

## **GREENGUARD CHILDREN & SCHOOLS<sup>SM</sup> STANDARD**

### **1 Background**

#### **1.1 Purpose**

The GREENGUARD Environmental Institute (GEI) has created this standard to establish a nationally recognized voluntary standard for qualifying building materials, finishes and furnishings as certified low emitting products for the indoor environment, specifically the educational environment for children.

#### **1.2 Scope**

##### **1.2.1 General**

The standard is applicable to the determination of organic emissions from building materials, finishes and furnishings. The effects of the emissions as they may relate to young children are partially addressed, however a complete toxicity study is beyond the scope of the standard.

The use of environmental test chambers and indoor exposure models to characterize the dynamic emissions from products and their components are well established.

The achievement of test results, that have meaning within the context of the standard, require rigorous sample selection procedures, defined sample collection and handling procedures, and the employment of precise and accurate analytical measurement systems and procedures. Additionally, the manufacturer of the product(s) evaluated in reference to the requirements set forth by the standard must have in place a production quality control system that is capable of assuring products shall be manufactured with consistently close results in similar emissions characteristics over time. Such relevant requirements are set forth in standards and procedures that are referenced by this standard.

This standard does not purport to address the safety concerns, if any, associated with its use. It is the responsibility of the user of the standard to establish appropriate safety and health practices, as well as to determine what regulatory limitations, if any, may exist.

##### **1.2.2 Application for Children**

Children are more heavily exposed to environmental toxins than adults. They consume more food, water, and have higher inhalation rates per pound of body weight than adults.

To account for inhalation exposure to young children with greater sensitivities, a body burden correction factor of 0.43 has been applied to current allowable emission levels from indoor materials and furnishings (details are provided in Appendix A). In addition, the exposure to individual volatile chemicals has been adjusted to allow no greater than 1/100 currently published Threshold Limit Values (TLVs) or no greater than ½ California's Chronic Reference Exposure Levels (CRELs), whichever is lower. The total VOC or TVOC measurement takes into account the complex mixture of all VOCs found to be out gassing from the product including those with and without TLVs or CRELs.

In addition, limits on emissions of phthalates have been added to the list of requirements. Recent research indicates that inhalation is an important route of exposure to phthalates, and that these chemicals have been associated with endocrine disorders, reproductive and developmental toxicity, asthma and allergies.

### 1.2.3 Suitability for Certification

This Standard was created with reference to ISO ISO/IEC 17007:2009 and is suitable for certification purposes.

### 1.3 Process

Certification procedures are presented in **GG.PM.001**, "Program Manual for GREENGUARD Product Certification Programs."

## 2 Terminology

**2.1 Product:** The end result of the manufacturing process, to be offered to the marketplace or as an OEM. A unique item distinguishable by a discrete model number. Specifically, any item supplied by the Manufacturer that the Manufacturer desires to have GREENGUARD certified. An OEM refers to a component product made by one manufacturer and sold to another company who uses it to make a final product for the marketplace.

## 3 Requirements

### 3.1 Emissions Testing

Product emissions are measured following the testing requirements of **GGTM.P066**, "Standard Method for Measuring and Evaluating Chemical Emissions from Building Materials, Finishes, and Furnishings using Dynamic Environmental Chambers" by an accredited indoor air quality testing laboratory recognized by the GEI. The testing and measurement methodologies are consistent and comply with those of the California Department of Health Services' CA/DHS/EHLB/R-174 "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers 2004" (CA Section 01350) and ANSI/BIFMA M7.1-2007 "Standard Test Method For Determining VOC Emissions From Office Furniture Systems, Components And Seating."

### 3.2 Exposure Modeling

Exposure concentrations are determined using the models presented in **GGTM.P066**. The surface areas for the major product types are presented in Table 6.4 in **GGTM.P066**, while surface areas for other products have been established and are available upon request. The surface areas for systems furniture, both open plan and private office, are those specified in ANSI/BIFMA M7.1-2007. As needed, specialized models (room size, ventilation rate and product area) are created for specific product use and documented within the certification report(s).

#### 3.2.1 Educational Environment

The educational environment is the default scenario for products specifically designed for educational environment use. GREENGUARD uses the CA/DHS/EHLB/R-174 classroom defined as: "... a 24-ft wide by 40-ft long classroom with an 8.5-ft high ceiling. Use a ventilation rate of  $0.9 \text{ h}^{-1}$ . This is a weekly average assuming 40 hours per week of ventilation system operation at  $3.0 \text{ h}^{-1}$  and 128 hours per week at  $0.2 \text{ h}^{-1}$  due to infiltration. The  $3.0 \text{ h}^{-1}$  value is approximately equivalent to the ASHRAE 62-2001 ventilation guideline of 15 cubic feet per minute (cfm) per occupant for 27 occupants in this space. Assume that only 90% of the room volume of  $231 \text{ m}^3$  is ventilated at this rate due to occupancy of the space by cabinetry, furnishings and other room contents."

### 3.2.2 Office Environment

The GREENGUARD office environment is the scenario utilized for products specifically designed for office environment use. The GREENGUARD office has dimensions of 3.05 m x 4.27 m x 2.44 m (10' x 14' x 8'), which results in a room volume of 32 m<sup>3</sup> (1130 ft<sup>3</sup>). The room has one 0.914 m x 2.13 m (3' x 7') door and four 1.09 m x 0.94 m (43" x 37") windows. The office is designed for single occupancy. The ventilation rate used is 0.72 ACH and is based on assumed floor occupancy of 7 people per 92.9 m<sup>2</sup> (1000 ft<sup>2</sup>) and ASHRAE Standard 62.1-2007 "Ventilation for Acceptable Indoor Air Quality" using the specified parameters of 5 cfm per person and 0.06 cfm/ft<sup>2</sup> for office spaces in office buildings. This room model is used for all office furniture with the exception of open plan workstation systems and seating. For open plan systems, a room volume of 16.3 m<sup>3</sup> (576 ft<sup>3</sup>) with the floor defined ventilation rate of 0.92 ACH is used, as defined in ANSI/BIFMA M7.1-2007. The room volume is derived from the BIFMA defined typical open plan office environment for a single workstation system of 2.44 m x 2.44 m (8' x 8') floor area with 2.74 m (9') ceilings, accounting for a standard 1.83 m x 1.83 m (6' x 6') open plan workstation system. Seating uses an average of the BIFMA M7.1-2007 private and open plan offices with an air flow rate of 24.8 m<sup>3</sup>/hr in a room volume of 40.7 m<sup>3</sup> (0.61 ACH).

### 3.2.3 Residential Environment

The residential environment is used for products specifically designed for use in a residential setting, specifically a bedroom. This includes mattresses and other bedding, cribs and other bedroom/nursery furniture. The GREENGUARD residential model is composed of two sets of parameters, one for a 2nd floor isolated bedroom/nursery 3.05 m x 4.27 m (10' x 14') and one for a 1st floor open living/dining area. The living/dining area includes a 20.9 m<sup>2</sup> (225 ft<sup>2</sup>) dining room, a 28.8 m<sup>2</sup> (310 ft<sup>2</sup>) kitchen with breakfast nook, a 20.9 m<sup>2</sup> (225 ft<sup>2</sup>) living room, and 6.97 m<sup>2</sup> (75 ft<sup>2</sup>) for the foyer/stairwell areas. It is assumed that the ceiling heights on the 2nd floor are 2.44 m (8') high and those on the first floor are 2.74 m (9') high, consistent with current construction trends. The ventilation rate of 0.45 ACH is the recommended typical residential ventilation rate from the USEPA Exposure Factors Handbook (Table 17-31) (August 1997).

### 3.2.4 Summary Table

A summary of the dimensions of the modeling environments is provided in the Table below.

Parameter	GREENGUARD Office	GREENGUARD /BIFMA Open Plan "Office"*	GREENGUARD Classroom	GREENGUARD Bedroom	GREENGUARD Living/Dining Area
Room Length	3.05 m (10 ft)	2.44 m (8 ft)	12.2 m (40 ft)	3.05 m (10 ft)	77.6 m <sup>2</sup> (835 ft <sup>2</sup> )
Room Width	4.27 m (14 ft)	2.44 m (8 ft)	7.31 m (24 ft)	4.27 m (14 ft)	
Room Height	2.44 m (8 ft)	2.74 m (9 ft)	2.59 m (8.5 ft)	2.44 m (8 ft)	2.74 m (9 ft)
Room Volume	32 m <sup>3</sup> (1130 ft <sup>3</sup> )	16.3 m <sup>3</sup> (576 ft <sup>3</sup> )	231 m <sup>3</sup> (8160 ft <sup>3</sup> )	32 m <sup>3</sup> (1130 ft <sup>3</sup> )	213 m <sup>3</sup> (7520 ft <sup>3</sup> )
Ventilated Fraction	1.0	1.0	0.9	1.0	1.0
Air Change Rate	0.72 hr <sup>-1</sup>	0.92 hr <sup>-1</sup>	0.9 hr <sup>-1</sup>	0.45 hr <sup>-1</sup>	0.45 hr <sup>-1</sup>

**\*For use with open plan office systems only**

### 3.3 Emissions Criteria

Product emissions are required to meet the following exposure concentration criteria at 168 hours with the exception of formaldehyde and the other CA chronic RELs. Formaldehyde and the other CA RELs criteria are required to be met at a time point no later than 336 hours. Data time points less than 336 hours must demonstrate that emissions have peaked before the compliance time point. For the 336 hour time point, the data is modeled for furniture utilizing the power-law model found in ANSI/BIFMA M7.1-2007; for all other product types the most appropriate emission calculation is made following Section 9.4.1 of ASTM D-5116-2006.

Individual VOCs <sup>1</sup>	≤1/100 TLV and ≤½ CA chronic REL
Formaldehyde <sup>2</sup>	≤0.0135 ppm/13.5 ppb
Total VOCs <sup>3</sup>	≤0.22 mg/m <sup>3</sup>
Total Aldehydes <sup>4</sup>	≤0.043 ppm/43 ppb
Total Phthalates <sup>5</sup>	≤0.01 mg/m <sup>3</sup>
Total Particles <sup>6</sup> (≤ 10µm)	≤0.02 mg/m <sup>3</sup>

<sup>1</sup>Any VOC not listed must produce an air concentration level no greater than 1/100 the Threshold Limit Value (TLV) industrial work place standard (Reference: American Conference of Government Industrial Hygienists, 6500 Glenway, Building D-7, Cincinnati, Ohio 45211-4438) and/or no greater than 1/2 the CA Chronic Reference Exposure Level (CREL) (<http://www.oehha.ca.gov/air/AllChrels.html> - (CRELs) Adopted by the State of California Office of Environmental Health Hazard Assessment (OEHHA)).

<sup>2</sup>Formaldehyde criteria established so that emission levels reach 0.014 ppm (13.5 ppb) within 14 days of installation (meeting CA 1350 requirements).

<sup>3</sup>Defined to be the total response of measured VOCs falling within the C<sub>6</sub> – C<sub>16</sub> range, with responses calibrated to a toluene surrogate.

<sup>4</sup>Defined to be the total response of a specific target list of aldehydes (2-butenal; acetaldehyde; benzaldehyde; 2,5-dimethylbenzaldehyde, 2-methylbenzaldehyde; 3-and/or 4-methylbenzaldehyde; butanal; 3-methylbutanal; formaldehyde; hexanal; pentanal; propanal), with each individually calibrated to a compound specific standard.

<sup>5</sup>Defined to be the total response of a specific target list of phthalates including dibutyl (DBP), diethylhexyl (DEHD), diethyl (DEP), butylbenzyl (BBP), di-octyl (DOP), and dimethyl (DMP) phthalates (conducted using a modified phthalate specific analytical method, OSHA 104).

<sup>6</sup>Particles applicable to fibrous, particle-releasing products with exposed surface area in air streams (a forced air test with specific test method).

## APPENDIX A BASIC INHALATION ASSUMPTIONS

1. Basic equation for inhalation:

$$ADD = [C \times IR \times ED / (BW \times AT)]$$

where,

ADD = Average daily dose (mg/kg-day)

IR = Inhalation rate (m<sup>3</sup>/day)

ED = Exposure duration (days)

BW = Body weight (kg)

AT = Averaging time (days)

= For non-carcinogenic effects, AT = ED

= For carcinogenic or chronic AT = 70 years or 25,550 days (lifetime)

C = Contaminant concentration in inhaled air, ug/m<sup>3</sup>

2. General Recommended Inhalation Rates:

Population		Mean	Upper Percentile
<b>Long Term Exposure</b>			
Children	< 1 year	4.5 m <sup>3</sup> /day	--
Children	1-2 Years	6.8 m <sup>3</sup> /day	--
Children	3-5 Years	8.3 m <sup>3</sup> /day	--
Children	6-8 Years	10 m <sup>3</sup> /day	--
Adults	Females	11.3 m <sup>3</sup> /day	--
Adults	Males	15.2 m <sup>3</sup> /day	--
<b>Short Term Exposure</b>			
Adults & Children			
	Rest	0.3 m <sup>3</sup> /hr	--
	Sedentary Activities	0.4 m <sup>3</sup> /hr	--
	Light Activities	1.0 m <sup>3</sup> /hr	
	Moderate Activities	1.2 m <sup>3</sup> /hr	--
	Heavy Activities	1.9 m <sup>3</sup> /hr	--
Outdoor Workers			
	Hourly Average	1.3 m <sup>3</sup> /hr	3.5 m <sup>3</sup> /hr
	Slow Activities	1.1 m <sup>3</sup> /hr	
	Moderate Activities	1.5 m <sup>3</sup> /hr	
	Heavy Activities	2.3 m <sup>3</sup> /hr	

3. Factor correction for children:

Ratio Inhalation rate/body mass

Adult female 11.3 m<sup>3</sup>/day/61kg = 0.18

Adult male 15.2 m<sup>3</sup>/day/72 kg = 0.21

Child (ages 0 - 8 years) 7.4 m<sup>3</sup>/day/16 kg = 0.46

0.20 (average adult)/0.46 (child) = 0.43