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GREENGUARD INDOOR AIR QUALITY (IAQ) STANDARD FOR CLEANERS AND CLEANING MAINTENANCE SYSTEMS

1 Background

1.1 Purpose

The GREENGUARD Environmental Institute (GEI) has created this standard to establish a nationally recognized voluntary standard for qualifying cleaners and cleaning maintenance systems as certified low emitting products/systems for the indoor environment.

1.2 Scope

1.2.1 General

The standard is applicable to the determination of organic emissions from cleaners and cleaning maintenance systems. 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.P057,** "Standard Method for Measuring and Evaluating Chemical Emissions from Cleaners and Cleaning Maintenance Systems 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 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).

3.2 Exposure Modeling

Exposure concentrations are determined using the models presented in **GGTM.P057**. The surface areas for the major product types on which cleaning products are used are presented in Table 6.4 in **GGTM.P057**, while surface areas for other product types have been established and are available upon request. 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, unless otherwise specified as indicated in 3.2.2, 3.2.3 and 3.2.4. 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 h^{-1}. This is a weekly average assuming 40 hours per week of ventilation system operation at 3.0 h^{-1} and 128 hours per week at 0.2 h^{-1} due to infiltration. The 3.0 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 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 office environment is used for cleaning products/systems specifically designed for office environment use and not found in use in educational environments. 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^3 (1130 ft^2). 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 an assumed floor occupancy of 7 people per 1000 ft^2 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^2 for office spaces in office buildings.

3.2.3 Bathroom Environment

The residential environment is used for cleaning products/systems specifically designed for use in a bathroom setting. The office room volume and ventilation rate are used for the bathroom model, with the absence of windows.

3.2.4 Residential Environment

The residential environment is used for cleaning products/systems specifically designed for use in a residential setting, specifically a kitchen. 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^2 (225 ft^2) dining room, a 28.8 m^2 (310 ft^2) kitchen with breakfast nook, a 20.9 m^2 (225 ft^2) living room, and 6.97 m^2 (75 ft^2) 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 Classroom	GREENGUARD Office	GREENGUARD Bathroom	GREENGUARD Bedroom	GREENGUARD Living/Dining Area
Room Length	12.2 m (40 ft)	3.05 m (10 ft)	3.05 m (10 ft)	3.05 m (10 ft)	77.6 m^2 (835 ft^2)
Room Width	7.31 m (24 ft)	4.27 m (14 ft)	4.27 m (14 ft)	4.27 m (14 ft)	
Room Height	2.59 m (8.5 ft)	2.44 m (8 ft)	2.44 m (8 ft)	2.44 m (8 ft)	2.74 m (9 ft)
Room Volume	231 m^3 (8160 ft^3)	32 m^3 (1130 ft^3)	32 m^3 (1130 ft^3)	32 m^3 (1130 ft^3)	213 m^3 (7520 ft^3)
Ventilated Fraction	0.9	1.0	1.0	1.0	1.0
Air Change Rate	0.9 hr^{-1}	0.72 hr^{-1}	0.72 hr^{-1}	0.45 hr^{-1}	0.45 hr^{-1}

3.3 Emissions Criteria

Product/process emissions are required to meet the following exposure concentration criteria at 4 hours (acute) and 14 hours (chronic) with no preconditioning.

	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]	Less Than 1/10 the ACGIH STEL/C TLV (or Less Than the TWA TLV if no STEL/C)	Less Than 1/100 the ACGIH TWA TLV
Total Phthalates (mg/m^3)[8]	NA	≤0.01

NA = Not Applicable

[1]Defined to be the total response of measured VOCs falling within the C_6 – C_{16} range, with responses calibrated to a toluene surrogate.

[2]Short-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.

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

[4]Compared 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).

[5]Compared 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.

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

[7]For the short-term exposure comparison, any VOC not otherwise listed must produce an air concentration level no greater than 1/10 the American Conference of Government Industrial Hygienists (ACGIH) Short-Term Exposure Level or Ceiling (STEL/C) Threshold Limit Value (TLV), or no greater than the Time-Weighted Average TLV if no STEL/C available. For the long-term exposure comparison, all VOC's must be less than 1/00 the ACGIH TWA TLV.

[8]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).

	Short-Term (Acute)	Long-Term (Chronic)
Step 1		
For All Emission Criteria	The emission rate (μg/unit-hr or μg/m^2-hr) measured at 4 elapsed exposure hours is combined with product use assumptions (product loading, ventilation rate, building volume) to determine a predicted exposure concentration (μg/m^3) as a result of product use.	The emission rate (μg/unit-hr or μg/m^2-hr) measured at 14 elapsed exposure hours is combined with product use assumptions (product loading, ventilation rate, building volume) to determine a predicted exposure concentration (μg/m^3) as a result of product use.
Step 2		
TVOC	The 4-hour predicted TVOC exposure concentration is compared directly to the GREENGUARD TVOC criterion.	The 14-hour predicted TVOC exposure concentration is used as a conservative proxy for chronic exposure and is compared directly to the GREENGUARD TVOC criterion.
Formaldehyde	The 4-hour predicted formaldehyde exposure concentration is compared directly to the GREENGUARD formaldehyde criterion.	The 14-hour 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 14-hour 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 predicted exposure at 14 hours 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 14-hour predicted exposure concentration for each chemical is compared to its corresponding Chronic MRL, RfC, and/or ½ CREL for determination of compliance with the GREENGUARD criteria. The predicted exposure at 14 hours 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 4-hour 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 4-hour 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	Individual VOCs detected in the emissions from the product for which an MRL, AREL, or MADL has not been established are compared to a database of chemicals for which Threshold Limit Values (TLVs) 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 are selected for further analysis. For these compounds, the 4-hour 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 to the 8-Hour Time Weighted Average (TWA) TLV 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 a database of chemicals for which Threshold Limit Values (TLVs) 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 are selected for further analysis. For these compounds, the 14-hour predicted exposure concentration for each chemical is compared to $1/100^{th}$ of its corresponding 8-Hour Time Weighted Average (TWA) TLV for determination of compliance with the GREENGUARD criteria.