



Berkeley Analytical Associates, LLC

Air Quality Research and Analysis

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April 24, 2009

Tim Cole
Forbo Flooring
2 Maplewood Dr.
Hazelton, PA 18202

Re: Section 01350 Emission Test Results, Forbo Flooring, Coral Classic, Product # C4730200.

Dear Mr. Cole:

Your vinyl backed tufted textile floor covering for entry system, Coral Classic, was tested by our laboratory to determine its emissions of toxic volatile organic chemicals (VOCs) of concern. The test was conducted following the procedures described in California Department of Health Services (CDHS) *Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers, Including Addendum 2004-01*, accessible at:

http://www.cal-iaq.org/VOC/Section01350_7_15_2004_FINAL_PLUS_ADDENDUM-2004-01.pdf. This testing procedure has been adopted by the Collaborative for High Performance Schools (CHPS, www.chps.net) to determine the compliance of Low Emitting Materials.

Calculations were performed using the parameters given below for a standard classroom to estimate the concentrations of VOCs of concern resulting from the use of your product in a classroom environment. The results of the test and the calculated concentrations for the standard classroom are presented in our laboratory report, 135-024-01A-Apr2409

Ventilation Rate	Room Volume	Surface Area Covered by Product
0.90 air changes per hour (volume fraction = 0.9)	231 m ³ or (40x24x8.5 ft = 8,160 ft ³)	89.2 m ² of floor area

Your Forbo Flooring, Coral Classic, Product # C4730200, **meets** the DHS Standard Practice requirements for use in a classroom with the above parameters.

Sincerely,

Raja S. Tannous
Laboratory Director

Attachment: Laboratory report

BERKELEY ANALYTICAL ASSOCIATES, LLC

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PRODUCT VOC EMISSION TEST RESULTS

Report Certification

Report Number & Date: 135-024-01A-Apr2409 -- 4/24/2009

Recalculation Job:

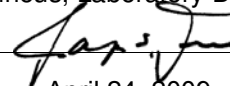
Original Specimen ID (if recal job):

Protocol or test method/criteria: CA DHS Section 01350 protocol

Certified By:

Raja S. Tannous, Laboratory Director

Signature



Date April 24, 2009

Customer Information

Customer:

Forbo Flooring

City/State/Country:

Hazleton, PA USA

Contact name/Title:

Tim Cole, Director of Support Services

Contact Address:

2 Maplewood Dr., Hazleton PA 18202

Phone number:

570-450-0238

Manufacturer Information

Manufacturing company:

Forbo Flooring

Product name:

Coral Classic

Product sample ID:

Production 71821901

Product category:

Carpet (09680)

Product subcategory:

Floor Covering for Entry System

Manufacturer ID:

Color - C4730200

Date manufactured:

3/25/2009

Date collected:

3/25/2009

Date shipped:

4/1/2009

Sample/Specimen Information

Date received:

4/2/2009

Specimen ID (Lab tracking No.):

135-024-01A

Specimen preparation:

Tested a 17.78 cm by 17.78 cm specimen with back surface covered and all edges sealed.

Conditioning period start & duration:

4/3/2009, 10 days

Test period start & duration:

4/13/2009, 96 hours

Protocol -- Emission tests are performed following California Dept. of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," CA/DHS/EHLRB/R-174, 07/15/04 (http://www.cal-iaq.org/VOC/Section01350_7_15_2004_FINAL_PLUS_ADDENDUM-2004-01.pdf). This practice is based on ASTM D 5116, "Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products" and incorporates the chamber testing portion of California Specification 01350 (<http://www.ciwmb.ca.gov/GreenBuilding/Specs/Section01350/>). Project-specific results are calculated as described in Specification 01350.

Table 1. Chamber Conditions for Test Period *

Parameter	Symbol	Units	Value
Product exposed area	A_c	m^2	0.0316
Chamber volume	V_c	m^3	0.067
Loading ratio	L_c	$m^2 m^{-3}$	0.47
Inlet air flow rate	Q	$m^3 h^{-1}$	0.067
Ventilation rate	a_c	h^{-1}	1.00
Temperature		$^{\circ}C$	23.0
Relative humidity		%	50.3

* Specified ranges: 22°C to 24°C, RH 45% to 55%, and Q 0.064 to 0.070 (small chamber) or 5.81 to 6.42 (mid-size chamber)

Table 2. Parameters used to calculate building VOC concentrations

Bldg. Component/ Material	Floor - Floor Covering (any)	Parameter	Symbol	Units	Building Type*
<u>Standard Classroom</u>					
Product exposed area		A_B		m^2	89.2
Building volume		V_B		m^3	231.1
Ceiling height				m	2.59
Loading ratio		L_B		$m^2 m^{-3}$	0.386
Ventilation rate		a_B		h^{-1}	0.90
Ventilation vol. fraction		V_{fB}			0.90
Vent. flow rate per area				$(m^3 h^{-1}) / m^2$	2.10
<u>Standard Office Space</u>					
Product exposed area		A_B		m^2	11.1
Building volume		V_B		m^3	30.6
Ceiling height				m	2.74
Loading ratio		L_B		$m^2 m^{-3}$	0.365
Ventilation rate		a_B		h^{-1}	0.75
Ventilation vol. fraction		V_{fB}			0.90
Vent. flow rate per area				$(m^3 h^{-1}) / m^2$	1.85

* Standard building types are: (1) School classroom defined in Table 7.4, CA/DHS/EHLB/R-174, 07/15/04; (2) Office space (individual) defined in Table 7.5, CA/DHS/EHLB/R-174, 07/15/04; and (3) Large office building with volume ceiling height from East End Project, Products Passed Section 01350, Calif. Integrated Waste Management Board. For floor products ceiling panels, 100% coverage is assumed. For wall paint and wallcoverings, exposed area is wall paint area for the building (<http://www.ciwmb.ca.gov/GreenBuilding/Specs/EastEnd/>).

Table 3. Pass/fail results of emission test for identified VOCs with chronic RELs
 (Only VOCs detected above quantitation limits are reported)

Substance	CAS No.	$\frac{1}{2}$ REL $\mu\text{g m}^{-3}$	Building Type
			Standard Classroom and/or Office Space
No formaldehyde or other CREL VOCs were detected*	None	None	PASS

* CREL compound concentrations were below the lower limit of quantitation (LOQ). For formaldehyde and acetaldehyde the LOQ is 1 μg per cubic meter and for all other CREL compounds, the LOQ is 2 μg per cubic meter.

Table 4. List of emitted VOCs* (Only VOCs detected above quantitation limits are reported. Individual VOCs with chronic RELs and/or on other lists of toxicants are shown first, followed by unlisted abundant compounds)

Substance	CAS No.	Surrogate?	Chronic REL* µg m ⁻³	CARB TAC Category	Prop 65 List?
Caprolactam	105-60-2			T-V	
2-Ethyl-1-hexanol	104-76-7				
n-Tetradecane	629-59-4				
4-tert-Butylcyclohexanol	98-52-2	Yes			

* For formaldehyde an interim Indoor REL (IREL) of 33 (µg per cubic meter), developed by Calif. Office of Environmental Health Hazard Assessment (Refer to CA/DHS/EHLB/R-174, 07/15/04), is used to set the pass/fail criterion as shown in Table 3.

Table 5. Emission Test Results for Individual VOCs*

Substance	96-h Chamber Concentration $\mu\text{g m}^{-3}$	Emission Factor $\mu\text{g m}^{-2} \text{ h}^{-1}$	Building Concentration $\mu\text{g m}^{-3}$
			<u>Standard Classroom</u>
2-Ethyl-1-hexanol	44.2	93.8	44.7
4-tert-Butylcyclohexanol	12.2	25.9	12.4
n-Tetradecane	5.6	12.0	5.7
Caprolactam	102.8	218.3	104.0
Substance	96-h Chamber Concentration $\mu\text{g m}^{-3}$	Emission Factor $\mu\text{g m}^{-2} \text{ h}^{-1}$	Building Concentration $\mu\text{g m}^{-3}$
			<u>Standard Office Space</u>
2-Ethyl-1-hexanol	44.2	93.8	50.7
4-tert-Butylcyclohexanol	12.2	25.9	14.0
n-Tetradecane	5.6	12.0	6.5
Caprolactam	102.8	218.3	117.9

* Parameters and reported values are defined and explained in Table 9

Table 6. TVOC Chamber & Building Concentrations for Different Test Periods

Test Duration	Chamber Conc. $\mu\text{g m}^{-3}$	Emission Factor $\mu\text{g m}^{-2} \text{ h}^{-1}$	Building Conc. $\mu\text{g m}^{-3}$
<u>Standard Classroom</u>			
24-h	231	490	233
48-h	234	496	236
96-h	246	522	249
<u>Standard Office Space</u>			
24-h	231	490	265
48-h	234	496	268
96-h	246	522	282

Table 7. Formaldehyde Chamber & Building Concentrations for Different Test Periods

Test Duration	Chamber Conc. $\mu\text{g m}^{-3}$	Emission Factor $\mu\text{g m}^{-2} \text{ h}^{-1}$	Building Conc. $\mu\text{g m}^{-3}$
<u>Standard Classroom</u>			
24-h	LQ	LQ	LQ
48-h	LQ	LQ	LQ
96-h	LQ	LQ	LQ
<u>Standard Office Space</u>			
24-h	LQ	LQ	LQ
48-h	LQ	LQ	LQ
96-h	LQ	LQ	LQ

Table 8. Pictures of The Tested Specimen



Table 9. Definition of Parameters and Notes to Tables

Parameter/Value	Definition
CAS No.	Chemical Abstract Service identification number
Surrogate?	“Yes” indicates compound was quantified by GC/MS total-ion-current (TIC) method using toluene as calibration reference
Chronic REL	Chronic Reference Exposure Level (REL) established by Calif. Office of Environmental Health Hazard Assessment, Feb. 2005 and adopted by Section 01350 as target IAQ limit for building; for formaldehyde, IAQ limit is interim Indoor REL of $33 \mu\text{g m}^{-3}$. No product may contribute more than $\frac{1}{2}$ IAQ limit for an REL compound, with the exception of acetaldehyde for which the full REL is allowed.
CARB TAC Cat.	Toxic Air Contaminant (TAC) on Calif. Air Resources Board list, Dec. 1999, with toxic category indicated
Prop 65 List?	“Yes” indicates compound is chemical known to cause cancer or reproductive toxicity listed by Calif. Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65), Mar. 2005
96-h Chamber Conc.	Measured chamber VOC concentration at 96-h time point minus any analytical blank or blank concentration for empty chamber operated following same procedure. Lower limit of quantitation (LOQ) for individual VOCs on lists of toxicants is $2 \mu\text{g m}^{-3}$, based on a 2 ng limit for a 1-liter sample. LOQ for TVOC is $20 \mu\text{g m}^{-3}$. LOQ for formaldehyde and acetaldehyde is given below
Emission Factor	Mass of compound emitted per square meter of exposed surface per hour (calculations shown below). Reporting limits for emission factors are established by LOQ or reporting limit for chamber concentration and specimen’s exposed surface area
Classroom/Office/Office Bldg. Conc.	Concentrations for school classroom, small office (individual), large office building, or specific project building calculated using parameters given in Table 2 (calculations shown below)
TVOC	Total Volatile Organic Compounds quantified by GC/MS TIC method using toluene as calibration reference
Formaldehyde & acetaldehyde	Volatile aldehydes quantified by HPLC following ASTM Method D 5197-97. LOQ for formaldehyde and acetaldehyde is $\sim 1 \mu\text{g m}^{-3}$
Individual VOCs	Quantified by thermal desorption GC/MS following EPA Methods TO-1 and TO-17. Compounds are quantified using multipoint calibrations prepared with pure substances unless otherwise indicated (see Surrogate?). VOCs with chronic RELs are listed first, followed by other TAC and Prop. 65 compounds. Additional abundant VOCs at or above reporting limit of $5 \mu\text{g m}^{-3}$ are listed last. VOCs are listed in order of decreasing volatility within each group
“<”	“Less than” concentrations established by LOQ
“HC”	Hydrocarbon compound
“LQ”	Indicates calculated value is below quantitation based on concentration LOQ
“na”	Not applicable

Equations Used in Calculations

An emission factor (EF) in $\mu\text{g m}^{-2} \text{h}^{-1}$ for a chemical substance in a chamber test is calculated using Equation 1:

$$EF = (Q (C - C_o)) / A_c \quad (1)$$

where C is the chamber concentration of the substance ($\mu\text{g m}^{-3}$) and C_o is the corresponding substrate or chamber blank concentration ($\mu\text{g m}^{-3}$). The other parameters are defined in Table 1. For an emitting unit, such as a chair, the number of units, N, is substituted for surface area, A_c , and EF is expressed as $\mu\text{g/unit-h}$.

A building concentration (C_B) in $\mu\text{g m}^{-3}$ can be estimated from the EF using Equation 2:

$$C_B = (EF * A_B) / Q_B \quad (2)$$

where A_B is the area of the product in the building space and Q_B is the outdoor air flow rate to the space.

An EF in $\mu\text{mol m}^{-2} \text{h}^{-1}$ for an individual VOC in a chamber test is calculated from the above EF using Equation 3:

$$EF (\mu\text{mol m}^{-2} \text{h}^{-1}) = EF (\mu\text{g m}^{-2} \text{h}^{-1}) / MW \quad (3)$$

where MW is the molecular weight (molar mass) of the respective compound.

A chamber concentration in ppb (molar basis) for an individual VOC is calculated from the chamber concentration ($C - C_o$) in $\mu\text{g m}^{-3}$ using Equation 4:

$$\text{Chamber concentration (ppb)} = (C - C_o) \times 24.45 / MW \quad (4)$$

where 24.45, in L/mol, is the molar volume of air at standard conditions (1 atm pressure, 25° C).

For a furniture component, the workstation concentration of formaldehyde and total aldehydes in ppb can be estimated from the corresponding aldehyde EF ($\mu\text{mol m}^{-2} \text{h}^{-1}$) using Equation 5:

$$\text{WS Aldehyde concentration (ppb)} = (EF_{\text{aldehyde}})(A_{\text{ws}})(24.45) / Q_{\text{ws}} \quad (5)$$

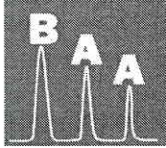
where A_{ws} is the surface area of the component in the workstation (m^2) and Q_{ws} is the outdoor air flow rate to the workstation (m^3/h).

Comments

The emission factor calculations are based on the the area of the top exposed surface.

Note: The test results presented herein are specific to this item. 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.

END OF REPORT



Berkeley Analytical Associates, LLC

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CHAIN OF CUSTODY PRODUCT / MATERIAL VOC EMISSION TEST

2007 Update

(Note: a separate COC must be filled for each product sample)

Client Information*	
Company:	FORBO FLOORING
Street Address:	8 MAPLEWOOD DRIVE
City/State:	HAZLETON / PA
Zip/Postal Code:	18202
Country:	NORTH AMERICA
Contact (for reporting):	TIM COLE OR KEVIN MAKAREWICZ
Contact Title:	TECHNICAL ANALYSIS
Phone/Fax Numbers:	800-342-0604 X 238 OR 255 / FAX: 570-45-0330
Email Address:	tim.cole@forbo.com / kevin.makarewicz@forbo.com

Test Protocol (Check One)*		
CA DHS Section 01350	<input checked="" type="checkbox"/>	10 d conditioning, 24 h, 48 h, 96 h
BIFMA - small chamber	<input type="checkbox"/>	72 h, 168 h
BIFMA - mid-size chamber	<input type="checkbox"/>	72 h, 168 h
01350 Screening (specify test points)		
BIFMA Screening (specify test points)	<input type="checkbox"/>	
Other, specify below:	<input type="checkbox"/>	

Manufacturer Information (if different from client)	
Company:	
City/State/Country:	
Contact Name/Title:	
Phone Number:	

Test Data Application Program (Check if Applicable)		
CHPS	<input checked="" type="checkbox"/>	
FloorScore	<input type="checkbox"/>	
CRI Greenlabel	<input type="checkbox"/>	
CRI Greenlabel Plus	<input type="checkbox"/>	
SCS Indoor Advantage, furniture	<input type="checkbox"/>	
SCS Indoor Advantage Gold, furniture	<input type="checkbox"/>	
SCS Indoor Advantage Gold, bldg product	<input type="checkbox"/>	

Sample Details	
Product Name*:	Coral Classic
Manufacturer Product ID #*:	Color - C4730200
Sample Internal ID #:	Production 71821901
Date Manufactured*:	March 2009 <i>3/25/09 Per email</i>
Product Category & Use*:	Floor Covering - Entry System
Sample Construction Material*:	Vinyl Backed Tufted Textile
Plant Name & Location*:	Forbo - Krommenie (Bonar Location)
Collection Location within Plant:	Netherlands warehouse in pilot manufacturing area
Date & Time Collected*:	March 25, 2009 - a.m.
Number of Sample Pieces*:	(4) Photo(s) of Collection Location:
Sample Collected by*:	Dick van Bergen
Phone/Fax Numbers*:	800-342-0604 x 255 Fax:570-450-0330
Email Address*:	tim.cole@forbo.com / kevin.makarewicz@forbo.com

Copy to Certifier (If Applicable)	
Organization:	
Contact:	

Notes or Comments from Client / Manufacturer	
PLEASE TEST FLOORING MATERIAL FOR CHPS 01350 FOR BOTH OFFICE AND CLASSROOM CLASSIFICATION.	

Shipping Details*	
Packed & Shipped By:	Kevin Makarewicz
Shipping Date:	April 1, 2009
Carrier/Airbill Number:	Fed Ex Priority Overnight <i>9043 8873 6853</i>

For BAA Use Only	
Condition of Shipping Package:	
Condition of Sample:	
Lab Tracking Number:	<i>135-024-01A</i>

Sample Handling				
Relinquished By*	Received By*	Signature*	Date*	Company*
	<i>Tim Cheng</i>	<i>TJ</i>	<i>4/2/09</i>	<i>BAA</i>