



**AmeriWorx**<sup>®</sup> Vinyl Tile  
VOC Test Report

**PROTOCOL:** Emissions tests are performed following California Department 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 . 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. 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	$L_C$	$m^2 \cdot m^3$	0.47
Inlet air flow rate	$Q$	$m^3 \cdot h^{-1}$	0.068
Ventilation rate	$a_C$	$h^{-1}$	1.01
Temperature		$^{\circ}C$	22.9
Relative humidity		%	50.3

\*Specified ranges: 22 oC 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)



## INDEX 1. DEFINITION OF PARAMETERS AND NOTES TO TABLES

BUILDING COMPONENT / MATERIAL FLOOR – FLOOR COVERING (ANY) PARAMETER	Symbol	Units	Building Type**
			<b>Standard Classroom</b>
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	$Vf_B$		0.90
Vent. Flow rate per area		$(m^3 h^{-1}) / m^2$	2.10
			<b>Standard Office Space</b>
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	$Vf_B$		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**

SUBSTANCE	CAS No.	½ REL $\mu g m^{-3}$	Building Type
No VOCs detected	None	None	Pass

**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 $\mu g m^{-3}$	CARB TAC Category	Prop 65 List?
No VOCs detected	None	None	None	None	None

\*\*\*Parameters are defined in Table 9

**TABLE 5. EMISSION TEST RESULTS FOR INDIVIDUAL VOC\*\*\*\****(Only VOCs detected above quantitation limits are reported.)*

SUBSTANCE	96-h Chamber Concentration $\mu\text{g m}^{-3}$	Emission Factor $\mu\text{g m}^{-2} \text{h}^{-1}$	Building Concentration $\mu\text{g m}^{-3}$
No VOCs detected	LQ	LQ	LQ

\*\*\*\*Parameters and reported values are defined 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 Concentration $\mu\text{g m}^{-3}$
			<b>Standard Classroom</b>
24-h	45	95	45
48-h	69	147	70
96-h	44	94	45
			<b>Standard Office Space</b>
24-h	45	95	51
48-h	69	147	79
96-h	44	44	51

**TABLE 7. FORMALDEHYDE CHAMBER & BUILDING CONCENTRATIONS FOR DEIFFERENT TEST PERIODS**

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

## INDEX 1. 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 California Office of Environmental Health Hazard Assessment, February 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 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 California Air Resources Board list, December 1999, with toxic category indicated
Prop 65 List?	"Yes" indicates compound is chemical known to cause cancer or reproductive toxicity listed by California 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 in Index 2). 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.	Concentrations for school classroom, small office (individual), large office building, or specific project building calculated using parameters given in Table 2 (calculations shown in Index 2)
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 ~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

## INDEX 2. 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**:

$$EF = (Q (C - C_0)) / A_c \quad (1)$$

where C is the chamber concentration of the substance ( $\mu\text{g m}^{-3}$ ) and  $C_0$  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, AC, and EF is expressed as  $\mu\text{g}/\text{unit-h}$ .

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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.

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An EF in the  $\mu\text{mol m}^{-2} \text{h}^{-1}$  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.

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A chamber concentration in ppb (molar basis) for an individual VOC is calculated from the chamber concentration ( $C - C_0$ ) in  $\mu\text{g m}^{-3}$  using **Equation 4**:

$$\text{Chamber concentration (ppb)} = (C - C_0) \times 24.45 / MW \quad (4)$$

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

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

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### Comments

The emission factor calculations are based on the area of the top surface. Back surface and all edges were sealed during the test.