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Standard Guide for Risk Characterization of Acute and Irritant Effects of Short-Term Exposure to Volatile Organic Chemicals Emitted from Bedding Sets[1]

This standard is issued under the fixed designation D6485; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide describes procedures for conducting risk characterization of exposure to volatile organic chemicals (VOCs) emitted from bedding sets or an ensemble of a mattress and supporting box spring.

1.2 This guide is for risk characterization of short-term exposures to a new bedding set brought into a residential indoor environment. The risk characterization considerations presented in this guide are applicable to both the general population and sensitive subgroups, such as convalescing adults.

1.3 The risk characterization addressed in this guide is limited to acute health and irritation effects resulting from short-term exposure to VOCs in indoor air. Although certain procedures described in this guide may be applicable to assessing long-term exposure, the guide is not intended to address cancer and other chronic health effects.

1.4 VOC emissions from bedding sets, as in the case of other household furnishings, usually are highest when the products are new. A used bedding set may also emit VOCs, either from the original materials or as a result of its use. The procedures presented in this guide also are applicable to used bedding sets.

1.5 Risk characterization procedures described in this guide should be carried out under the supervision of a qualified toxicologist or risk assessment specialist, or both.

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D6177 Practice for Determining Emission Profiles of Volatile Organic Chemicals Emitted from Bedding Sets

D6178 Practice for Estimation of Short-term Inhalation Exposure to Volatile Organic Chemicals Emitted from Bedding Sets

E609 Terminology Relating to Pesticides

E943 Terminology Relating to Biological Effects and Environmental Fate

2.2 *Government Standards:*[3]

EPA 600/R 92/047 Reference Guide to Odor Thresholds for Hazardous Air Pollutants Listed in the Clean Air Act Amendments of 1990

29 CFR 1910 Occupational Safety and Health Standards

3. Terminology

3.1 *Definitions*—For definitions of terms used in this guide, refer to Terminology D1356.

[1] This guide is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.05 on Indoor Air.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from U.S. Government Printing Office, Superintendent of Documents, 732 N. Capitol St., NW, Washington, DC 20401-0001, http://www.access.gpo.gov.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *acute exposure guideline levels (AEGLs), n*—represent short-term threshold or ceiling exposure values intended for the protection of the general public, including susceptible or sensitive individuals, but not hypersusceptible or hypersensitive individuals (**1**).[4]

3.2.1.1 *Discussion*—AEGLs are for once-in-a-lifetime exposure due to accidental releases. Three AEGLs, each representing distinct biological endpoints (sensory irritation or notable discomfort, irreversible or serious effect, and life-threatening effects or death) for four different exposure periods ranging from 30 min to 8 h, are derived.

3.2.2 *bedding set, n*—an ensemble that includes a mattress for sleeping and a supporting box spring.

3.2.3 *ceiling limit, n*—a maximum allowable air concentration, established by the Occupational Safety and Health Administration (OSHA), that must not be exceeded during any part of the workday.

3.2.4 *emission profile, n*—a time-series of emission rates for one or more chemicals.

3.2.5 *hazard index (HI), n*—a summation of hazard quotients (see3.2.6) for chemicals potentially having similar target organ effects or for chemicals that are considered to have additive effects.

3.2.6 *hazard quotient (HQ), n*—the ratio of the exposure calculated for a chemical to the toxicity/irritancy threshold or reference value for that chemical.

3.2.6.1 *Discussion*—If a HQ exceeds a value of 1, there would be a concern for potential toxic/irritant effects. A HQ is not to be interpreted as a statistical probability, for example, a ratio of 0.001 does not mean that there is a one in a thousand chance of an effect occurring.

3.2.7 *inhalation reference concentration (RfC), n*—an estimate (with uncertainty spanning an order of magnitude) of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects.

3.2.7.1 *Discussion*—The time period under consideration is up to and including seven years, or a portion of a lifetime, for subchronic RfC and a lifetime for chronic RfC. In accordance with the U.S. Environmental Protection Agency (EPA) (**2**), the uncertainty in the estimates for RfC spans an order of magnitude.

3.2.8 *lethal concentration 50 (LC_{50}), n*—a calculated concentration of a chemical in air to which exposure for a specific length of time is expected to cause death in 50 % of a defined experimental animal population.

3.2.9 *lethal concentration low (LCL_o), n*—the lowest calculated concentration of a chemical in air to which exposure over any period of time is reported to have caused death in humans or animals.

3.2.10 *lowest-observed-adverse effect level (LOAEL), n*—the lowest dose of a chemical in a study or group of studies that produces statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control.

3.2.11 *minimal risk level (MRL), n*—an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure.

3.2.11.1 *Discussion*—MRLs are developed by the Agency for Toxic Substances and Disease Registry (ATSDR). They are intended to serve as a screening tool to help public health professionals and are derived for acute (1 to 14 days), intermediate (14 to 364 days), and chronic (365 days or longer) exposure durations and for oral and inhalation routes of exposure (**3, 4**).

3.2.12 *no-observed-adverse-effect level (NOAEL), n*—that dose of a chemical at which there are no statistically or biologically significant increases in frequency or severity of adverse effects seen between the exposed population and its appropriate control.

3.2.12.1 *Discussion*—Effects may be produced at this dose, but they are not considered to be adverse.

3.2.13 *potential inhaled dose, n*—the estimated dose of an airborne chemical that an individual is likely to have inhaled within a specified period of time.

3.2.13.1 *Discussion*—It is calculated as the product of air concentration to which an individual is exposed times breathing rate times duration of exposure. The potential inhaled dose can be different from the dose actually absorbed by a target organ.

3.2.14 *short-term exposure, n*—an exposure of one week or less in duration.

3.2.15 *toxic concentration low (TCL_o), n*—the lowest air concentration of a substance introduced by the inhalation route over any period of time that is reported to have produced any significant toxic effects in animals or humans.

3.2.16 *uncertainty factor, n*—number, greater than unity, to account for incomplete understanding of errors encountered in extrapolating exposure or health effects derived for one set of conditions or basis to another.

3.2.16.1 *Discussion*—An uncertainty or *safety factor* is used to account for differences in toxicological effects within a species or between two species. For example, a factor of 10 or 100 is used in the calculation of an RfC to account for uncertainties in the extrapolation from the experimental data and exposure conditions.

4. Summary of Guide

4.1 This guide describes procedures for conducting risk characterization of short-term exposures to VOCs emitted from new bedding sets in a residential environment. The risk characterization discussed in this guide addresses acute health and irritant effects of the short-term exposures.

4.2 Four major steps in risk assessment include hazard identification, evaluation of health effects data (including dose-response assessment), exposure assessment, and risk characterization (**5, 6**). This guide addresses hazard

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.

assessment, evaluation of health effects data, and risk characterization. Companion documents (see Practices D6177 and D6178) provide procedures for estimation of human exposure to emissions of VOCs from bedding sets when a new bedding set is first brought into a house.

5. Significance and Use

5.1 The objective of this guide is to describe procedures and data sources for conducting risk characterization of acute inhalation exposure to chemicals emitted from bedding sets. Risk characterization can be used to identify chemical(s) that pose potentially significant human health risks for the scenario(s) and population(s) selected for exposure assessment. Such identification of chemicals can help in identifying the components or materials used in the manufacture of bedding sets that should be further examined. Risk characterization also includes an assessment of potential odors associated with individual chemicals emitted by the bedding set.

6. Exposure and Effects

6.1 *Concepts of Exposure and Dose*—In very basic terms, exposure is defined as human contact with a chemical or physical agent (see Terminology E943). Exposure by means of the inhalation route is of interest in this document: It can be expressed as the product of airborne concentration times duration of exposure, provided that the concentration remains constant during the time period of interest. If the concentration varies over time, then exposure is defined as the area under the curve obtained when concentration values are plotted against time. Exposure is expressed as concentration multiplied by time with resultant units such as ppm-h or mg/m^3-h. Dose is the quantity of chemical or physical agent that enters an organism or target organ (see Terminology E943), with units such as mg. Dose also can be expressed as rate, with mass/time units such as mg/day. The dose rate can be normalized in relation to body mass, with units such as mg/kg-day. A specific term that is used in risk characterization is potential inhaled dose—the product of average concentration in an environment times the duration in the environment times the average breathing rate while in the environment, commonly expressed in mass units such as milligrams. Chronic exposure generally refers to a long-term perspective, such as repeated exposures or exposures throughout an individual's lifetime, whereas acute exposure refers to a short-term perspective such as one week, one hour, or even an instantaneous exposure.

6.2 *Chronic Toxic Effects*—In the United States and in many other countries, two forms of health effects assessment are used, depending on the nature of the toxic effect under consideration: one is used for cancer and the other for toxic effects other than cancer (**6**). This is primarily because for cancer (a chronic toxic effect), a threshold for dose-response relationship may not exist, or if one does exist, it is very low and may not be reliably identified. During the 1970s and 1980s, the emphasis of risk assessment was on cancer as the end point. On the other hand, for toxic effects other than cancer, a standard procedure used for evaluating health effects involves identifying the highest exposure among all experimental studies at which no toxic effect was observed, that is, the NOAEL. Much of the emphasis related to non-cancer effects has been on chronic effects (**6**). In recent years, however, researchers such as Berglund et al. (**7**) have been giving increased attention to acute effects by categorizing the effects of indoor air pollutants on human health into groups, such as reversible effects, including general symptoms, such as headache, inflammatory irritation such as rashes, and perceptions including odors.

6.3 *Acute Effects*—The scope of this guide relates to effects of short-term exposure to airborne chemicals in indoor spaces. Specific guidelines available for considering acute effects of exposure to chemicals in air are quite limited. Minimal risk levels (MRLs) are derived for acute exposure of 1 to 14 days (**3**, **4**). Other guidelines, such as AEGLs, developed by the National Advisory Committee for Acute Exposure Guideline Levels for Hazardous Substances (NAC/AEGL Committee) are applicable only for one-time, short-term hazardous exposures during chemical emergency situations (**1**). EPA's non-chronic reference concentrations for inhalation (RfCs) may exist for acute and subchronic exposures of less than seven years (**2**). CalEPA has developed acute dose-response assessments for many substances, expressing the results as acute inhalation reference exposure levels (RELs). American Industrial Hygiene Association (AIHA) has developed emergency response planning guidelines (ERPGs) for acute exposures at three different levels of severity. These values represent concentrations for exposure of the general population for up to 1 hour associated with effects expected to be mild or transient (ERPG-1), irreversible or serious (ERPG-2), and potentially life-threatening (ERPG-3).

7. Procedures for Hazard Identification

7.1 *Identification of Chemicals:*

7.1.1 Compile a list of target chemicals that are identified through screening tests of emissions. Target chemicals are to be selected by a qualified toxicologist or a risk assessment specialist based on their presence in the screening samples and their expected irritant or health effects. Information on procedures for emissions testing, including screening samples, is given in Practice D6177.

7.1.2 All target chemicals for which emissions data have been collected may be of interest, potentially even those with measured air concentrations that are below their respective detection limits.

7.2 *Compilation of Inhalation Toxicity and Odor Thresholds*—Using data sources, such as those listed in 7.3 through 7.5 (these lists are not exhaustive), collect, compile and document with references the following information for each chemical noting when exposure levels and limits are derived from animal, rather than human, studies:

7.2.1 Exposure levels reported to produce adverse health effects in humans,

7.2.2 Human exposure limits specified in regulatory standards and guidelines,

7.2.3 Toxicological values for humans and experimental mammals, and

7.2.4 Human odor threshold values.