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MATERIAL VOC EMISSION TEST RESULTS

Page 1, Manufacturer, Client, Project & Specimen Information

Laboratory Certification

Report number/Date..... EMIT1116, 3/17/04
Protocol..... Section 01350
Original report number & date if
recalculation.....
Certified by (Name/Title)..... Alfred T. Hodgson, Research Director
Signature
Date..... 3/18/04

Manufacturer Information

Manufacturing company..... Forbo Linoleum
City/State/Country..... Hazleton, PA
Contact name/Title..... Tim Cole, Director of Support Services
Phone number..... 800-342-0604 x238
Product name/Number..... Marmoleum, #3173
Product category/Subcategory..... Linoleum Flooring
Manufacturer's ID..... #8, 9.9 g/m²
Date manufactured..... 2/04
Date collected..... 2/6/04
Date shipped..... 2/19/04

Client Information (if different)

Organization.....
City/State/Country.....
Contact name/Title.....
Phone number.....

Architectural Project Information (Section 01350)

Organization.....
City/State/Country.....
Project name.....
Type of building.....
Contact name/Title.....
Phone number.....

Specimen Information

Date received..... 2/23/04
Laboratory tracking number..... JC135009
Specimen preparation..... Taped to stainless steel plate
Conditioning period start date &
duration..... 2/27/04, 10 days
Test period start date & duration.... 3/8/04, 96 hours

Page 2, Pass/Fail Summary, Chamber Conditions, Building Parameters

Summary - The protocol used to perform this VOC emission test is given under Laboratory Certification, Page 1. Scientific Certification Systems (SCS) Low Emitting Material tests and Project-Specific Section 01350 (Special Environmental Requirements) tests are conducted following the full Section 01350 guidelines with prior conditioning of the test specimen as given for the Collaborative for High Performance Schools (CHPS) program (refer to <http://www.chps.net>).

Table 1. Pass/fail results of emission test for identified VOCs with chronic RELs. Only VOCs detected above quantitation limits are reported. If no VOCs are listed in Table 1, the material passes the Section 01350 VOC emission requirements.

Substance	CAS No.	½ REL µg m ⁻³	Standard Classroom	Hypothetical Office	Other Building
No VOCs with chronic RELs			Pass	Pass	na

Table 2. Chamber conditions for 96-h test period

Parameter	Symbol	Units	Value
Material exposed area	A _C	m ²	0.0273
Chamber volume	V _C	m ³	0.067
Loading ratio	L _C	m ² m ⁻³	0.41
Inlet gas flow rate	Q	m ³ h ⁻¹	0.067 ± 0.003
Ventilation rate	a _c	h ⁻¹	1.0 ± 0.05
Temperature		°C	23 ± 1
Relative humidity		%	50 ± 5

Table 3. Parameters used to calculate building VOC concentrations

Parameter	Symbol	Units	Floor & Ceiling Materials		Other Materials/ Building
			Standard Classroom ^a	Typical Large Office Bldg ^b	
Material exposed area	A _B	m ²	89.2	30,500	na
Building volume	V _B	m ³	231	83,800	na
Ceiling height		m	2.59	2.74	na
Loading ratio	L _B	m ² m ⁻³	0.39	0.36	na
Ventilation rate	a _B	h ⁻¹	0.90	0.75	na
Ventilated vol. fraction	vf _B		0.90	0.90	na
Vent. flow rate per area		(m ³ h ⁻¹)/m ²	2.10	1.85	na

- Standard classroom, Table 13a, Building Material Emissions Study, California Dept. of Health Services, May 14, 2003
- Volume & ceiling height from East End Project, Products Passed Section 01350, Calif. Integrated Waste Management Board. For floor & ceiling materials, 100% coverage is assumed. For wall materials, material exposed area is wall paint area for the building (<http://www.ciwmb.ca.gov/GreenBuilding/Specs/EastEnd/>)

Page 3, Results of VOC Emission Test**Table 4.** VOC emission test results*. Only VOCs detected above quantitation limits are reported. Individual VOCs with chronic RELs are listed first, followed by compounds on other lists of toxicants, followed by unlisted abundant compounds

Substance	CAS No.	Surrogate?	Chronic REL $\mu\text{g m}^{-3}$	CARB TAC Cat.	Prop 65 List?	96-h Chamber Conc. $\mu\text{g m}^{-3}$	Emission Factor $\mu\text{g m}^{-2} \text{h}^{-1}$	Class- room Conc. $\mu\text{g m}^{-3}$	Office Conc. $\mu\text{g m}^{-3}$	Other Bldg. Conc. $\mu\text{g m}^{-3}$
TVOC		Yes				27.7	68.1	32.5	36.7	na
1-Methyl-2-pyrrolidinone	872-50-4				Yes	27.3	66.9	31.9	36.1	na
2-(2-Ethoxyethoxy)ethanol	111-90-0					15.3	37.6	17.9	20.3	na

*Parameters and reported values are defined and explained in Table 6

Table 5. TVOC and formaldehyde 24- and 48-hour chamber concentrations

Substance	Concentration, $\mu\text{g m}^{-3}$	
	24-h	48-h
TVOC	36.8	31.2
Formaldehyde	LQ	LQ

Page 4, Definitions, Notes to Tables**Table 6.** Definition of parameters and notes to tables

Parameter/Value	Definition
CAS No.	Chemical Abstract Service identification number for chemical substance
Surrogate?	"Yes" indicates compound was quantified by GC/MS total-ion-current (TIC) method using mixture of 12 common hydrocarbons as calibration reference
Chronic REL	Chronic Reference Exposure Level (REL) established by Cal/EPA Office of Environmental Health Hazard Assessment, Aug. 2003 and adopted by Section 01350 as target IAQ limit for building; for formaldehyde, IAQ limit is $33 \mu\text{g m}^{-3}$ rather than REL. No material may contribute more than $\frac{1}{2}$ IAQ limit for any REL compound
CARB TAC Cat.	Toxic Air Contaminant (TAC) on Cal/EPA 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), Feb. 2003
96-h Chamber Conc.	Measured chamber VOC concentration at final 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 material per hour (calculations shown below). Reporting limits for emission factors are established by LOQ or reporting limit for chamber concentration and material's exposed surface area
Classroom/Office/Other Bldg. Conc.	Concentrations for standard school classroom, hypothetical office building, or specific project building calculated using parameters given in Table 3 (calculations shown below)
TVOC	Total Volatile Organic Compounds quantified by GC/MS TIC method using mixture of 12 common hydrocarbons as calibration reference
Formaldehyde & acetaldehyde	Volatile aldehydes quantified by HPLC following ASTM Method D 5197-97. LOQ for formaldehyde and acetaldehyde is approximately $1 \mu\text{g m}^{-3}$
Individual VOCs	Quantified by thermal desorption GC/MS following EPA Methods TO-1 and TO-17. Compound was quantified using multipoint calibration prepared with pure substance 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
"LQ"	Indicates calculated value is below quantitation based on concentration LOQ
"na"	Not applicable

Page 5, Equations Used in Calculations, Comments

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

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

where C is the VOC chamber concentration ($\mu\text{g m}^{-3}$) and C_o is the substrate or chamber blank VOC concentration ($\mu\text{g m}^{-3}$). The remaining parameters are defined in Table 2. A building concentration (C_B) in $\mu\text{g m}^{-3}$ is calculated using Equation 2, and parameters are defined in Table 3.

$$C_B = (EF * A_B) / (V_B * vf_B * a_B) \quad (2)$$

Comments: None