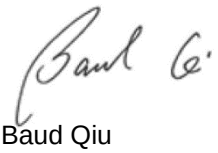
GREENGUARD CERTIFICATION TEST REPORT

MANUFACTURER INFORMATION	LION CHEMTECH CO LTD DANIEL KIM 41-5 MOONPYONG-DONG, DAEDUK-GU DAEJEON 306-220 REPUBLIC OF KOREA	
PRODUCT DESCRIPTION	Solid Surfaces	
TEST GROUP	Solid Surfaces - 01	
CATEGORY	BUILDING PRODUCTS	
TEST TYPE	**Certification**	**Year** 9

	Environment	TVOC	Formaldehyde	Total Aldehydes	CREL/TLV
GREENGUARD	Office	✓	✓	✓	✓
GREENGUARD Gold	Office	✓	✓	✓	✓
	Classroom	✓	✓	✓	✓

✓ **- meets criteria; X - over criteria**

Laboratory Approval:



Baud Qiu
Operations Manager
Greater China

EXECUTIVE SUMMARY

PROJECT DESCRIPTION

UL Environment is pleased to present the certification test results of the **Building Products** product identified as "Solid Surfaces" representing LION CHEMTECH CO LTD's **Solid Surfaces - 01** test group. This study was conducted using a UL Environment's GREENGUARD test method (1) following the requirements of GREENGUARD Certification program, ASTM Standard D 5116, and the United States Environmental Protection Agency (USEPA) (2, 3). Testing of the product was conducted using standard environmental chamber operating conditions as presented in Table 1. The product to be tested was delivered to UL Environment by the manufacturer as presented in the Chain of Custody description in Appendix 1. A picture of the sample is provided in Appendix 2.

The product was monitored for emissions of total volatile organic compounds (TVOC), formaldehyde, total aldehydes, and other individual volatile organic compounds (VOCs) over a 168 hour exposure period. These emissions were measured and the resultant air concentrations were determined for each of the potential pollutants. Determination of compliance is based on predicted air concentrations modeled using the office loading and ventilation conditions referenced in CDPH/EHLB/Standard Method (4). Product loading is based on a standard worksurface usage (6.4 m^2) in a 30.6 m^3 room.

RESULTS

Emissions data and expected air concentrations are given in Tables 2-4, detected individual volatile organic compounds are listed in Tables 5 and 6 as measured chamber concentrations and emission factors. Individual aldehydes are listed in Tables 7 and 8 as measured chamber concentrations and emission factors. Appendix 3 presents supplemental emissions information on individual VOCs, which may be requested by certain purchasing programs. Results for the GREENGUARD Gold Certification program are included as Appendix 4.

The results for the tested product identified as "Solid Surfaces" are shown below:

GREENGUARD Acceptable IAQ Criteria		168 Hour Product Measurement	Product Compliance for IAQ
TVOC[a]	≤ 0.5 mg/m^3	0.001 mg/m^3	Yes
Formaldehyde	≤ 0.05 ppm	< 0.001 ppm	Yes
Total Aldehydes[b]	≤ 0.1 ppm	< 0.001 ppm	Yes
4-Phenylcyclohexene	≤ 0.0065 mg/m^3	< 0.001 mg/m^3	Yes
Individual VOCs[c]	all ≤ 1/10 TLV	----------	Yes

[a] "TVOC" is the sum of all VOCs measured via TD/GC/MS which elute between n-hexane (C_6) and n-hexadecane (C_{16}) quantified using calibration to a toluene surrogate.

[b] "Total Aldehydes" is the sum of all measured normal aldehydes from formaldehyde to nonanal, plus benzaldehyde. Heptanal through nonanal are analyzed using TD/GC/MS. The remaining aldehydes are analyzed using HPLC/UV methodology. All aldehydes are quantified to authentic standards.

[c] All individual VOCs detected met the criteria of less than 1/10 the ACGIH established threshold limit values (TLVs) (ref. 13).

PRODUCT EVALUATION METHODOLOGIES

ENVIRONMENTAL CHAMBER

The product was tested in an environmental chamber and chemical emissions were analytically measured. Environmental chamber operation and control measures used in this study complied with GREENGUARD Method and Laboratory Quality Requirements and ASTM Standard D 5116. The chamber used is manufactured from stainless steel and/or aluminum to minimize contaminant adsorption. Air flow through the chamber enters and exits through an aerodynamically designed air distribution manifold also manufactured of stainless steel. Supply air to the chamber is stripped of formaldehyde, VOCs, and other contaminants, so that any contaminant backgrounds present in the empty chamber fall below strict levels (< 10 µg/m³ TVOC, < 10 µg/m³ total particles, < 2 µg/m³ formaldehyde, < 2 µg/m³ for any individual VOC). UL Environment chambers are process controlled and are equipped with a continuous data acquisition system for verification of the operating conditions of air flow, temperature, and humidity.

Environmental chamber study parameters are presented in Table 1.

ANALYTICAL MEASUREMENTS

Target List Aldehydes by HPLC/UV

Emissions of selected low molecular weight aldehydes including formaldehyde were measured following ASTM D 5197 and USEPA Method TO-11A, measurement by HPLC, or high performance liquid chromatography (5, 6). Solid sorbent cartridges with 2,4-dinitrophenylhydrazine (DNPH) were used to collect formaldehyde and other low-molecular weight carbonyl compounds in chamber air. The DNPH reagent in the cartridge reacted with collected carbonyl compounds to form the stable hydrazone derivatives retained by the cartridge.

The hydrazone derivatives were eluted from a cartridge with HPLC-grade acetonitrile. An aliquot of the sample was analyzed for low-molecular weight aldehyde hydrazone derivatives using reverse-phase high-performance liquid chromatography (HPLC) with UV detection. The absorbances of the derivatives were measured at 360 nm. The mass responses of the resulting peaks were determined using multi-point calibration curves prepared from standard solutions of the hydrazone derivatives. Measurements are reported to a quantifiable level of 0.1 µg based on a standard air volume collection of 45 L.

Volatile Organic Compounds by TD/GC/MS

VOC measurements were made using gas chromatography with mass spectrometric detection (GC/MS). Chamber air was collected onto a solid sorbent which was then thermally desorbed into the GC/MS. Instrumentation included a sample concentrator (Perkin Elmer Model TurboMatrix ATD or TurboMatrix 650), a Hewlett-Packard/Agilent 6890 or 7890 Series Gas Chromatograph and a Hewlett-Packard/Agilent 5973 or 5975 Mass Selective Detector (GC/MS). The sorbent collection technique, separation, and detection analysis methodology has been adapted from techniques presented by the USEPA and other researchers. The technique follows USEPA Compendium Method TO-17 and ASTM D 6196 and is generally applicable to C_6 - C_{16} organic chemicals with boiling points ranging from 35ºC to 250ºC (6-10). Measurements are reported to a quantifiable level of 0.04 µg based on a standard air volume collection of 18 L.

Individual VOCs were separated and detected by GC/MS. The TVOC measurements were made

by adding all individual VOC responses obtained by the mass spectrometer and calibrating the total mass relative to toluene. Individual VOCs were identified using UL Environment's specialized indoor air mass spectral database and quantitated using multipoint calibration standards, if available. Other compounds were identified with less certainty using a general mass spectral library available from the National Institute of Standards and Technology (NIST). Calibration is typically based on toluene equivalent unless an authentic standard is available. This library contains mass spectral characteristics of more than 75,000 compounds as made available from NIST, the USEPA and the National Institutes of Health (NIH). A match is first sought in the UL Environment's database, which includes data for the gas chromatographic retention time of the compound in addition to the mass spectrum. This additional information, along with the use of spectra generated on UL Environment equipment, makes confidence in identifications made from the UL Environment database higher than in identifications made using only the NIST/USEPA/NIH mass spectral library.

If data are to be used in determining compliance to the GREENGUARD Gold standard, all individual VOCs of concern are quantified using multipoint calibration to authentic standards as detailed in CDPH/EHLB/Standard Method.

AIR CONCENTRATION DETERMINATIONS

Emission rates of formaldehyde, total aldehydes, and TVOC were used in a computer model to determine potential air concentrations of the pollutants. The computer model used the measured emission rate changes over the one-week time period to determine the change in air concentrations that would accordingly occur.

The emission factor can be modeled according to a first-order decay:

$$EF_m = EF_0 e^{-kt}$$

where,
EF_m = modeled emission factor (µg/m²·hr) or (µg/unit·hr)
EF_0 = initial emission factor (µg/m²·hr) or (µg/unit·hr)
k = rate constant (hr^{-1})
t = time (hr)

or a power law decay:

$$EF_m = EF_0 t^{-k}$$

where,
EF_m = modeled emission factor (µg/m²·hr) or (µg/unit·hr)
EF_0 = initial emission factor (µg/m²·hr) or (µg/unit·hr)
k = rate constant (hr^{-1})
t = time (hr).

Regression analysis was used to determine the model that best fits the data. The use of least squares fitting, a mathematical procedure for finding the best-fitting curve to a given set of points by minimizing the sum of the squares of the offsets of the points from the curve, dictates the appropriate model for the given product.

The model measurements were made with the following assumptions: air within open office areas of the building is well-mixed at the breathing level zone of the occupied space; environmental conditions are maintained at 50% relative humidity and 23ºC (73ºF); there are no

additional sources of these pollutants; and there are no sinks or potential re-emitting sources within the space for these pollutants.

The constant emission factor (as determined at 168 hour) is used to determine compliance with the GREENGUARD Criteria by calculating an exposure concentration. The predicted exposure concentrations ($C_{P,t}$) (µg/m³) are calculated from the modeled emission factors as:

$$C_{P,t} = EF_{m,t}\left(\frac{A}{V}\right)\left(\frac{1}{N}\right)$$

where,

$C_{P,t}$ = predicted exposure concentration at time t (µg/m³)
$EF_{m,t}$ = modeled emission factor at time t (µg/m²·hr) or (µg/unit·hr)
A = product area exposed in room (m² or unit) = 6.4 m²
V = room volume (m³) = 30.6 m³
N = room air change per hour (hr^{-1}) = 0.68 hr^{-1}

If data are to be used in determining compliance to the GREENGUARD Gold standard, the 168 hour data are modeled according to UL 2818, “GREENGUARD Certification Program for Chemical Emissions for Building Materials, Finishes and Furnishings” (11). Data results are presented in a supplemental GREENGUARD Gold report based on the VOC emissions in this test report.

QUALITY CONTROL PROCEDURES FOR ENVIRONMENTAL CHAMBER EVALUATIONS

UL Environment's IAQ testing laboratories are ISO/IEC 17025 accredited with defined and executed internal and third party verification programs encompassing emission test methods and low level pollutant measurements. UL Environment's quality control/assurance plan is designed to ensure the integrity of the measured and reported data obtained during its product evaluation studies. This QC program encompasses all facets of the measurement program from sample receipt to final review and issuance of reports. As a firm with ISO/IEC 17025 accredited IAQ testing laboratories, UL Environment's product control, testing, data handling, and reporting protocols and procedures are standardized and controlled. UL Environment participates in proficiency and accreditation measurement programs for VOC and emission testing as required by the State of California, Germany Ministry of Health's Blue Angel Program, LGC Standards Air Proficiency Testing Scheme, and GREENGUARD Certification programs. Quality Assurance is maintained through UL Environment's computerized data management system. An electronic "paper trail" for each analysis is also maintained and utilized to track the status of each sample, and to store the results. A complete quality report can be provided upon request and all test data and analysis procedures are available on site for customer review.

Chamber Evaluations

One of the most critical parameters in UL Environment's product evaluations is the measurement of ultratrace levels of gaseous chemicals, typically in the ppb air concentration range. This necessitates a very rigidly maintained effort to control background contributions and contamination. These contributions must be significantly less than those levels being measured for statistically significant data to be obtained. UL Environment addresses this control in many directions including chamber construction materials, air purification and humidification, sampling materials and chemicals, sample introduction, and analysis.

Supply air purity is monitored on a weekly basis, using identical methodology to the chamber testing. The supply air is assured to contain less than 10 µg/m³ TVOC, < 10 µg/m³ total particles, < 2 µg/m³ formaldehyde, and < 2 µg/m³ for any individual VOC. Preventative maintenance ensures supply air purity, and corrective action is taken when any potential problems are noted in weekly samples. Supply air filter maintenance is critical for ensuring the purity of the chamber supply air. Chamber background samples are obtained prior to product exposure to ensure contaminant backgrounds meet the required specifications prior to product exposure. Results of this monitoring are maintained at UL Environment and available for on-site inspection.

All environmental chamber procedures are in accordance with ASTM D 5116 and D 6670 (12), and the GREENGUARD test method is strictly followed so that all data quality objectives are met.

Various measures are routinely implemented in a product's evaluation program. These include but are not limited to:

appropriate record keeping of sample identifications and tracking throughout the study;

calibration of all instrumentation and equipment used in the collection and analysis of samples;

validation and tracking of all chamber parameters including air purification, environmental controls, air change rate, chamber mixing, air velocities, and sample recovery;

analysis of spiked samples for accuracy determinations;

duplicate analyses of 10% of all samples evaluated and analyzed;

multi-point calibration and linear regression of all standardization;

analysis of controls including chamber backgrounds, sampling media, and instrumental systems.

VOC and Aldehyde Measurements

Precision of TVOC and aldehyde analyses is assessed by the Relative Standard Deviation (%RSD) from duplicate samples, defined as the standard deviation of each data set divided by the mean multiplied by 100. All QC data measurements are calculated based on the 12 month period indicated below. The VOC accuracy is based on recovery of toluene mass spiked onto sorbent material. The aldehyde accuracy is based on LGC Standard formaldehyde proficiency test results, measured by the mean Relative Percent Difference (%RPD). Third party proficiency and round robin testing for low level VOCs for national and international programs are continuously conducted and reported in UL Environment's quarterly Quality Assurance Report, and are available to all customers.

12 Month Period	December 1, 2016 through November 30, 2017	
Precision Mean RSD %	TVOC	5.8
	Total Aldehydes (Including Formaldehyde)	3.7
Accuracy %	VOC – Toluene Recovery	100.1
	Formaldehyde Mean RPD	1.9

TABLE 1

ENVIRONMENTAL CHAMBER STUDY PARAMETERS
LION CHEMTECH CO LTD

Product Description:	BUILDING PRODUCTS; SOLID SURFACES - 01; Solid Surfaces (two-sided area = 0.1800 m²)
Product Manufacture Date:	November 12, 2017
Product Collection Date:	November 14, 2017
Product Shipping Date:	November 14, 2017
Date Received at UL Environment:	November 23, 2017
Test Period:	12/05/2017 - 12/12/2017**
Testing Laboratory Location:	ULE Guangzhou Laboratory 1F-3F, Building A1, Nansha Science and Technology Innovation Center, No. 25 South Huanshi Avenue, Nansha District, Guangzhou, CHINA
Chamber Volume:	0.0878 m³
Product Loading:	2.05 m²/m³
Test Conditions:	1.0 ± 0.05 ACH 50 % RH ± 5% RH 23 °C ± 1°C
Test Description:	The product was received by ULE Guangzhou Laboratory as packaged and shipped by the customer. The package was visually inspected and stored in a controlled environment immediately following sample check-in. Just prior to loading, the product was unpackaged and prepared for the required loading to expose the finished surfaces only. The sample was placed inside the environmental chamber, and tested according to the specified protocol.

Environmental chamber test following ASTM D 5116, “Standard Guide for Small Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials / Products.”

**The manufacturing date was not within 10 days of receipt and testing of product.

TABLE 2

SUMMARY OF TVOC CHAMBER CONCENTRATIONS, EMISSION FACTORS AND PREDICTED AIR CONCENTRATIONS

SOLID SURFACES

ELAPSED EXPOSURE HOUR*	CHAMBER CONCENTRATION µg/m³	EMISSION FACTOR µg/m²•hr	PREDICTED AIR CONCENTRATION** µg/m³
0 (Background)	BQL	BQL	---
6	8.8	4.3	1
24	12.5	6.1	2
48	11.5	5.6	2
72	7.4	3.6	1
96	6.1	3.0	1
168	4.2	2.0	1
1st Order Exponential Decay Constant = k_T = 0.009			

*Exposure hours are nominal (± 1 hour).
**Prediction based on a standard worksurface usage of 6.4 m² in a 30.6 m³ room with 0.68 ACH. This room model is based on CDPH/EHLB/Standard Method.
BQL = Below quantifiable level of 0.04 µg based on a standard 18 L air collection volume.

TABLE 3

SUMMARY OF FORMALDEHYDE CHAMBER CONCENTRATIONS, EMISSION FACTORS AND PREDICTED AIR CONCENTRATIONS

SOLID SURFACES

ELAPSED EXPOSURE HOUR*	CHAMBER CONCENTRATION µg/m³	EMISSION FACTOR µg/m²•hr	PREDICTED AIR CONCENTRATION**	
			µg/m³	ppm
0 (Background)	BQL	BQL	---	---
6	BQL	BQL	< 1	< 0.001
24	BQL	BQL	< 1	< 0.001
48	BQL	BQL	< 1	< 0.001
72	BQL	BQL	< 1	< 0.001
96	BQL	BQL	< 1	< 0.001
168	BQL	BQL	< 1	< 0.001

*Exposure hours are nominal (± 1 hour).
**Prediction based on a standard worksurface usage of 6.4 m² in a 30.6 m³ room with 0.68 ACH. This room model is based on CDPH/EHLB/Standard Method.
BQL = Below quantifiable level of 0.1 µg based on a standard 45 L air collection volume.

TABLE 4

SUMMARY OF TOTAL ALDEHYDE CHAMBER CONCENTRATIONS, EMISSION FACTORS AND PREDICTED AIR CONCENTRATIONS

SOLID SURFACES

ELAPSED EXPOSURE HOUR*	CHAMBER CONCENTRATION µg/m³	EMISSION FACTOR µg/m²•hr	PREDICTED AIR CONCENTRATION**	
			µg/m³	ppm
0 (Background)	BQL	BQL	---	---
6	BQL	BQL	< 1	< 0.001
24	BQL	BQL	< 1	< 0.001
48	BQL	BQL	< 1	< 0.001
72	BQL	BQL	< 1	< 0.001
96	BQL	BQL	< 1	< 0.001
168	BQL	BQL	< 1	< 0.001

*Exposure hours are nominal (± 1 hour).
**Prediction based on a standard worksurface usage of 6.4 m² in a 30.6 m³ room with 0.68 ACH. This room model is based on CDPH/EHLB/Standard Method.
BQL = Below quantifiable level of 0.1 µg based on a standard 45 L air collection volume.

TABLE 5

CHAMBER CONCENTRATIONS OF IDENTIFIED INDIVIDUAL VOLATILE ORGANIC COMPOUNDS (µg/m³)

SOLID SURFACES

CAS NUMBER	COMPOUND IDENTIFIED	ELAPSED EXPOSURE HOUR						
		0 (BG)	6	24	48	72	96	168
80-62-6	Methyl methacrylate (2-Propenoic acid, 2-methyl-, methyl ester)	BQL	5.9	5.6	8.6	7.4	6.1	4.2
1066-42-8	Silanediol, dimethyl-*	BQL	2.9	2.7	2.9			

*****Indicates NIST/EPA/NIH best library match only based on retention time and mass spectral characteristics
†Denotes quantified using multipoint authentic standard curve. Other VOCs quantified relative to toluene.
BQL = Below quantifiable level of 2.0 µg/m³.

TABLE 6

EMISSION FACTORS OF IDENTIFIED INDIVIDUAL VOLATILE ORGANIC COMPOUNDS (µg/m²•hr)

SOLID SURFACES

CAS NUMBER	COMPOUND IDENTIFIED	ELAPSED EXPOSURE HOUR					
		6	24	48	72	96	168
80-62-6	Methyl methacrylate (2-Propenoic acid, 2-methyl-, methyl ester)	2.9	2.7	4.2	3.6	3.0	2.0
1066-42-8	Silanediol, dimethyl-*	1.4	1.3	1.4			

*Indicates NIST/EPA/NIH best library match only based on retention time and mass spectral characteristics.
†Denotes quantified using multipoint authentic standard curve. Other VOCs quantified relative to toluene.
Quantifiable level is 0.04 µg based on a standard 18 L air collection volume.

TABLE 7

CHAMBER CONCENTRATIONS OF INDIVIDUAL ALDEHYDES (µg/m³)

SOLID SURFACES

CAS NUMBER	COMPOUND IDENTIFIED	ELAPSED EXPOSURE HOUR						
		0 (BG)	6	24	48	72	96	168
4170-30-3	2-Butenal	BQL	BQL	BQL	BQL	BQL	BQL	BQL
75-07-0	Acetaldehyde	BQL	BQL	BQL	BQL	BQL	BQL	BQL
100-52-7	Benzaldehyde	BQL	BQL	BQL	BQL	BQL	BQL	BQL
5779-94-2	Benzaldehyde, 2,5-dimethyl	BQL	BQL	BQL	BQL	BQL	BQL	BQL
529-20-4	Benzaldehyde, 2-methyl	BQL	BQL	BQL	BQL	BQL	BQL	BQL
620-23-5 /104-87-0	Benzaldehyde, 3- and/or 4-methyl	BQL	BQL	BQL	BQL	BQL	BQL	BQL
123-72-8	Butanal	BQL	BQL	BQL	BQL	BQL	BQL	BQL
590-86-3	Butanal, 3-methyl	BQL	BQL	BQL	BQL	BQL	BQL	BQL
50-00-0	Formaldehyde	BQL	BQL	BQL	BQL	BQL	BQL	BQL
66-25-1	Hexanal	BQL	BQL	BQL	BQL	BQL	BQL	BQL
110-62-3	Pentanal	BQL	BQL	BQL	BQL	BQL	BQL	BQL
123-38-6	Propanal	BQL	BQL	BQL	BQL	BQL	BQL	BQL

BQL = Below quantifiable level of 2.0 µg/m³.

TABLE 8

EMISSION FACTORS OF INDIVIDUAL ALDEHYDES (µg/m²•hr)

SOLID SURFACES

CAS NUMBER	COMPOUND IDENTIFIED	ELAPSED EXPOSURE HOUR					
		6	24	48	72	96	168
4170-30-3	2-Butenal	BQL	BQL	BQL	BQL	BQL	BQL
75-07-0	Acetaldehyde	BQL	BQL	BQL	BQL	BQL	BQL
100-52-7	Benzaldehyde	BQL	BQL	BQL	BQL	BQL	BQL
5779-94-2	Benzaldehyde, 2,5-dimethyl	BQL	BQL	BQL	BQL	BQL	BQL
529-20-4	Benzaldehyde, 2-methyl	BQL	BQL	BQL	BQL	BQL	BQL
620-23-5 /104-87-0	Benzaldehyde, 3- and/or 4-methyl	BQL	BQL	BQL	BQL	BQL	BQL
123-72-8	Butanal	BQL	BQL	BQL	BQL	BQL	BQL
590-86-3	Butanal, 3-methyl	BQL	BQL	BQL	BQL	BQL	BQL
50-00-0	Formaldehyde	BQL	BQL	BQL	BQL	BQL	BQL
66-25-1	Hexanal	BQL	BQL	BQL	BQL	BQL	BQL
110-62-3	Pentanal	BQL	BQL	BQL	BQL	BQL	BQL
123-38-6	Propanal	BQL	BQL	BQL	BQL	BQL	BQL

BQL = Below quantifiable level of 0.1 µg based on a standard 45 L air collection volume.

REFERENCES

1. UL 2821, “GREENGUARD Certification Program Method for Measuring and Evaluating Chemical Emissions From Building Materials, Finishes and Furnishings Using Dynamic Environmental Chambers” 2013.

2. ASTM D 5116, "Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products." ASTM, West Conshohocken, PA, 2010.

3. USEPA Report 600/8-89-074, Research Triangle Park, North Carolina, 1989.

4. State of California's Indoor Air Quality Program, “Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources using Environmental Chambers” Version 1.2, January 2017.

5. ASTM D 5197, “Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology).” ASTM, West Conshohocken, PA, 2009.

6. EPA, “Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air - Second Edition,” (EPA/625/R-96/010b), Center for Environmental Research Information, Office of Research and Development, USEPA Cincinnati, OH, 1999. http://www.epa.gov/ttnamti1/files/ambient/airtox/tocomp99.pdf

7. Bertoni, G., F. Bruner, A. Liberti, and C. Perrino, “Some Critical Parameters in Collection, Recovery, and Gas Chromatographic Analysis of Organic Pollutants in Ambient Air Using Light Adsorbents.” J. Chromatogr., 203, 263-270, 1981.

8. Bruner, F., G. Bertoni, and G. Crescentini, “Critical Evaluation of Sampling and Gas Chromatographic Analysis of Halocarbons and Other Organic Air Pollutants.” J. Chromatogr., 167, 399-407, 1978.

9. Mangani, F., A. Mastrogiacomo, and O. Marras, “Evaluation of the Working Conditions of Light Adsorbents and Their Use as Sampling Material for the GC Analysis of Organic Air Pollutants in Work Areas.” Chromatographia, 15, 712-716, 1982.

10. ASTM D 6196 “Practice for the Selection of Sorbents and Pumped Sampling/ Thermal Desorption Analysis Procedures for Volatile Organic Compounds in Air.” ASTM, West Conshohocken, PA, 2009.

11. UL 2818, “GREENGUARD Certification Program for Chemical Emissions for Building Materials, Finishes and Furnishings” 2013.

12. ASTM D 6670, “Standard Practice for Full-Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials/Products.” ASTM, West Conshohocken, PA, 2007.

13. ACGIH, 2012 Threshold Limit Values for Chemical Substances and Physical Agents, Cincinnati, OH.

APPENDIX 1

CHAIN OF CUSTODY

UL Environment
2211 Newmarket Parkway, Suite 106
Marietta, GA 30067-9399 USA
T.888.485.4733/F.770.980.0072
W:UL.com/environment

Chain Of Custody
For UL GREENGUARD Certification Programs

9225

Laboratory Use Only		Receipt #			
Project #	1000302112	**Reference**			
Product #	1063666	**Rush**	☐ Confirm with Laboratory Contact prior to submitting product		
Order #	11872940	**Task Line**	1.1	**UL Business Unit**	UL VS

Test Information			
☑	Annual Certification Test: Year 17	GREENGUARD ☐	GREENGUARD GOLD ☑
☐	Quarterly Test: Year ______ Quarter ______	GREENGUARD ☐	GREENGUARD GOLD ☐

☐ Profile Study Test			☐ Out-of-Scope Test		
Test Group	solid surfaces -01	Product Category	stone surfacing material	Subcategory	
Application:	☐ Wall	☐ Floor/Ceiling	☐ Work Surface	☐ Panel	☐ Other: ______
For Wet Products Only:	Coverage Rate:		Density:		Specific Gravity:

Product and Company Information			
Product Description/ Name	solid surfaces		
Manufacture ID#	[illegible]	***Date of Manufacture**	12-NOV-17
Company Submitting Sample	[illegible]	Contact Name	MIN, Jung-Yong
		Job Title	Manager
Address	(Kun Chemtech Co LTD), [illegible], Daejeon [illegible], Republic of Korea(south korea)	Contact Phone	82-42-930-3300
		Contact Email	

Collection Information			
Collector Name	Claire Jun	***Date Collected**	14-NOV-17
Collector Phone	82-42-930-3321	Time Collected	[illegible]
Collector Signature	[signature]	Collection Location	-

Shipping Information			
Carrier	DHL		
Shipper Name	Jack Suh	***Date Shipped**	14-NOV-17
Shipper Phone	82-42-930-3300	Time Shipped	TBD
Shipper Signature		Air Bill #	TBD (Confirm by e-mail)

Post Testing Information (Must be Completed)			
☐ Return Samples (information must be provided below for sample return)			☐ Discard sample(s) after testing
Return Shipper		Shipper Acct #	

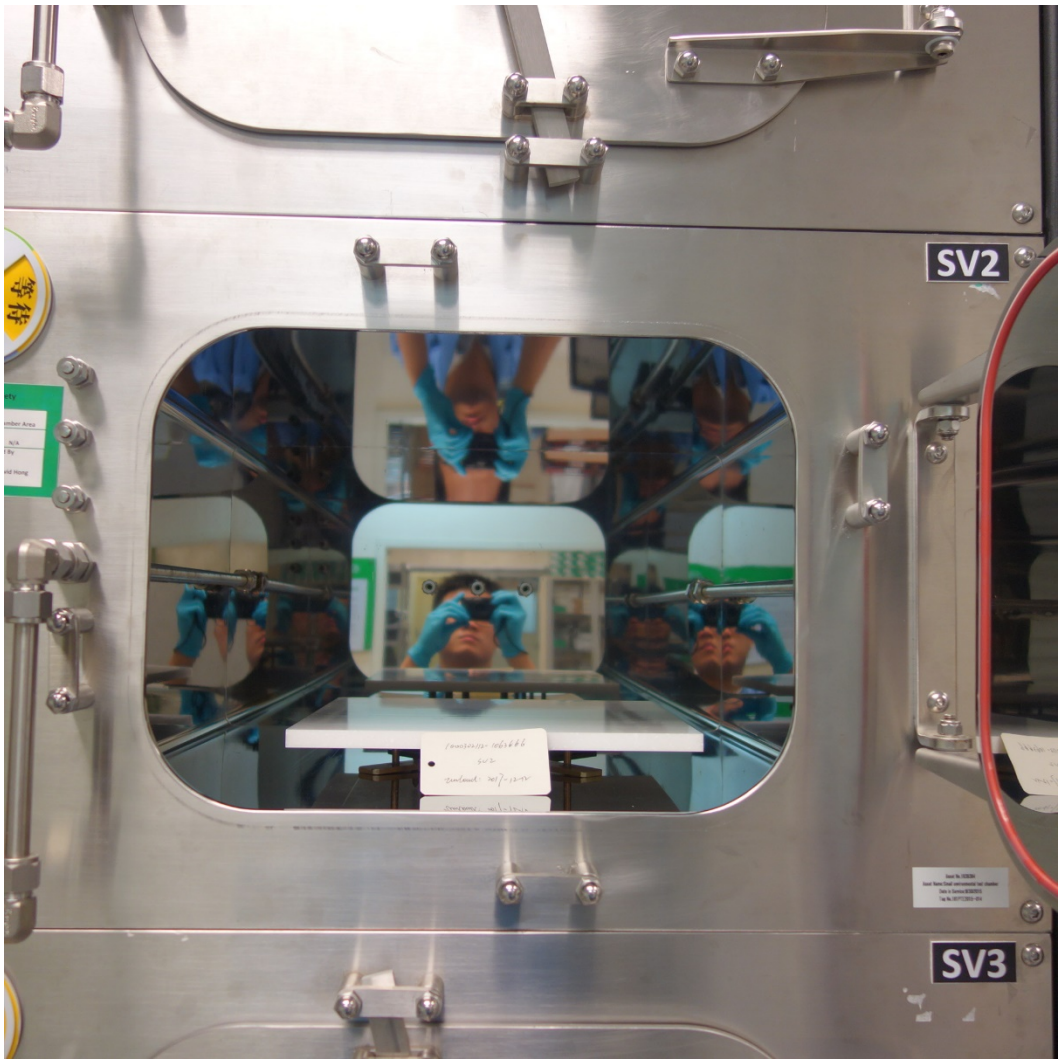
Laboratory Use Only – Receiving Information					
Receive Date	2017.11.23		Receive Time	15:05	
Sample/ Package Condition Upon Arrival	☑ Acceptable ☐ Not Acceptable		Sample Condition Notes		
Receiver Name	[illegible]		Receiver Signature	[signature]	
Completed By	UL Environment	Based On		Date	

02-EN-F0852 – Issue 4.0

APPENDIX 2

PHOTOGRAPH OF SAMPLE

SOLID SURFACES



APPENDIX 3

SUPPLEMENTAL EMISSIONS INFORMATION

The table below represents the chemical emissions identified in the "Solid Surfaces" sample found on certain regulatory lists. This addendum only provides a statement regarding possible health effects associated with this compound and not the relative risks of exposure. Proper interpretation of the risks associated with exposure to a given regulated compound requires a more detailed evaluation of toxicological activity. You may be required to submit this information for certain purchasing programs. You may also use this information to assist in further product development efforts.

CAS NUMBER	COMPOUND	✓() = FOUND IN LISTING (CLASS)					
		CAL PROP. 65	NTP	IARC	CAL AIR TOXICS	CREL	TLV
80-62-6	Methyl methacrylate (2-Propenoic acid, 2-methyl-, methyl ester)			✓(3)	✓(IIA)		✓

†Denotes quantified using multipoint authentic standard curve

CAL Prop. 65: California Health and Welfare Agency, Proposition 65 Chemicals
1 = known to cause cancer
2 = known to cause reproductive toxicity

NTP: National Toxicology Program
2A = known to be carcinogenic to humans
2B = reasonably anticipated to be carcinogenic to humans

IARC: International Agency on Research of Cancer
1 = carcinogenic to humans
2A = probably carcinogenic to humans
2B = possibly carcinogenic to humans
3 = unclassifiable as to carcinogenicity to humans
4 = probably not carcinogenic to humans

California Air Toxics
I = Substances identified as Toxic Air Contaminants, known to be emitted in California, with a full set of health values reviewed by the Scientific Review Panel.
IIA = Substances identified as Toxic Air Contaminants, known to be emitted in California, with one or more health values under development by the Office of Environmental Health Hazard Assessment for review by the Scientific Review Panel.
IIB = Substances NOT identified as Toxic Air Contaminants, known to be emitted in California, with one or more health values under development by the Office of Environmental Health Hazard Assessment for review by the Scientific Review Panel.
III = Substances known to be emitted in California and are NOMINATED for development of health values or additional health values.
IVA = Substance identified as Toxic Air Contaminants, known to be emitted in California and are TO BE EVALUATED for entry into Category III.
IVBA =Substance NOT identified as Toxic Air Contaminants, known to be emitted in California and are TO BE EVALUATED for entry into Category III.
V = Substance identified as Toxic Air Contaminants, and NOT KNOWN TO BE EMITTED from stationary source facilities in California based on information from the AB 2588 Air Toxic "Hot Spots" Program and the California Toxic Release Inventory.
VI = Substances identified as Toxic Air Contaminants, NOT KNOWN TO BE EMITTED from stationary source facilities in California, and are active ingredients in pesticides in California.

CREL: California Office of Environmental Health's Hazard Assessment (OEHHA), Chronic Reference Exposure Levels
✓ = Found in Listing

ACGIH TLV American Conference of Governmental Industrial Hygienists Threshold Limit Values for Chemical Substances and Physical Agents.
✓ = Found in Listing.

APPENDIX 4

GREENGUARD GOLD SUPPLEMENTAL REPORT FOR GREENGUARD CERTIFICATION

SOLID SURFACES

COMPLIANCE WITH GREENGUARD GOLD STANDARD

GREENGUARD Gold Acceptable IAQ Criteria		Predicted Concentration*		Product Compliance for IAQ
		Office	Classroom	
TVOC	**≤ 0.22 mg/m³**	0.001 mg/m³	< 0.001 mg/m³	Yes
Formaldehyde	**≤ 0.0073 ppm**	< 0.001 ppm	< 0.001 ppm	Yes
Total Aldehydes	**≤ 0.043 ppm**	< 0.001 ppm	< 0.001 ppm	Yes
1-Methyl-2-Pyrrolidinone	**≤ 0.16 mg/m³**	< 0.001 mg/m³	< 0.001 mg/m³	Yes
Individual VOCs	**≤ 1/100 TLV and ≤ ½ chronic REL**	See Below		

Results at 168 hours based on testing per CDPH/EHLB/Standard Method V1.1.

*Office model based on a standard worksurface usage of 6.4 m² in a 30.6 m³ room with 0.68 ACH. Classroom model based on a standard worksurface usage of 24.6 m² in a 231 m³ classroom with 0.82 ACH. Both models are based on CDPH/EHLB/Standard Method.

Note that certain environments and/or modeling scenarios may prevent assessment of low level CREL and TLV analytes due to the emissions being below the lower LOQ (0.04 µg). For example, benzene ½ CREL is 1.5 µg/m³.

TOP TEN MOST ABUNDANT IDENTIFIED VOCS, INCLUDING ALDEHYDES

CAS Number	Chemical	168 Hour Chamber Concentration (µg/m³)	168 Hour Emission Factor (µg/m²•hr)	Predicted Concentration** (µg/m³)	
				Office	Classroom
80-62-6	Methyl methacrylate (2-Propenoic acid, 2-methyl-, methyl ester)	4.2	2.0	0.6	0.3

Results at 168 hours based on testing per CDPH/EHLB/Standard Method.

†Denotes quantified using multipoint authentic standard curve. Other VOCs quantified relative to toluene.

‡Indicates compound identified and quantified by DNPH derivitization and HPLC/UV analysis with multipoint authentic standard.

*Identification based on NIST mass spectral database only.

**Office model based on a standard worksurface usage of 6.4 m² in a 30.6 m³ room with 0.68 ACH. Classroom model based on a standard worksurface usage of 24.6 m² in a 231 m³ classroom with 0.82 ACH. Both models are based on CDPH/EHLB/Standard Method.

CHEMICALS OF CONCERN WITH EXISTING TLV, CREL, CA PROP 65 OR CAL TOXIC AIR CONTAMINANT VALUES

CAS Number	Chemical	168 Hour Chamber Concentration (µg/m³)	168 Hour Emission Factor (µg/m²•hr)	Predicted Concentration* (µg/m³)		✓ INDICATES PRESENCE ON LIST			
				Office	Classroom	CA PROP 65	CA TAC	CA CREL	ACGIH TLV
80-62-6	Methyl methacrylate (2-Propenoic acid, 2-methyl-, methyl ester)	4.2	2.0	0.6	0.3		✓(IIA)		✓

Results at 168 hours based on testing per CDPH/EHLB/Standard Method.

†Denotes quantified using multipoint authentic standard curve. Other VOCs quantified relative to toluene.

‡Indicates compound identified and quantified by DNPH derivitization and HPLC/UV analysis.

*Office model based on a standard worksurface usage of 6.4 m² in a 30.6 m³ room with 0.68 ACH. Classroom model based on a standard worksurface usage of 24.6 m² in a 231 m³ classroom with 0.82 ACH. Both models are based on CDPH/EHLB/Standard Method.

COMPARISON OF CHEMICALS FOUND WITH EXISTING TLV AND/OR CHRONIC REL

CAS Number	Chemical	1/100 TLV[a] (µg/m³)	½ CA Chronic REL[b] (µg/m³)	Predicted Concentration* (µg/m³)		Product Compliance
				Office	Classroom	
80-62-6	Methyl methacrylate (2-Propenoic acid, 2-methyl-, methyl ester)	2,100	---	0.6	0.3	Yes

[a]American Conference of Governmental Industrial Hygienists. Threshold Limit Values for Chemical Substances and Physical Agents. Cincinnati, OH: ACGIH, 2012.

[b]http://www.oehha.ca.gov/air/allrels.html - Chronic Reference Exposure Levels (CRELs) Adopted by the State of California Office of Environmental Health Hazard Assessment (OEHHA), February 2012.

*Office model based on a standard worksurface usage of 6.4 m² in a 30.6 m³ room with 0.68 ACH. Classroom model based on a standard worksurface usage of 24.6 m² in a 231 m³ classroom with 0.82 ACH. Both models are based on CDPH/EHLB/Standard Method.