



UL 2823

GREENGUARD Certification Program Method for Measuring and Evaluating Chemical and Particle Emissions From Electronic Equipment Using Dynamic Environmental Chambers

GREENGUARD Certification Program Method for Measuring and Evaluating Chemical and Particle Emissions From Electronic Equipment Using Dynamic Environmental Chambers, UL 2823

First Edition, Dated March 29, 2013

Summary of Topics

This revision to 2823 is issued for editorial updates.

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Using Dynamic Environmental Chambers**

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March 29, 2013

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PREFACE

UL Environment certifies indoor products for low chemical emissions using testing procedures described herein to cover a breadth of product types and building applications. The science of measuring product emissions developed from research conducted by the Environmental Protection Agency, Department of Energy, the Department of Housing and Urban Development, the Consumer Product Safety Commissions, California Department of Health Services, the state of Washington Department of General Administration, and additional national and international researchers. UL Environment offers product testing and consulting services to manufacturers of products and end users. UL Environment brings together performance based, field validated standards to define low emitting products and materials for the indoor environment; 2) provide a third party, non-industry and publicly available certification process for manufactured products; and 3) establish a public directory of certified products for architects, designers, specifiers, purchasers, and consumers.

The following Method incorporates the best-learned practices for testing and evaluating electronic equipment for GREENGUARD Certification, including computers, video monitors, televisions, DVD players, cable boxes, scanners, receivers, CD players, and speakers. Elements of the Method include sample handling and shipment, sample preparation, product loadings and descriptions, environmental chamber exposure, analytical measurements, exposure modeling and allowable levels for the GREENGUARD Certification Program. Analytes include total volatile organic compounds (TVOC), individual VOCs, formaldehyde and other aldehydes, ozone, and fine particulate matter 2.5 micrometers and smaller ($PM_{2.5}$). All individual VOCs emitting from products are measured as allowed by UL 2823, GREENGUARD Environmental Labeling Program Method for Measuring and Evaluating Chemical and Particle Emissions From Electronic Equipment Using Dynamic Environmental Chambers, and each measured VOC is required to meet defined allowable levels. UL 2823 incorporates additional criteria to provide a higher margin of safety for young children. This method reduces allowable chemical levels. It also requires that emissions meet the 1/2 CREL criteria of certain target chemicals as listed in 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) and adopted by the California High Performance School (CHPS) Program. UL 2823 requires a review of measured chemical emissions across a broader range of risk based exposure levels established by the US Environmental Protection Agency (EPA), the Agency for Toxic Substances and Disease Registry (ATSDR) of the Center for Disease Control (CDC), and the State of California Office of Environmental Health Hazard Assessment (OEHHA). This further strengthens the criteria by requiring product emissions be less than defined risk-based air concentration levels for both acute (short-term) and chronic (long-term) exposures.

This document will be updated as new test protocols and standards become available.

GENERAL

1 Scope

1.1 Electronic equipment may emit a variety of volatile chemicals into the indoor air space of a building. The following methodology measures total volatile organic compounds (TVOC), individual volatile organic compounds (IVOCs), formaldehyde and other aldehydes, ozone and respirable particle emission levels from electronic equipment using test conditions defined to simulate product use in realistic commercial office, educational, healthcare and/or residential settings. The levels of emissions are determined by observing the TVOC, IVOC, aldehyde, ozone, and respirable particle ($PM_{2.5}$) concentrations 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.

1.2 This method may be used for certification solely by UL and its affiliated entities in the UL GREENGUARD certification program. Accordingly, only UL or its affiliated entities can determine and declare whether a product is in compliance with the requirements in this method. Any purported determination or declaration of testing, conformance, compliance or certification to this method by any other party is null and void and cannot be used to meet the requirements of this method.

1.3 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. Ozone is measured using a UV-absorbance based ozone analyzer. Respirable particles ($PM_{2.5}$) are monitored using a 90° light scattering measurement to continuously determine airborne particle concentrations over time. Specialized analysis of chamber air samples may be conducted for other specific target chemicals as specified for a specific product/project requirement.

1.4 The methodology provides a standard means of reproducibly and accurately testing electronic equipment under a realistic, yet highly controlled, atmosphere.

1.5 The methodology with standardized measurement and analyses provides consistent testing of materials within a product group.

1.6 This protocol applies to any electronic equipment belonging to a product category generally used within an enclosed indoor environment. This includes, for example, computers, video monitors, televisions, DVD players, cable boxes, scanners, receivers, CD players, and speakers used in public and commercial office buildings, schools, medical buildings, residences and other building types. The protocol applies to products that can be tested alone or as part of a system.

1.7 This method establishes the procedures for product sample collection, emission testing and analysis, indoor air concentration modeling and associated documentation requirements.

1.8 This method also establishes performance criteria for specific chemicals of interest.

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1.9 While this practice may list specific chemicals and associated maximum allowable concentrations, as required by criteria indoor air guidelines and specifications, it does not assess the human risk involved with use of the materials as an installer or manufacturer.

1.10 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.

1.11 This method may be used for certification solely by UL and its affiliated entities in the UL GREENGUARD certification program. Accordingly, only UL or its affiliated entities can determine and declare whether a product is in compliance with the requirements in this method. Any purported determination or declaration of testing, conformance, compliance or certification to this method by any other party is null and void and cannot be used to meet the requirements of this method.

2 Objectives and Use

2.1 Objectives

2.1.1 Measure VOCs, including aldehydes, and other potential pollutants from electronic equipment.

2.1.2 Provide compound-specific data on VOCs 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** and other government and private product specification programs.

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 air concentrations of VOCs.

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

2.1.7 Rank and evaluate products within a category or across categories with respect to their emission profiles, types, or chemicals and their levels.

2.1.8 Provide compound specific emission parameters for use in indoor exposure models.

2.2 Use

2.2.1 Small ($0.05 - 1 \text{ m}^3$) chamber evaluations are used to determine source emission rates and emissions factors from electronic equipment components.

2.2.2 Intermediate (approximately $1 - 6 \text{ m}^3$ volume) chamber evaluations are used to determine source emission rates and emission factors from electronic equipment products.

2.2.3 Large ($> 25 \text{ m}^3$) chambers are used for the evaluation of electronic equipment systems.

2.2.4 Emission rates are used in indoor air quality models to predict indoor air concentrations of compounds emitted from the tested material. 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.

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4 Terminology – Acronyms and Abbreviations

ACGIH – American Conference of Governmental Industrial Hygienists

ACH – Air changes per hour

ARB – Air Resources Board, Cal/EPA

AREL – Acute Reference Exposure Level

ASTM – American Society for Testing and Materials

AQS – Air Quality Sciences, Inc.

ATSDR – Agency for Toxic Substances and Disease Registry

BQL – Below quantifiable limit

Cal/DHS – California Department of Health Services

Cal/EPA – California Environmental Protection Agency

CIWMB – California Integrated Waste Management Board, Cal/EPA

COC – Chain of Custody

CREL – Chronic Reference Exposure Level

DL – Detection limit

DNPH – 2,4-Dinitrophenylhydrazine

EF – Emission factor

EPA – U.S. Environmental Protection Agency

GC/MS – Gas chromatography/mass spectrometry

HAP – Hazardous Air Pollutant

HPLC – High performance liquid chromatography

IAQ – Indoor Air Quality

IRIS – Integrated Risk Information System

ISO – International Standards Organization

IUR – Inhalation Unit Risk

IVOC – Individual volatile organic compounds

LOQ – Limit of quantitation, lower

MFC – Mass flow controller

MRL – Minimal Risk Level

MSDS – Material safety data sheet

Prop65 – California Proposition 65

QL – Quantifiable limit

REL – Reference exposure level

RfC – Reference Concentration

RH – Relative humidity in percent

STEL/C – short-term exposure limit or ceiling

TAC – Toxic Air Contaminant

TD/GC/MS – Thermal desorption GC/MS

TIC – Total ion-current chromatogram

TLV – Threshold Limit Value

TVOC – Total volatile organic compounds

TWA – Time-weighted average

VOC – Volatile organic compound

WEEL – Workplace Environmental Exposure Level

5 Definitions

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

5.2 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.

5.3 Acute REL – Non-cancer acute reference exposure level developed by Cal/EPA OEHHA.

5.4 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).

5.5 Air Flow Rate – Air volume entering the emission test chamber per unit time.

5.6 Air Velocity – Air speed over the surface of the test specimen.