

GREENGUARD INDOOR AIR QUALITY (IAQ) STANDARD FOR ELECTRONIC EQUIPMENT

1 Background

1.1 Purpose

The GREENGUARD Environmental Institute (GEI) has created this standard to establish a nationally recognized voluntary standard for qualifying electronic consumer products, office and equipment, and general electronic products used in commercial, healthcare, residential, educational, and general use environments, as certified low emitting products for the indoor environment.

1.2 Scope

1.2.1 General

The standard is applicable to the determination of organic and inorganic emissions from electronic products. While this standard may list specific chemicals and associated maximum allowable concentrations, as required by criteria indoor air guidelines and specifications, 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 Acute and Chronic Risk Review

This standard includes a review of measured chemical emissions across a broad range of risk based exposure levels established by the US Environmental Protection Agency (EPA), the Agency for Toxic Substances and Disease Registry (ATSDR) of the Center for Disease Control (CDC), and the State of California Office of Environmental Health Hazard Assessment (OEHHA), in addition to the requirements of the GREENGUARD Children & Schools Standard. This standard requires product emissions be less than defined risk-based air concentration levels for both acute (short-term) and chronic (long-term) exposures.

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.P072**, “Standard Method for Measuring and Evaluating Chemical and Particle Emissions from Electronic Equipment Using Dynamic Environmental Chambers” by an accredited indoor air quality testing laboratory recognized by the GEI. The testing and measurement methodologies are consistent with those of ASTM D 6670 regarding the measurement of emissions in large environmental chambers and ISO/IEC 28360:2007, “Information Technology - Office Equipment - Determination of Chemical Emission Rates from Electronic Equipment.”

3.2 Exposure Modeling

Exposure concentrations are determined using the models as presented in **GGTM.P072**. For office equipment, the office model as detailed in Section 3.2.1 is used as it is the most conservative use scenario, as compared to the educational environment, due to extended daily exposure durations (8 hours for office vs. 2 hours for classroom), weekly exposure frequency (5 days vs. 3 days), and daily air change rate variables (0.72 ACH vs. 2.8 ACH).. For consumer products or specialized commercial or healthcare products, defined exposure models (room size, ventilation rate and product use parameters) are used and are documented within the certification report(s). Typical models are presented in Section 3.2.2, as applied to commercial, residential and certain healthcare applications. Products used in these environments must meet these requirements as a minimum. Other models covering additional environments or based on specialized use of the product shall be detailed in the certification report.

3.2.1 Office Environment

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 m³ (1130 ft³). 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 m² (1000 ft²) 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/ft² for office spaces in office buildings.

3.2.2 Exposure Models

A summary of key exposure model parameters for representative indoor spaces is provided in the Table below.

Parameter	GREENGUARD Office	GREENGUARD Pharmaceutical	GREENGUARD Classroom	GREENGUARD Bedroom	GREENGUARD Living/Dining Area
Room Length	3.05 m (10 ft)	10.66 m (35 ft)	12.2 m (40 ft)	3.05 m (10 ft)	77.6 m ² (835 ft ²)
Room Width	4.27 m (14 ft)	10.66 m (35 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 ³ (1130 ft ³)	311 m ³ (11025 ft ³)	231 m ³ (8160 ft ³)	32 m ³ (1130 ft ³)	213 m ³ (7520 ft ³)
Ventilated Fraction	1.0	1.0	0.9	1.0	1.0
Air Change Rate	0.72 hr ⁻¹	1.5 hr ⁻¹	0.9 hr ⁻¹	0.45 hr ⁻¹	0.45 hr ⁻¹

3.3 Emissions Criteria

Product emissions requirements for maximum (acute) and average (chronic) exposures are presented below.

	Short-Term (Acute)	Long-Term (Chronic)
TVOC (mg/m ³) ¹	≤5.0	≤0.22
Formaldehyde (ppm) ²	≤0.040	≤0.013
Carcinogens ³	NA	Less Than the EPA IUR
Chronic Noncancer Toxins ⁴	NA	Less Than the ATSDR MRL, ½ the CA CREL, and the EPA RfC
Acute Noncancer Toxins ⁵	Less Than the ATSDR MRL and the CA AREL	NA
Developmental/Reproductive Toxins ⁶	Less Than the ATSDR MRL and the CA AREL	NA
Other Individual VOCs ⁷ (Occupational Exposure Levels)	Less Than 1/10 the STEL/C corresponding to the ACGIH TLV and AIHA WEEL (or Less Than the TWA if no STEL/C)	Less Than 1/100 the TWA corresponding to the ACGIH TLV and AIHA WEEL
Total Phthalates (mg/m ³) ⁸	NA	≤0.01
Ozone (ppm)	NA	≤0.05
Respirable Particles (PM _{2.5}) (mg/m ³) ⁹	NA	≤0.035

NA = Not Applicable

¹Defined to be the total response of measured VOCs falling within the C₆ – C₁₆ range, with responses calibrated to a toluene surrogate.

²Short-term level based on the ATSDR Acute Duration Minimal Risk Level (MRL). Long-term level based on ½ CA-OEHHA determined ALARA (As Low As Reasonably Achievable) value.

³Compared the concentration corresponding to an E-5 risk level for the EPA Inhalation Unit Risk (IUR). Excludes formaldehyde, which is covered by (2) above.

⁴Compared to the EPA Reference Concentration (RfC), CA Chronic Reference Exposure Level (CREL), and the ATSDR Intermediate or Chronic Duration MRL. Intermediate MRLs shall be used if a Chronic MRL is not available for that compound. Excludes Developmental and Reproductive endpoints (see Developmental/Reproductive Toxins).

⁵Compared to ATSDR Acute Duration MRL and CA Acute Reference Exposure Level (AREL). Excludes Developmental and Reproductive endpoints which are covered by Developmental/Reproductive Toxins in (6) below.

⁶Compared to CA ARELs and ATSDR MRLs for chemicals with Developmental or Reproductive endpoints.

⁷For the short-term exposure comparison, any VOC not otherwise listed must produce an air concentration level no greater than 1/10 the Short-Term Exposure Level or Ceiling (STEL/C) listed as an American Conference of Government Industrial Hygienists (ACGIH) Threshold Limit Value (TLV) or American Industrial Hygiene Association (AIHA) Workplace Environmental Exposure Limit (WEEL), or no greater than the Time-Weighted Average TLV or WEEL if no STEL/C available. For the long-term exposure comparison, all VOC's must be less than 1/100 the TWA listed as an ACGIH TLV or AIHA WEEL.

⁸Defined 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).

⁹Respirable particles are based on the National Air Quality Ambient Standard 24-hour average, promulgated January, 2007. Results based on an 8-hour average.

	Short-Term (Acute)*	Long-Term (Chronic)*
Step 1		
For All Emission Criteria	The maximum emission rate ($\mu\text{g}/\text{m}^2\text{-hr}$) measured during an 8-hour testing period is combined with product use assumptions (product loading, ventilation rate, building volume) to determine a predicted exposure concentration ($\mu\text{g}/\text{m}^3$) as a result of product use.	The average (8-hour time-weighted) emission rate ($\mu\text{g}/\text{m}^2\text{-hr}$) is combined with product use assumptions (product loading, ventilation rate, building volume) to determine a predicted exposure concentration ($\mu\text{g}/\text{m}^3$) as a result of product use.
Step 2		
TVOC	The maximum predicted TVOC exposure concentration is compared directly to the GREENGUARD TVOC criterion.	The average predicted TVOC exposure concentration is used as a conservative proxy for chronic exposure and is compared directly to the GREENGUARD TVOC criterion.
Formaldehyde	The maximum predicted formaldehyde exposure concentration is compared directly to the GREENGUARD formaldehyde criterion.	The average formaldehyde predicted exposure concentration is used as a conservative proxy for chronic exposure and is compared directly to the GREENGUARD formaldehyde criterion.
Carcinogens (EPA IRIS - Inhalation Unit Risk)	Not applicable to acute exposures.	Individual VOC's detected in the emissions from the product are compared to a database of chemicals for which carcinogenic risks as a result of inhalation exposure have been evaluated by the US EPA. These compounds evaluated by the US EPA will have an established Inhalation Unit Risk (IUR). The IUR can be used to determine the risk level (excess cancers in a given population) posed by exposure to the chemical at a given concentration. Those compounds found to be emitting from the product that have been evaluated by the US EPA for inhalation carcinogenic risks are selected for further analysis. For these compounds, the average predicted exposure concentration is compared to the concentration corresponding to an E-5 risk level (1 excess cancer per population of 100,000 people) for the EPA IUR. The average predicted exposure is used as a conservative proxy for chronic exposure.
Chronic Non-cancer Toxins	Not applicable to acute exposures.	Individual VOC's detected in the emissions from the product are compared to a database of chemicals for which Minimal Risk Levels (ATSDR Chronic MRL's), Reference Concentrations (EPA RfC's), and Chronic Reference Exposure Levels (California CREL's) have been established. Those compounds found to be emitting from the product and having an established Chronic MRL, RfC, and/or CREL are selected for further analysis. For those compounds, the average predicted exposure concentration for each chemical is compared to its corresponding Chronic MRL, RfC, and/or 1/2 CREL for determination of compliance with the GREENGUARD criteria. The average predicted exposure is used as a conservative proxy for chronic exposure.

Acute Non-cancer Toxins	Individual VOC's detected in the emissions from the product are compared to a database of chemicals for which Minimal Risk Levels (ATSDR Acute MRL's) and Acute Reference Exposure Levels (California ARELs) have been established. Those compounds found to be emitting from the product and having an established MRL and/or AREL with endpoints other than Developmental/Reproductive are selected for further analysis. For those compounds, the maximum predicted exposure concentration for each chemical is compared to its corresponding Acute MRL and/or AREL for determination of compliance with the GREENGUARD criteria.	Not applicable to chronic exposures.
Developmental/ Reproductive Toxins (MRLs and ARELs)	Individual VOC's detected in the emissions from the product are compared to a database of chemicals for which Minimal Risk Levels (ATSDR MRLs) and Acute Reference Exposure Levels (California ARELs) have been established. Those compounds found to be emitting from the product and having an established MRL and/or AREL with Developmental/Reproductive endpoints are selected for further analysis. For those compounds, the maximum predicted exposure concentration for each chemical is compared to its corresponding MRL and/or AREL, with Developmental/Reproductive endpoints, for determination of compliance with the GREENGUARD criteria.	Not applicable to chronic exposures.
Other Individual VOCs (Occupational Exposure Levels)	Individual VOCs detected in the emissions from the product for which an MRL, AREL, or MADL has not been established are compared to databases of chemicals for which Threshold Limit Values (TLVs) or Workplace Environmental Exposure Limits (WEELs) have been established. Those compounds found to be emitting from the product and not having an established MRL, AREL or MADL but having a TLV and/or WEEL are selected for further analysis. For these compounds, the maximum predicted exposure concentration for each chemical is compared to 1/10 th of its corresponding Short Term Exposure Limit or Ceiling value (STEL/C) TLV or WEEL or to the Weighted Average (TWA) TLV or WEEL if no STEL/C exists.	Individual VOCs detected in the emissions from the product for which a NSRL, IUR, Chronic MRL, RfC, or CREL has not been established are compared to databases of chemicals for which Threshold Limit Values (TLVs) or Workplace Environmental Exposure Limits (WEELs) have been established. Those compounds found to be emitting from the product and not having an established NSRL, IUR, Chronic MRL, RfC or CREL but having a TLV and/or WEEL are selected for further analysis. For these compounds, the average predicted exposure concentration for each chemical is compared to 1/100 th of its corresponding Time Weighted Average (TWA) TLV or WEEL for determination of compliance with the GREENGUARD criteria.