GREENGUARD Environmental Institute
2211 Newmarket Parkway, Suite 110
Marietta, GA 30067
1.800.427.9681
www.greenguard.org

STANDARD METHOD FOR THE EVALUATION OF CHEMICAL EMISSIONS FROM FLOORING PRODUCTS USING ENVIRONMENTAL CHAMBERS

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Forward

The following test method is used to support flooring products being tested according to the GREENGUARD Certification program (including Children and Schools), the Carpet and Rug Institute's Green Label and Green Label Plus Programs, and other Green programs requiring emissions testing of flooring. Product testing incorporates the requirements of the State of California's DHS practice "Standard Practice for the testing of Volatile Organic Emissions Sources Using Small Scale Environmental Chambers CCA/DHS/EHLB/R-174) as adopted by the CHPs program and the state's 1350 Building program. The method ensures that product testing and the calculations of estimated building concentrations meet or exceed the CA 1350 requirements for school and office environments and CHPs for schools. All exposure modeling for the GREENGUARD Children and Schools Program and CRI Green Label Plus Programs use the more conservative office model for products that may be used in both office and classroom environments.

This standard test method, which incorporates the most current science of emissions testing, including global ISO requirements for environmental chamber testing, can be used for other emissions test programs requiring the measurement of chemical emissions and assessment of data. Various federal, state, municipal, and other publicly available programs or standards may apply this standard test method with appropriate acknowledgement.

Emissions data obtained using this method can be used for the California CHPS Program, the State of CA DHS's "Standard Practice for the Testing Of Volatile Organic Emissions Sources Using Small Scale Environmental Chambers" (CA/DHS/EHLB/R-174), CA Section 01350, the German Blue Angel Programs, the Green Guide for Health Care, the National Association of Home Builders (NAHB), MBDC's Cradle to Cradle Certification, LEED credits, Green Globes, and other private and government product specification programs.

This standard method is developed and maintained by the GREENGUARD Environmental Institute (GEI). The master document at GEI's headquarters in Atlanta Georgia is the official document. This document is revised as new science, test protocols and allowable levels become available, and will be reviewed on an annual basis. Significant revisions will be reviewed through a consensus process of users and interested parties.

1.0 Scope

Building materials, such as flooring products, may emit a variety of volatile chemicals into the indoor air space of a building. Flooring products includes all surface covering material, such as carpet, resilients, stone, tile, wood and miscellaneous hard and soft materials; as well as the underlayment (cushion) and subflooring materials, and flooring adhesives. The following methodology measures total volatile organic compounds (TVOC), individual volatile organic compound (IVOCs), formaldehyde, and the other aldehyde emission levels from materials using test conditions defined to simulate product use in realistic commercial office, educational, healthcare and/or residential settings. The level of total or individual volatile organic chemical emissions is determined by observing the TVOC, IVOC, or aldehyde concentration in a dynamic environmental chamber under specified test conditions. The observed chamber concentration is then converted by a mathematical calculation to an emission rate, a product specific variable, and then modeled to obtain room concentration estimates.

The quantity of VOCs in the environmental chamber air is determined by gas chromatography/mass spectrometry (GC/MS). The methodology is generally applicable to volatile organic compounds with boiling points from 60°C to 290°C emitting from individual products. Emissions of selected aldehydes are measured using reverse-phase high-performance liquid chromatography (HPLC) with UV detection. Specialized analysis of chamber air samples may be conducted for other specific target chemicals as required for a specific product/project requirement.

1.1 The methodology provides a standard means of reproducibly and accurately testing flooring under a realistic, yet highly controlled, atmosphere.
1.2 The methodology with standardized measurement and analyses provides consistent testing of materials within a product group.
1.3 The protocol applies to products that can be tested whole or by a representative component or material in an environmental chamber.
1.4 This methodology is applicable for newly manufactured products before they are used in construction. Products taken from inventory or from within buildings can also be studied but data will not be considered representative of newly manufactured products.
1.5 This method establishes the procedures for product sample collection, emission testing and analysis, indoor concentration modeling and associated documentation requirements.
1.6 This method incorporates the elements of the original test method, “EPA Carpet Policy Dialogue Method” and additional requirements and improvements for the measurement of VOCs from flooring.
1.7 This methods meets the testing, reporting, and compliance requirements of the GREENGUARD certification, CRI Green label, and CA 1350 and CHPs Programs.
1.8 This method includes acceptance criteria for specific chemicals of interest.
1.9 While this practice may list specific chemicals and associated maximum allowable concentrations, as required by program criteria, indoor air guidelines and

specifications, it does not assess the human risk involve with use of the materials either as an installer and/or as an end user.

2.0 This practice does not purport to address safety concerns, if any, associated with the use of this practice. It is the responsibility of the user of this protocol to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2.0 Objectives and Use

2.1 Objectives

2.1.1 Measure VOCs, including aldehydes, and other potential pollutants from flooring and associated materials and assemblies.

2.1.2 Provide compound-specific data on VOCs and their sources to manufacturers for assessing product emissions and developing improved products for indoor environments.

2.1.3 Obtain emission data for use by the GREENGUARD Certification Program, The Carpet and Rug Institute's Green Label and Green Label Plus Indoor Air Quality Testing Programs, California and National CHPS Programs, State of CA DHS's "Standard Practice for the Testing Of Volatile Organic Emissions Sources Using Small Scale Environmental Chambers" (CA/DHS/EHLB/R-174), CA section 1350, the Green Guide for Healthcare, the National Homebuilders Association (NAHB), MBDC'S Cradle to Cradle Certification, LEED Credits, Green Globes, and other approved programs or specifications.

2.1.4 Provide compound-specific data on VOC sources and assist in evaluating indoor air quality in buildings.

2.1.5 Provide emissions data for the development and use of models for prediction of indoor concentrations of VOCs.

2.1.6 Identify irritants, odorants, and hazardous VOCs emitting from flooring materials and their emission parameters to assist in risk evaluations.

2.1.7 Rank and evaluate products within a category or across categories respect to their emission profiles, types, or chemicals and their levels. Provide compound specific emission parameters for use in indoor exposure models.

2.2 Use

2.2.1 Small (0.05 – 1 m^3) chamber evaluations are used to determine source emission rates and emissions factors from representative cuts of flooring materials or related products.

2.2.2 Intermediate (approximately 1 – 6 m^3 volume) chamber evaluations are used to determine source emission rates and emission factors from representative cuts of flooring materials and related products and from larger installations of flooring.

2.2.3 Large (approximately 6 – 30 m^3) chambers evaluation are used to determine source emissions rates and emission factors from full scale installation of flooring.

2.2.4 Emission rates are used in indoor air quality models to predict indoor concentrations of compounds emitted from the tested flooring. The concentrations observed in the chambers are not to be directly used as a substitute for concentrations expected in full-scale indoor environments.

2.2.5 Emission factors are used to compare emission levels among products at a specific exposure time point.

2.2.6 Determined emission factors and exposure concentrations are used to evaluate flooring for defined indoor air quality standards, guidelines and specifications.

3.0 References and Documents

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Cal/EPA, ARB list of Toxic Air Contaminants (TACs). The current version of this list is accessible at http://www.arb.ca.gov/toxics/taclist.htm

Carpet & Rug Institute (CRI), Green Label Program http://www.carpet-rug.org/drill_down_2.cfm?page=8&sub=4&requesttimeout=350

Carpet & Rug Institute (CRI), Green Label Plus Program http://www.carpet-rug.org/drill_down_2.cfm?page=8&sub=3&requesttimeout=350

European Committee for Standardization. PrEN 13419-3. Building Products, Determination of the Emissions of Volatile Organic Compounds. Part 3: Procedure for Sampling, Storage of Samples and Preparation of Test Specimens

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GREENGUARD Chemical Emissions Test Method, 2006 http://www.greenguard.org/uploads/GGTM.P066.R0.pdf

GREENGUARD Product Certification Program Laboratory Qualifications and Proficiency Requirements, 2005, http://www.greenguard.org

ISO 16000-3. Indoor air - Part 3: Determination of formaldehyde and other carbonyl compounds – Active sampling method

ISO 16000-6. Indoor air – Part 6 Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS/FID

ISO 16000-9. Determination of the emission of volatile organic compounds from building products and furnishing – Emission test chamber method

ISO 16017-1. Indoor, ambient and workplace air -- Sampling and analysis of volatile organic compounds by sorbent tube/thermal desorption/capillary gas chromatography -- Part 1: Pumped sampling

ISO Guide 43-1. Proficiency testing by interlaboratory comparisons – Part 1: Development and operation of proficiency testing schemes.

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4.0 Terminology

4.1 Acronyms and Abbreviations

ACH – Air changes per hour
ARB – Air Resources Board, Cal/EPA
ASTM – American Society for Testing and Materials
AQS – Air Quality Sciences, Inc.
BQL – Below quantifiable limit
Cal/DHS – California Department of Health Services
Cal/EPA – California Environmental Protection Agency
CHPS – Collaborative for High Performance Schools
CIWMB – California Integrated Waste Management Board, Cal/EPA
COC – Chain of Custody
CRI – Carpet and Rug Institute
DL – Detection limit
DNPH – 2,4-Dintrophenylhydrazine
EF – Emission factor
EPA – U.S. Environmental Protection Agency
GC/MS – Gas chromatography/mass spectrometry
GEI – GREENGUARD Environmental Institute
GL – Green Label
GLP – Green Label Plus
HAP – Hazardous Air Pollutant
HPLC – High performance liquid chromatography
IAQ – Indoor air quality
ISO – International Standards Organization
IVOC – Individual volatile compounds
LOQ – Limit of quantitation, lower
MFC – Mass flow controller
MSDS – Material safety data sheet
OEHHA – Office of Environmental Health Hazard Assessment, Cal/EPA
Prop 65 – California Proposition 65
QL – Quantifiable limit
REL – Reference exposure level
RH – Relative humidity in percent
TAC – Toxic Air Contaminant
TD/GC/MS – Thermal desorption GC/MS
TIC – Total ion-current chromatogram
TVOC – Total volatile organic compounds
VCT – Vinyl composition tile
VOC – Volatile organic compound

4.2 Definitions

Absolute Humidity (AH) - The amount of water vapor present in a unit volume of air; expressed as grams of water per grams of air.

Accuracy - The degree of conformity of a value generated by a specific procedure to the assumed or accepted true value; includes both precision and bias.

Air Exchange Rate (ACH) - The volume of purified inlet air, adjusted to standard environmental conditions of 23°C and 50% RH, that enters the chamber environment in one hour divided by the volume of the chamber (typically expressed as hr^{-1}).

Air flow rate - Air volume entering the emission test chamber per unit time.

Air velocity - Air speed over the surface of the test specimen.

Aldehydes - Formaldehyde, acetaldehyde and other carbonyl compounds detectable by derivatization with DNPH and analysis by HPLC.

Background Concentrations – VOC and aldehyde concentrations in emission test chamber in the absence of a product test specimen.

Chain-of-Custody - Document providing written evidence of transfer of a product sample, air sample, or another document from one organization to another organization or from one individual to another individual within the same organization. Document is signed and dated by each party involved in the transfer.

Chronic REL - Noncancer chronic reference exposure level developed by Cal/EPA OEHHA.

Concentration – Mass of VOC per unit air volume expressed at standardized conditions for temperature and humidity (i.e., 298K, 101.3 kPa)

Data Acquisition System – System used to monitor, acquire and store data defining the environmental conditions for an emission test.

Emission Factor (EF) – A product specific factor typically describing the mass of a chemical emitted from a product per exposed area of the product per unit time ($\mu g/m^2 \cdot hr$) or the mass of chemical emitted per weight per unit time ($\mu g/g \cdot hr$).

Emission Rate (ER) – The rate of emission of a specific compound is defined as the total $\mu g/hr$ of a chemical emitted from a product.

Humidity (H) –A measure of the amount of water vapor in the air.

Intermediate Environmental Chamber - A test apparatus consisting of an enclosed volume of between 1m^3 to 6 m^3 with controlled environmental operational parameters used for the purpose of providing accurate and reproducible emission measurements from sources of indoor air pollutants.

Large Environmental Chamber - A test apparatus consisting of an enclosed volume of greater than 6 m^3 with controlled environmental operational parameters used for the purpose of providing accurate and reproducible emission measurements from sources of indoor air pollutants.

Loading - The physical act of placing the sample in the chamber, sealing the chamber door, and starting the test.

Loading Factor or Loading Ratio (L) - The ratio of the area of exposed surface(s) of the test specimen to the chamber volume (m^2/m^3).

Manufacturer's Identification Number - Unique product identifier from which a manufacturer is be able to determine the product name, product category or subcategory, manufacturing location, date of manufacture, production line, and other pertinent identifying information for the product.

Mass Flow Controller - Electronic device based on principle of thermal conductivity used to control the flow rate of air entering the emission test chamber and the flow rate of air passing through a sampling device.

Precision - The degree of agreement of repeated measurements of the same property. The precision of a method is expressed quantitatively as the standard deviation computed from the results of a series of controlled determinations.

Product Category – General group of similar products intended for a particular application and performance, such as flooring, cushion and adhesives.

Product Subcategory – Group of products within a product category having similar chemistry, construction, weight, formulation and manufacturing process and which may have a similar VOC emissions profile (including specific chemicals and decay profile over time).

Product Loading – The ratio of the amount of material to be placed in the chamber to the volume of the chamber. Typically based on the area (m^2/m^3 of chamber volume), or mass (g/m^3) or unit ($1\ unit/m^3$).

Relative Humidity (RH) - The ratio of the amount of water vapor actually present in the air to the greatest amount possible at the same temperature; expressed as percent saturation.

Representative Product Sample – A product sample, which is representative of the product manufactured and produced under typical operating conditions.

Sampling Interval - Time over which a single air sample is collected.

Sampling Period – Established time for collection of an air sample from the emission test chamber.

Small Environmental Chamber - A test apparatus consisting of an enclosed volume of between a few liters and 1 m^3 (nominally 50-100 L or 0.05 – 1 m^3) with controlled environmental operational parameters used for the purpose of providing accurate and reproducible emission measurements from sources of indoor air pollutants.

Sorbent Tube – Solid phase sampling device through which a sample of chamber exhaust air at controlled flow rate is passed to capture VOCs. Device typically contains Tenax-TA, or equivalent, as primary sorbent material, sometimes backed up by higher surface area sorbent material to quantitatively capture the most volatile VOCs.

Test Specimen - Portion of representative sample prepared for emission testing in an emission test chamber following a defined procedure.

Total-ion-current Chromatogram – Chromatographic representation of a GC/MS analysis produced as the sum of all of the scanned masses between m/z 35 – 350, or some other range.

Total Volatile Organic Compounds (TVOC) - The sum of those VOCs that elute between the retention times of n-hexane and n-hexadecane on a non-polar or equivalent capillary GC column. TVOC is estimated based on a toluene response factor.

Temperature (T) - Degree of hotness or coldness expressed in degrees Celsius.

Ventilation Rate – Same as air change rate

Volatile Organic Compound (VOC) - Those nonpolar and moderately polar organic chemicals with boiling points between 60°C and 290°C that are amenable to monitoring, based on sorbent collection /thermal desorption/GC/MS analysis. The volatility range of chemicals amenable to the method will depend on the sorbent cartridges and thermal desorption chromatographic system used by the laboratory.

Zero Time - Time establishing the beginning of an emission test or when product is placed in a chamber and door is sealed.

4.3 Symbols

Symbol	Description	Units
A	Projected surface area	m^2
C	Chamber concentration of VOC	$\mu g/m^3$
$C_{P,t}$	Predicted exposure concentration at time t	$\mu g/m^3$
EF	Emission factor	$\mu g/m^2 \cdot hr$
EF_o	Initial emission factor	$\mu g/m^2 \cdot hr$
EF_t	Measured emission factor at time t	$\mu g/m^2 \cdot hr$
ER	Emission rate	µg/hr
k	Rate constant	hr^{-1}
L	Product loading factor	m^2/m^3
N	Chamber air exchange rate	hr^{-1}
N_e	Modeled air changes per hour	hr^{-1}
Q	Area specific flow rate	m/hr
SER	Area specific emission rate	$\mu g/m^2 \cdot hr$
T	Time after start of test	hr or day
t	Time	hr
V	Volume	m^3
vf_B	Building ventilated volume fraction	Unitless

5.0 Sample Collection, Handling, and Product Tracking

Purpose

Guidelines are established for the collection, handling and documentation of product samples to ensure the samples tested are reliable, representative, uncontaminated, and well preserved.

5.1 Personnel

5.1.1 Personnel responsible for sample collection must perform the task carefully and conscientiously and according to specific instructions, if supplied. Improper sample collection may impact the integrity of the sample and invalidate analysis, data and use of data.

5.1.2 Individuals engaged in sample collection and handling must be qualified by training and experience and possess an understanding of the relevant practices and techniques or, at a minimum, be under the direct supervision of such an individual.

5.2 Representative Sample

5.2.1 Products selected or requested for testing are to be representative of similar products produced by the manufacturer. These products shall be treated no differently than similar products or components produced in the normal course of business and available in the marketplace.

5.3 Sample Preservation

5.3.1 Special care shall be taken to prevent contamination of the product sample from any external source, prior to, during and subsequent to the sample collection procedure.

5.3.2 Powder free latex gloves are recommended during collection and packaging of the sample. Latex gloves minimize the risk of sample contamination by perfumes, soaps, or other contaminants on the hands of sample collection personnel.

5.3.3 Cutting knives and collection equipment must be free of organic solvent contamination.

5.3.4 Product samples may be packaged in two ways: 1) using the manufacturers standard product packaging materials, including sealed containers (as provided to distributors and/or customers); or 2) using contaminant-free, airtight, specialized Mylar or polyethylene lined foil barrier bags provided by the laboratory (specialized sample bags). In each case, care shall be taken to ensure that the sample package is tightly sealed to minimize contamination from external sources or off gassing during shipment and storage. If the manufacturer's standard product packaging does not meet sealing requirements, then other specialized packaging must be used.

5.3.5 The product will remain in its packaging as received, or transferred to a specialized bag (see Section 5.3.4), foil bag or otherwise sealed to preserve the integrity of the sample, until immediately prior to loading into

the environmental chamber. Until it is unpacked it will be stored in an environmentally controlled indoor environment free of contamination with environmental control of 20º – 25ºC and relative humidity no great than 60% RH.

5.4 Location of Sampling

5.4.1 Generally, samples are to be collected directly from the manufacturing or packaging line. The most appropriate location is dependent on the product and packaging process employed by the manufacturer. When collecting samples directly off the manufacturing line, the collection location shall be chosen to ensure easy access so that a representative selection of the material is obtained. Sample collection personnel shall document the sample collection location and any relevant observations. This information shall be included on the chain of custody (COC) form.

5.5 Sample Age

5.5.1 Samples shall be packaged no more than 1 hour following collection off the manufacturing line or immediately following completion of the manufacturer's product packaging process. However, the sample shall not be packaged until it has reached room temperature. If additional time is required for the product to reach room temperature beyond the one hour, note this on the chain of custody.

5.5.2 Samples shall be shipped from the manufacturing facility within 24 hours of collection and packaging.

5.5.3 Samples to be tested for the GREENGUARD Certification Program shall arrive at the testing laboratory within 7 days of shipment, although overnight shipment is recommended.

5.5.4 Samples to be tested for the Carpet and Rug Institute's (CRI) Green Label (GL) and Green Label Plus (GLP) Programs shall arrive at the testing laboratory within 7 days of sample collection, although overnight shipment is recommended.

5.5.5 For samples that are to be tested for the GREENGUARD Certification Program, timing of sample collection shall be coordinated between the manufacturing facility and the testing laboratory to ensure that preparation and loading of samples can occur within 10 days of receipt at the laboratory.

5.5.6 For samples that are to be tested for the CRI GL and GLP Programs, timing of sample collection shall be coordinated between the manufacturing facility and the testing laboratory to ensure that testing begins no later than 9 days from sample collection date.

5.5.7 The schedules for sample collection, shipping, specimen preparation, and testing is summarized below.

	CRI Green Label and Green Label Plus
Manufacturing Date	Date product comes off of final manufacture line
Sample Collection	Same as *Manufacturing Date*
Shipment to Laboratory	Within 24 hours of sample collection
Arrival at Laboratory	Within 7 days of sample collection date
Testing Date	No sooner than 5 days from sample collection date and no later than 9 days from sample collection date

	GREENGUARD Certification Program
Manufacturing Date	Date product comes off of final manufacture line
Sample Collection	Same as *Manufacturing Date*
Shipment to Laboratory	Within 24 hours of sample collection
Arrival at Laboratory	Not to exceed 7 days of shipment date
Testing Date	Not to exceed 10 days after arrival and product acceptance at laboratory

5.6 Sample Collection Procedures

5.6.1 Tile and Plank Products - Tile and plank products are collected directly from the manufacturing or packaging line. If standard manufacturer packaging materials are not used, a minimum of four representative tiles, strips or planks, each with a minimum surface area of at least 64 square inches, shall be collected. The tiles, strips or planks shall be stacked tightly together face to back and immediately placed in specialized packaging as described in Sections 5.3 and 5.5. Following packaging, the COC must be fully completed. The white and yellow copies of the completed three-part form (Section 5.8) shall be attached to the outside of the sample package. The pink copy of the COC is a record retained by the manufacturer. No more than 1 hour shall elapse between the time of sample collection and packaging.

5.6.2 Sheet and Roll Goods - Sheet and roll goods are collected directly from the manufacturing or packaging line. Sheet and roll goods shall be cut at a minimum width of 12" across the entire width of the roll. Following cutting, the product shall be tightly rolled and immediately placed in specialized packaging as described in Sections 5.3 and 5.5 (unless such size material can be collected from the packaging line using the manufacturer's standard packaging materials). Following packaging, the COC must be fully completed. The white and yellow copies of the completed three-part form (Section 5.8) shall be attached to the outside of the sample package. The pink copy of the COC is retained as a record for the manufacturer. No more than 1 hour shall elapse between the time of collection and packaging (Section 5.5.1).

5.6.3 Containerized and Wet Products - Containerized and wet products can be supplied in original, standard 1-quart or 1-gallon consumer containers. Adhesives can be supplied in their consumer packaging such as an applicator tube or can (if less than 1 gallon). Alternatively, adhesive samples can be collected in clean, unused paint cans (1-pint or 1-quart size). Special care is required to assure that these samples are representative of the larger batches from which they are collected. Containers shall be filled so there is minimal unfilled headspace above or below the adhesive. The collection procedure shall be documented. Following packaging, the COC must be fully completed. The white and yellow copies of the completed three-part form (Section 2.9) shall be attached to the outside of the sample package. The pink copy of the COC is retained as a record for the manufacturer. Samples of containerized products sent to a laboratory shall also be accompanied by a Material Safety Data Sheet (MSDS) and a specification sheet that describe the products, list the major chemical ingredients, identify the intended uses and describe the application methods. Disposal recommendations should also be provided.

5.7 Packaging and Shipment of Samples

5.7.1 Samples are shipped to the testing laboratory in sealed Mylar or polyethylene lined foil "barrier" bags (specialized bags) provided by the testing laboratory, in the manufacturer's standard packaging, or in otherwise sealed containers. Heavy duty aluminum foil, shiny side out, may be used. The type of packaging used must ensure that the sample is tightly sealed to minimize contamination from external sources or off gassing during shipment and storage.

5.7.2 Samples must be packaged to avoid cross contamination. Different types of products should be packaged individually for shipping.

5.7.3 Samples are to be shipped to the testing laboratory within 24 hours of collection and packaging.

5.8 Chain of Custody Documentation

5.8.1 The manufacturer is responsible for the completion of the Chain of Custody form. This form must be completed by the responsible manufacturer's employee/representative or by an independent third party.

5.8.2 The chain of custody form includes the following information:

5.8.2.1 Testing Information

5.8.2.2 Product Description

5.8.2.3 Product Category

5.8.2.4 Company Details

5.8.2.5 Company Contact Details

5.8.2.6 Post Testing Instruction.

5.8.2.7 Shipping Details – Shipping Date, Carrier, Shipping Mode, Shipping Time, Shipper Name and Signature

5.8.2.8 Laboratory Receiving Details – Received By, Received Date, Condition of Shipping Package, Condition of Sample.

5.9 Receipt of Samples by Laboratory

5.9.1 Once the product sample is received by the laboratory, the packages will be checked against the shipping invoice to ensure all packages and components have been received.

5.9.2 The laboratory will visually inspect the shipping containers upon arrival to ensure they are intact and do not appear to have been contaminated during shipping.

5.9.3 The sample custodian shall note the condition of the package and container on the chain-of-custody form and sign and date the form.

5.9.4 If containers are damaged or missing, the laboratory will contact the manufacturer as soon as feasible.

5.9.5 If a package or container is significantly damaged or the other criteria are not met, the laboratory shall reject the sample as described in Section 5.10.

5.9.6 Valid samples are assigned a unique identifier and entered into an electronic data management system for sample and data tracking purposes.

5.9.7 The product is to remain in its original packaging (as received) until immediately prior to preparation for loading into the environmental chamber. It is to be stored in a normal indoor environment not expected to contaminate the product.

5.10 Rejection of Samples by Laboratory

5.10.1 The testing laboratory has the right to reject a product sample for testing due to, but not limited to, any of the following reasons:

5.10.2 Shipping package is severely damaged upon arrival.

5.10.3 Product container (i.e., external bag, foil package, can, tube, etc) is damaged upon arrival so that integrity of the sample is compromised.

5.10.4 Chain of Custody form is missing or incomplete.

5.10.5 Product sample arrives with insufficient time to initiate testing within the required time frame.

5.10.6 When a product sample is rejected, the testing laboratory shall inform the manufacturer immediately and provide the reason for rejection.

5.10.7 The manufacturer has the right to collect a new sample and resubmit it for testing, subject to the conditions described within this practice. All costs for recollection and shipment shall be the responsibility of the manufacturer.

5.11 Storage of Samples by Laboratory Prior to and Following Testing

5.11.1 Before Testing: Samples are stored in original, sealed packaging in a controlled environment not expected to contaminate the sample. This environment must be free of chemical contamination and environmentally controlled at 20º - 25ºC and not greater than 60% RH.

5.11.2 After Testing: Following testing and report issuance, the product is stored for 30 days. After this time, the product is either returned to the manufacturer or disposed of depending on the request of the client. The yellow copy of the chain of custody form is returned or destroyed with the product.

6.0 Chamber Testing Protocol

6.1 Test Specimen Preparation

6.1.1 The test specimen dimensions given in this section are for illustrative purposes. The dimensions are optimized for small-scale test chambers with volumes typically ranging from 50 to 100 L operating at 1 air change. Loading factors are established to be representative of realistic indoor environments and optimized for analytical measurement in the chambers.

6.1.2 Sample specimen replicates should be prepared for analysis as part of the laboratory quality program. The fraction of replicates is established by the laboratory's quality assurance plan, and should be a minimum of one replicate for every ten samples prepared of a product type.

6.1.3 Completion of specimen preparation and placement of the test specimen in the environmental chamber is considered the starting time for the VOC emission test (i.e., zero time).

6.1.4 If special substrates and/or edge sealing materials are used for specimen preparation, emissions tests shall be conducted to determine background concentrations of VOCs for these materials. They shall not emit VOCs above the limits specified for the chamber background, and every attempt should be made to use materials that do not emit measurable amounts of any target VOC of concern.

6.2 Selection and Preparation of Test Specimens

6.2.1 The period of time required to unpack a product, prepare a product for testing and placement of the product in the test chamber should be minimized and be less than 10 minutes in all situations. Any exceptions shall be reported, and time recorded for preparation and placement of the specimen for the start of the test.

6.2.2 All exposed surface dimensions of specimens shall be accurately measured (±2 mm) after they are cut and prepared for testing.

6.2.3 Specimen sizes are to be adjusted according to the chamber volume to achieve the specified loading factor of 0.41 m^2/m^3. The loading is optimized to represent realistic indoor environments for flooring products and to ensure that chamber concentrations expected are within the analytical range of the analysis.

6.2.4 Flooring and Cushion

6.2.4.1 *Selection of test specimen from package containing stacked pieces of the product samples*: Open the packaging containing the product sample. Select a piece from the center of the stack in a random manner, i.e., do not purposefully select the piece based on any appearance characteristic. Cut the specimen from the center of the selected piece at least 1" away from the previously cut edges .

6.2.4.2 *Selection of test specimens from sample rolls*: Open the package containing the product sample. Discard at least the outer two layers of the roll. Cut the test specimen from the remaining material at least 1" away from the edges.

6.2.4.3 *Specimen preparation for sheet, tile type (resilient) and carpet flooring products, including floor underlayment (e.g. carpet cushion)*: The flooring material is unpackaged and placed on an inert surface to be cut to dimensions that correspond to a loading ratio of 0.41 m^2/m^3. Emissions from the edges of the flooring material may differ from the normally exposed surface, and edges must be sealed. This may be accomplished by placing the sample specimen into an appropriately sized stainless steel tray, and pressing flat to seal the bottom and edges against the tray interior (if the material has an adhesive backing, the liner is peeled off prior to being placed into the stainless steel tray). The surface of the product must not be higher than the edge of the tray, and no more than 1/8" lower. Alternatively, the sample can be attached to a clean metal sheet to cover the back using low VOC metal tape to seal the edges as well.

6.2.4.3.1 *Additional preparation for laminate and wood flooring*: Cut a minimum of two sections of material which, when assembled, provide a single piece with the dimensions to provide the target loading factor. Assemble the pieces as appropriate for type of flooring (tongue & groove, snap seam, etc). Seal back and cut edges to expose the top surface only.

6.2.5 Flooring Adhesives

6.2.5.1 Preparation of Adhesive Product Test Specimens

6.2.5.1.1 Adhesive is generally applied to an inert substrate such as a stainless steel plate, unless specifically designed to be applied to a porous substrate. The substrate should have dimensions that correspond to a surface loading ratio of $0.41 m^2/m^3$. The adhesive is applied at a specified weight loading, using either a trowel or roller based on the adhesive type or manufacturer's recommendations. The type of adhesive being tested determines the method and loading rate.

6.2.5.1.2 Do not use material from the surface of the product. Open and stir product with stainless ladle and remove test aliquot from at least 1" below the surface.

6.2.5.1.3 Weigh substrate before applying adhesive.

6.2.5.1.4 Application instructions using 1/4" nap roller:

6.2.5.1.4.1 Pour some adhesive into a disposable tray, from which the surface of the roller can be wetted.

6.2.5.1.4.2 Make a single pass on the substrate in one direction.

6.2.5.1.4.3 Rotate the substrate 1/4-turn (90°) and make a subsequent final pass.

6.2.5.1.4.4 Weigh the assembly to determine the total adhesive weight.

6.2.5.1.4.5 Repeat the application until weight is within 10% of the target weight.

6.2.5.1.4.6 Reject the sample if it is more than 10% over the target weight.

6.2.5.1.4.7 Load the assembly in the environmental chamber within 5 minutes and record the time.

6.2.5.1.5 Application instructions using Trowel: (Standard applicator is a 1/8" x 1/8" x 1/8" u-notched trowel):

6.2.5.1.5.1 Hold the trowel at a 45º angle to the plate making one pass across the plate to spread the adhesive;

6.2.5.1.5.2 Rotate the plate 1/4-turn and make one additional pass.

6.2.5.1.5.3 Weigh the assembly and repeat the application if necessary.

6.2.5.1.5.4 Visually inspect for even distribution of the adhesive.

6.2.5.1.5.5 Reject the sample if it is more than 10% over the target weight, or if there are areas of the plate that are not covered with adhesive or the application is visibly not evenly distributed.

6.2.5.1.5.6 Load the assembly in the environmental chamber within 5 minutes and record the time.

6.2.5.2 The container with the unused material is re-sealed within 5 minutes of sample preparation.

6.2.6 Product assemblies consisting of sub flooring materials, cushion, and adhesives may be prepared. Details of the assembly compounds and preparation on process must be documented. Edges must be sealed either

by placing the assembly on a tray or sealing the edges with low VOC metal tape.

6.3 Environmental Chamber Testing

6.3.1 Facilities

Chemical Emissions - A facility designed and operated to measure organic emissions and emission rates from building materials and indoor finishes and furnishings should contain environmental test chambers, conditioning chambers, sample storage areas, purification systems, monitoring and control systems, sample collection and analysis equipment, standards generation and calibration systems, data acquisition systems, and data modeling and reporting systems.

6.3.2 Equipment

Environmental Test Chamber Requirements - The chamber and analytical requirements are fully defined in the referenced documents, U.S. EPA's "Carpet Policy Dialogue Compendium Report" and "GREENGUARD Product Certification Program Laboratory Qualifications and Proficiency Requirements", which are based upon the referenced ASTM documents D5116 and 6670.

6.3.3 Chamber Sizes:

For testing of representative samples of flooring products, chambers of 0.05 -0.10 m^3 are generally used.

6.3.4 Environmental Chamber Performance Requirements

6.3.4.1 *Principle:* The principle of the test is to determine the specific emission rates or emission factors of VOCs emitted from prepared specimens of flooring. The test is conducted in an environmental chamber at specified constant conditions of temperature, relative humidity, ventilation rate and product loading factor. As the air in the chamber is fully mixed, VOC concentrations measured at the chamber exhaust are representative of air concentrations in the chamber. From the airflow rate into the chamber, the VOC concentration, and the exposed surface area of the specimen, an area-specific emission rate or emission factor is calculated using the state-state form of the mass-balance model. The chamber test is conducted following the guidance of ASTM Standard D 5116, "Guide for Small Chamber Environmental Chamber Determination of Organic Emissions from Indoor Materials/Products", or ASTM D 6670, "Standard Practice for Full-Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials/Products".

6.3.4.2 *Test Conditions:* The test shall be conducted at the conditions and within the limits specified in Table 11.1. Standard test conditions for chamber tests are 1 ± 0.05 air change (ACH) and inlet air conditions controlled at 23 ± 2ºC and 50 ± 5% RH. Standard conditions for the purpose of calibrating flow measurement devices

and calculating all flow rates shall be 23°C (298 K) and one atmosphere pressure (101.3 kPa). The chamber shall be ventilated at 1 ± 0.05 air changes per hour. The loading factor shall be optimized to produce a value which is close to the value for many materials in both the classroom and office building scenarios and within the analytical range of the measurement system.

6.3.4.3 *Duration:* Dependent on the certification program requirements, the chamber test shall last between 24 and 336 hours, but may be extended to a longer period to capture on going emissions patterns, emitting VOCs, and their levels or meet other standard requirements. Sealing of the chamber following insertion of the product specimen into the chamber establishes the zero time or start of the test. Testing durations for the GREENGUARD and CRI programs are summarized below. Other programs or test protocols may call for other time periods.

Carpet and other flooring:

	GREENGUARD	Green Label	Green Label Plus
Initial Certification	168 hours	24 hours	336 hours
Annual Recertification	168 hours	24 hours	24 hours
Quarterly Monitoring	24 hours	24 hours	24 hours

Carpet cushion and other flooring underlayment:

	GREENGUARD	Green Label	Green Label Plus
Initial Certification	168 hours	24 hours	N/A
Annual Recertification	168 hours	24 hours	N/A
Quarterly Monitoring	24 hours	24 hours	N/A

Flooring adhesives:

	GREENGUARD	Green Label	Green Label Plus
Initial Certification	168 hours	24 hours	24/336 hours
Annual Recertification	168 hours	24 hours	24/336 hours
Quarterly Monitoring	24 hours	24 hours	24/336 hours (Semi-Annual)

6.3.4.4 *Apparatus and Facilities:* The apparatus and facilities shall be constructed to maintain the test specimen at the specified conditions within a non-contaminating and environmentally controlled environment 20º - 25ºC and humidity no greater than 60%.

6.3.4.5 *Clean air supply and flow control:* A clean air generator or high purity air is used to supply pressurized clean, dry air. The flow rate of the supply air to a chamber shall be regulated and monitored

with electronic mass flow controllers (MFCs), or equivalent, with an accuracy of ± 2 % at 1 Lpm, or better, and capable of continuously maintaining the flow within ± 5 % of the specified value. MFCs are calibrated periodically according to the Laboratory's quality assurance plan. At a minimum, flow measurement devices shall be calibrated on an annual basis against NIST traceable standards. At a minimum, the air exchange rate shall be monitored immediately before the product is placed in the chamber (at the same time background contamination checks are made) by accurately measuring the air flow into the chamber. ACH (h^{-1}) is then calculated as air flow (m^3/h) divided by chamber volume (m^3). The accuracy of this air exchange rate must be confirmed (with ±10% accuracy) using procedures similar to those presented in ASTM Method E741 for tracer gas application. Alternatively, ASTM Method E741 may be used as the primary method for determining the air exchange rate. The frequency of ACH verification is prescribed by the Laboratory's quality assurance standards and should occur whenever flow changes are made to chamber air and at a minimum of twice per year, if conditions are not changed. Supply air contamination shall not exceed 10 µg m^{-3} and 2 µg m^{-3} for any individual VOC. Use of pressurized cylinders is not permitted.

6.3.5 Chamber and materials:

6.3.5.1 Environmental test chambers shall be constructed of inert, smooth, electropolished surfaces such as stainless steel. Glass is inappropriate because of adsorption effects.

6.3.5.2 All joints and openings shall be sealed. All seals shall be made of non-VOC emitting and non-VOC adsorbing/absorbing materials.

6.3.5.3 The air within the chamber shall be free of any obstructions or contamination such as humidifiers or refrigeration coils. Internally or externally mounted fans may be used to keep the chamber air well mixed if it can be demonstrated through the use of quality control samples that the fans do not contaminate the chamber air samples or irreversibly absorb/adsorb formaldehyde or representative VOCs (toluene and n-decane). The internal chamber air shall only come in contact with inert materials.

6.3.5.4 The surfaces and seals of the chamber shall be sufficiently chemically inert such that formaldehyde at the level of 0.005 ppm and representative VOCs at the level of 10 µg/m^3 are not irreversibly retained on the interior surfaces.

6.3.5.5 Background concentrations in the empty chamber ventilated at 1.0 air changes per hour shall not exceed 2 µg m^{-3} for any individual VOC or aldehyde, and 10 µg m^{-3} for TVOC.

6.3.5.6 Temperature and humidity control: The temperature of the chamber shall be maintained at 23 ± 2°C throughout the test period. All

surfaces of the chamber shall be held at the same temperature so that the temperature inside the chamber is uniform. The humidity of the chamber air shall be maintained at 50 ± 5% RH. The humidity can be established by controlling the humidity of the inlet air. Water used in bubblers to saturate gas streams shall be free of organic solvents and contaminants (i.e., HPLC grade or equivalent).

6.3.5.7 Monitoring and data acquisition: Instrumentation must be available to control and monitor the temperature and humidity with adequate accuracy, precision, and sensitivity to control these parameters and to document that the emission test is conducted within the control limits stated above. The measurements shall be made at the inlet air stream, inside the chamber or immediately at the chamber exhaust using electronic probes. The probes shall be calibrated periodically according the laboratory's quality assurance plan. At a minimum, these probes shall be calibrated on an annual basis against NIST traceable standards.

6.4 Procedures

6.4.1 *Chamber cleaning and preparation:* Prior to the actual testing, clean chambers by wiping down the inner surfaces with deionized water. Soap or detergent is not recommended because of contamination and residue left on chamber materials. Chambers are then dried and purged at standard test conditions for a minimum of twelve hours, or 12 ACH's prior to use.

6.4.2 *Background measurement:* Prior to sample loading, collect chamber air background samples for VOC's and aldehydes to determine the levels of TVOC, IVOCs and formaldehyde in the clean chamber. VOC and aldehyde samples are to be collected to provide lower quantitation limits of at least 2 µg m^{-3} for individual VOCs and 10 µg m^{-3} for TVOC.

6.4.3 *Specimen loading:* The time for basic sample preparation shall be minimized and shall never exceed 10 minutes. Once the product has been prepared, it is to be loaded into the environmental chamber within five minutes. The times should be documented. Load the prepared product into the environmental chamber, approximately centered on the bottom surface. There shall be sufficient space for chamber air to circulate freely around the exposed face of the specimen. Immediately after loading, the environmental chamber is sealed.

6.4.4 *Chamber air leakage:* Air tightness is determined on an annual basis by capping the inlet and exhaust manifold and introducing a known concentration of a tracer gas such as SF_6 or CO. The concentration is monitored over a period of time. The ending concentration shall be equal to or less than 0.03 ACH. Additionally, the air leakage of specific chambers can be determined periodically after loading a test specimen, if appropriate. This can be accomplished by measuring the flow rate at the chamber exhaust and comparing this to the supply airflow rate. The flow measurement device shall have low pressure drop. The exhaust flow rate shall be within 10% of the inlet flow rate by this method.

6.4.5 *Replicate tests*: A fraction of the tests shall be conducted in replicate using specimens prepared from the same product sample. The fraction of replicates is determined by the laboratory's quality assurance plan and should be no less than 1 out of every 20 samples for those products sufficient for replicate measurement.

6.5 Air Sampling

Sampling schedule: Chamber air samples shall be collected for VOCs and aldehydes centered around the elapsed time points after initiating the chamber test, or as otherwise dictated by the test program or specification requirements. The elapsed time points for the GREENGUARD and CRI programs are listed in the table below. The California 1350 test according to the DHS practice requires 264, 288, and 336 hours, and additional programs may require other time points.

Carpet and Other Flooring Air Sampling Schedules			
	GREENGUARD	**Green Label**	**Green Label Plus**
Initial Certification	6,24,48,72,96, and 168 hours	24 hours	24,264,288, and 336 hours
Annual Recertification	6,24,48,72,96, and 168 hours	24 hours	24 hours
Quarterly Monitoring	24 hours	24 hours (TVOC only)	24 hours (TVOC only)
Carpet Cushion and Other Flooring Underlayment Air Sampling Schedules			
	GREENGUARD	**Green Label**	**Green Label Plus**
Initial Certification	6,24,48,72,96, and 168 hours	24 hours	N/A
Annual Recertification	6,24,48,72,96, and 168 hours	24 hours	N/A
Quarterly Monitoring	24 hours	24 hours (TVOC only)	N/A

Flooring Adhesives Air Sampling Schedules			
	GREENGUARD	**Green Label**	**Green Label Plus**
Initial Certification	6,24,48,72,96, and 168 hours	24 hours	24 and 336 hours
Annual Recertification	6,24,48,72,96, and 168 hours	24 hours	24 and 336 hours
Quarterly Monitoring	24 hours	24 hours (TVOC only)	24 and 336 hours (Semi-Annual)

6.6 Sampling Media

6.6.1 VOC sampling media for individual VOCs and TVOC shall consist of thermally desorbed, solid-phase sorption tubes containing Tenax-TA. Refer to ASTM documents D6196 and D 6345, and U.S. EPA Methods TO-1 and TO-17. The samplers shall be capable of quantitatively collecting VOCs with a broad range of functional groups and volatilities

approximately within the volatility range of n-hexane through n-hexadecane (C_6 - C_{16}). Minimal losses of analytes (i.e., < 5%) due to breakthrough shall occur. This can be accomplished by the use of sampling tubes containing two or more sorbent materials in series, with the highest surface area material used as the backup to prevent the breakthrough of the most volatile compounds. Before use, samplers shall be conditioned by thermal desorption. Samplers taken from refrigerated storage shall be warmed to room temperature prior to use.

6.6.2 Sampling media for formaldehyde, acetaldehyde and other low molecular weight aldehydes shall consist of cartridges containing a solid support material (e.g., silica gel) treated with an acid solution of 2,4-dinitrophenylhydrazine (DNPH) as a derivatizing reagent. Refer to ASTM document D 5197 for guidance. Samplers shall be warmed to room temperature prior to use.

6.6.3 *Flow control*: Sampling flow rates shall be regulated with electronic mass flow controllers with an accuracy of ±2 % full scale, or better, and capable of continuously maintaining the flow during sampling within ±5 % of the specified value.

6.7 Sampling procedures:

Air samples shall be collected directly from the chamber exhaust at the specified elapsed times. A short manifold with multiple ports and a maximum length of 4 inches is used at the exhaust to allow simultaneous collection of multiple samples. No other tubing is allowed between the chamber exhaust and the sampler inlet. The DNPH cartridge is placed downstream of the VOC sorption tubes to reduce the chance of VOC sample contamination with residual acetontrile that may be present in the DNPH cartridge. The total sampling flow rate at any time shall not exceed 75% of the inlet flow rate. The start and stop times and the sampling flow rates shall be recorded. A unique identification number is assigned to each air sample.

6.8 Duplicate samples:

A fraction of the air samples shall be collected in duplicate. The fraction of duplicates is determined by the laboratory's quality assurance plan and recommended to be no less than 1 out of every 10 samples.

6.9 Sample storage:

Following collection, air samples shall be sealed in clean airtight containers and stored at reduced temperature in a dedicated refrigerator or freezer. Samples shall be analyzed as soon as practical after collection. Use unexposed sample tubes as storage blanks.

6.10 Chemical Analyses

Principle: Chamber air samples are analyzed using instrumental methods that are capable of identifying individual VOCs or aldehydes and quantifying them using multi-point calibrations prepared using pure standards. The methods

provide sufficient sensitivity and accuracy to reliably quantify individual VOCs or aldehydes at concentrations of 2 µg m^{-3}, or less.

6.11 Analytical Instruments

6.11.1 VOCs and TVOC: Sorbent tube samples for individual VOCs and TVOC shall be analyzed by thermal desorption GC/MS (TD-GC/MS). The thermal desorber desorption and inlet parameters shall be optimized to obtain quantitative recovery of range of VOCs expected. The GC column and oven temperature parameters shall be optimized for the analysis of volatiles. The MS shall be an electron impact instrument operated in the scanning mode over a mass range of at least *m/z* 35-350.

6.11.2 Formaldehyde, acetaldehyde and other low molecular weight aldehydes: Aldehyde samples shall be analyzed by HPLC equipped with a UV detector and an analytical column providing full resolution of the formaldehyde hydrazone derivative from unreacted DNPH in a sample.

6.12 Methods for Individual VOCs

6.12.1 The analytical methods for individual VOCs shall be based on ASTM D 6196, “Standard Practice for Selection of Sorbents, Sampling and Thermal Desorption Analysis Procedures for Volatile Organic Compounds in Air.” Other relevant practices are EPA Methods TO17, “Determination of Volatile Organic Compounds in Ambient Air Using Active Sampling Onto Sorbent Tubes” and TO-1, “Determination of Volatile Organic Compounds in Ambient Air Using Tenax Adsorption and Gas Chromatography/Mass Spectrometry (GC/MS)” or equivalent methods. Standards and chamber samples shall be analyzed using identical conditions.

6.12.2 The analytical methods for formaldehyde, acetaldehyde and other low molecular weight aldehydes shall be based on ASTM Standard D 5197, “Standard Test Method for Formaldehyde and other Carbonyl Compounds in Air (Active Sampler Methodology)” or an equivalent method. It is recognized that unsaturated low molecular weight aldehydes such as acrolein are not accurately determined by this method. Higher molecular weight aldehydes approximately beginning with butanal can be analyzed by the method for individual VOCs.

6.12.3 Phthalate analysis is based on OSHA Method 104 for phthalates with a quantifiable level of 10 µg based on a standard 240 L air collection volume. Samples are collected by drawing known volumes of air through OVS-Tenax sampling tubes. Samples are desorbed with toluene and analyzed by GC using a flame ionization detector (FID). The phthalate target list includes: diethylhexyl phthalate, butyl benzyl phthalate, di-n-octyl phthalate, dibutyl phthalate, diethyl phthalate, dimethyl phthalate.

6.13 TVOC Method

TVOC measurements are made by adding all individual VOC responses obtained by the mass spectrometer between the elution times of n-hexane and n-hexadecane and calibrating the total mass relative to toluene.

6.14 Identification of Individual VOCs

6.14.1 The identification of an individual VOC by GC/MS shall be determined by comparing the chromatographic retention time and mass spectrum of the unknown to the corresponding parameters for the pure compound analyzed on the same instrument using identical methods. Matching retention times and mass spectra provide positive, confirmed identifications. All VOCs of concern occurring on the referenced lists (Section 7) shall be identified and levels reported.

6.14.2 If no high quality match is obtained, the unknown spectrum is compared to spectra contained in the latest version of the NIST/USEPA/NIH mass spectral library. A trained analyst shall decide if the identification is likely based on the match quality and the reasonableness of the retention time. Compounds identified by this procedure shall be clearly indicated. If no highly probable match is obtained, the compound shall be labeled as an unknown.

6.14.3 Aldehyde hydrazone derivatives analyzed by HPLC shall be identified by matching the chromatographic retention times of the unknowns with the retention times of derivatives of the pure compounds analyzed on the same instrument using identical methods.

6.15 Analytical Calibrations

6.15.1 Target VOCs of concern shall be quantified by GC/MS based on multi-point calibrations prepared using pure compounds. If possible, other positively identified VOCs shall be quantified by the same method. A minimum of four points shall be used. Target analytes shall be introduced onto sorbent tubes as gas or liquid standards and then analyzed using methods identical to those used for the analysis of chamber samples. Analyze calibration standards or perform full calibrations at least once every month or more frequently to ensure accuracy for the analyses.

6.15.2 Individual VOCs not positively identified by GC/MS shall be quantified using appropriate surrogates. Fully describe the method. Use toluene as the reference compound for calculating compound mass. VOCs quantified by this surrogate method shall be clearly indicated.

6.15.3 Aldehydes analyzed by HPLC shall be quantified based on multi-point calibrations prepared from hydrazone derivatives of the pure compounds. Standards and samples shall be analyzed using identical methods. Analyze calibration standards or perform full calibrations at least once every month or more frequently to ensure accuracy for the analyses.

6.16 Quantifiable Limit (QL)

6.16.1 A lower QL often is quantitatively defined as the analyte mass that produces response that is 10 times higher than the instrumental noise level or is 10 times the standard deviation for repeated analyses of a low level standard. A lower QL that is higher than this absolute value may be defined based on practical considerations.

6.16.2 For TVOC, the lower QL is 10 $\mu g\ m^{-3}$, or better.

6.16.3 The lower QL for VOCs appearing on list of chemicals of concern or allowable emission levels is 2 µg m^{-3}, or better.

6.16.4 The lower QL for non- listed VOCs is 2 µg m^{-3}, or better.

6.16.5 A QL verification sample shall be analyzed after each calibration. Target analytes shall be introduced onto sorbent tubes as gas or liquid standards at or below the level of quantitation and then analyzed using methods identical to those used for the analyses of chamber samples.

6.17 Calculations

6.17.1 Emission Factor Calculations:

6.17.1.1 Conversion from chamber concentration (C) (µg/m³) to emission factor (EF) (µg/m²·hr)

6.17.1.2 During the sampling period, the products are treated as a constant-emission source. The chamber concentration is considered to be at a steady-state during the sampling period. Thus, the emission factor is directly calculated from the chamber concentration as:

$$EF = C \times \left(\frac{N}{L} \right)$$

where,

EF = emission factor (µg/m²·hr) or (µg/unit·hr)

C = chamber concentration (µg/m³)

N = chamber air exchange rate (hr^{-1})

L = product loading (m²/m³)

6.18 Exposure Modeling

6.18.1 The emission rates of VOCs, TVOC, formaldehyde, and total aldehydes can be used in a computer exposure model to determine potential air concentrations of the pollutants. The computer model uses the measured emission rate changes over the test time period to determine the change in air concentrations that would consequently occur.

6.18.2 Modeling parameters used in this example below will change, depending on the specific standard and its indoor parameters (see appropriate standard).

6.18.3 The predicted exposure concentrations ($C_{P,t}$) (µg/m^3) are calculated from the measured emission factors as:

$$C_{P,t} = EF_t \left(\frac{A}{V} \right) \left(\frac{1}{N} \right)$$

where,

$C_{P,t}$ = predicted exposure concentration at time t (µg/m³)

EF_t = measured emission factor at time t (µg/m^2·hr)

A = product area exposed in room (m^2)

V = room volume (m^3)

N = room air change per hour (hr^{-1})

6.18.4 For GREENGUARD's Children and Schools Certification for products with constant emission factor, the predicted exposure concentrations are calculated according to the equation of 6.18.3 with the addition of a ventilated volume fraction Vf_B which is assumed to be 0.9, unless otherwise measured or specified.

$$C_{P,t} = EF_t\left(\frac{A}{V}\right)\left(\frac{1}{N}\right)\left(\frac{1}{Vf_B}\right)$$

6.18.5 For all flooring products in the CRI Green Label (GL) Program the measured 24 hour emission factors are used to determine compliance for both annual and quarterly testing, according to the emission factor criteria in Table 7.1. For an annual test, the additional top three emitting VOCs must also be reported. Quarterly test compliance is based on the TVOC emission factor only and its criteria.

6.18.6 For carpet CRI Green Label Plus (GLP) Initial Certification tests, an emission profile test is conducted with time points of 24, 264, 288 and 336 hours. The 336-hour point is used to determine compliance. All emitting chemicals must meet the ½ chronic CREL concentrations presented in Table 7.6 and all specific 336 hour concentration criteria of Table 7.2.

Subsequent quarterly testing compliance is determined in the same manner as for the CRI Green Label Program. Quarterly test compliance is based on 24 hour TVOC emission factor and its criteria.

For on-going annual recertification, all the calculated 24 hour room concentrations in Table 7.2 must be met for product compliance.

6.18.7 For adhesive CRI Green Label Plus (GLP) Initial, Semi-Annual and on-going Annual Certification tests, an emission profile test is conducted at the time points of 24 and 336 hours. Both time points are used to determine compliance. All emitting chemicals must meet the specific 24 or 336 hour concentration criteria of Table 7.3. If all of the 24-hour criteria are met, no testing is required at the 336 hour point. If the 24-hour TVOC requirement is met but not all of the individual VOC 24-hour criteria are met, the product is evaluated at the 336-hour point to determine compliance for the individual VOCs. If the 24 hour TVOC criteria is not met, the product is considered to be out of compliance and no further testing at 336 hours occurs.

6.18.8 For all flooring products, for GREENGUARD Annual Certification tests, a full emissions profile test is conducted with time points of 6, 24, 48, 72, 96 (or 120) and 168 hours. The constant emission factor (as determined at 168 hour) is used to determine compliance with the GREENGUARD

criteria by calculating an exposure concentration. The building parameters including ventilation rate and material loading used in the calculations are detailed in Table 11.3. Parameters are used in equation of 6.18.3 to determine exposure concentrations. The exposure concentration is compared to allowable limits in Sections 7.4 and 7.5 must be met for GREENGUARD Certifications.

6.18.9 For all flooring products, for GREENGUARD quarterly tests, data at 24 hour is collected and used in conjunction with the parameters in Table 10.4 and product decay parameter measured during the annual testing to determine predicted room concentrations. These concentrations are compared with the allowable levels in Sections 7.4and 7.5 to determine compliance with the GREENGUARD Program.

6.18.10 For data requiring modeling for longer term exposure predictions, various models are available. For products with decreasing emission sources, the emission factor can be modeled according to the first-order decay:

$$EF_m = EF_0 e^{-kt}$$

where,

EF_m = modeled emission factor ($\mu g/m^2 \cdot hr$)
EF_0 = initial emission factor ($\mu g/m^2 \cdot hr$)
k = rate constant (hr^{-1})
t = time (hr)

or a power law decay:

$$EF_m = EF_0 t^{-k}$$

where,

EF_m = modeled emission factor ($\mu g/m^2 \cdot hr$)
EF_0 = initial emission factor ($\mu g/m^2 \cdot hr$)
k = rate constant (hr^{-1})
t = time (hr).

Regression analysis will be used to determine the model that best fits the data. The use of least squares fitting, a mathematical procedure for finding the best-fitting curve to a given set of points by minimizing the sum of the squares of the offsets of the points from the curve, will dictate the appropriate model for the given product.

6.18.11 For GREENGUARD Certification, Office ventilation rates are based on the ASHRAE 62.1-2007 ventilation standard for acceptable indoor air quality. The office ventilation rate is based on the ASHRAE parameters of 5 CFM per person and 0.06 CFM/ft² for office spaces in commercial buildings. These parameters are applied to the GREENGUARD office size (32 m³) for a single occupant, which results in a ventilation rate of

0.72 ACH. The air change rate to building volume ratio is similar to the State of CA DHS's "Standard Practice for the Testing Of Volatile Organic Emissions Sources Using Small Scale Environmental Chambers" (CA/DHS/EHLB/R-174) requirements and will result in equivalent or more stringent estimated building concentrations.

6.18.12 For GREENGUARD Children and Schools Certification - The classroom testing and modeling requirements of State of CA DHS's "Standard Practice for the Testing Of Volatile Organic Emissions Sources Using Small Scale Environmental Chambers" (CA/DHS/EHLB/R-174) are required for use in the GREENGUARD Children and Schools Program. These parameters are applied to a classroom (40' x 24' x 8.5' or 231 m^3) with an occupancy of 27 students and ventilation rate of 0.9 ACH. Classroom ventilation rates determined using the ASHRAE 62.1-2007 ventilation standard for acceptable indoor air quality are based on the ASHRAE parameters of 10 CFM per person and 0.12 CFM/ft^2 for classrooms in educational environments. These parameters applied to the 40' x 24' x 8.5' (or 231 m^3) classroom, with an occupancy of 27 students, result in a ventilation rate of 2.8 ACH. To account for older schools, times of inactive ventilation, and to harmonized with State of CA DHS's "Standard Practice for the Testing Of Volatile Organic Emissions Sources Using Small Scale Environmental Chambers" (CA/DHS/EHLB/R-174), ACH of 0.9 ACH is applied. It is assumed if applicable, that only 90% of the room volume of 231 m^3 is ventilated at this rate due to occupancy and furnishings, and room content. The classroom ventilation rates and product areas are those required by CHPS IEQ Credit 2.2 and specified by State of CA DHS's "Standard Practice for the Testing Of Volatile Organic Emissions Sources Using Small Scale Environmental Chambers" (CA/DHS/EHLB/R-174).

For Products that are to be certified under the GREENGUARD Children and Schools Program and are considered to be office environment specific or those used in both classrooms and offices, the office modeling requirements as outlined in the DHS "Standard Practice for Testing of Volatile Organic Emissions Sources Using Small Scale Environmental Chambers" (CA/DHS/EHLB-174) or equivalent are required as outlined in Table 7.5 of the DHS Practice. Predicted exposure modeling requirements of the DHS Practice Section 3.12.3.4 are applicable.

6.18.13 Conversion to ppm

6.18.13.1 For formaldehyde, the conversion from $\mu g/m^3$ to ppm is obtained by use of the partial molar volume of formaldehyde via the following formula:

ppm = [($\mu g/m^3$) x (24.45 m^3/mol)] / [(gram molecular weight of formaldehyde) x (1000)]

6.18.13.2 For total aldehydes, The conversion from $\mu g/m^3$ to ppm is obtained by summation of the partial molar volumes of all aldehydes via the following formula:

ppm = Σ[($\mu g/m^3$) x (24.45 m^3/mol)] / [(gram molecular weight of aldehyde X) x (1000)]

6.18.14 The model measurements are made with the following assumptions: air within open office areas of the building is well-mixed at the breathing level zone of the occupied space; environmental conditions are maintained at 50% relative humidity and 23ºC (73ºF); there are no additional sources of these pollutants; and there are no sinks or potential re-emitting sources within the space for these pollutants.

7.0 Target Chemicals and Maximum Allowable Concentrations

7.1 Green Label Certification Allowable Limits:

	Carpet	Cushion	Adhesives
	Emission Factor ($\mu g/m^2 \cdot hr$)	**Emission Factor ($\mu g/m^2 \cdot hr$)**	**Emission Factor ($\mu g/m^2 \cdot hr$)**
Total VOCs (TVOC)	≤ 0.5	≤ 1.0	≤ 10
Formaldehyde	≤ 0.05	≤ 0.05	≤ 0.05
4-Phenylcyclohexene	≤ 0.05	≤ 0.05	N/A
Styrene	≤ 0.4	N/A	N/A
Butylated Hydroxytoluene (BHT)	N/A	≤ 0.3	N/A
2-Ethyl-1-hexanol	N/A	N/A	≤ 3.0

All criteria plus reporting of the other top 3 emitting VOCs are required for initial and on-going annual certification test.

The total VOC criteria (TVOC) is the only requirement for the quarterly test compliance.

7.2 Green Label Plus Certification Allowable Limits for Carpet:

ANALYTE	24 hr CRI CRITERIA		336 hr CRI CRITERIA	
	EF ($\mu g/m^2 \cdot hr$)	**Conc. ($\mu g/m^3$)**	**EF ($\mu g/m^2 \cdot hr$)**	**Conc. ($\mu g/m^3$)**
Acetaldehyde	20	11	16	9
Benzene	55	30	55	30
ε-Caprolactam	120	65	190	100
2-Ethylhexanoic acid	46	25	46	25
Formaldehyde	50	27	30	16.5
1-Methyl-2-pyrrolidinone	300	160	300	160
Naphthalene	20	11	8.2	4.5
Nonanal	24	13	24	13
Octanal	24	13	13	7.2
4-Phenylcyclohexene (4-PC)	50	27	17	9.2
Styrene	410	220	410	220
Toluene	280	150	280	150
Vinyl acetate	400	220	190	100
TVOC	500	270	---	---

Initial certification requires that all concentration criteria at 336 hours be met in addition to complying with all ½ chronic RELs (Table 7.5).

Annual recertification requires that 24 hour concentrations be met.

Quarterly test requires only TVOC emission factor at 24 hour be met.

All concentrations at 24 hour and 336 hour are calculated based on usage of 11.15 m^2 of carpet in a 30.58 m^3 room (less 10% for furnishings) with 0.75 ACH.

7.3 Green Label Plus Certification Allowable Limits for Adhesive:

ANALYTE	24 hr CRI CRITERIA	336 hr CRI CRITERIA	
	EF ($\mu g/m^2 \cdot hr$)	EF ($\mu g/m^2 \bullet hr$)	Conc. ($\mu g/m^3$)
Acetaldehyde	≤ 16	≤ 16	≤ 9
Benzothiazole	≤ 31	≤ 31	≤ 16.5
2-Ethyl-1-hexanol	≤ 300	≤ 300	≤ 160
Formaldehyde‡	≤ 50	≤ 31	≤ 16.5
Isooctylacrylate	≤ 690	≤ 690	≤ 370
Methyl biphenyl	≤ 95	≤ 95	≤ 50
2-Methyl-pyrrolidinone	≤ 300	≤ 300	≤ 160
Naphthalene	≤ 8.3	≤ 8.3	≤ 4.5
Phenol	≤ 185	≤ 185	≤ 100
4-Phenylcyclohexene (4-PC)	≤ 50	≤ 17	≤ 9
Styrene	≤ 410	≤ 410	≤ 220
Toluene	≤ 280	≤ 280	≤ 150
Vinyl acetate	≤ 185	≤ 185	≤ 100
Vinyl cyclohexene	≤ 85	≤ 85	≤ 44
Xylene (m-, o-, p-)	≤ 650	≤ 650	≤ 350
TVOC	≤ 8,000	---	---

All concentrations at 24 hour and 336 hour are calculated based on usage of 11.15 m^2 of adhesive in a 30.58 m^3 room (less 10% for furnishings) with 0.75 ACH.

7.4 GREENGUARD Certification

Allowable Limits for GREENGUARD Product Certification of Flooring: Requirements met at 168 hours (7 days) with no preconditioning.

	Flooring
Individual VOCs[1]	≤ 0.1 TLV
Formaldehyde	≤ 0.05 ppm
4-Phenylcyclohexene	≤ 0.0065 mg/m^3
Styrene	≤ 0.07 mg/m^3
Total VOCs[2]	≤ 0.5 mg/m^3
Total Aldehydes[3]	≤ 0.1 ppm

[1] Any VOC not listed must produce an air concentration level no greater than 1/10 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).

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

[3] 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.

7.5 GREENGUARD Children & Schools

Allowable Limits for GREENGUARD Children & Schools Certification of Flooring: Requirements to be met at 168 hours (7 days) with no preconditioning. (All concentrations at all calculations based on usage of 11.15 m^2 in a 30.58 m^3 room (less 10% for furnishings) with 0.75 ACH, or equivalent.)

	Flooring
Individual VOCs[1] [7]	½ CA chronic REL
Formaldehyde[2] [7]	≤ 0.0135 ppm/13.5 ppb
Individual VOCs[1]	≤ 1/100 TLV
Total VOCs[3]	≤ 0.22 mg/m^3
Total Aldehydes[4]	≤ 0.043 ppm/43 ppb
Total Phthalates[5]	≤ 0.01 mg/m^3
Total Particles (≤ 10µm)[6]	≤ 0.02 mg/m^3

[1] 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/chronic_rels/AllChrels.html - (CRELs) Adopted by the State of California Office of Environmental Health Hazard Assessment (OEHHA), February 2005).

[2] Formaldehyde criteria established so that emission levels reach 0.014ppm (13.5 ppb) no later 14 days of installation (meeting CA 1350 requirements).

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

[4] 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..

[5] Total phthalates include dibutyl (DBP), diethylhexyl (DEHD), diethyl (DEP), butylbenzyl (BBP), di-octyl (DOP), and dimethyl (DMP) phthalates (conducted using phthalate specific analytical method).

[6] Particles applicable to fibrous particle releasing products with exposed surface area in air streams (a forced air test with specific test method).-Not applicable to flooring.

[7] Required as per of CA1350 CA/DHS/EHLB/R-174 document and CHPS for classrooms.

7.6 All Applicable VOCs with Existing TLVs and CA CRELs

Allowable Limits for GREENGUARD Children & Schools Certification: Requirements to be met at 168 hours (7 days) with no preconditioning. CRI GLP requires that only ½ CRELs be met at 336 hours for initial testing (TLVs are not part of the GLP Program).

CHEMICAL	**CAS NUMBER**	**1/100 TLV[a] (µg/m³)**	**1/2 Chronic[b] REL (µg/m³)**
1,1,1,2-Tetrachloro-2,2-difluoroethane (FC-112a)	76-11-9	41700	
1,1,2,2-Tetrachloro-1,2-difluoroethane (FC-112)	76-12-0	41700	
1,1,2,2-Tetrachloroethane	79-34-5	69	

CHEMICAL	CAS NUMBER	1/100 TLV[a] (µg/m³)	1/2 Chronic[b] REL (µg/m³)
1,1,2-Trichloro-1,2,2-trifluoroethane (FC-113)	76-13-1	76700	
1,1,2-Trichloroethane	79-00-5	550	
1,1-Dichloro-1-nitroethane	594-72-9	120	
1,1-Dichloroethylene (Vinylidene chloride)	75-35-4	200	35
1,1-Difluoroethylene (Vinylidene fluoride)	75-38-7	13100	
1,1-Dimethylhydrazine	57-14-7	0.25	
1,2,3-Trichloropropane	96-18-4	600	
1,2,4-Trichlorobenzene	120-82-1	370*	
1,2-Butylene oxide (1,2-Epoxybutane)	106-88-7	59†	10
1,2-Diaminoethane (Ethylenediamine)	107-15-3	250	
1,2-Dibromoethane (Ethylene dibromide) 1,2-dibromo)	106-93-4		0.4
1,2-Dichloroethane (Ethylene dichloride)	107-06-2	400	200
1,2-Dichloropropane (Propylene dichloride)	78-87-5	3470	
1,3,5-Triglycidyl-s-triazinetrione	2451-62-9	0.5	
1,3-Butadiene	106-99-0	44	10
1,3-Dichloro-5,5-dimethyl hydantoin	118-52-5	2	
1,3-Dichloropropene	542-75-6	45	
1,3-Dioxalane	646-06-0	610	
1,4-Dichloro-2-butene	764-41-0	0.25	
1,6-Hexanediamine (Hexamethylenediamine)	124-09-4	23	
1-Bromopropane	106-94-5	500	
1-Chloro,2,3-epoxy-propane (Epichlorohydrin)	106-89-8	19	1.5
1-Chloro-1-nitropropane	600-25-9	100	
1-Chloro-2-propanol	127-00-4	40	
1-Hexene	592-41-6	1720	
1-Methylbutyl acetate (2-Pentyl acetate; sec-Amyl acetate)	626-38-0	2660	
1-Nitropropane	108-03-2	910	
2,2-Dichloropropionic acid	75-99-0	50	
2,2-Dimethylbutane (Hexane)	75-83-2	17600	
2,3-Dimethylbenzene (Hexane)	79-29-8	17600	
2,3-Epoxy-1-propanol (Glycidol)	556-52-5	61	
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)	93-76-5	100	
2,4,6-Trinitrophenylmethylnitramine (Tetryl)	479-45-8	15	
2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	100	
2,6-Dimethyl-4-heptanone (Diisobutyl ketone)	108-83-8	1450	
2-Aminoethanol (Ethanolamine)	141-43-5	75	
2-Aminopyridine (2-Pyridinamine)	504-29-0	20	
2-Butanone (Methyl ethyl ketone [MEK])	78-93-3	5900	
2-Butoxyethanol (Ethylene glycol monobutyl ether)	111-76-2	970	
2-Butoxyethyl acetate (Ethylene glycol monobutyl ether acetate)	112-07-2	1300	
2-Chloro-1,3-butadiene (∃-Chloroprene)	126-99-8	360	
2-Chloro-1-propanol	78-89-7	40	
2-Diethylaminoethanol	100-37-8	96	
2-Ethoxyethanol (Ethylene glycol monoethyl ether)	110-80-5	180	35
2-Ethoxyethyl acetate (Ethylene glycol monoethyl ether acetate)	111-15-9	270	150
2-Ethylhexanoic acid	149-57-5	50	

CHEMICAL	CAS NUMBER	1/100 TLV[a] (µg/m³)	1/2 Chronic[b] REL (µg/m³)
2-Hydroxypropyl acrylate (2-Propenoic acid, 2-hydroxypropyl ester)	999-61-1	28	
2-Isopropoxyethanol (Ethylene glycol isopropyl ether)	109-59-1	1060	
2-Methylbutyl acetate	624-41-9	2660	
2-Methylpentane	107-83-5	17600	
2-N-Dibutylaminoethanol	102-81-8	35	
2-Nitropropane	79-46-9	360	
3-Amino-1,2,4-triazole (Amitrole; 3-Amino-s-triazole)	61-82-5	2	
3-Methyl pentane (Pentane, 3-methyl)	96-14-0	17600	
3-Pentyl acetate	620-11-1	2660	
4,4'-Diaminodiphenylmethane (4,4'-Methylenedianilline)	101-77-9	8.1	
4,4'-Thiobis(6-tert-butyl-m-cresol)	96-69-5	100	
4,6-Dinitro-o-cresol	534-52-1	2	
4-Methoxyphenol (Mequinol)	150-76-5	50	
4-Vinyl cyclohexene	100-40-3	4.4	
Acetaldehyde	75-07-0	450*	9**
Acetic acid	64-19-7	250	
Acetophenone (Ethanone, 1-phenyl) (9CI)	98-86-2	490	
Acetylene tetrabromide (1,1,2,2-Tetrabromoethane)	79-27-6	140	
Acetylsalicyclic acid (Aspirin)	50-78-2	50	
Acrolein (2-Propenal)	107-02-8	2.3*	
Acrylamide (2-Propenamide)	79-06-1	0.3	
Acrylic acid (2-Propenoic acid)	79-10-7	59	
Acrylic acid, ethyl ester (Ethyl acrylate)	140-88-5	200	
Acrylic acid, methyl ester (Methyl acrylate; 2-Propenoic acid, methyl ester)	96-33-3	70	
Acrylic acid, n-butyl ester (n-Butyl acrylate; 2-Propenoic Acid, butyl ester)	141-32-2	110	
Acrylonitrile (Vinyl cyanide)	107-13-1	43	2.5
Adipic acie (Hexanedioic acid)	124-04-9	50	
Adiponitrile	111-69-3	88	
Aldrin	309-00-2	2.5	
Allyl alcohol (2-Propen-1-ol)	107-18-6	11.9	
Allyl chloride (1-Propene, 3-chloro)	107-05-1	30	
Allyl glycidyl ether (AGE; Oxirane, [(2-propenyloxy)methyl]-)	106-92-3	47	
Allyl propyl disulfide	2179-59-1	30	
∀-Chloroacetophenone (Phenacyl chloride)	532-27-4	3.2	
∀-Methylstyrene (iso-Propenylbenzene; (1-Methylethenyl)benzene)	98-83-9	2420	
∀-Pinene	80-56-8	1120	
Aniline	62-53-3	76	
Anisidine (o,p-isomers)	29191-52-4	5	
ANTU (∀-Naphthylthiourea)	86-88-4	3	
Benzene	71-43-2	16	30
Benzotrichloride (Benzyl trichloride; Benzene, (trichloromethyl)-)	98-07-7	8*	
Benzoyl chloride	98-88-4	28*	

CHEMICAL	CAS NUMBER	1/100 TLV[a] (µg/m³)	1/2 Chronic[b] REL (µg/m³)
Benzyl acetate	140-11-4	610	
Benzyl chloride (Benzene, (Chloromethyl))	100-44-7	52	
Biphenyl (Diphenyl; 1,1'-Biphenyl (9CI))	92-52-4	13	
bis(2-Dimethylaminoethyl) ether (DMAEE)	3033-62-3	3.3	
bis(Chloromethyl) ether	542-88-1	0.047	
Bromochloromethane (Chlorobromomethane)	74-97-5	10600	
Bromotrifluoromethane (Trifluorobromomethane)	75-63-8	60900	
Butanethiol (n-Butyl mercaptan)	109-79-5	18	
Butylated hydroxytoluene (BHT; 2,6-Di-tert-butyl-p-cresol)	128-37-0	20	
Camphor, synthetic	76-22-2	120	
Caprolactam	105-60-2	50	
Carbon disulfide	75-15-0	310	400
Chlorinated diphenyl oxide	31242-93-0	5	
Chloroacetaldehyde	107-20-0	32*	
Chloroacetone (2-Propanone, 1-chloro)	78-95-5	38*	
Chloroacetyl chloride	79-04-9	2.3	
Chlorobenzene (Monochlorobenzene)	108-90-7	460	500
Chlorodifluoromethane (FC-22)	75-45-6	35400	
Chlorodiphenyl (42 % chlorine)	53469-21-9	10	
Chlorodiphenyl (54% chlorine)	11097-69-1	5	
Chloropentafluoroethane	76-15-3	63200	
Cresol, All isomers	1319-77-3	220	300
Crotonaldehyde (2-Butenal)	4170-30-3	8.6*	
Crufomate	299-86-5	50	
Cumene (Benzene, 1-methylethyl-)	98-82-8	2460	
Cyclohexane	110-82-7	3440	
Cyclohexanol	108-93-0	2060	
Cyclohexanone	108-94-1	500	
Cyclohexene	110-83-8	10100	
Cyclohexylamine	108-91-8	410	
Cyclopentadiene	542-92-7	2030	
Cyclopentane	287-92-3	17200	
)-3-Carene	13466-78-9	1120	
Diacetone alcohol (4-Hydroxy-4-methyl-2-pentanone)	123-42-2	2380	
Dichloroacetic acid	79-43-6	26.4	
Dichloroacetylene	7572-29-4	3.9*	
Dichlorodifluoromethane (FC-12)	75-71-8	49500	
Dichlorodiphenyltrichloroethane (DDT)	50-29-3	10	
Dichloroethyl ether (bis[2 Chloroethyl] ether)	111-44-4	290	
Dichlorofluoromethane (FC-21)	75-43-4	420	
Dichloromethane (Methylene chloride)	75-09-2	1740	200
Dichlorotetrafluoroethane (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	76-14-2	69900	
Dicyclopentadiene	77-73-6	270	
Diethanolamine	111-42-2	20	1.5
Diethyl ether (Ethyl ether)	60-29-7	12100	
Diethyl ketone	96-22-0	7050	
Diethyl phthalate	84-66-2	50	

CHEMICAL	CAS NUMBER	1/100 TLV[a] (µg/m³)	1/2 Chronic[b] REL (µg/m³)
Diethylamine	109-89-7	150	
Diethylene dioxide (1,4-Dioxane)	123-91-1	720	1500
Diethylene triamine	111-40-0	42	
Difluorodibromomethane	75-61-6	8580	
Diglycidyl ether (DGE)	2238-07-5	5.3	
Dihydroxybenzene (Hydroquinone)	123-31-9	20	
Diisopropylamine	108-18-9	210	
Dimethoxymethane (Methylal)	109-87-5	31100	
Dimethylbenzene (Xylene o-,m-,p-isomer)	1330-20-7	4340	350
Dimethyl disulfide	624-92-0	19.3	
Dimethylaniline (N,N-Dimethylaniline)	121-69-7	250	
Dimethylethoxysilane	14857-34-2	21	
Dimethylformamide	68-12-2	300	40
Dimethylphthalate (1,2-Benzenedicarboxylic acid, dimethyl ester)	131-11-3	50	
Dinitolmide	148-01-6	50	
Dinitrobenzene	100-25-4	10	
Dinitrotoluene	25321-14-6	2	
Diphenylamine	122-39-4	100	
Dipropyl ketone (4-Heptanone)	123-19-3	2330	
Dipropylene glycol methyl ether [bis-(2-Methoxypropyl) ether; DPGME]	34590-94-8	6060	
Divinyl benzene	1321-74-0	530	
Dodecyl mercaptan (1-Dodecanethiol)	112-55-0	8	
Enflurane	13838-16-9	5660	
EPN (O-Ethyl-O-[4nitrophenyl]phenylthiophosphonate)	2104-64-5	0	
Ethanethiol (Ethyl mercaptan)	75-08-1	13	
Ethyl acetate	141-78-6	14400	
Ethyl amyl ketone (3-Heptanone, 5-methyl-)	541-85-5	1310	
Ethyl bromide (Bromoethane)	74-96-4	220	
Ethyl butyl ketone (3-Heptanone)	106-35-4	2340	
Ethyl chloride (Chloroethane)	75-00-3	2640	15000
Ethyl cyanoacrylate (Ethyl 2-cyanoacrylate)	7085-85-0	10	
Ethyl formate (Formic acid, ethyl ester)	109-94-4	3030	
Ethyl tert-butyl ether (ETBE)	637-92-3	210	
Ethylbenzene	100-41-4	4340	1000
Ethylene chlorohydrin (2-Chloroethanol)	107-07-3	33*	
Ethylene glycol dinitrate	628-96-6	3.1	
Ethylene glycol	107-21-1	1000*	200
Ethylenimine	151-56-4	8.8	
Ethylidene norbornene	16219-75-3	250*	
Formamide (Methanamide)	75-12-7	180	
Formic acid (Methanoic acid)	64-18-6	94	
Furfural (2-Furaldehyde)	98-01-1	79	
Furfuryl alcohol (2-Furanmethanol)	98-00-0	400	
Glutaraldehyde	111-30-8	2*	0.04
Heptane (n-Heptane)	142-82-5	16400	
Hexachlorobenzene (HCB)	118-74-1	0.02	

CHEMICAL	CAS NUMBER	1/100 TLV[a] (µg/m³)	1/2 Chronic[b] REL (µg/m³)
Hexachlorobutadiene	87-68-3	2.1	
Hexachlorocyclopentadiene	77-47-4	1.1	
Hexachloroethane	67-72-1	97	
Hexachloronaphthalene	1335-87-1	2	
Hexafluroacetone	684-16-2	6.8	
Hexane (n-Hexane)	110-54-3	1760	3500
Hexane, other isomers		17600	
Hexylene glycol	107-41-5	1210*	
Hydrogenated terphenyls	61788-32-7	49	
Indene	95-13-6	480	
Isoamyl alcohol (1-Butanol, 3-methyl)	123-51-3	3610	
Isobutyl acetate (Isobutyl acetate)	110-19-0	7130	
Isobutyl alcohol (1-Propanol, 2-methyl)	78-83-1	1520	
Isobutyl nitrite	542-56-3	42*	
Isooctyl alcohol	26952-21-6	2660	
Isopentane	78-78-4	17700	
Isopentyl acetate (Isoamyl acetate; 3-Methylbutyl acetate)	123-92-2	2660	
Isophorone (2-Cyclohexen-1-one, 3,5,5-trimethyl-)	78-59-1	280*	1000
Isophorone diisocyanate	4098-71-9	0.45	
Isopropanol (2-Propanol)	67-63-0	4920	3500
Isopropyl acetate	108-21-4	4180	
Isopropyl ether (Diisopropyl ether)	108-20-3	10400	
Isopropyl glycidyl ether (IGE)	4016-14-2	2380	
Isopropylamine (2-Propanamine)	75-31-0	120	
Maleic anhydride	108-31-6	4	0.35
m-Dinitrobenzene	99-65-0	10	
Mesityl oxide	141-79-7	600	
Methacrylic acid (2-Propenoic acid, 2-methyl)	79-41-4	700	
Methyl 2-Cyanoacrylate (Mecrylate)	137-05-3	10	
Methyl acetylene-propadiene mixture	MAPP	16400	
Methyl alcohol (Methanol)	67-56-1	2600	2000
Methyl amyl alcohol (Methyl isobutyl carbinol ; 4-Methyl-2-pentanol)	108-11-2	1040	
Methyl bromide (Methane, bromo)	74-83-9	39	2.5
Methyl Cellosolve® (2-Methoxyethanol)	109-86-4	160	30
Methyl Cellosolve® acetate (2-Methoxyethyl acetate; Ethylene glycol methyl ether acetate)	110-49-6	240	45
Methyl chloroform (1,1,1-Trichloroethane)	71-55-6	19100	500
Methyl ethyl ketone peroxide	1338-23-4	15*	
Methyl formate (Formic acid, methyl ester)	107-31-3	2460	
Methyl isoamyl ketone (2-Hexanone, 5-methyl)	110-12-3	2340	
Methyl isobutyl ketone (Hexone)	108-10-1	2050	
Methyl isopropyl ketone (2-Butanone, 3-methyl)	563-80-4	7050	
Methyl methacrylate (Methacrylic acid, methyl ester)	80-62-6	2050	
Methyl n-amyl ketone (2-Heptanone)	110-43-0	2330	
Methyl n-butyl ketone (2-Hexanone)	591-78-6	200	
Methyl propyl ketone (2-Pentanone)	107-87-9	7050	
Methyl silicate	681-84-5	60	

CHEMICAL	CAS NUMBER	1/100 TLV[a] (µg/m³)	1/2 Chronic[b] REL (µg/m³)
Methyl vinyl ketone (3-Buten-2-one)	78-94-4	6*	
Methylacrylonitrile (2-Propenenitrile, 2-methyl-)	126-98-7	27	
Methylamine	74-89-5	64	
Methylcyclohexane	108-87-2	16100	
Methylcyclohexanol	25639-42-3	2340	
Methylhydrazine	60-34-4	0.19	
Methylisocyanate	624-83-9	0.47	
Methyl-tert-butyl ether (MTBE; tert-Butyl methyl ether)	1634-04-4	1800	4000
Monochloroacetic acid	79-11-8	19.4	
Morpholine	110-91-8	710	
m-Phenylenediamine	108-45-2	1	
m-Phthalodinitrile (1,3-Benzenedicarbonitrile)	626-17-5	50	
m-Toluidine	108-44-1	88	
m-Xylene (meta-Xylene)	108-38-3	4340	350
m-Xylene ∀,∀'-diamine	1477-55-0	1*	
N,N-Dimethylacetamide	127-19-5	360	
n-Amyl acetate (1-Pentyl acetate; Acetic acid, pentyl ester)	628-63-7	2260	
Naphthalene	91-20-3	520	4.5
n-Butanol (N-Butyl alcohol)	71-36-3	610	
n-Butyl acetate	123-86-4	7130	
n-Butyl glycidyl ether (BGE)	2426-08-6	1330	
n-Butyl lactate (Propanoic acid, 2-hydroxy-, butyl ester)	138-22-7	300	
n-Butylamine	109-73-9	150*	
N-Ethylmorpholine	100-74-3	240	
Nicotine (Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-)	54-11-5	5	
N-Isopropylaniline	768-52-5	110	
Nitrapyrin (2-Chloro-6-(trichloromethyl) pyridine	1929-82-4	100	
Nitrobenzene	98-95-3	50	
Nitroethane	79-24-3	3070	
Nitromethane	75-52-5	500	
Nitrotoluene, m-isomer (3-Nitrotoluene)	99-08-1	110	
Nitrotoluene, o-isomer (2-Nitrotoluene)	88-72-2	110	
Nitrotoluene, p-isomer (4-Nitrotoluene)	99-99-0	110	
N-Methyl aniline (Monomethyl aniline)	100-61-8	22	
Nonane	111-84-2	10500	
n-Propyl acetate	109-60-4	8350	
n-Propyl alcohol (n-Propanol)	71-23-8	4920	
n-Propyl nitrate (Nitric acid, propyl ester)	627-13-4	1070	
n-Valeraldehyde	110-62-3	1760	
N-Vinyl-2-Pyrrolidinone (1-Vinyl-2-pyrrolidinone)	88-12-0	2.3	
o-Anisidine (Benzenamine, 2-methoxy-)	90-04-0	5	
o-Chlorobenzylidene malononitrile	2698-41-1	3.9*	
o-Chlorostyrene	2039-87-4	2830	
o-Chlorotoluene (Toluene, 2-chloro)	95-49-8	2590	
Octachloronaphthalene	2234-13-1	1	
Octane, All isomers	111-65-9	14010	
Octane, All isomers	540-84-1	14010	

CHEMICAL	CAS NUMBER	1/100 TLV[a] (µg/m³)	1/2 Chronic[b] REL (µg/m³)
o-Dichlorobenzene (1,2-Dichlorobenzene)	95-50-1	1500	
o-Methylcyclohexanone	583-60-8	2290	
o-Nitrobenzene (Dinitrobenzene)	528-29-0	10	
o-Phenylenediamine	95-54-5	1	
o-sec-Butylphenol	89-72-5	310	
o-Toluidine	98-53-4	88	
o-Xylene (Xylene, ortho)	95-47-6	4340	350
p-Dichlorobenzene (1,4-Dichlorobenzene)	106-46-7	600	400
Pentachloronaphthalene	1321-64-8	5	
Pentachloronitrobenzene	82-68-8	5	
Pentachlorophenol	87-86-5	5	
Perchloromethyl mercaptan	594-42-3	7.6	
Phenol	108-95-2	190	100
Phenothiazine	92-84-2	50	
Phthalic anhydride (1,3-Isobenzofurandione)	85-44-9	61	10
Picric acid (2,4,6-Trinitrophenol)	88-89-1	1	
p-Nitroaniline	100-01-6	30	
p-Nitrochlorobenzene (p-Chloronitrobenzene)	100-00-5	6.4	
p-Phenylenediamine	106-50-3	1	
Propanoic acid, 2-chloro- (2-Chloropropionic acid)	598-78-7	4.4	
Propargyl alcohol	107-19-7	23	
Propiolactone, beta	57-57-8	15	
Propionaldehyde	123-38-6	480	
Propionic acid	79-09-4	300	
Propoxur	114-26-1	5	
Propylene	115-07-1	8600	1500
Propylene glycol dinitrate (PGDN)	6423-43-4	3.4	
Propylene glycol-1-methyl ether (1-Methoxy-2-propanol)	107-98-2	3690	3500
Propylene oxide (1,2-Epoxypropane)	75-56-9	48	15
Propyleneimine (2-Methylazridine)	75-55-8	47	
Propyne (Methyl acetylene)	74-99-7	16400	
p-tert-Butyltoluene (Toluene, 4-t-butyl (Benzene,1-(1,1-dimethylethyl)-4-methyl))	98-51-1	61	
p-Toluidine (p-Aminotoluene)	106-49-0	88	
p-Xylene (para-Xylene)	106-42-3	4340	350
Pyridine	110-86-1	31	
Pyrocatechol (Catechol ;1,2-Benzenediol)	120-80-9	230	
Quinone (p-Benzoquinone; 2,5-cyclohexadiene-1,4-dione)	106-51-4	4.4	
sec-Butanol (sec-Butyl alcohol)	78-92-2	3000	
sec-Butyl acetate (Acetic acid, 1-methylpropyl ester)	105-46-4	9500	
sec-Hexyl acetate	108-84-9	2950	
Stoddard solvent	8052-41-3	5250	
Styrene, monomer (Phenylethylene; Vinyl benzene)	100-42-5	850	450
tert-Amyl acetate (1,1-Dimethylpropyl acetate)	625-16-1	2660	
tert-Amyl methyl ester (TAME)	994-05-8	800	
tert-Butanol (tert-Butyl alcohol)	75-65-0	3030	
tert-Butyl acetate	540-88-5	9500	

CHEMICAL	CAS NUMBER	1/100 TLV[a] (µg/m³)	1/2 Chronic[b] REL (µg/m³)
tert-Pentane	463-82-1	17700	
Tetrachloroethylene (Perchloroethylene)	127-18-4	1700	17.5
Tetrachloromethane (Carbon tetrachloride)	56-23-5	310	20
Tetrachloronaphthalene	1335-88-2	20	
Tetrafluoroethylene	116-14-3	82	
Tetrahydrofuran	109-99-9	0	
Tetramethyl succinonitrile	3333-52-6	28	
Tetranitromethane	509-14-8	0.4	
Tetryl (2,4,6-Trinitrophenylmethylnitramine)	479-45-8	15	
Thioglycolic acid	68-11-1	38	
Toluene (Toluol)	108-88-3	1880	150
Toluene-2,6-diisocyanate (Benzene, 1,3-diisocyanato-2-methyl)	91-08-7	0.36	
Toxaphene (Chlorinated camphene)	8001-35-2	5	
Trichloroethylene	79-01-6	2690	300
Trichloromethane (Chloroform)	67-66-3	490	150
Trichloronaphthalene	1321-65-9	50	
Trichloronitromethane (Chloropicrin)	76-06-2	6.7	0.2
Triethanolamine	102-71-6	50	
Triethylamine (N,N-Diethylethanamine)	121-44-8	41	100
Trimethyl benzene	25551-13-7	1230	
Trimethyl benzene, All isomers	108-67-8	1230	
Trimethyl benzene, All isomers	526-73-8	1230	
Trimethyl benzene, All isomers	95-63-6	1230	
Triphenyl amine	603-34-9	50	
Vinyl acetate (Acetic acid ethenyl ester)	108-05-4	350	100
Vinyl bromide (Ethene, bromo-)	593-60-2	22	
Vinyl chloride (Chloroethylene)	75-01-4	26	
Vinyl cyclohexene dioxide (7-Oxabicyclo[4.1.0]heptane, 3-oxiranyl)	106-87-6	5.7	
Vinyl fluoride	75-02-5	19	
Vinyl toluene (Methyl styrene, All isomers)	25013-15-4	2420	
Xylidine, mixed isomers	1300-73-8	25	

[a] - ACGIH, 2004 Threshold Limit Values for Chemical Substances and Physical Agents, Cincinnati, OH

[b] - http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html - Chronic Reference Exposure Levels (CRELs) adopted by the State of California Office of Environmental Health Hazard Assessment (OEHHA), February 2005 (Acetaldehyde allowed full CREL)

* - Indicates the Short Term Exposure Limit (STEL) or Ceiling value

† - AIHA 2005 Workplace Environmental Exposure Level (WEEL)

** - Full REL value allowed per CA DHS.

8.0 Quality Assurance / Quality Control

8.1 Small chamber testing of organic emissions from indoor products should be conducted within the framework of a quality management system which includes:

- A brief project description of what material is being tested, how the testing is to be conducted, and who is responsible for various project activities.
- Data quality objectives and acceptance criteria which define the precision, accuracy, and completeness preferred for each parameter being measured.

Data Quality Goals for Small Environmental Chamber Test Measurements

Parameter	Goal	Precision	Accuracy	Completeness[1]
Temperature	23º C	± 2.0º C	± 0.5ºC	>90%
Relative Humidity	50%	± 5.0% RH	± 5.0% RH	>90%
Air Exchange (ACH)	1.0 ACH	± 5.0%	± 5.0%	>90%
Substrate Area	Variable	± 1%	± 10.0%	>90%
Chamber Air Concentration: VOCs Aldehydes	TVOC < 180 ng IVOC < 36 ng Formaldehyde < 90 ng	± 20% RSD[2]	±20%	>90%

[1]Completeness characterizes the percentage of the planned measurements that are actually conducted.
[2]RSD = Relative Standard Deviation for replicate chamber samples.

8.2 Record Keeping and Logs: Various logging requirements shall be implemented for all test parameters, including chamber and analytical performance. Personnel conducting each procedure shall be noted. Records of the devices used, date and time of tests, and the test results shall be so noted and be part of the QA/QC recording process. The completeness of records indicates the care and attention given the QC process. Logs that shall be maintained include:

- Sample tracking logs to record receipt, storage, and disposition of materials to be tested.
- GC standards preparation log to document preparation of all standards
- Calibration logs to contain environmental systems calibration data.
- Instrument maintenance logs to document repairs and maintenance on all equipment.
- Work orders to record all pertinent information for each test, including sample details, sample identification number, sampling requested, and sampling times.
- GC run logs to record run number and test identification number.
- Sample tube baking logs.
- Sample Management and Custody

8.3 Quality control activities are carried out by project staff in a routine, consistent manner to provide necessary feedback in the operation of all measurement systems, including:

- Routine maintenance and calibration of systems.
- Daily recording of GC calibration accuracy and precision.
- Collection and analysis of duplicate samples, analytical as wall as material replicates.
- QC checking of sorbent tubes.
- Periodic analysis of audit samples supplied by an independent source. The acceptance criteria is based upon the statistical distribution of reporting laboratories.
- QC procedures and acceptance criteria are summarized in the following table.

8.4 All records (including temperature, relative humidity, air change, and background levels) are maintained and available for review in accordance with AQS' records policy. Prior arrangements need to be made with the Quality Manager.

8.4.1 Chamber Record Requirements

Chamber Operating Parameters	Acceptance Criteria	Monitoring Frequency
Air Change (ACH)	0.95 to 1.05 ACH	Bi-Annually
Inlet Air Temperature	21º C to 25º C	Before and after each test
Inlet Air Relative Humidity	45% to 55%	Before and after each test
Mixing measured without test object in place	Within 5% of theoretical well mixed model	Bi-Annually
Recovery tests	% Recovery – 80% to 120%	Bi-Annually
Measurement of Chamber Air Concentrations:		
VOCs:		
Analysis of blank sorbent tubes prior to tests	TVOC < 180 ng; IVOC < 36 ng	10% of tubes
Chamber air samples collected and analyzed in duplicate	<20% RSD	10% of samples
Laboratory blanks (unexposed sorbent tubes prepared, stored, and analyzed with samples)	TVOC < 180 ng; IVOC < 36 ng	1 every analytical batch
Multipoint calibration – toluene	Calibration Curve from 36-1000 ng meets criteria of r2 ≥ 0.985 and RRF ≤ 20 %.	At least once per month
Daily 500 ng calibration check - toluene	+/- 20% difference of 500 ng curve midpoint	Every day
Aldehydes:		
Analysis of blank cartridges:		
Method Blank	< 90 ng formaldehyde	1 per day
Cartridge Batch Blank	< 90 ng formaldehyde	1 per batch
Chamber air samples collected and analyzed in duplicate	< 20% RSD	10% of Samples
Laboratory blanks (unexposed sorbent tubes	< 90 ng formaldehyde	Every analytical batch

prepared, stored, and analyzed with samples)		
Multipoint calibration	R2 ≥ 0.985	At least once per month
Daily calibration check	± 20%	Every day

8.4.2 Internal auditing: Internal auditing of the quality management system is performed annually at a minimum to evaluate compliance with established criteria. Internal audits are conducted in accordance with established procedures. The internal auditor is a trained employee of AQS or a qualified sub contractor. All audits are documented in an audit report and are available for review at AQS' facilities (prior arrangements need to be made with the Quality Manager)

8.4.3 Corrective action: The need for corrective action may be identified through management reviews, internal QC checks, audits or observations made during routine sampling, and analysis activities by project staff. Any employee may initiate corrective action. Corrective action will be developed and implemented by managers, supervisors, and employees. All corrective actions will be documented and root cause determined. Action may be taken until the problem has been satisfactorily resolved, and the Quality Manager has acknowledged approval.

9.0 Proficiency Testing

9.1 General Requirements

For GREENGUARD Certification, CRI Green Label, and Green Label Plus Program testing, all analytical laboratories must include proficiency testing as part of their quality program and be found to be proficient. This establishes the bias and accuracy of test results. Regular participation in a proficiency-testing scheme provides independent verification of the analytical competence of a laboratory and shows a commitment to the maintenance and improvement of performance. Performance must be within 20% of the real value to be acceptable.

9.2 GREENGUARD Certification Requirements

For the GREENGUARD Certification Program, the laboratory must show two back to back proficient rounds for acceptance on the quarterly proficiency program, including acceptable performance on the Euro Proficiency Testing program offered by GREENGUARD and Blue Angel, as globally recognized throughout Europe. The chemical spikes on the tubes will be in a concentration range of 0.1 - 1 µg/tube, which corresponds to a concentration range of 20 - 200 µg/m³. The analysis is to be conducted using gas chromatography with thermodesorption according to the guidance of ISO/DIS 16000 and appropriate GEI standards. Specific chemicals loaded on the tubes will be those representative of chemicals found in the emissions of indoor products. Some chemicals that may be included are demonstrated below:

Alcohols	2-butoxyethanol, 2-(2-butoxyethoxy)ethanol, 2-ethyl-1-hexanol, 2-phenoxyethanol, propylene glycol
Alkanes	Decane, dodecane, pentadecane
Aromatic hydrocarbons	styrene, toluene, trimethylbenzenes, o-xylene, 4-phenylcyclohexene
Esters	2-(2-butoxyethoxy)ethyl acetate, 2-butoxyethyl acetate, n-butyl acetate, texanol isobutyrate, texanol (2,2,4-trimethyl-1,3-pentandiol monoisobutyrate)
Ketones and Aldehydes	acetophenone, hexanal, octanal
Terpenes	3-carene, limonene, longifolene, α-pinene

Following demonstration of analytical proficiency, the laboratory will be expected to participate in an annual round robin testing of representative products being tested for the Greenguard Certification program. Acceptable performance within two standard deviations of the average across all laboratories is expected for specific target emissions of a product. Participation in this effort will follow the guidelines of the Euro Proficiency Testing Program.

9.3 Green Label Plus Requirements

For the Green Label Plus Program, proficiency evaluation at a minimum of twice per year is required. The proficiency evaluation shall consist of measuring the following list of target chemicals in the rage being measured from the carpet:

Vinyl Acetate
Benzene
Toluene
Styrene
Octanal
1-Methyl-2-pyrrolidnone
2-Ethylhexanoic Acid
Nonanal
Naphthalene
Caprolactam
4-Phenylcyclohexene
Acetaldehyde
Formaldehyde

Certain quality procedures must be executed and reported yearly based on requirements of CRI's Program Agreement with California. This agreement supports acceptance of the GLP Program for use in California's 1350 and CHPS program. These include:

- Authentic calibration of target VOCs and all CREL on Proposition 65 chemicals with a minimum of 4 points per target chemical calibration.
- Quantification of other VOCs based on surrogate compounds.
- Internal standard calibrations made once every three months as a minimum.
- Analytical proficiency evaluations twice per year.
- Determination of minimum detectable levels (MDLs) periodically through out the year.
- Certified third party audit of program and standard operating conditions yearly.

10.0 Reporting Test Results

10.1 The Report of the Test Results Should Contain the Following Sections:

10.1.1 *Laboratory identification*: Name, address, phone number and other contact information for the laboratory.

10.1.2 *Manufacturer, product and sample identification:*

10.1.2.2 Product name, product number, product category and subcategory (if applicable)

10.1.2.3 Manufacturer's ID number and other identification numbers (if applicable)

10.1.2.4 Manufacturing date, collection date, shipment date and date of arrival at laboratory (on chain of custody)

10.1.2.5 Laboratory sample ID or tracking number.

10.1.3 *Testing conditions:* Chamber volume, air change rate, temperature, relative humidity, exposed area of test specimen (or other relevant test specimen measurement parameter), chamber loading factor, test specimen preparation details, conditioning period start date and duration (if applicable), and test period start date and end date.

10.1.4 *Chamber methodology:* Referenced methods/practices followed to operate chambers; description of the chamber used, how air flows through the chamber, supply air contaminant levels (either in report or readily available upon request).

10.1.5 *Data analysis procedures:* Analytical methods used to determine measured chamber concentrations and to derive emission factors from measured chamber concentrations; methodology and parameters used to calculate room concentrations from the emission factors including the assumed product area, room volume, and ventilation rate.

10.1.6 *Test results:* For GREENGUARD Certification tests, for all time points list emission factors of the TVOC, all individual VOCs, formaldehyde, total aldehydes and other individual aldehydes quantified.

10.1.6.1 *Provide the following information:*

10.1.6.1.1 CAS numbers for individual VOCs.

10.1.6.1.2 Identify those VOCs with chronic RELs and VOCs on the other lists of toxic substances including CA Proposition 65; Class I and Class II carcinogens.

10.1.6.1.3 Provide estimated concentrations for modeled building scenarios for TVOC, formaldehyde, and total aldehydes at all time points, and for all target list chemicals at the 168-hr time point.

10.1.6.1.4 Indicate non-listed VOCs which were quantitated using surrogate compound standards instead of authentic standards.

10.1.6.1.5 Report ten most abundant VOCs in addition to the target VOCs.

10.1.7 *Test results:* For Green Label and Green Label Plus Tests, for all time points, list emission factors of TVOC and all target VOC quantities.

Provide the following information:

10.1.7.1 Identify those VOCs with chronic RELs and VOCs on the other lists of toxic substances including CA Proposition 65; CA Toxic Air Contaminants (TACs); Class I and Class II carcinogens.

10.1.7.2 Provide estimated concentrations for modeled building scenarios for TVOC and formaldehyde at all time points, and for target list chemicals at the 24 and 336 hour time points for GLP initial and annual testing. Provide the 24 hour TVOC and target VOC emission factors for GL annual program and 24 hour TVOC emission factor for GL and GLP quarterly testings.

10.1.7.3 Indicate non-listed VOCs which were quantitated using surrogate compound standards instead of authentic standards.

10.1.7.4 Report three most abundant VOCS in addition to the target VOCs for annual GL certification test.

10.1.7.5 Report three most abundant VOCs in additional to the target VOCs for annual GLP certification tests.

10.1.8 Certification of the Report with date

10.1.9 Report any additional facts, which may have influenced the test results. These may include, but are not limited to, the following:

10.1.9.1 Dates of most recent internal and external calibrations, methods and compounds used

10.1.9.2 Dates of most recent proficiency evaluation(s) and corrective actions taken, if any

10.1.9.3 Any deviations of laboratory parameters from specified values

10.1.9.4 Any other relevant observations.

10.2 Attach a copy of the completed and signed chain-of-custody (COC) form with the laboratory report.

11.0 Tables

Table 11.1 Chamber conditions for test period

Parameter	Symbol	Units	Value
Chamber volume	V	m^3	0.05 – 0.10
Loading factor**	L	m^2/m^3	0.4 (variable, depends on product type and usage and expected levels of VOCs in chambers)
Air change rate	a	hr^{-1}	1.0 ± 0.05
Temperature	T	ºC	23 ± 2
Relative humidity	RH	%	50 ± 5

** Specimen sizes are to be adjusted according to the chamber volumes to achieve the specified loading factor range.

Table 11.2 All chronic inhalation Reference Exposure Levels (RELs) adopted by Cal/EPA OEHHA as of August 2006.

Substance (CAS #)	*Listed in CAPCOA - 1993*	*Chronic Inhalation REL (µg/m³)*	*Hazard Index Target(s)*	*Human Data*
Acetaldehyde* (75-07-0)	☑	9	Respiratory system	
Acrolein (107-02-8)	☑	0.06	Respiratory system; eyes	
Acrylonitrile (107-13-1)	☑	5	Respiratory system	
Ammonia (7664-41-7)	☑	200	Respiratory system	☑
Arsenic (7440-38-2) & arsenic compounds	☑	0.03	Development; Cardiovascular system; Nervous system	
Benzene (71-43-2)	☑	60	Hematopoietic system; development; nervous system	☑
Beryllium (7440-41-7) and beryllium compounds	☑	0.007	Respiratory system; immune system	☑
Butadiene (106-99-0)		20	Reproductive system	
Cadmium (7440-43-9) & cadmium compounds	☑	0.02	Kidney; respiratory system	☑
Carbon tetrachloride (56-23-5)	☑	40	Alimentary system; development; nervous system	
Carbon disulfide (75-15-0)		800	Nervous system; reproductive system	☑
Chlorinated dioxins (1746-01-6) & dibenzofurans (5120-73-19)	☑	0.00004	Alimentary system (liver); reproductive system; development; endocrine system; respiratory system; hematopoietic system	
Chlorine (7782-50-5)	☑	0.2	Respiratory system	
Chlorine dioxide (10049-04-4)		0.6	Respiratory system	
Chlorobenzene (108-90-7)	☑	1000	Alimentary system; kidney; reproductive system	
Chloroform (67-66-3)	☑	300	Alimentary system; kidney; development	
Chloropicrin (76-06-2)	☑	0.4	Respiratory system	
Chromium hexavalent: soluble except chromic trioxide	☑	0.2	Respiratory system	
Chromic trioxide (as chromic acid mist)	☑	0.002	Respiratory system	☑
Cresol mixtures (1319-77-3)	☑	600	Nervous system	
Dichlorobenzene (1,4-) (106-46-7)	☑	800	Nervous system; respiratory system; alimentary system; kidney	
Dichloroethylene (1,1) (75-35-4)	☑	70	Alimentary system	
Diesel Exhaust*		5	Respiratory system	

Substance (CAS #)	*Listed in CAPCOA - 1993*	*Chronic Inhalation REL (µg/m³)*	*Hazard Index Target(s)*	*Human Data*
Diethanolamine (111-42-2)		3	Cardiovascular system; nervous system	
Dimethylformamide (N,N-) (68-12-2)		80	Alimentary system ; respiratory system	☑
Dioxane (1,4-) (123-91-1)	☑	3,000	Alimentary system; kidney; cardiovascular system	
Epichlorohydrin (106-89-8)	☑	3	Respiratory system; eyes	
Epoxybutane (1,2-) (106-88-7)		20	Respiratory system; cardiovascular system	
Ethylbenzene (100-41-4)		2,000	Development; alimentary system (liver); kidney; endocrine system	
Ethyl chloride (75-00-3)	☑	30,000	Development; alimentary system	
Ethylene dibromide (106-93-4)	☑	0.8	Reproductive system	☑
Ethylene dichloride (107-06-2)	☑	400	Alimentary system (liver)	
Ethylene glycol (107-21-1)		400	Respiratory system; kidney; development	☑
Ethylene glycol monoethyl ether (110-80-5)	☑	70	Reproductive system; hematopoietic system	
Ethylene glycol monoethyl ether acetate (111-15-9)	☑	300	Development	
Ethylene glycol monomethyl ether (109-86-4)	☑	60	Reproductive system	
Ethylene glycol monomethyl ether acetate (110-49-6)	☑	90	Reproductive system	
Ethylene oxide (75-21-8)	☑	30	Nervous system	
Fluoride including Hydrogen Fluoride		13 F 14 HF	Bone and teeth; respiratory system	☑
Formaldehyde (50-00-0)	☑	3	Respiratory system; eyes	☑
Glutaraldehyde (111-30-8)	☑	0.08	Respiratory system	
Hexane (n-) (110-54-3)		7000	Nervous system	
Hydrazine (302-01-2)	☑	0.2	Alimentary system; endocrine system	
Hydrogen chloride (7647-01-0)	☑	9	Respiratory system	
Hydrogen cyanide (74-90-8)	☑	9	Nervous system; endocrine system; cardiovascular system	☑
Hydrogen sulfide (7783-06-4)	☑	10	Respiratory system	
Isophorone (78-59-1)		2000	Development; liver	
Isopropanol (67-63-0)		7,000	Kidney; development	

Substance (CAS #)	*Listed in CAPCOA - 1993*	*Chronic Inhalation REL (µg/m³)*	*Hazard Index Target(s)*	*Human Data*
Maleic anhydride (108-31-6)	☑	0.7	Respiratory system	
Manganese & manganese compounds	☑	0.2	Nervous system	☑
Mercury & mercury compounds (inorganic)	☑	0.09	Nervous system	☑
Methanol (67-56-1)	☑	4,000	Development	
Methyl bromide (74-83-9)	☑	5	Respiratory system; nervous system; development	
Methyl chloroform (71-55-6)	☑	1,000	Nervous system	
Methyl isocyanate (624-83-9)		1	Respiratory system; reproductive system	
Methyl t-butyl ether (1634-04-4)		8,000	Kidney; eyes; alimentary system (liver)	
Methylene chloride (75-09-2)	☑	400	Cardiovascular system; nervous system	☑
Methylene dianiline (4,4'-) (101-77-9)	☑	20	Eyes; alimentary system (hepatotoxicity)	
Methylene Diphenyl Isocyanate (101-68-8)		0.7	Respiratory system	
Naphthalene (91-20-3)	☑	9	Respiratory system	
Nickel & compounds (except nickel oxide)	☑	0.05	Respiratory system; hematopoietic system	
Nickel oxide (1313-99-1)		0.1	Respiratory system; hematopoietic system	
Phenol (108-95-2)	☑	200	Alimentary system; cardiovascular system; kidney; nervous system	
Phosphine (7803-51-2)	☑	0.8	Respiratory system; alimentary system; nervous system; kidney; hematopoietic system	
Phosphoric acid (7664-38-2)		7	Respiratory system	
Phthalic anhydride (85-44-9)	☑	20	Respiratory system	☑
Propylene (115-07-1)		3,000	Respiratory system	
Propylene glycol monomethyl ether (107-98-2)		7,000	Alimentary system (liver)	
Propylene oxide (75-56-9)	☑	30	Respiratory system	
Selenium and selenium compounds (other than hydrogen selenide)	☑	20	Alimentary system; cardiovascular system; nervous system	☑
Silica (crystalline, respirable)		3	Respiratory system	☑
Styrene (100-42-5)	☑	900	Nervous system	☑
Sulfuric acid (7664-93-9)		1	Respiratory system	
Tetrachloroethylene* (perchloroethylene) (127-18-4)	☑	35	Kidney; alimentary system (liver)	

Substance (CAS #)	*Listed in CAPCOA - 1993*	*Chronic Inhalation REL (µg/m³)*	*Hazard Index Target(s)*	*Human Data*
Toluene (108-88-3)	☑	300	Nervous system; respiratory system; development	
Toluene diisocyanates (2,4-&2,6-)	☑	0.07	Respiratory system	☑
Trichloroethylene (79-01-6)	☑	600	Nervous system; eyes	☑
Triethylamine (121-44-8)		200	Eyes	
Vinyl acetate (108-05-4)		200	Respiratory system	
Xylenes (m-, o-, p-)	☑	700	Nervous system; respiratory system	☑

Table 11.3 Parameters to be used for calculation of VOC concentrations in offices and classrooms for the GREENGUARD Program

Parameter	Unit of Measure	GG Office Model	GG School Model	*For Children and Schools office
Room Length	ft	10	40	-
Room Width	ft	14	24	-
Room Height	ft	8	8.5	9
Room Volume	m^3	32	231	30.6
Air Change Rate (hr^{-1})	hr^{-1}	0.72	0.9**	0.75**
Flooring Loading	m^2	13.1	89.2	11.1

*Office Model applicable for products used in commercial environments (From CA/DHS/EHLB/R-174)
**Used with an additional ventilated fraction of 0.9