. At the end of this period, the specimen was transferred directly to a small-scale chamber. If conditioning was not required, the specimen was placed directly into the small-scale chamber. The chamber conditions for the test period are summarized in Table 1. Air samples were collected from the chamber at one or more specified elapsed times. Samples for the analysis of individual VOCs and TVOC, as required, were collected on multisorbent tubes containing Tenax-TA backed by a carbonaceous sorbent. Samples for the analysis of low molecular weight aldehydes, as required, were collected on treated DNPH cartridges.

Analyses of target chemicals and chemical groups were performed using the following procedures as required. Note: The target chemicals and chemical groups selected for the test (Table 2) determined which procedures were used. VOC samples were analyzed by thermal desorption GC/MS. TVOC was calculated using toluene as the calibration reference. Individual VOCs (iVOCs) were quantified using multi-point (4 or more points) with calibration curves prepared with pure standards, unless otherwise noted. iVOCs without pure standards were quantified based on their total-ion-current responses using toluene as the calibration reference. Formaldehyde and acetaldehyde were analyzed by HPLC and quantified using multi-point (4 or more points) calibration curves. The analytical instruments and their operating parameters used for these analyses are described in Appendix A.

Availability of Data – All data, including but not limited to raw instrument files, calibration files, and quality control checks used to generate the test results will be made available to the customer upon request.

Table 1. Chamber conditions for test period

Parameter	Symbol	Units	Value
Tested specimen exposed area	A_S	m^2	0.032
Chamber volume	V_C	m^3	0.067
Loading ratio	L	m^2/m^3	0.473
Avg. Inlet gas flow rate & Range	Q_C	m^3/h	0.067 (0.064-0.070)
Avg Temperature & Range		$^{\circ}C$	23.2 (22-24)
Avg Relative humidity & Range		%	50 (45-55)
Test period duration		h	24
Earlier air sampling time(s)		h	none

*All standards identified in this section are included in Berkeley Analytical's scope of ISO/IEC17025 accreditation, Testing Laboratory TL-383, International Accreditation Service, www.iasonline.org

VOC Emission Test Results

Target Chemicals – The target chemicals and chemical groups selected for this test are listed in Table 2.

Table 2. Target chemicals and chemical groups and applicable sampling and analytical method standards

Chemical/Chemical Group	CAS No	Standard
TVOC	--	EPA TO-17
Formaldehyde	50-00-0	ASTM D 5197
Acetaldehyde	75-07-0	ASTM D 5197
iVOCs	--	EPA TO-17

Chamber Background Concentrations – Background concentrations of target chemicals and chemical groups measured at time zero are reported in Table 3. Reported chamber concentrations are background corrected.

Table 3. Chamber background VOC concentrations at time zero. Only target chemicals and chemical groups that were detected in the chamber background are listed

Chemical/Chemical Group	CAS No	Chamber Conc (µg/m ³)
2-Propanone (acetone)	67-64-1	2.7
Acetaldehyde	75-07-0	LQ
Decanal	112-31-2	2.2
Formaldehyde	50-00-0	LQ
Nonanal	124-19-6	5.9
TVOC	--	LQ

VOC Emission Test Results, Continued

Emitted VOCs – Individual VOCs (iVOCs) detected in the test above lower limits of quantitation are reported in Table 4. All iVOCs with pure standard calibrations are listed first. iVOCs quantified using toluene as the reference standard are listed next; identifications of these compounds are considered tentative.

Table 4. iVOCs detected above lower limits of quantitation in chamber air sample

Chemical	CAS No	Surrogate?*
Caprolactam	105-60-2	
2-Ethyl-1-hexanol	104-76-7	
Acetic acid	64-19-7	Yes
Unidentified Compound	--	Yes
1-Nonanol	143-08-8	Yes
1-Heptanol	111-70-6	Yes
C8 Alcohol	--	Yes
1-Octanol, 3,7-dimethyl-	106-21-8	Yes
1-Undecanol	112-42-5	Yes

*"Yes" response indicates iVOC quantified using toluene as the calibration reference; all other iVOCs quantified using pure standards

VOC Emission Test Results, Continued

VOC Chamber Concentrations and Emission Factors – The chamber sample was analyzed for TVOC and the iVOCs listed in Table 4. The emission factors for TVOC and iVOCs were calculated from the chamber parameters, the measured quantity of the test specimen and the chamber concentrations. Chamber concentrations and emission factors for iVOCs and TVOC are listed in Table 5 and Table 6, respectively.

Table 5. Measured chamber concentrations and calculated emission factors for iVOCs

Chemical/Chemical Group	Elapsed Time (h)	Chamber Concentration ($\mu\text{g}/\text{m}^3$)	Emission Factor ($\mu\text{g}/\text{m}^2\text{-h}$)
1-Heptanol	24	5.1	10.9
1-Nonanol	24	8.8	18.8
1-Octanol, 3,7-dimethyl-	24	15.3	32.4
1-Undecanol	24	2.9	6.2
2-Ethyl-1-hexanol	24	5.8	12.3
Acetic acid	24	4.5	9.6
C8 Alcohol	24	2.5	5.3
Caprolactam	24	15.4	32.7
Unidentified Compound	24	8.4	17.8

Table 6. Measured chamber concentrations and calculated emission factors for TVOC

Chemical/Chemical Group	Elapsed Time (h)	Chamber Concentration ($\mu\text{g}/\text{m}^3$)	Emission Factor ($\mu\text{g}/\text{m}^2\text{-h}$)
TVOC	24	75	159

Photographs of Tested Product Specimen

Photo Documentation – The product sample specimen is photographed immediately following specimen preparation and prior to initiating the test. Typically, the top and bottom faces of the specimen are photographed. Bottom faces may show a stainless steel plate or other substrate if required by the test.



Definitions**Table 7.** Definitions of parameters

Parameter/Value	Definition
CARB TAC	Toxic Air Contaminant (TAC) on California Air Resources Board list, with toxic category indicated
CAS No.	Chemical Abstract Service registry number providing unique chemical ID
Chamber Conc.	Measured chamber VOC concentration at time point minus any analytical blank or background concentration for empty chamber measured prior to test. Lower limit of quantitation (LQ) or reporting limit for individual VOCs is 2 µg/m ³ unless otherwise noted
CREL	Chronic non-cancer Reference Exposure Level established by Cal/EPA OEHHA (http://www.OEHHA.ca.gov/air/allrels.html)
Emission Factor	Mass of compound emitted per unit area per hour (calculation shown below). Reporting limits for emission factors are established by LQ or reporting limit for chamber concentration and specimen area tested
Formaldehyde & acetaldehyde	Volatile aldehydes quantified by HPLC following ASTM Standard Method D 5197. LQs for formaldehyde and acetaldehyde are 1 µg/m ³ and 1.6 µg/m ³ , respectively
Individual VOC (iVOC)	Quantified by thermal desorption GC/MS following EPA Method TO-17. Compounds quantified using multi-point calibrations prepared with pure chemicals unless otherwise indicated.
LQ	Indicates calculated value is below its lower limit of quantitation
Prop 65 list	“Yes” indicates the compound is a chemical known to cause cancer or reproductive toxicity according to California Safe Drinking Water Toxic Enforcement Act of 1986 (Proposition 65)
TVOC	Total Volatile Organic Compounds eluting over retention time range bounded by n-pentane and n-heptadecane and quantified by GC/MS TIC method using toluene as calibration reference. LQ for TVOC is 20 µg/m ³
“na”	Not applicable
“<”	Less than value established by LQ

Equations and Comments

Equations Used in Calculations – An emission factor (EF) in $\mu\text{g}/\text{m}^2\text{-h}$ for a chemical in a chamber test of a building product sample is calculated using Equation 1:

$$\text{EF} = (Q_c(C - C_o)) / A_s \quad (1)$$

where Q_c is the chamber inlet air flow rate (m^3/h), C is the VOC chamber concentration ($\mu\text{g}/\text{m}^3$), C_o is the corresponding chamber background VOC concentration ($\mu\text{g}/\text{m}^3$), and A_s is the tested specimen exposed area (m^2).

Comments: None

END OF REPORT

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Richmond, CA 94804-3614

Appendix A
Analytical Instruments & Operating Parameters

Table A1. Description of analytical instrument components

Component	Description
HPLC	1260 Infinity Quaternary LC, G1314F VW Detector, Agilent
Analytical column	Poroshell 120 EC-C18, Agilent
Column dimensions	2.1 mm x 100 mm
Thermal desorber	Unity / TD100, Markes International, Ltd.
Gas chromatograph	Model 7890A, Agilent
Analytical column	DB-624, J&W Scientific
Column dimensions	1 µm film, 0.18 mm ID, 20 m
Mass spectrometer	Model 5975C MSD, Agilent

Table A2. HPLC operating parameters for analysis of formaldehyde and acetaldehyde

Parameter	Value
Solvent A	65/35% H ₂ O/Acetonitrile
Solvent B	100% Acetonitrile
Flow rate	0.3 mL/min
End time	11 min
Detector wavelength	360 nm

Table A3. Thermal desorption GC/MS parameters used for analysis of iVOCs and TVOC

Parameter	Value
Thermal desorption	
Tube desorb temperature	285 °C
Trap temperature	-5 °C
Trap desorb temperature	300 °C
Trap desorb split ratio	10:1
Gas chromatograph	
Initial temperature	40 °C
Initial temperature time	6.0 min
Final temperature	225 °C
Final temperature time	3 min
Mass spectrometer	
Low scan mass, <i>m/z</i>	30 amu
High scan mass, <i>m/z</i>	450 amu
Scan rate	3.42 Hz

CHAIN OF CUSTODY RECORD/SAMPLE ANALYSIS REQUEST FORM

Project Name / Number: <u>1703766 000</u>			Sampling Date: <u>5/7/2017</u>							
Ship To: <u>Berkeley Analytical</u> <u>815 Harbor Way</u> <u>Richmond, CA 94804</u>			SAMPLERS: <u>Mike Posson</u>							
Lab Contact: <u>Al Hodgson</u> Phone: <u>510-236-2325</u> E-mail: <u>mposson@exponent.com</u>			Exponent Contact: <u>Mike Posson</u> Direct Phone: <u>510-387-7695</u> Email: <u>mposson@exponent.com</u> Office Location: <input type="checkbox"/> Farmington Hills, MI (248) 324-9100 <input type="checkbox"/> Menlo Park, CA (650) 326-9400 <input checked="" type="checkbox"/> Oakland, CA (510) 268-5000 <input type="checkbox"/> Other: _____							
Sample No.	Time	Vol(L)	Fungi: Spore Trap Analysis	Fungi: Direct Microscopic Exam	Culturable Fungi: Std. Quant. Analysis	Fungi: w/Pen. and Asp. Speciation	24-hr. ULL-EMMSAM Test (ASTM D5116)	Matrix	Area	Remarks / Sample Location
A76-1B	N/A	N/A					X	B		Per Estimate # 170510-2
A11-1B	↓	↓								
A10-1B	↓	↓								
C1-1B	↓	↓								
MATRIX CODE: BC = Biocassette ST = Spore Trap B = Bulk T = Tape D = Dust SW = Swab OTHER: please identify code: _____			PRIORITY: <input checked="" type="checkbox"/> Standard <input type="checkbox"/> Rush <input type="checkbox"/> Next Day <input type="checkbox"/> 2-Day <input type="checkbox"/> Same Day (Extra Fee) Due Date: _____							
Shipped Via: <input checked="" type="checkbox"/> FedEx <input type="checkbox"/> UPS <input type="checkbox"/> Courier <input type="checkbox"/> Hand <input type="checkbox"/> Other: _____			Condition of Samples Upon Receipt: _____				Custody Seal Intact: <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> None			

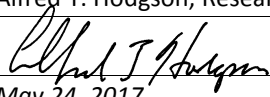
Relinquished by: Michael Posson Date/Time: 5/11/17 @ 1345 Received by: F. MASRI Date/Time: 5/12/17

Relinquished by: _____ Date/Time: _____ Received by: _____ Date/Time: _____

BERKELEY ANALYTICAL
 815 Harbour Way South, Suite 6
 Richmond, CA 94804-3614
 Ph. 510-236-2325; Fax 510-236-2335
 E-mail info@berkeleyanalytical.com

Building Product VOC Emission Factors

Customer & Building Product Sample Information

Report Certification	
Report number	096-071-04A-May2417
Report date	May 24, 2017
Certified by (Name/Title)	Alfred T. Hodgson, Research Director
Signature	
Date	May 24, 2017

Standard	
Test method	ASTM D 5116-10 (Small Chamber)

Customer Information	
Manufacturer or organization	Exponent, Inc.
City/State/Country	Oakland, CA
Contact name/Title	Mike Posson
Phone number	510-387-7695

Product Sample Information*	
Manufacturer (if not customer)	Same as above
Product name / Number	24"x24" Carpet Tile - Installed / C1-1B
Product CSI category	Other (99 10 00)
Customer sample ID	not provided
Manufacturing location	not provided
Date sample manufactured	not provided
Date sample collected	May 7, 2017
Date sample shipped	May 11, 2017
Date sample received by lab	May 12, 2017
Condition of received sample	No observed problems
Lab sample tracking number	096-071-04A
Conditioning start date & duration (if applicable)	None
Chamber test start date & duration	May 15, 2017; 1 days (24 hours)
Total test start date & duration	May 15, 2017; 1 days (24 hours)

*Chain-of-custody (COC) form for product sample is attached to this report

Test Method for Building Product Samples

Test Specimen Preparation – Cut a test specimen from the received sample leaving top and bottom surfaces exposed. The emission factor calculations are based on the top surface of 17.8cm*17.8cm. Photographs of the tested specimen are given later in this report. The test results presented herein are specific to this item.

Test Protocol Summary* – This VOC emission test was performed following the guidance of [ASTM Standard Guide D 5116](#). If required by the test, chemical sampling and analysis for VOCs were performed following [U.S. EPA Compendium Method TO-17](#). If required, sampling and analysis for low molecular weight aldehydes were performed following [ASTM Standard Method D 5197](#). The product specimen was prepared from the supplied product sample. If conditioning was required, the specimen was placed directly into the conditioning environment and maintained at controlled conditions of air flow rate, temperature and relative humidity for the specified period. At the end of this period, the specimen was transferred directly to a small-scale chamber. If conditioning was not required, the specimen was placed directly into the small-scale chamber. The chamber conditions for the test period are summarized in Table 1. Air samples were collected from the chamber at one or more specified elapsed times. Samples for the analysis of individual VOCs and TVOC, as required, were collected on multisorbent tubes containing Tenax-TA backed by a carbonaceous sorbent. Samples for the analysis of low molecular weight aldehydes, as required, were collected on treated DNPH cartridges.

Analyses of target chemicals and chemical groups were performed using the following procedures as required. Note: The target chemicals and chemical groups selected for the test (Table 2) determined which procedures were used. VOC samples were analyzed by thermal desorption GC/MS. TVOC was calculated using toluene as the calibration reference. Individual VOCs (iVOCs) were quantified using multi-point (4 or more points) with calibration curves prepared with pure standards, unless otherwise noted. iVOCs without pure standards were quantified based on their total-ion-current responses using toluene as the calibration reference. Formaldehyde and acetaldehyde were analyzed by HPLC and quantified using multi-point (4 or more points) calibration curves. The analytical instruments and their operating parameters used for these analyses are described in Appendix A.

Availability of Data – All data, including but not limited to raw instrument files, calibration files, and quality control checks used to generate the test results will be made available to the customer upon request.

Table 1. Chamber conditions for test period

Parameter	Symbol	Units	Value
Tested specimen exposed area	A_s	m^2	0.032
Chamber volume	V_c	m^3	0.067
Loading ratio	L	m^2/m^3	0.473
Avg. Inlet gas flow rate & Range	Q_c	m^3/h	0.067 (0.064-0.070)
Avg Temperature & Range		$^{\circ}C$	23.3 (22-24)
Avg Relative humidity & Range		%	50 (45-55)
Test period duration		h	24
Earlier air sampling time(s)		h	none

*All standards identified in this section are included in Berkeley Analytical's scope of ISO/IEC17025 accreditation, Testing Laboratory TL-383, International Accreditation Service, www.iasonline.org

VOC Emission Test Results

Target Chemicals – The target chemicals and chemical groups selected for this test are listed in Table 2.

Table 2. Target chemicals and chemical groups and applicable sampling and analytical method standards

Chemical/Chemical Group	CAS No	Standard
TVOC	--	EPA TO-17
Formaldehyde	50-00-0	ASTM D 5197
Acetaldehyde	75-07-0	ASTM D 5197
iVOCs	--	EPA TO-17

Chamber Background Concentrations – Background concentrations of target chemicals and chemical groups measured at time zero are reported in Table 3. Reported chamber concentrations are background corrected.

Table 3. Chamber background VOC concentrations at time zero. Only target chemicals and chemical groups that were detected in the chamber background are listed

Chemical/Chemical Group	CAS No	Chamber Conc (µg/m ³)
Acetaldehyde	75-07-0	LQ
Formaldehyde	50-00-0	LQ
TVOC	--	LQ

VOC Emission Test Results, Continued

Emitted VOCs – Individual VOCs (iVOCs) detected in the test above lower limits of quantitation are reported in Table 4. All iVOCs with pure standard calibrations are listed first. iVOCs quantified using toluene as the reference standard are listed next; identifications of these compounds are considered tentative.

Table 4. iVOCs detected above lower limits of quantitation in chamber air sample

Chemical	CAS No	Surrogate?*
Caprolactam	105-60-2	
2-Propanone (acetone)	67-64-1	
1,2-Propanediol (Propylene glycol)	57-55-6	
2-Ethyl-1-hexanol	104-76-7	
Nonanal	124-19-6	
2-(Hexyloxy) ethanol	112-25-4	Yes

*"Yes" response indicates iVOC quantified using toluene as the calibration reference; all other iVOCs quantified using pure standards

VOC Emission Test Results, Continued

VOC Chamber Concentrations and Emission Factors – The chamber sample was analyzed for TVOC and the iVOCs listed in Table 4. The emission factors for TVOC and iVOCs were calculated from the chamber parameters, the measured quantity of the test specimen and the chamber concentrations. Chamber concentrations and emission factors for iVOCs and TVOC are listed in Table 5 and Table 6, respectively.

Table 5. Measured chamber concentrations and calculated emission factors for iVOCs

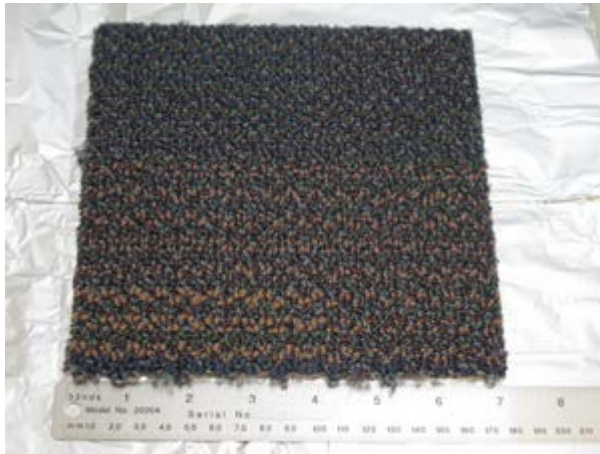
Chemical/Chemical Group	Elapsed Time (h)	Chamber Concentration ($\mu\text{g}/\text{m}^3$)	Emission Factor ($\mu\text{g}/\text{m}^2\text{-h}$)
1,2-Propanediol (Propylene glycol)	24	3.8	8.1
2-(hexyloxy) ethanol	24	2.3	5.0
2-Ethyl-1-hexanol	24	2.7	5.6
2-Propanone (acetone)	24	4.3	9.1
Caprolactam	24	8.3	17.5
Nonanal	24	2.1	4.5

Table 6. Measured chamber concentrations and calculated emission factors for TVOC

Chemical/Chemical Group	Elapsed Time (h)	Chamber Concentration ($\mu\text{g}/\text{m}^3$)	Emission Factor ($\mu\text{g}/\text{m}^2\text{-h}$)
TVOC	24	23	49

Photographs of Tested Product Specimen

Photo Documentation – The product sample specimen is photographed immediately following specimen preparation and prior to initiating the test. Typically, the top and bottom faces of the specimen are photographed. Bottom faces may show a stainless steel plate or other substrate if required by the test.



Definitions

Table 7. Definitions of parameters

Parameter/Value	Definition
CARB TAC	Toxic Air Contaminant (TAC) on California Air Resources Board list, with toxic category indicated
CAS No.	Chemical Abstract Service registry number providing unique chemical ID
Chamber Conc.	Measured chamber VOC concentration at time point minus any analytical blank or background concentration for empty chamber measured prior to test. Lower limit of quantitation (LQ) or reporting limit for individual VOCs is 2 µg/m ³ unless otherwise noted
CREL	Chronic non-cancer Reference Exposure Level established by Cal/EPA OEHHA (http://www.OEHHA.ca.gov/air/allrels.html)
Emission Factor	Mass of compound emitted per unit area per hour (calculation shown below). Reporting limits for emission factors are established by LQ or reporting limit for chamber concentration and specimen area tested
Formaldehyde & acetaldehyde	Volatile aldehydes quantified by HPLC following ASTM Standard Method D 5197. LQs for formaldehyde and acetaldehyde are 1 µg/m ³ and 1.6 µg/m ³ , respectively
Individual VOC (iVOC)	Quantified by thermal desorption GC/MS following EPA Method TO-17. Compounds quantified using multi-point calibrations prepared with pure chemicals unless otherwise indicated.
LQ	Indicates calculated value is below its lower limit of quantitation
Prop 65 list	“Yes” indicates the compound is a chemical known to cause cancer or reproductive toxicity according to California Safe Drinking Water Toxic Enforcement Act of 1986 (Proposition 65)
TVOC	Total Volatile Organic Compounds eluting over retention time range bounded by n-pentane and n-heptadecane and quantified by GC/MS TIC method using toluene as calibration reference. LQ for TVOC is 20 µg/m ³
“na”	Not applicable
“<”	Less than value established by LQ

Equations and Comments

Equations Used in Calculations – An emission factor (EF) in $\mu\text{g}/\text{m}^2\text{-h}$ for a chemical in a chamber test of a building product sample is calculated using Equation 1:

$$\text{EF} = (Q_c(C - C_o)) / A_s \quad (1)$$

where Q_c is the chamber inlet air flow rate (m^3/h), C is the VOC chamber concentration ($\mu\text{g}/\text{m}^3$), C_o is the corresponding chamber background VOC concentration ($\mu\text{g}/\text{m}^3$), and A_s is the tested specimen exposed area (m^2).

Comments: Odor investigation test and tested per worst case exposure leaving both surfaces and edges exposed.

END OF REPORT

BERKELEY ANALYTICAL
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Appendix A
Analytical Instruments & Operating Parameters

Table A1. Description of analytical instrument components

Component	Description
HPLC	1260 Infinity Quaternary LC, G1314F VW Detector, Agilent
Analytical column	Poroshell 120 EC-C18, Agilent
Column dimensions	2.1 mm x 100 mm
Thermal desorber	Unity / TD100, Markes International, Ltd.
Gas chromatograph	Model 7890A, Agilent
Analytical column	DB-624, J&W Scientific
Column dimensions	1 µm film, 0.18 mm ID, 20 m
Mass spectrometer	Model 5975C MSD, Agilent

Table A2. HPLC operating parameters for analysis of formaldehyde and acetaldehyde

Parameter	Value
Solvent A	65/35% H ₂ O/Acetonitrile
Solvent B	100% Acetonitrile
Flow rate	0.3 mL/min
End time	11 min
Detector wavelength	360 nm

Table A3. Thermal desorption GC/MS parameters used for analysis of iVOCs and TVOC

Parameter	Value
Thermal desorption	
Tube desorb temperature	285 °C
Trap temperature	-5 °C
Trap desorb temperature	300 °C
Trap desorb split ratio	10:1
Gas chromatograph	
Initial temperature	40 °C
Initial temperature time	6.0 min
Final temperature	225 °C
Final temperature time	3 min
Mass spectrometer	
Low scan mass, <i>m/z</i>	30 amu
High scan mass, <i>m/z</i>	450 amu
Scan rate	3.42 Hz

CHAIN OF CUSTODY RECORD/SAMPLE ANALYSIS REQUEST FORM

Project Name / Number: <u>1703766 000</u>			Sampling Date: <u>5/7/2017</u>							
Ship To: <u>Berkeley Analytical</u> <u>815 Harbor Way</u> <u>Richmond, CA 94804</u>			SAMPLERS: <u>Mike Posson</u>							
Lab Contact: <u>Al Hodgson</u> Phone: <u>510-236-2325</u> E-mail: <u>mposson@exponent.com</u>			Exponent Contact: <u>Mike Posson</u> Direct Phone: <u>510-387-7695</u> Email: <u>mposson@exponent.com</u> Office Location: <input type="checkbox"/> Farmington Hills, MI (248) 324-9100 <input type="checkbox"/> Menlo Park, CA (650) 326-9400 <input checked="" type="checkbox"/> Oakland, CA (510) 268-5000 <input type="checkbox"/> Other: _____							
Sample No.	Time	Vol(L)	Fungi: Spore Trap Analysis	Fungi: Direct Microscopic Exam	Culturable Fungi: Std. Quant. Analysis	Fungi: w/Pen. and Asp. Speciation	24-hr. ULL-EMSA/AN Test (ASTM D5116)	Matrix	Area	Remarks / Sample Location
A76-1B	N/A	N/A					X	B		Per Estimate # 170510-2
A11-1B	↓	↓					↓	↓		
A10-1B	↓	↓					↓	↓		
C1-1B	↓	↓					↓	↓		
MATRIX CODE: BC = Biocassette ST = Spore Trap B = Bulk T = Tape D = Dust SW = Swab OTHER: please identify code: _____			PRIORITY: <input checked="" type="checkbox"/> Standard <input type="checkbox"/> Rush <input type="checkbox"/> Next Day <input type="checkbox"/> 2-Day <input type="checkbox"/> Same Day (Extra Fee) Due Date: _____							
Shipped Via: <input checked="" type="checkbox"/> FedEx <input type="checkbox"/> UPS <input type="checkbox"/> Courier <input type="checkbox"/> Hand <input type="checkbox"/> Other: _____			Condition of Samples Upon Receipt: _____				Custody Seal Intact: <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> None			

Relinquished by: Michael Posson Date/Time: 5/11/17 @ 1345 Received by: F. MASRI Date/Time: 5/12/17

Relinquished by: _____ Date/Time: _____ Received by: _____ Date/Time: _____

Attachment B

Photographs

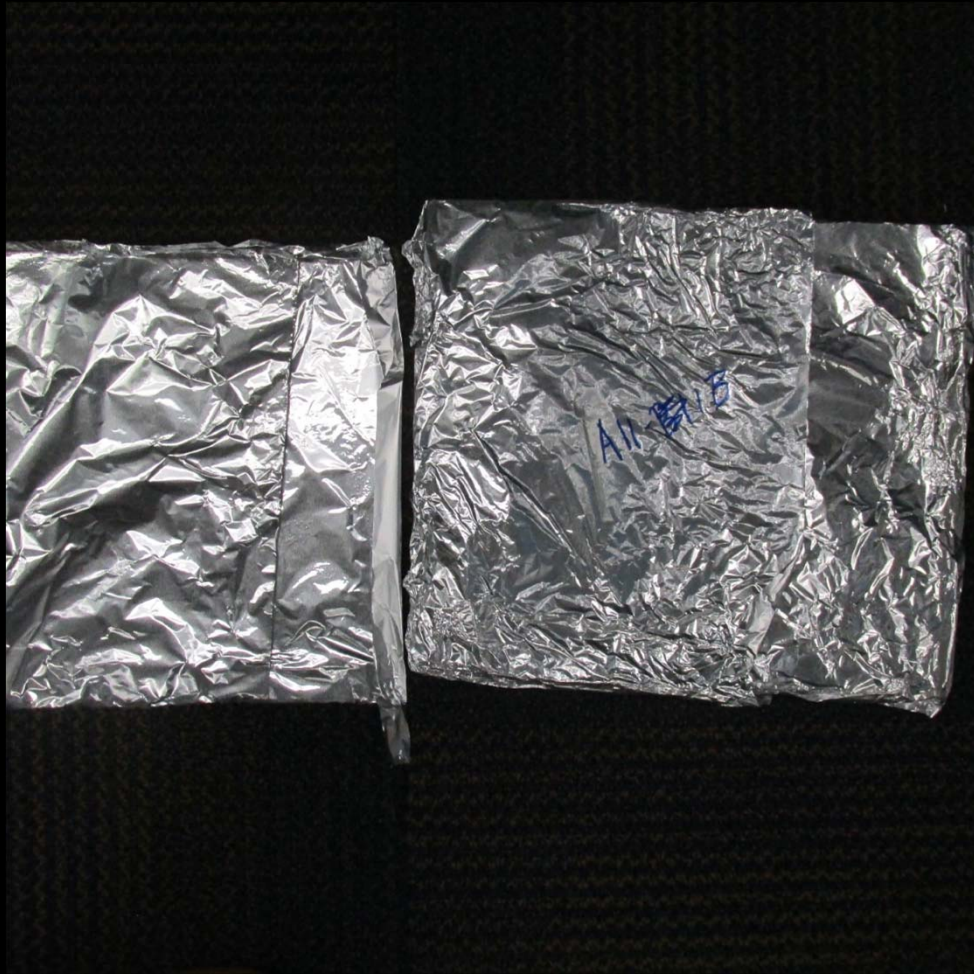


Photo 1. Sample A11-1B, Room A11 (Right)



Photo 2. Sample A76-1B, Room A76 (Right)

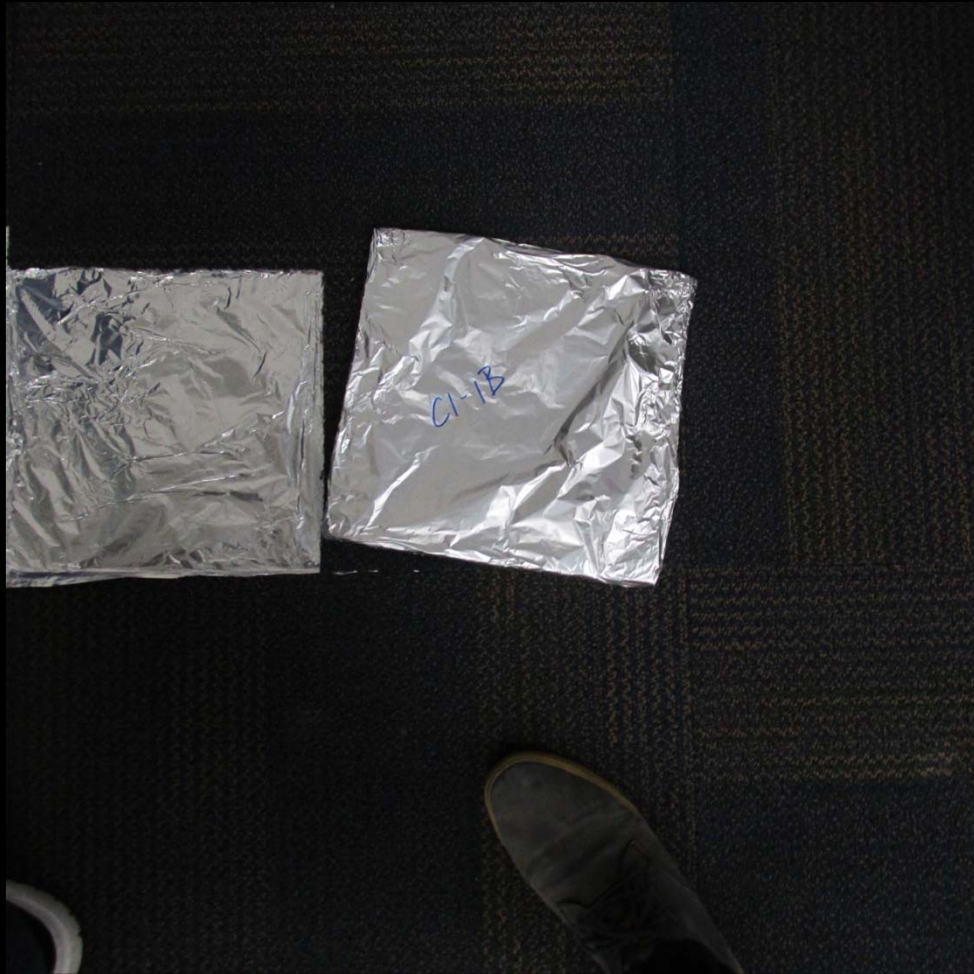


Photo 3. Sample C1-1B, Room C1 (Right)



Photo 4. Sample A10-1B, Room A10 (Right)



Photo 5. Foil Covering of Concrete Slab, Room A76