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Target VOC List

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Won, D.; Lusztyk, E.; Shaw, C.Y.

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Consortium for Material Emissions and Indoor Air Quality Modelling II (CMEIAQ-II)

In 2000, the Institute for Research in Construction, National Research Council Canada (IRC/NRC) launched the second phase of the Material Emissions and Indoor Air Quality Modelling project (CMEIAQ-II). The second phase of this project is the direct result of the support and suggestions from the first phase's consortium members for continued work on this research topic. In the second phase, the research is directed towards two principal objectives. The first is to develop the knowledge and tools needed to estimate concentrations of volatile organic compounds (VOCs) generated by the emissions from building materials and furnishings in order to gain a better understanding of the effects of those products on indoor air quality (IAQ). The second is to provide the scientific bases needed to enhance indoor air quality guidelines for office and residential buildings. An important addition to the project in this phase was the Health and End Users Advisory Committee, which was tasked to provide much needed input from the health sector and advice to help tailor the project outputs to better meet the needs of end-users.

Phase II Tasks

The specific tasks of the phase II research were:

- To assemble a target VOC list on which to focus our efforts for the analysis of the emission test results. The list includes chemicals which are known to be emitted from various materials, and, especially, chemicals known to have health effects;
- To determine the ranges of variation of the emissions from selected materials, which may result from material variability or environmental influences;
- To expand the database to include a total of 69 materials, and to re-analyze the existing data to cover as many VOCs on the new target list as possible;
- To refine the Material Emission DataBase and Indoor Air Quality (MEDB-IAQ) simulation program to make it more user-friendly;
- To develop and validate empirical and mass-transfer based source models; and
- To develop a best practice guide for managing VOCs/IAQ in office buildings.

Significance of the Project

A recent report by a multidisciplinary group of European scientists (EUROVEN) based on existing and limited literature, recommends that outdoor air supply rates need to be increased to 30 L/s per person from the current ASHRAE recommendation of 10 L/s per person to improve indoor air quality for health, comfort, and productivity concerns. On the other hand, a previous NRC experimental study indicates that increasing the ventilation rate to speed up the removal of air-borne VOCs, even when energy use is not a concern, is not effective. The most efficient strategy to maintain indoor air quality is to remove the contaminants at the source (source control) and then to rely on ventilation (dilution) to remove the air-borne VOCs.

This research contributes to improved indoor air quality by developing knowledge and tools for effectively applying source control to reduce ventilation needs (and hence, save

energy). The work provides the relative contribution by a given product to up to 90 VOC concentrations (some of which are known to have adverse health effects), allowing intelligent, informed choices of building materials and indoor consumer products. Product manufacturers will benefit by learning how their products can be improved with respect to VOC emissions, and where their products stand relative to others in simulations of their actual use. The information collected in Phase II will also make it easier for investigators to diagnose possible IAQ problems in buildings, and explore trade-offs between increased ventilation and source control.

The consortium for Phase II (which has a Steering Committee, a Technical Advisory Committee, and a Health & End Users Advisory Committee) was established to set the research priorities and help fund the project. Members of the consortium include: Public Works & Government Services Canada, Natural Resources Canada, Canada Mortgage and Housing Corporation, Health Canada and the National Research Council. In addition, the following organizations have made significant in-kind contributions to the consortium project through close research collaboration with the IRC/NRC project team: Canadian Composite Panel Association, Carleton University, Chemical Manufactures Association (Rohm & Haas), Dalhousie University, Gypsum Board Association, Saskatchewan Research Council, Syracuse University, University of Calgary, University of Miami, U.S. Environmental Protection Agency (EPA), U.S. National Institute of Standards and Technology (NIST), and Virginia Polytechnic Institute & State University.

The CMEIAQ-II final research reports include:

Report 1.1	Target VOC list
Report 1.2	Methodology for Analysis of VOCs in Emission Testing of Building Materials
Report 2.1	Specimen Variability: A Case Study
Report 2.2	Effects of Environmental Factors on VOC Emissions from a Wet Material
Report 2.3	Effects of Material Temperature on VOC Emissions from a Dry Building Material
Report 3.1	Material Emission Data: Small Environmental Chamber Tests
Report 3.2	MEDB-IAQ Version 4.1 Beta
Report 4.1	Model Development for VOC Emissions from Wet Building Materials
Report 4.2	Validation of a Mass-transfer Model for VOC Emissions from Wet Building Materials
Report 4.3	Validation of Empirical Models with Long-term Emission Testing Data
Report 5.1	Indoor Air Quality Guidelines and Standards
Report 5.2	Managing VOCs and Indoor Air Quality in Office Buildings: An Engineering Approach

Reports 1.1 and 1.2 provide the information on the Target VOC list and the analysis method for the VOCs on the list. Reports 2.1 and 2.2 present research outcomes on both inherent and environmental factors inducing variability in material emissions. Report 2.3 discusses VOC emissions as a function of surface temperatures, which can be applied to emissions from a radiant floor heating system. Report 3.1 provides material emission testing data and the resulting coefficients for empirical emission models for the expansion of MEDB-IAQ simulation software. Report 3.2 is a user manual for the revised MEDB-IAQ. Reports 4.1 and 4.2 deal with the development of a mass-transfer based model for wet building materials and the validation of the model with experimental data. Report 4.3 compares empirical models based on short-term emission testing data with those based on long-term data. Report 5.1 contains summaries of existing guidelines and standards associated with indoor air quality. Report 5.2 is a manual for property managers and building operators for their duties in managing VOCs in office buildings.

Target VOC List

Summary

A list of 90 compounds was compiled as a guide to identify and quantify specific chemicals emitted from building materials. The chemicals on the target VOC list include compounds that are: 1) known or suspected to have health or irritation concerns; 2) known to be emitted from the tested building materials; and 3) often found in indoor air. This list originally consisted of 120 compounds that are abundant indoors and that are emitted from building materials. It was refined, in consultation with the project's Health and End-User Advisory Committee (HEUAC), based on existing lists compiled by national and international organizations out of concerns on human health. The IRC target VOC list will be used to guide the identification and quantification of the chemicals emitted from the building materials tested under the Phase 2 of the Material Emissions and Indoor Air Quality Modelling project. Forty-two of the 48 building material tests completed in Phase 1 of the project were also reanalyzed to cover all chemicals on this target list (six had used GC/FID, making re-analysis impractical).

Table of Contents

Summary ..... **iv**

List of Tables: ..... **vi**

1. Introduction **1**

2. Criteria of Target VOC List **1**

3. Procedure of Developing Target VOC List **2**

4. Referenced Existing Lists and Levels **2**

4.1 EC VOC List 3
4.2 Japanese List 3
4.3 Health Canada's Priority Substances Lists (PSL1 and 2) 3
4.4 Health Canada's Domestic Substances List (DSL) 3
4.5 California Proposition 65 4
4.6 US 2001 CERCLA 4
4.7 US EPA Hazardous Air Pollutants (HAPs) 4
4.8 WHO Air Pollutants with Health Endpoints 4
4.9 California Chronic Reference Exposure Level (CRELs) 5
4.10 US EPA Voluntary Children's Chemical Evaluation Program (VCCEP) 5
4.11 US NIOSH Method 2549 5
4.12 California Target Compounds List 5

5. IRC Target VOC List **6**

6. References **7**

List of Tables:

Table 1. Referenced existing lists for Target VOC List. 9
Table 2. IRC Target VOC List..... 11
Table 3. Reference levels for Target VOCs..... 14
Table 4. Chamber air concentration at 24 h (CMEIAQ-I, wet materials). 17
Table 5. Chamber air concentration at 24 h (CMEIAQ-I, dry materials)..... 20
Table 6. Chamber air concentration at 24 h (CMEIAQ-II). 26

Target VOC List

1. Introduction

The VOC fingerprint of any given building material can be extremely complex, with the potential for hundreds of individual chemicals being emitted. Identifying and quantifying all chemicals emitted from one building material is frequently impractical as a result. Therefore, to successfully achieve the test objective, certain criteria are needed for selecting specific chemicals for identification and quantification when conducting a material emission test.

The most common approach is to focus on chemicals in greatest abundance. The advantage of this approach is that the data analysis is relatively easy. On the other hand, the disadvantages are that: 1) the most abundant chemicals are not necessarily the most worrisome compounds, 2) quantifying the chemical against the calibration standard of the same chemical may not be possible if the chemical is not included in calibration mixtures, and 3) sometimes the true identity of a peak is obscured when the ion characteristics of the chemical are not properly identifiable.

Another approach is to look for relevant chemicals to support a specific purpose (i.e., potential health concerns). The advantages of this approach are that finding chemicals with specific interests can be assured and quantifying a chemical can be done against the calibration standard of the chemical in question. The disadvantage is that chemicals for other important applications may be missed. However, this disadvantage is likely to exist for any approach as long as not all peaks are analyzed.

In Phase 1 of CMEIAQ, where the principle objectives were to develop the emissions testing and analytical methodologies, the first approach was used, and only 5 or 6 most abundant chemicals were analyzed. In Phase 2, the second approach was adopted and a list of target chemicals was compiled. The list of chemicals, and the rational behind the list, will be explained in this report.

2. Criteria of Target VOC List

The target VOC list for material emissions was intended to include those chemicals:

1) known or suspected to have health or irritation concerns (health criterion);
2) known to be emitted from the building materials (building material criterion);
3) often found in indoor air (indoor air criterion), and
4) suitable for sorbent sampling and analysis with GC/MS or carbonyl analysis with HPLC (analytic criterion).

The first criterion is aimed to include chemicals with known or suspected heath implications. The emission rate of those chemicals can provide the information for estimating human exposure to those worrisome compounds.

The second criterion is to look for chemicals in the indoor air that are known to be emitted from building materials. Although the information on the chemicals in the

second category are not as important as those in the first category from the human health point of view, chemicals in a relatively large quantity deserve more attention.

The third criterion is to include chemicals frequently found in indoor air, whose exact source may be unclear, but could conceivably include building materials or furnishings. The emission information gained can thus be used to identify the sources of these compounds.

The fourth criterion is to focus chemical analysis efforts on volatile organic compounds that our highly refined laboratory capabilities can accurately sample, detect, and quantify. The methods used to analyze these chemicals are explained in Report 1.2.

Any compound may satisfy one or more of the above conditions, but to be included in the Target VOC list, it must satisfy criterion 4, plus at least one of criteria 1, 2 or 3.

3. Procedure of Developing Target VOC List

The target list was developed through the following procedures:

First, a list of 120 compounds was compiled based on the abundance in indoor air and the relevance to material emissions. Specifically, the list consists of compounds that

1) were identified from the 48 commonly-used building materials tested by IRC,
2) were recommended by European Commission (EC) to be included in an analysis of TVOC for the indoor air quality investigation (list #1 in Table 1), and,
3) were identified in a calibration mixture, "Japanese Indoor Air Standards Mix" by Supelco (list #2 in Table 1).

The 120-compound IRC list represents the chemicals satisfying the 2nd (building material) criterion (Section 2). The EC VOC list includes chemicals primarily based on the 3rd criterion (indoor air), while the Japanese list satisfies the 3rd and 4th criteria (IA and analytical).

After comparing with eight published lists compiled by national and international organizations (lists #3-11 in Table 1), the IRC list was reduced to 90 compounds by eliminating those compounds that either have no known health risk, or were not emitted (or detected) from the 48 building material specimens tested in Phase I.

4. Referenced Existing Lists and Levels

Many agencies have produced guidelines related to indoor contaminant levels. Typically, these levels pertain to occupational environments. A selection of these reference levels (summarized in Table 1) is provided as background information. These levels vary among the referenced lists and are not directly comparable to the chamber air concentration values included in this report. The reader is cautioned to obtain expert advice when conducting any analysis or interpretation of technical materials. Detailed information on individual lists can be found via the links provided in Table 1.

4.1 EC VOC List

Sixty-three volatile organic compounds were recommended to be included in a TVOC analysis for indoor air quality investigations by the European Commission (European Commission, 1997). This list was used as a backbone of the IRC Target VOC list due to the fact that the list is intended for assessing the effects of VOCs in indoor air on occupants' comfort and health. Consequently, 56 out of 63 compounds on the EC list are incorporated in the IRC target VOC list. The excluded compounds are two alkenes (1-octene, 1-decene), two cyclohexanes (methylcyclopentane, methylcyclohexane), two halocarbons (teterachloroethene, 1,1,1-trichloroetane), and tetrahydrofuran. Those chemicals did not meet the 2nd criterion (building material) in Section 2.

4.2 Japanese List

The Japanese Indoor Air Standards mix available from Supelco® consists of 52 volatile organic compounds that are similar to those developed for the chemical analysis method defined by the Japan Ministry of Health and Welfare for the analysis of VOCs in drinking water using GC/MS (Sigma-Aldrich, 2004). Although the standards mix is intended for those following methods defined by the Japan Environment Agency for the analysis of volatile constituents in water, the list includes VOCs that are frequently found in indoor environments. Among these 52 compounds, 41 species are included in the IRC target list.

4.3 Health Canada's Priority Substances Lists (PSL1 and 2)

The Priority Substances List (PSL) consists of substances and groups of substances assessed under Canadian Environmental Protection Act (CEPA) for their risks to human health or the environment. The first PSL list (PSL1) published in 1989 includes 44 substances, among which 25 substances were assessed as "toxic" and 19 were considered as non-toxic or insufficient –data available for conclusion under Section 11 of CEPA 1988 (equivalent to Section 64 of CEPA 1999) (Health Canada 2003 a; Canadian Environmental Network, 2003). The second PSL list (PSL2), published in 1995, consists of 25 substances and is currently being assessed (Health Canada 2003 b; Canadian Environment Network, 2003).

4.4 Health Canada's Domestic Substances List (DSL)

CEPA Priority Substances are listed on the Domestic Substances List (DSL), which includes substances that were used for manufacturing purposes, or manufactured in or imported into Canada in a quantity of 100 kg or more in any calendar year (Canadian Environmental Network, 2003). The DSL was initially developed in the mid 1980's, and with amendments, now lists approximately 23,000 compounds. In a pilot project, Health Canada selected 30 of the 123 substances that may present the greatest potential for exposure of individuals in Canada for assessing the extent of their health risk (Health Canada, 2003 c). Most of the excluded chemicals did not meet either the 2nd (building material) or the 4th (analytic) criteria in Section 2.

4.5 California Proposition 65

The Proposition 65 list, which is required by the Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65), comprises 701 substances known to the State of California to cause cancer or reproductive toxicity (OEHHA, 2003a and 2004). A chemical is listed if it is identified as causing cancer or reproductive toxicity by the qualified experts of authoritative bodies including the United States Environmental Protection Agency (EPA), the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP), the United States Food and Drug Administration (FDA), and the National Institute for Occupational Safety and Health (NIOSH) or if a state or federal agency has formally required that the chemical be labeled or identified as causing cancer or reproductive toxicity (OEHHA, 2003b).

4.6 US 2001 CERCLA

The objective of the CERCLA (Comprehensive Environmental Responses, Compensation, and Liability Act) Priority List of Hazardous Substances is to rank substances across all NPL (National Priorities List) hazardous waste sites to provide guidance in selecting which substances will be the subject of toxicological profile prepared by ATSDR (Agency for Toxic Substances and Disease Registry, an agency of the U.S. Department of Health and Human Services). The list includes 275 inorganic and organic compounds that are most frequently found at the NPL sites and that are determined to pose the most significant potential threat to human health due to their known or suspected toxicity and potential for human exposure at these NPL sites. The list is based on data from ATSDR's HazDat database, which contains information from ATSDR's public health assessments and health consolations (ATSDR, 2003).

4.7 US EPA Hazardous Air Pollutants (HAPs)

Hazardous air pollutants (HAPs) are air pollutants that are defined by the US Federal Clean Air Act as being a threat or risk of cancer or other serious adverse health affects. EPA must identify the chemicals to be controlled and the major source categories of these chemicals. From the188 compounds (formerly 189) included in the HAPs list, 22 substances are included in the IRC target VOC list.

4.8 WHO Air Pollutants with Health Endpoints

World Health Organization (WHO) provided health-based guidelines for 55 airborne inorganic and organic compounds for carcinogenic and non-carcinogenic health endpoints. The non-carcinogenic endpoints include development toxicity, reproductive toxicity, respiratory toxicity, neurotoxicity, hepatotoxicity, hematotoxicity, eye/nose/throat irritation, and odor annoyance. The lowest concentration at which effects are observed in humans, animals, and plants was used as a staring point for the non-carcinogenic endpoints. Uncertainty factors determined through scientific judgment in consensus and averaging time were also taken into account in determining the health endpoint for non-carcinogenic compounds. The classification by the International Agency for Research on Cancer (IARC) was used to determine a chemical as a carcinogen. The endpoint of carcinogen was determined by linear extrapolation from the high dose level, which is characteristic of animal experiments or occupation exposure

with cancer responses (WHO, 1999). Among 55 substances, a total of 18 substances including 3 carcinogens are included in the IRC target VOC list.

4.9 California Chronic Reference Exposure Level (CRELs)

A chronic reference level is an airborne level that is deemed to pose no significant health risk to individuals indefinitely exposed to that level. CRELs are based solely on health considerations, and are developed from the best available data in the scientific literature by State of California (OEHHA, 2003c). As of August 2003, the list included 79 substances. Section 01350 developed by State of California requires that modeled indoor air concentration of any chemical at 96-hr not exceed 50% of the CRELs, with the exception of formaldehyde. The 50% concentration limit of CRELs for each building material was based on the fact that each CREL is the recommended airborne level from all sources and not just from a single source. The September 2002 CREL list was used in this report.

4.10 US EPA Voluntary Children's Chemical Evaluation Program (VCCEP)

The Voluntary Children's Chemical Evaluation Program (VCCEP) announced by the US Environmental Protection Agency (EPA) in December 2000 is intended to provide data to enable the public to understand the potential health risks to children associated with certain chemical exposures. EPA asked companies which manufacture and/or import 23 chemicals which have been found in human tissues and the environment in various monitoring programs to volunteer to sponsor their evaluation in Tier 1 of a pilot of the VCCEP. The 23 compounds on the VCCEP Pilot list were selected if there were monitoring data indicating that exposure to humans had occurred and if the chemicals are present in the environment. The biomonitoring data sets used for VCCEP pilot chemical selection included samples from human blood, breast milk, and exhaled breath. Presence in the environment was established by monitoring data indicating presence in indoor air or presence in drinking water as an unregulated contaminant (US EPA, 2003b). A total of 19 compounds from the VCCEP pilot list are included in the IRC target VOC list.

4.11 US NIOSH Method 2549

The US National Institute of Occupational Safety and Health (NIOSH) developed a general-purpose monitoring method incorporating multi-layer sorbent tube sampling, thermal desorption (TD), gas chromatography (GC), and mass spectrometry (MS) for a wide range of volatile organic compounds. Method 2549 is intended for industrial hygiene professionals to quantify, or at worst screen for, VOCs that might be present in an uncharacterized workplace atmosphere. The method provides a list of 42 common VOCs with mass spectra data.

4.12 California Target Compounds List

The California Target Compounds List was not available at the time that the IRC Target VOC List was developed. However, this list is included in this report as a reference for future refinement of IRC Target VOC List .

California Department of Health Services produced a list of 121 Target Compounds as an outcome of an emission study with 77 building materials. The California Target Compounds list includes chemicals

- listed as probable or known human carcinogens on the list of Toxic Air Contaminants and the Proposition 65 list,
- known to cause reproductive toxicants on the Proposition 65 list,
- with established chronic reference exposure levels (CRELs),
- with known odour thresholds,
- emitted in a large amount including compounds with emission factors greater than 1.5 $\mu g/m^2/h$,
- with chromatography peaks exceeding 5% of the Total Volatile Organic Compound (TVOC) area, and
- the 10 most abundant compounds (State of California, 2003).

Among the 121 compounds identified in this list, 64 compounds are included in IRC target VOC list. Chemicals not included in the IRC target list are mostly oxygenated and chlorinated compounds, which are not known to be emitted in large amounts from building materials.

5. IRC Target VOC List

The 90 compounds on the IRC Target VOC List are summarized in Table 2. The chemicals are grouped into 10 chemical groups: aldehydes, ketones, alcohols/glycols/glycol ethers, esters, halocarbons, aliphatic hydrocarbons, aromatic hydrocarbons, cycloalkanes, terpenes, and others. CAS numbers and chemical properties such as molecular weight (MW), boiling point (BP), and vapor pressure (VP) are also included as reference values in Table 2. Cross referencing with existing lists are also given. The total numbers in the last column indicate the frequency with which a chemical appears in the referenced lists. Most of the chemicals on the IRC Target VOC List are found in at least one of the referenced existing lists. Exceptions are 1,2-propanediol, 2-methyl-2-propanol, isopropyltoluene, ethyl cyclohexane, propyl cyclohexane, decahydronaphthalene, and gamma terpinene, which were observed to be emitted in relatively large amounts from building materials in the previous phase of the project. Out of 90 compounds, half are considered to have health implications as they are listed on at least one of the health-relevant existing lists (#3 to #10 in Table 1). The other half of compounds are mainly associated with large emissions from building materials or other indoor sources.

Table 3 summarizes guideline levels established by national and international agencies to promote occupational and public safety against chemicals. The table includes the guideline for air pollutants with non-carcinogenic and carcinogenic health endpoints established by the World Health Organization (WHO), the non-cancer chronic reference exposure level set by the California Environmental Protection Agency (Cal-EPA), the permissible exposure level recommended by the Occupational Safety and Health Administration (OSHA), and the occupational exposure limits set by the American Conference of Governmental Industrial Hygienists (ACGIH). Additionally, the odour detection threshold and the mucous membrane irritation threshold levels are summarized in Table 3.

Tables 4 to 6 present the chamber air concentration measured at ~24 h for the materials tested in CMEIAQ-I and CMEIAQ-II. It should be noted that a direct comparison of the level in Tables 4 to 6 with that in Table 3 might not be appropriate due to various loading ratios and air change rates in actual buildings. Tables 4 to 6 are anticipated to provide a snap shot of the potential contribution of each material to Target VOCs indoors.

The IRC target VOC list is intended to provide a manageable number of chemicals for the building material emissions study. For more general applications to indoor air quality, the list needs to be expanded. For example, most halocarbons that are widely detected indoors are excluded from the current list based on the judgment that building materials are not the major sources of these compounds. It is expected that the list will be further refined as knowledge of the specific chemical emission profiles from building materials expands, as does our understanding of the health impact of volatile organics.

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Table 1. Referenced existing lists for Target VOC List.

#	List Name	Agency	Purpose of the List	Reference
1	EC VOC List	Eur.Com.: European Commission Joint Research Center-Environment Institute (Brussels)	Compounds to be included in TVOC analysis in Indoor Air Quality Investigations	European Commission (1997) Total volatile organic compounds (TVOC) in indoor air quality investigations, Report No19, EUR 17675 EN, European Commission/Joint Research Centre – Environment Institute.
2	Japanese List	JEA: Japan Environment Agency (Japan)	Japanese Indoor Air VOCs Standards Mix for chemical analysis	http://www.sigmaaldrich.com/suite7/Brands/Supelco_Home/Datanodes.html?cat_path=983799,986363,986373&supelco_name=Chemical%20Reference%20Standards%20and%20Reagents&id=986373
3	PSL1, PSL2	HC: Health Canada	Priority Substances List under CEPA (Canadian Environment Protection Act)	PSL1: http://www.hc-sc.gc.ca/hecs-sesc/exsd/psl1.htm PSL2: http://www.hc-sc.gc.ca/hecs-sesc/exsd/psl2.htm
4	DSL	HC: Health Canada	Domestic Substances List for the Pilot Program	http://www.hc-sc.gc.ca/hecs-sesc/exsd/screening3.htm
5	Proposition 65	OEHHA: Office of Environmental Health Hazard Assessment (California)	Chemicals known to the State of California to Cause Cancer or Reproductive Toxicity	http://www.oehha.org/prop65.html
6	2001 CERCLA	ATSDR: Agency for Toxic Substances and Disease Registry (USA)	CERCLA (The Comprehensive Environmental Response, Compensation, and Liability Act) Priority List of Hazardous Substances	http://www.atsdr.cdc.gov/97list.html#list
7	HAPs	US EPA: Environmental Protection Agency (USA)	Hazardous Air Pollutants	http://www.epa.gov/ttn/atw/188polls.html
8	Air Pollutants	WHO: World Health Organization (Geneva)	Guidelines for air pollutants with non-carcinogenic and carcinogenic health endpoints	http://www.who.int/environmental_information/Air/Guidelines/Chapter3.htm#3.2

Table 1 (cont'd)

#	List Name	Agency	Purpose of the List	Reference
9	CRELs	OEHHA: Office of Environmental Health Hazard Assessment (California)	Chronic reference exposure level	http://www.oehha.org/air/chronic_rels/51702chrel.html
10	VCCEP	US EPA: Environmental Protection Agency (USA)	Voluntary children's chemical evaluation program	http://www.epa.gov/chemrtk/vccep/
11	Method 2549	NIOSH: National Institute for Occupational Safety and Health (USA)	List of Common VOCs for Screening	National Institute for Occupational Safety and Health (1996) Volatile organic compounds (screening): Method 2549, NIOSH Manual of Analytical Methods, Fourth Edition, available at http://www.cdc.gov/niosh/nmam/pdfs/2549.pdf
12	Cal Target List	Cal-DHS: Department of Health Services (California)	Target list for material emissions study	State of California (2003) Building material emissions study, available at http://www.ciwmb.ca.gov/Publications/GreenBuilding/43303015.pdf

Table 2. IRC Target VOC List

VOC #	Group	#	CAS #	Chemical Compound	Properties [1]			Existing List [2]												Totals
					MW	BP (^{o}C)	VP (mmHg) @23ºC	1	2	3	4	5	6	7	8	9	10	11	12	
1	Aldehydes	1	75-07-0	Acetaldehyde	44.1	20.5	835.880			1		1		1	1	1			1	6
2		2	107-02-8	Acrolein	56.1	52.84	252.631			1			1	1	1	1			1	6
3		3	100-52-7	Benzaldehyde	106.1	178.9	1.030	1										1	1	3
4		4	123-72-8	Butanal	72.1	75.0	101.397	1											1	2
5		5	112-31-2	Decanal	156.3	215.2	0.086		1										1	2
6		6	50-00-0	Formaldehyde	30.0	-18.95	3652.842			1		1	1	1	1	1			1	7
7		7	98-01-1	Furfural	96.1	161.9	1.935												1	1
8		8	111-71-7	Heptanal	114.2	153.0	3.095												1	1
9		9	66-25-1	Hexanal	100.2	128.5	10.007	1										1	1	3
10		10	124-19-6	Nonanal	142.2	195.2	0.315	1	1									1	1	4
11		11	124-13-0	Octanal	128.2	174.2	1.017												1	1
12		12	110-62-3	Pentanal	86.1	103.2	30.886	1											1	2
13	Ketones	1	78-93-3	Methyl ethyl ketone	72.1	79.8	86.952	1	1		1		1	1			1	1		7
14		2	67-64-1	Acetone	58.1	56.4	210.521		1		1		1		1		1	1	1	7
15		3	98-86-2	Acetophenone	120.2	202.2	0.342	1						1					1	3
16		4	108-94-1	Cyclohexanone	98.1	155.9	3.825	1										1	1	3
17		5	108-10-1	Methyl isobutyl ketone	100.2	116.7	17.716	1	1		1		1	1				1	1	7
18	Alcohols, Glycols, GlycoEthers	1	107-21-1	1,2-Ethanediol	62.1	197.5	0.076			1				1		1			1	4
19		2	57-55-6	1,2-Propanediol	76.1	187.8	0.107													0
20		3	71-36-3	1-Butanol	74.1	117.8	6.119	1	1		1							1	1	5
21		4	107-98-2	1-Methoxy-2-propanol	90.1	119.2	12.5 @25ºC	1								1				2
22		5	71-23-8	1-Propanol	60.1	97.4	18.171		1						1					2
23		6	111-76-2	2-Butoxyethanol	118.2	171.5	0.746	1		1				1	1			1	1	6
24		7	112-34-5	2-(2-Butoxyethoxy)ethanol	162.2	231.2	0.018	1											1	2
25		8	110-80-5	2-Ethoxyethanol	90.1	135.2	4.640	1		1		1			1	1			1	6
26		9	104-76-7	2-Ethyl-1-hexanol	130.2	184.8	0.111												1	1
27		10	109-86-4	2-Methoxyethanol	76.1	124.6	7.891	1		1		1			1	1			1	6
28		11	75-65-0	2-Methyl-2-propanol	74.1	82.6	36.795													0
29		12	67-63-0	2-Propanol	60.1	82.4	40.302	1	1		1				1	1		1	1	7
30		13	64-17-5	Ethanol	46.1	78.4	52.728	1	1									1		3
31		14	108-95-2	Phenol	94.1	182.0	0.453			1			1	1		1		1	1	6
32	Esters	1	108-21-4	1-Methylethyl acetate	102.1	88.7	54.620	1												1
33		2	111-15-9	2-Ethoxyethyl acetate	132.2	156.5	2.040	1				1				1			1	4
34		3	123-86-4	Butyl acetate	116.2	126.2	10.238	1	1									1	1	4
35		4	141-78-6	Ethyl acetate	88.1	77.2	84.635	1	1									1		3
36		5	6846-50-0	TM-PD-DIB**	286.4			1												1

Table 2 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Properties [1]			Existing List [2]												Totals
					MW	BP (^{o}C)	VP (mmHg) @23ºC	1	2	3	4	5	6	7	8	9	10	11	12	
37	Halo-Carbons	1	95-50-1	1,2-Dichlorobenzene	147.0	180.6	1.185			1			1				1	1		4
38		2	106-46-7	1,4-Dichlorobenzene	147.0	174.2	1.543	1	1	1		1	1	1	1	1	1	1		10
39		3	75-09-2	Dichloromethane	84.9	39.9	399.297			1		1	1	1		1		1	1	7
40		4	79-01-6	Trichloroethylene	131.4	87.1	67.117	1	1	1			1	1	1	1	1		1	9
41	Aliphatic Hydrocarbons	1	107-83-5	2-Methylpentane	86.2	60.4	194.413	1												1
42		2	96-14-0	3-Methylpentane	86.2	63.4	174.557	1												1
43		3	124-18-5	Decane	142.3	174.3	1.246	1	1		1						1	1	1	6
44		4	112-40-3	Dodecane	170.3	216.5	0.115	1	1								1		1	4
45		5	142-82-5	Heptane	100.2	98.6	41.184	1	1									1	1	4
46		6	544-76-3	Hexadecane	226.4	287.0	0.001	1	1											2
47		7	110-54-3	Hexane	86.2	68.9	139.877	1	1					1		1		1	1	6
48		8	111-84-2	Nonane	128.3	151.0	3.930	1	1										1	3
49		9	111-65-9	Octane	114.2	125.8	12.554	1	1									1	1	4
50		10	629-62-9	Pentadecane	212.4	270.8	0.003	1	1										1	3
51		11	629-59-4	Tetradecane	198.4	253.7	0.009	1	1										1	3
52		12	629-50-5	Tridecane	184.4	235.6	0.047	1	1										1	3
53		13	1120-21-4	Undecane	156.3	196.1	0.352	1	1								1		1	4
54	Aromatic Hydrocarbons	1	95-93-2	1,2,4,5-Tetramethylbenzene	134.2	197.0	0.479		1											1
55		2	611-14-3	2-Ethyltoluene	120.2	165.3	2.297	1	1										1	3
56		3	620-14-4	3-Ethyltoluene	120.2	161.5	2.673		1										1	2
57		4	622-96-8	4-Ethyltoluene	120.2	162.2	2.634		1										1	2
58		5	4994-16-5	4-Phenylcyclohexene	158.3		0.0379 @25ºC	1											1	2
59		6	71-43-2	Benzene	78.1	80.2	86.554	1	1	1		1	1	1	1	1	1	1	1	11
60		7	526-73-8	1,2,3-Trimethylbenzene	120.2	176.3	1.483		1										1	2
61		8	95-63-6	1,2,4-Trimethylbenzene	120.2	169.5	1.994	1	1		1						1		1	5
62		9	95-47-6	1,2-Dimethylbenzene	106.2	144.6	5.885	1	1	1			1	1	1	1	1	1	1	10
63		10	108-67-8	1,3,5-Trimethylbenzene	120.2	164.9	2.176	1	1										1	3
64		11	108-38-3	1,3-Dimethylbenzene	106.2	139.3	7.522	1	1	1			1	1	1	1	1	1	1	10
65		12	106-42-3	1,4-Dimethylbenzene	106.2	138.5	7.918	1	1	1			1	1	1	1	1	1	1	10
66		13	98-82-8	Isopropylbenzene	120.2	152.6	4.008							1			1		1	3
67		14	103-65-1	Propylbenzene	120.2	159.4	3.016	1												1
68		15	100-41-4	Ethylbenzene	106.2	136.4	8.582	1	1		1		1	1	1	1	1		1	9
69		16	91-20-3	Naphthalene	134.2	177.3	1.276	1			1	1	1	1		1	1		1	8
70		17	99-87-6	4-Isopropyltoluene	128.2	218.1	0.229													0
71		18	100-42-5	Styrene	104.2	145.3	5.408	1	1	1			1	1	1	1	1		1	9
72		19	108-88-3	Toluene	92.1	110.8	25.641	1	1	1		1	1	1	1	1	1	1	1	11

Table 2 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Properties [1]			Existing List [2]												
					MW	BP (^oC)	VP (mmHg) @23ºC	1	2	3	4	5	6	7	8	9	10	11	12	Totals
73	Cyclo-Alkanes	1	110-82-7	Cyclohexane	84.2	80.9	89.933	1			1									2
74		2	1678-93-9	Butylcyclohexane	140.3	181.1	1.148												1	1
75		3	1678-91-7	Ethylcyclohexane	112.2	132.0	11.480													0
76		4	1678-92-8	Propylcyclohexane	126.2	156.9	3.706													0
77		5	91-17-8	Decahydronaphthalene	138.3	187.5	1.061													0
78	Terpenes	1	80-56-8	alpha-Pinene	136.2	156.3	4.227	1	1								1	1	1	5
79		2	99-86-5	alpha-Terpinene	136.2	177.4	1.319												1	1
80		3	127-91-3	beta-Pinene	136.2	166.2	2.576	1	1									1		3
81		4	99-85-4	gamma-Terpinene	136.2	183.2	0.947													0
82		5	13466-78-9	3-Carene	136.2	170.2	3.72 @25ºC	1											1	2
83		6	79-92-5	Camphene	136.2	160.7	3.685				1									1
84		7	138-86-3	Limonene	136.2	176.7	1.743	1	1									1		3
85	Other	1	3777-69-3	2-Pentylfuran	138.2	58.2		1												1
86		2	872-50-4	1-Methyl-2-pyrrolidinone	99.1	202.2	0.293					1							1	2
87		3	64-19-7	Acetic acid	60.1	118.1	14.028												1	1
88		4	142-62-1	Hexanoic acid	116.2	205.9	0.0435 @25ºC	1											1	2
89		5	142-96-1	n-Butyl ether	130.2	140.4	5.313												1	1
90		6	109-52-4	Pentanoic acid	102.1	185.7	0.207												1	1

[1] Properties

MW: Molecular weight
BP: Boiling point
VP: Vapour pressure

Ref: Chemical properties handbook, McGraw Hill

URL: http://www.knovel.com/knovel2/Toc.jsp?SpaceID=10093&BookID=49&NodeID=78617026#node78617026

**2,2,4-Trimethyl-1,3-pentanediol diisobutyrate

[2] Existing Lists

#	List Name	Agency	Total # (1)	Total # (2)
1	EC VOC list	Eur. Com.	63	58
2	Japanese List	JEA	52	45
3	Priority Substances List 1 & 2	HC	44, 25	24
4	Domestic Substances List for the pilot program	HC	30, 10	19
5	Proposition 65	OEHHA	701	21
6	2001 CERCLA	ATSDR	275	30
7	HAPs	EPA	188	36
8	Air Pollutants	WHO	55	34
9	Chronic reference exposure level (C-REL)	OEHHA	78	40
10	Voluntary Children's Chem. Eval. Program (VCCEP)	EPA	23	39
11	Method 2549	NIOSH	42	51
12	Cal Target List	Cal-DHS	121	87

Total # (1): total # of compounds on the list.
Total # (2): total # of compounds overlapping with those on IRC target list.

Table 3. Reference levels for Target VOCs.

VOC #	Group	#	CAS #	Chemical Compound	Reference Levels (μg/m³)							
					WHO Guidelines [3]		C-REL[4]	OSHA [5]	Odor Detect.	Mucous Mem.	Occup. Exposure Limit [6]	
					(ug/m³)	(avg. time)		PEL	Threshold [6]	Irr.Threshold	Denmark	USA
1	Aldehydes	1	75-07-0	Acetaldehyde	50	(1 yr)	9	3.6E+05	3.4E+02	2.1E+05	4.5E+04	4.5E+04
2		2	107-02-8	Acrolein	50	(30 min)	0.06	2.3E+02	4.1E+02	1.2E+02	2.3E+02	2.3E+02
3		3	100-52-7	Benzaldehyde					1.9E+02	4.8E+04		
4		4	123-72-8	Butanal					2.8E+01	1.1E+05		
5		5	112-31-2	Decanal					5.9E+00			
6		6	50-00-0	Formaldehyde	100	(30 min)	3	9.2E+02	1.1E+03	1.5E+02	3.7E+02	3.7E+02
7		7	98-01-1	Furfural				2.0E+04	2.5E+02	3.1E+04	7.9E+03	7.9E+03
8		8	111-71-7	Heptanal					2.3E+01			
9		9	66-25-1	Hexanal					5.8E+01	1.3E+05		
10		10	124-19-6	Nonanal					1.4E+01			
11		11	124-13-0	Octanal					7.2E+00			
12		12	110-62-3	Pentanal					2.2E+01	1.2E+05	1.8E+05	1.8E+05
13	Ketones	1	78-93-3	Methyl ethyl ketone				5.9E+05	8.7E+02	8.9E+05	1.5E+05	5.9E+05
14		2	67-64-1	Acetone	n.p.			2.4E+06	1.4E+04	3.1E+06	5.9E+05	1.8E+06
15		3	98-86-2	Acetophenone					1.8E+03	1.5E+04		4.9E+04
16		4	108-94-1	Cyclohexanone				2.0E+05	8.3E+01	9.3E+04	1.0E+05	1.0E+05
17		5	108-10-1	Methyl isobutyl ketone				4.1E+05	5.4E+02	4.0E+05	1.0E+05	2.0E+05
18	Alcohols, Glycols, GlycoEthers	1	107-21-1	1,2-Ethanediol			400		6.3E+04		1.3E+05	1.3E+05
19		2	57-55-6	1,2-Propanediol								
20		3	71-36-3	1-Butanol				3.0E+05	9.0E+01	3.6E+05	1.5E+05	1.5E+05
21		4	107-98-2	1-Methoxy-2-propanol			7000		1.2E+01		1.8E+05	3.7E+05
22		5	71-23-8	1-Propanol	n.p.			5.0E+05	6.0E+03	7.7E+05	4.9E+05	4.9E+05
23		6	111-76-2	2-Butoxyethanol	13100	(1 wk)		2.4E+05	5.1E+00	4.2E+05	1.2E+05	1.2E+05
24		7	112-34-5	2-(2-Butoxyethoxy)ethanol					9.2E+00			
25		8	110-80-5	2-Ethoxyethanol	n.p.		70	7.4E+05	4.6E+03		1.9E+04	1.9E+04
26		9	104-76-7	2-Ethyl-1-hexanol					5.0E+02	7.2E+03		
27		10	109-86-4	2-Methoxyethanol	n.p.		60	8.0E+04	3.6E+03		1.6E+04	1.6E+04
28		11	75-65-0	2-Methyl-2-propanol				3.0E+05	7.1E+04		1.5E+05	3.0E+05
29		12	67-63-0	2-Propanol	n.p.		7000	9.8E+05	1.2E+03	7.1E+05	4.9E+05	9.8E+05
30		13	64-17-5	Ethanol				1.9E+06	2.8E+02	1.1E+06	1.9E+06	1.9E+06
31		14	108-95-2	Phenol			200	1.9E+04	4.3E+02	2.0E+04	3.9E+03	1.9E+04
32	Esters	1	108-21-4	1-Methylethyl acetate				1.0E+06	1.0E+04	5.4E+05	6.3E+05	1.0E+06
33		2	111-15-9	2-Ethoxyethyl acetate	n.p.		300	5.4E+05	1.0E+03	1.2E+05	2.7E+04	2.7E+04
34		3	123-86-4	Butyl acetate				7.1E+05	4.7E+01	1.1E+05	7.1E+05	7.1E+05
35		4	141-78-6	Ethyl acetate				1.4E+06	2.4E+03	6.6E+04	5.4E+05	1.4E+06
36		5	6846-50-0	TM-PD-DIB**								

Table 3 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Reference Levels (μg/m³)							
					WHO Guidelines [3]		C-REL[4]	OSHA [5]	Odor Detect.	Mucous Mem.	Occup. Exposure Limit [6]	
					(ug/m³)	(avg. time)		PEL	Threshold [6]	Irr.Threshold	Denmark	USA
37	Halo-Carbons	1	95-50-1	1,2-Dichlorobenzene				3.0E+05	4.5E+02	3.3E+04	1.5E+05	1.5E+05
38		2	106-46-7	1,4-Dichlorobenzene	1000	(1 yr)	800	4.5E+05	3.0E+02		1.5E+05	6.0E+04
39		3	75-09-2	Dichloromethane			400	8.7E+04	3.4E+03		1.2E+05	1.7E+05
40		4	79-01-6	Trichloroethylene	n.v.		600	5.4E+05	8.0E+03		5.4E+04	2.7E+05
41	Aliphatic Hydrocarbons	1	107-83-5	2-Methylpentane					2.9E+02		7.1E+05	1.8E+06
42		2	96-14-0	3-Methylpentane								
43		3	124-18-5	Decane					4.4E+03		2.6E+05	
44		4	112-40-3	Dodecane					1.5E+04			
45		5	142-82-5	Heptane				2.1E+06	4.1E+04	2.2E+06	8.2E+05	1.6E+06
46		6	544-76-3	Hexadecane								
47		7	110-54-3	Hexane			7000	1.8E+06	7.9E+04		8.8E+04	1.8E+05
48		8	111-84-2	Nonane					6.8E+03		1.0E+06	1.0E+06
49		9	111-65-9	Octane				2.3E+06	2.8E+04		9.3E+05	1.4E+06
50		10	629-62-9	Pentadecane								
51		11	629-59-4	Tetradecane								
52		12	629-50-5	Tridecane					1.7E+04			
53		13	1120-21-4	Undecane					7.8E+03			
54	Aromatic Hydrocarbons	1	95-93-2	1,2,4,5-Tetramethylbenzene					1.5E+02			
55		2	611-14-3	2-Ethyltoluene								
56		3	620-14-4	3-Ethyltoluene								
57		4	622-96-8	4-Ethyltoluene								
58		5	4994-16-5	4-Phenylcyclohexene								
59		6	71-43-2	Benzene	n.v.		60	3.2E+04	3.3E+04		1.6E+04	3.2E+04
60		7	526-73-8	1,2,3-Trimethylbenzene								
61		8	95-63-6	1,2,4-Trimethylbenzene					7.8E+02		1.2E+05	1.2E+05
62		9	95-47-6	1,2-Dimethylbenzene	870 *	(1 yr)	700 *	4.3E+05 *	3.8E+03	1.9E+05	1.5E+05 *	4.3E+05 *
63		10	108-67-8	1,3,5-Trimethylbenzene					1.2E+03		1.2E+05	1.2E+05
64		11	108-38-3	1,3-Dimethylbenzene	870 *	(1 yr)	700 *	4.3E+05 *	1.4E+03		1.5E+05 *	4.3E+05 *
65		12	106-42-3	1,4-Dimethylbenzene	870 *	(1 yr)	700 *	4.3E+05 *	2.1E+03	1.8E+05	1.5E+05 *	4.3E+05 *
66		13	98-82-8	Isopropylbenzene				2.5E+05	1.2E+02	3.4E+05	2.5E+05	2.5E+05
67		14	103-65-1	Propylbenzene					4.8E+01	2.3E+05		
68		15	100-41-4	Ethylbenzene	22000	(1 yr)	2000	4.3E+05	1.0E+04	3.2E+05	1.5E+05	3.1E+05
69		16	91-20-3	Naphthalene			9	5.5E+04	7.9E+01		5.5E+04	5.5E+04
70		17	99-87-6	4-Isopropyltoluene					1.2E+01		1.3E+05	
71		18	100-42-5	Styrene	260	(1 wk)	900	4.3E+05	1.6E+02	5.1E+04	1.1E+05	2.1E+05
72		19	108-88-3	Toluene	260	(1 wk)	300	7.5E+05	6.4E+02	4.9E+05	1.3E+05	1.9E+05

Table 3 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Reference Levels (μg/m³)							
					WHO Guidelines [3]		C-REL[4]	PEL [5]	Odor Detect.	Mucous Mem.	Occup. Exposure Limit [6]	
					(ug/m³)	(avg. time)			Threshold [6]	Irr.Threshold	Denmark	USA
73	CycloAlkanes	1	110-82-7	Cyclohexane				1.0E+06	3.2E+05		6.9E+05	1.0E+06
74		2	1678-93-9	Butylcyclohexane								
75		3	1678-91-7	Ethylcyclohexane								
76		4	1678-92-8	Propylcyclohexane								
77		5	91-17-8	Decahydronaphthalene					5.7E+05			
78	Terpenes	1	80-56-8	alpha-Pinene					3.9E+03			
79		2	99-86-5	alpha-Terpinene					2.3E+03			
80		3	127-91-3	beta-Pinene								
81		4	99-85-4	gamma-Terpinene					1.5E+03			
82		5	13466-78-9	3-Carene								
83		6	79-92-5	Camphene								
84		7	138-86-3	Limonene					2.5E+03			
85	Other	1	3777-69-3	2-Pentylfuran								
86		2	872-50-4	1-Methyl-2-pyrrolidinone								
87		3	64-19-7	Acetic acid				2.5E+04	4.3E+01	2.3E+04	2.5E+04	2.5E+04
88		4	142-62-1	Hexanoic acid					6.0E+01			
89		5	142-96-1	n-Butyl ether					3.0E+01			
90		6	109-52-4	Pentanoic acid					2.0E+01			

[3] Guidelines for Air Quality (WHO)

- Guidelines for air pollutants with non-carcinogenic and carcinogenic health endpoints (Ref: http://www.who.int/environmental_information/Air/Guidelines/Chapter3.htm#3.2).
- n.p.: not provided & n.v.: no value is available for chemicals with cancer health endpoints.

[4] C-REL

- Non-caner chronic reference exposure level, Office of Env. Health Hazard Assessment, California EPA (Ref: http://www.oehha.org/air/chronic_rels/AllChrels.html).
- C-REL of a chemical is the airborne concentration that would pose no significant health risk to the general public.

[5] PEL

- PEL: permissible exposure level recommended by the Occupational Safety and Health Administration (OSHA), US Department of Labor

[6] VOCBASE

- Database with properties of 808 VOCs, B.Jensen, P.Wolkoff, Nat. Inst. Occup. Health, Denmark 1996
- **Mucous Membrane Irritation Level** = 0.03*RD50, where **RD50** is the conc. Inducing a 50% decrease in respiratory rate in mice
- **Occupational exposure limits**: Threshold limit values, American Conference of Governmental Industrial Hygienists (ACGIH), 1994 - 1995

*** Dimethylbenzenes (mixture of 1,2-, 1,3- & 1,4-dimethylbenzene, CAS #: 1330-20-7)**

****2,2,4-Trimethyl-1,3-pentanediol diisobutyrate**

Table 4. Chamber air concentration at 24 h (CMEIAQ-I, wet materials).

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (µg/m³) at 24 h															
					WET MATERIALS (CMEIAQ-I) [7]															
					AD3	AD6	AD10	CK2	CK5	CK9	PT5	PT7	PT8	UR3	UR5	UR8	WS6	WX2	WX4	WX6
1	Aldehydes	1	75-07-0	Acetaldehyde																
2		2	107-02-8	Acrolein																
3		3	100-52-7	Benzaldehyde						55.7	113.4	32.3		12.3	11.5	26.8			6.9	22.3
4		4	123-72-8	Butanal						3.2			34.2	61.4	12.6	154.8			24.9	
5		5	112-31-2	Decanal				3.8		8.6	206.5	208.6	86.2	336.9				290.2	34.7	215.3
6		6	50-00-0	Formaldehyde																
7		7	98-01-1	Furfural																
8		8	111-71-7	Heptanal							19.0			242.1						
9		9	66-25-1	Hexanal									66.8	432.8	96.2	1448.3			99.2	10.1
10		10	124-19-6	Nonanal	1.2			2.5		8.7	147.6	212.9		435.9					87.6	196.3
11		11	124-13-0	Octanal							41.6	55.3								48.4
12		12	110-62-3	Pentanal						10.3			41.7	177.3	36.6	349.1			44.5	
13	Ketones	1	78-93-3	Methyl ethyl ketone						19.5			143.3	21.8		102.2	20.0			
14		2	67-64-1	Acetone			11.4	38.8	27.7	1.1	19.2	47.0	110.7	103.1					14.3	
15		3	98-86-2	Acetophenone						9.9	232.0	58.0								32.0
16		4	108-94-1	Cyclohexanone							11.9									
17		5	108-10-1	Methyl isobutyl ketone										3.7						
18	Alcohols, Glycols, GlycoEthers	1	107-21-1	1,2-Ethanediol																
19		2	57-55-6	1,2-Propanediol							2701.6	6421.1								
20		3	71-36-3	1-Butanol										89.0		57.1				
21		4	107-98-2	1-Methoxy-2-propanol																
22		5	71-23-8	1-Propanol																
23		6	111-76-2	2-Butoxyethanol																
24		7	112-34-5	2-(2-Butoxyethoxy)ethanol																
25		8	110-80-5	2-Ethoxyethanol																
26		9	104-76-7	2-Ethyl-1-hexanol							86.7	23.5								
27		10	109-86-4	2-Methoxyethanol																
28		11	75-65-0	2-Methyl-2-propanol																
29		12	67-63-0	2-Propanol												91.0				
30		13	64-17-5	Ethanol	38.3															
31		14	108-95-2	Phenol																
32	Esters	1	108-21-4	1-Methylethyl acetate																
33		2	111-15-9	2-Ethoxyethyl acetate										34.1						
34		3	123-86-4	Butyl acetate																
35		4	141-78-6	Ethyl acetate	29.5				243.1	164.9										
36		5	6846-50-0	TM-PD-DIB**							23.2	108.7								4.1

Table 4 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (µg/m³) at 24 h															
					WET MATERIALS (CMEIAQ-I) [7]															
					AD3	AD6	AD10	CK2	CK5	CK9	PT5	PT7	PT8	UR3	UR5	UR8	WS6	WX2	WX4	WX6
37	Halo-Carbons	1	95-50-1	1,2-Dichlorobenzene											0.5	2.7				
38		2	106-46-7	1,4-Dichlorobenzene	0.9		3.3		0.7	1.9	6.2	2.9	5.4	4.9	4.4	16.0	3.4	7.7	4.6	
39		3	75-09-2	Dichloromethane			416.7													
40		4	79-01-6	Trichloroethylene									25.0	132.4					8.7	
41	Aliphatic Hydrocarbons	1	107-83-5	2-Methylpentane	0.9	1074.5	4.4			9.6				9.0	27.5	55.5				
42		2	96-14-0	3-Methylpentane	1.5	613.9				4.3				5.6	6.9	18.7				
43		3	124-18-5	Decane	0.2	1.4	10.3		7069.1	13.8			2039.4	2147.5	2396.7	15796.3	12926.3	4108.4	2554.7	
44		4	112-40-3	Dodecane	0.6			0.4	677.4	6.8	5.1		1228.3	314.3	424.1	891.9	2783.5	1708.9	443.8	
45		5	142-82-5	Heptane						3.5	6.1	2.6	5.3	19.6	10.9	35.9			4.2	
46		6	544-76-3	Hexadecane	30.3						6.5									
47		7	110-54-3	Hexane		11.1	50.0			9.5	91.8	3.5	6.7	17.1	195.6	28.9	1.3		3.5	
48		8	111-84-2	Nonane			3.5	0.1	1600.6	30.6	16.9	8.7	234.1	184.0	1711.3	4839.6	8430.9	1119.8	765.4	
49		9	111-65-9	Octane			21.6		2.1	3.0	10.2		8.3	33.6	14.2	73.0	11.7	15.4	3.8	
50		10	629-62-9	Pentadecane	308.4						4.9		4.0						1.6	
51		11	629-59-4	Tetradecane	501.7						9.3		22.3	7.5				45.2	1.5	
52		12	629-50-5	Tridecane	45.8				0.9				104.7	16.3	3.4	9.9		255.7	5.7	
53		13	1120-21-4	Undecane	0.3	1.3	8.2	0.9	4274.4	21.3	2.1		5362.0	1124.5	1143.3	10594.9	8377.6	4011.3	1228.7	
54	Aromatic Hydrocarbons	1	95-93-2	1,2,4,5-Tetramethylbenzene						1.7			66.5	12.4	24.3	18.3		322.8		
55		2	611-14-3	2-Ethyltoluene			0.6		7.5	50.0			8.3	48.4	3.9	12.8	23.4	570.6	13.4	
56		3	620-14-4	3-Ethyltoluene			3.2		19.5	659.1			34.1	228.8	12.8	55.0	106.0	1049.7	6.4	
57		4	622-96-8	4-Ethyltoluene			1.0		10.7	265.3			15.8	85.4	5.8	21.9	46.2	510.4	2.7	
58		5	4994-16-5	4-Phenylcyclohexene																
59		6	71-43-2	Benzene	4.1	0.9	5.1	0.7	11.1	6.5	14.9	8.2	25.7	15.1	4.9	45.1	5.5	5.3	12.5	7.5
60		7	526-73-8	1,2,3-Trimethylbenzene					13.1	10.0			94.1	111.5	12.9	40.8	48.0	1145.2	15.6	
61		8	95-63-6	1,2,4-Trimethylbenzene					39.6	231.1			62.7	385.7	25.6	64.3	147.1	1688.8	14.8	
62		9	95-47-6	1,2-Dimethylbenzene			1.3		15.3	20806.4	2.7		19.1	36.7	1.8	438.1	153.1	158.5	4.6	
63		10	108-67-8	1,3,5-Trimethylbenzene			0.7		13.7	208.1			13.3	89.3	8.0	19.2	48.2	632.2	5.7	
64		11	108-38-3	1,3-Dimethylbenzene	0.9	1.0	5.8		21.4	33970.3	2.7		66.7	115.3	8.3	2911.4	686.8	261.7	7.0	0.8
65		12	106-42-3	1,4-Dimethylbenzene	0.6		4.0		14.7	23354.6	1.9		45.9	79.3	5.7	2001.6	472.2	179.9	4.8	0.5
66		13	98-82-8	Isopropylbenzene						290.4	15.0			15.1	0.7	6.3	8.3		1.1	
67		14	103-65-1	Propylbenzene			1.3		7.2	118.7	6.4		6.5	46.5	2.2	12.5	19.2	269.2	5.2	
68		15	100-41-4	Ethylbenzene			1.8		4.1	42518.7	5.3		9.7	21.5	1.3	380.7	114.2	28.8	1.3	
69		16	91-20-3	Naphthalene	0.0					3.1	5.6		87.8	3.5	2.6			44.7	2.8	
70		17	99-87-6	4-Isopropyltoluene						2.7										
71		18	100-42-5	Styrene			17.3				7.9									
72		19	108-88-3	Toluene	2.5	1.1	8.7	0.2	8.1	408.3	2.7		17.7	22.6	4.4	210.0	4.7	6.5	11.6	0.7

Table 4 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (µg/m³) at 24 h															
					WET MATERIALS (CMEIAQ-I) [7]															
					AD3	AD6	AD10	CK2	CK5	CK9	PT5	PT7	PT8	UR3	UR5	UR8	WS6	WX2	WX4	WX6
73	Cyclo-Alkanes	1	110-82-7	Cyclohexane		5.3	0.4		84.6	28.3				2.0	0.6	7.3				
74		2	1678-93-9	Butylcyclohexane					666.1	2.9				201.4	405.5	1761.6	2397.8	462.8	277.1	
75		3	1678-91-7	Ethylcyclohexane			4.3		23.9	12.6			2.9	6.5	4.2	107.7	29.7			
76		4	1678-92-8	Propylcyclohexane					724.7	8.1			73.4	135.0	658.3	1629.6	3426.2	301.5	329.6	
77		5	91-17-8	Decahydronaphthalene					282.8	7.3			249.4	74.8	277.1	846.5	1547.9	72.1	263.4	
78	Terpenes	1	80-56-8	alpha-Pinene						7.5										
79		2	99-86-5	alpha-Terpinene																
80		3	127-91-3	beta-Pinene																
81		4	99-85-4	gamma-Terpinene																
82		5	13466-78-9	3-Carene																
83		6	79-92-5	Camphene						15.1										
84		7	138-86-3	Limonene						162.0										23.6
85	Other	1	3777-69-3	2-Pentylfuran																
86		2	872-50-4	1-Methyl-2-pyrrolidinone																
87		3	64-19-7	Acetic acid	1.7			4436.7				76.5			3.8					
88		4	142-62-1	Hexanoic acid																
89		5	142-96-1	n-Butyl ether								15.5								
90		6	109-52-4	Pentanoic acid																
				TVOC *	9618	2998	984	4797	92393	100701	11958	22115	87506	35248	52827	61800	10650	106558	48313	20671

* Compounds calibrated against toluene.
**2,2,4-Trimethyl-1,3-pentanediol diisobutyrate

[7] Materials

AD3: Adhesive (water proof)
AD6: Adhesive (interior & exterior use)
AD10: Adhesive (residential flooring)
CK2: Caulking sealant (for bath and kitchen)
CK5: Caulking sealant (100% silicon for door & window frames)
CK9: Thermoplastic caulking
PT1: Paint (water based)
PT2: Paint (water based)
PT8: Paint (oil based)
UR3: Polyurethane (oil based)
UR5: Polyurethane (oil based)
UR8: Polyurethane (oil based)
WS6: Wood stain (oil based)
WX2: Floor wax (oil based)
WX4: Floor wax (oil based)
WX6: Acrylic floor polishing (for regular & non-wax floor)

Table 5. Chamber air concentration at 24 h (CMEIAQ-I, dry materials).

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (µg/m³) at 24 h													
					DRY MATERIALS (CMEIAQ-I) [8]													
					ACT1	ACT2	ACT3	CRP1	CRP2	CRP3	CRP4	CRP5	CRP6	GB1	GB2	GB3	MPL1	OAK1
1	Aldehydes	1	75-07-0	Acetaldehyde														
2		2	107-02-8	Acrolein														
3		3	100-52-7	Benzaldehyde	0.26		0.65				0.21	0.07	0.76	0.58	0.39	0.13	0.43	
4		4	123-72-8	Butanal	0.35	0.41	0.52	0.08		0.14			0.26	0.83			0.62	
5		5	112-31-2	Decanal	0.47	0.53	1.93						6.11		7.01	8.49	10.43	1.40
6		6	50-00-0	Formaldehyde														
7		7	98-01-1	Furfural													0.48	
8		8	111-71-7	Heptanal	0.23		0.49						0.14	0.48	1.85	1.50	1.34	
9		9	66-25-1	Hexanal	3.70		3.11						0.12	2.86	3.62	0.99	1.43	0.29
10		10	124-19-6	Nonanal	0.36	0.31	1.43		0.31						10.18	6.88	11.19	1.23
11		11	124-13-0	Octanal	0.23		0.61				0.16		1.44	0.48	1.75	1.63	5.42	0.34
12		12	110-62-3	Pentanal	1.75		1.03							0.53	0.86	0.82	0.76	
13	Ketones	1	78-93-3	Methyl ethyl ketone		0.16				0.04	0.32		0.10	1.02			0.67	
14		2	67-64-1	Acetone	0.86	0.51	2.14	38.88	0.30	0.50	0.36	0.35	0.44				6.38	4.18
15		3	98-86-2	Acetophenone				0.19			0.22		0.66	0.06			0.14	
16		4	108-94-1	Cyclohexanone											1.19			
17		5	108-10-1	Methyl isobutyl ketone					0.12					4.77				
18	Alcohols, Glycols, GlycoEthers	1	107-21-1	1,2-Ethanediol														
19		2	57-55-6	1,2-Propanediol				1.66					2.83					
20		3	71-36-3	1-Butanol													0.91	
21		4	107-98-2	1-Methoxy-2-propanol														
22		5	71-23-8	1-Propanol														
23		6	111-76-2	2-Butoxyethanol														
24		7	112-34-5	2-(2-Butoxyethoxy)ethanol														
25		8	110-80-5	2-Ethoxyethanol														
26		9	104-76-7	2-Ethyl-1-hexanol	0.07		0.56							0.68	2.60	7.65	0.94	
27		10	109-86-4	2-Methoxyethanol														
28		11	75-65-0	2-Methyl-2-propanol														
29		12	67-63-0	2-Propanol				96.18										
30		13	64-17-5	Ethanol					0.16								0.79	
31		14	108-95-2	Phenol		13.63											13.89	
32	Esters	1	108-21-4	1-Methylethyl acetate														
33		2	111-15-9	2-Ethoxyethyl acetate											2.30		5.81	
34		3	123-86-4	Butyl acetate										0.03				
35		4	141-78-6	Ethyl acetate			0.43											1.43
36		5	6846-50-0	TM-PD-DIB**	14.93		13.01											

Table 5 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (μg/m³) at 24 h													
					DRY MATERIALS (CMEIAQ-I) [8]													
					ACT1	ACT2	ACT3	CRP1	CRP2	CRP3	CRP4	CRP5	CRP6	GB1	GB2	GB3	MPL1	OAK1
37	Halo-Carbons	1	95-50-1	1,2-Dichlorobenzene						0.08	0.52	0.14	0.07					
38		2	106-46-7	1,4-Dichlorobenzene	0.08	0.06		0.03			0.09		0.30	0.34	1.09	0.32	0.22	
39		3	75-09-2	Dichloromethane	0.15		0.14	0.32	0.15	0.13	0.17			0.09			0.03	
40		4	79-01-6	Trichloroethylene				0.07				0.19		0.12	1.78		0.78	
41	Aliphatic Hydrocarbons	1	107-83-5	2-Methylpentane	0.20		0.03	0.53		0.03	0.04	0.12		1.19	0.11		0.09	
42		2	96-14-0	3-Methylpentane	0.25			0.11			0.03	0.02		0.13			0.06	
43		3	124-18-5	Decane	0.06	0.66	0.11	0.71	0.12	0.82	0.51	0.26	1.00	0.57	1.59	0.92	0.58	0.03
44		4	112-40-3	Dodecane	0.42	0.23	1.91	5.26	1.43	10.83	3.17	0.29	2.73	0.19	3.90	1.70	0.36	0.07
45		5	142-82-5	Heptane	0.03		0.03	86.42						0.13			0.03	
46		6	544-76-3	Hexadecane	0.15	2.14	0.64	444.62	0.47	0.36	143.70	0.06	0.19				0.08	0.04
47		7	110-54-3	Hexane	0.53	0.03	0.07	0.25		0.04		0.05	0.14	0.34			0.13	
48		8	111-84-2	Nonane		0.11				0.13	0.08		0.03	0.38	0.31		0.15	
49		9	111-65-9	Octane	0.07								0.03	0.19			0.05	0.01
50		10	629-62-9	Pentadecane	0.39	4.39	1.35	1.15	1.99	3.45	2.27	1.36	5.08		0.77	0.84	0.14	0.06
51		11	629-59-4	Tetradecane	1.08	2.76	3.22	2.99	1.46	23.73	2.46	0.24	0.79	0.29	2.44	3.54	0.27	0.22
52		12	629-50-5	Tridecane	1.02	0.70	2.97	1.36	1.18	28.93	5.54	0.31	0.31	0.19	1.68	5.02	0.09	0.21
53		13	1120-21-4	Undecane	0.08	0.24	0.33	4.70	0.62	2.20	1.47	0.70	2.74	0.34	2.64	1.29	0.54	0.03
54	Aromatic Hydrocarbons	1	95-93-2	1,2,4,5-Tetramethylbenzene	0.00					0.20	0.18		0.17		0.08		0.03	
55		2	611-14-3	2-Ethyltoluene		0.06	0.02			0.05	0.04	0.04	0.06	0.05	0.12	0.10	0.02	
56		3	620-14-4	3-Ethyltoluene	0.03	0.37	0.07	0.26		0.18	0.21	0.23	0.44	0.14	0.34	0.28	0.04	
57		4	622-96-8	4-Ethyltoluene	0.02	0.14	0.07	0.11		0.11	0.11	0.15	0.22	0.07	0.20	0.07	0.02	
58		5	4994-16-5	4-Phenylcyclohexene	0.01	0.02	0.03	31.09	3.35	4.44	4.37	6.62	16.69					
59		6	71-43-2	Benzene	0.06	0.07	0.05	0.29	0.08	0.10	0.12	0.10	0.19	0.18	0.19	0.13	0.17	0.05
60		7	526-73-8	1,2,3-Trimethylbenzene	0.01	0.07	0.03	0.11		0.14			0.06	0.20	0.22	0.17		
61		8	95-63-6	1,2,4-Trimethylbenzene	0.03	0.35	0.05	0.27		0.24	0.22	0.06	0.18	0.19	0.44	0.34	0.09	
62		9	95-47-6	1,2-Dimethylbenzene	0.02	0.05	0.02	16.09	0.04	0.17	0.22	0.95	0.09	0.18	0.45	0.22	0.11	0.01
63		10	108-67-8	1,3,5-Trimethylbenzene	0.01	0.08	0.03	0.05		0.06	0.09	0.04	0.04	0.06	0.15	0.11	0.03	
64		11	108-38-3	1,3-Dimethylbenzene	0.09	0.17	0.08	132.54	0.09	0.31	0.88	0.62	0.25	0.90	2.43	1.49	0.27	0.06
65		12	106-42-3	1,4-Dimethylbenzene	0.06	0.12	0.05	91.12	0.06	0.22	0.60	0.43	0.17	0.62	1.67	1.03	0.19	0.04
66		13	98-82-8	Isopropylbenzene				0.16		0.36	0.07	2.14	1.13				0.02	
67		14	103-65-1	Propylbenzene		0.07	0.01	0.14		0.29	0.07	0.97	0.98	0.11		0.08	0.02	
68		15	100-41-4	Ethylbenzene	0.02	0.05	0.02	19.82	0.01	0.06	0.17	0.22	0.08	0.15	0.39	0.29	0.05	0.02
69		16	91-20-3	Naphthalene			0.04	0.33	0.06	0.14	0.32		0.13		0.12	0.21	0.34	
70		17	99-87-6	4-Isopropyltoluene		0.03	0.33		0.04	0.11	0.03		0.07	2.54	0.44		0.71	
71		18	100-42-5	Styrene	0.01		0.03	0.52	0.56	2.83	0.09	2.97	6.05		0.11		0.03	0.00
72		19	108-88-3	Toluene	1.40	0.38	0.03	3.05	0.02	0.43	1.00	0.63	0.59	1.28	1.33	0.48	0.33	0.11

Table 5 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (μg/m³) at 24 h													
					DRY MATERIALS (CMEIAQ-I) [8]													
					ACT1	ACT2	ACT3	CRP1	CRP2	CRP3	CRP4	CRP5	CRP6	GB1	GB2	GB3	MPL1	OAK1
73	Cyclo-Alkanes	1	110-82-7	Cyclohexane	0.01			0.52			0.29	0.26		0.04				
74		2	1678-93-9	Butylcyclohexane						0.08								
75		3	1678-91-7	Ethylcyclohexane	0.02													
76		4	1678-92-8	Propylcyclohexane		0.04				0.07								
77		5	91-17-8	Decahydronaphthalene														
78	Terpenes	1	80-56-8	alpha-Pinene		0.27	0.12			0.14	0.17		0.15	39.85	16.94	3.56		
79		2	99-86-5	alpha-Terpinene			0.45							0.10				
80		3	127-91-3	beta-Pinene		0.12	0.10							4.41	4.40	1.38		
81		4	99-85-4	gamma-Terpinene			0.22							0.13				
82		5	13466-78-9	3-Carene		0.06	0.44							1.60	0.63			
83		6	79-92-5	Camphene			0.37							4.03	1.47	0.39		
84		7	138-86-3	Limonene		0.06	2.21	1.03	1.17	1.76	0.22	0.29	0.32	7.60	2.41	0.41	0.21	
85	Other	1	3777-69-3	2-Pentylfuran	0.12		0.31								0.39		0.18	
86		2	872-50-4	1-Methyl-2-pyrrolidinone														
87		3	64-19-7	Acetic acid	2.03		5.35	4.03	1.43	3.49	3.48	1.38			0.77	1.11	83.06	128.09
88		4	142-62-1	Hexanoic acid														
89		5	142-96-1	n-Butyl ether			0.04								0.43			
90		6	109-52-4	Pentanoic acid														
				TVOC *	48	53	125	798	82	267	156	144	404	72	147	124	133	111

* Compounds calibrated against toluene.

**2,2,4-Trimethyl-1,3-pentanediol diisobutyrate

[8] **Materials**

ACT1: Acoustical ceiling tile
ACT2: Acoustical ceiling tile
ACT3: Acoustical ceiling tile
CRP1: Carpet (nylon, latex backing, residential)
CRP2: Carpet (nylon, latex backing, residential)
CRP3: Carpet (nylon, latex backing, residential)
CRP4: Carpet (olefin, commercial)
CRP5: Carpet (polypropylene, commercial)
CRP6: Carpet (nylon, commercial)
GB1: Gypsum wallboard
GB2: Gypsum wallboard
GB3: Gypsum wallboard
MPL1: Solid maple
OAK1: Solid red oak

Table 5 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (μg/m³) at 24 h												
					DRY MATERIALS (CMEIAQ-I) [9]												
					OSB1	OSB2	OSB3	PIN1	PLY1	PLY2	PLY3	UP1	UP2	UP3	VIN1	VIN2	VIN3
1	Aldehydes	1	75-07-0	Acetaldehyde													
2		2	107-02-8	Acrolein													
3		3	100-52-7	Benzaldehyde	0.25	0.46	0.66				0.42	0.17		0.68		0.66	0.96
4		4	123-72-8	Butanal	1.35		19.42	0.92	2.94	1.45	2.65	0.08		0.47		0.11	
5		5	112-31-2	Decanal	0.07	24.57	3.25	2.68	2.98	6.63	10.40	0.73	0.33	4.29	0.21	0.47	
6		6	50-00-0	Formaldehyde													
7		7	98-01-1	Furfural	1.77												
8		8	111-71-7	Heptanal	1.41	2.66	2.93		0.62	1.68	1.66	0.09					
9		9	66-25-1	Hexanal	27.89	8.90	244.70	2.13	8.70	18.83	12.95	0.11					
10		10	124-19-6	Nonanal	2.52	24.63	2.63	4.43	2.92	8.60	9.97	2.17	0.29	3.84		0.25	1.36
11		11	124-13-0	Octanal		3.44	1.60	1.32	0.88	3.85	5.41	0.50	0.04			0.07	
12		12	110-62-3	Pentanal	6.70	11.21	20.61	2.16	3.16	4.59	4.47		0.03			0.04	
13	Ketones	1	78-93-3	Methyl ethyl ketone	0.36						1.28	2.18		1.43			
14		2	67-64-1	Acetone	3.01			1.93	4.79	4.03	8.74	0.49	0.44	1.66	0.22	0.41	0.20
15		3	98-86-2	Acetophenone	0.12											0.23	
16		4	108-94-1	Cyclohexanone													
17		5	108-10-1	Methyl isobutyl ketone													
18	Alcohols, Glycols, GlycoEthers	1	107-21-1	1,2-Ethanediol													
19		2	57-55-6	1,2-Propanediol									8.83	1.30			
20		3	71-36-3	1-Butanol	1.27							1.09		1.52	0.25	1.44	
21		4	107-98-2	1-Methoxy-2-propanol													
22		5	71-23-8	1-Propanol													
23		6	111-76-2	2-Butoxyethanol													
24		7	112-34-5	2-(2-Butoxyethoxy)ethanol													
25		8	110-80-5	2-Ethoxyethanol													
26		9	104-76-7	2-Ethyl-1-hexanol								0.84	0.41	1.50	0.54	1.29	
27		10	109-86-4	2-Methoxyethanol													
28		11	75-65-0	2-Methyl-2-propanol													
29		12	67-63-0	2-Propanol													
30		13	64-17-5	Ethanol						1.74							
31		14	108-95-2	Phenol													46.74
32	Esters	1	108-21-4	1-Methylethyl acetate				0.57					1.65		1.88		
33		2	111-15-9	2-Ethoxyethyl acetate	1.02												
34		3	123-86-4	Butyl acetate								0.24					
35		4	141-78-6	Ethyl acetate													
36		5	6846-50-0	TM-PD-DIB**									4.90	27.49			305.24

Table 5 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (μg/m³) at 24 h												
					DRY MATERIALS (CMEIAQ-I) [9]												
					OSB1	OSB2	OSB3	PIN1	PLY1	PLY2	PLY3	UP1	UP2	UP3	VIN1	VIN2	VIN3
37	Halo-Carbons	1	95-50-1	1,2-Dichlorobenzene								0.28					
38		2	106-46-7	1,4-Dichlorobenzene	0.36				0.32	0.69	0.18	0.34	0.03	0.53	0.01	0.07	0.14
39		3	75-09-2	Dichloromethane							1.27	0.32	0.33		0.13	0.12	
40		4	79-01-6	Trichloroethylene	0.50				0.23								
41	Aliphatic Hydrocarbons	1	107-83-5	2-Methylpentane	3.17			11.16		0.15			0.02		0.03		
42		2	96-14-0	3-Methylpentane	0.32					0.17			0.02				
43		3	124-18-5	Decane			0.97	2.93	0.19	0.81	0.46	1.36	0.18	1.61	0.10	0.28	6.22
44		4	112-40-3	Dodecane	0.27	2.07	0.15	1.70	0.12	0.27	0.19	7.14	2.99	4.33	0.72	0.28	132.31
45		5	142-82-5	Heptane	0.24		0.15	0.44	1.10	0.36	0.14		0.00			0.02	
46		6	544-76-3	Hexadecane			0.09			0.13	0.12		0.24	2.06	0.16	0.43	2.94
47		7	110-54-3	Hexane	1.10		0.76	2.44	0.29	0.31	0.17			0.07	0.02	0.02	
48		8	111-84-2	Nonane	0.51	0.48	0.79		0.20		0.17					0.02	0.94
49		9	111-65-9	Octane	0.63	0.28	1.42	0.37	2.09	0.66	0.23				0.16		
50		10	629-62-9	Pentadecane			0.10		0.22	0.19	0.16	0.27	1.64	12.26	0.57	0.58	25.63
51		11	629-59-4	Tetradecane	0.16	0.70	0.16	0.50	0.69	0.61	0.24	3.92	6.84	53.29	0.57	0.86	323.32
52		12	629-50-5	Tridecane		0.66	0.05		0.19	0.15		10.53	8.18	39.20	0.06	0.48	361.59
53		13	1120-21-4	Undecane	0.15	1.70	0.53	0.84	0.26	0.59	0.24	6.50	0.94	1.76	0.81	0.41	6.14
54	Aromatic Hydrocarbons	1	95-93-2	1,2,4,5-Tetramethylbenzene								2.54	0.04	0.76		0.06	
55		2	611-14-3	2-Ethyltoluene	0.03							1.61	0.00	0.08		0.01	0.53
56		3	620-14-4	3-Ethyltoluene	0.09							0.53	0.01	0.25		0.05	1.37
57		4	622-96-8	4-Ethyltoluene	0.04							0.24	0.00	0.17		0.02	0.68
58		5	4994-16-5	4-Phenylcyclohexene								0.78	0.76	11.74	0.06		
59		6	71-43-2	Benzene	0.74	0.40	0.62	0.54	0.28	0.18	0.27	0.08	0.10	0.14	0.04	0.06	0.18
60		7	526-73-8	1,2,3-Trimethylbenzene								2.27	0.01	0.41		0.03	1.98
61		8	95-63-6	1,2,4-Trimethylbenzene	0.12							2.19	0.02	0.69		0.06	3.23
62		9	95-47-6	1,2-Dimethylbenzene	0.17		0.06	0.09	0.09	0.12	0.03	0.35	0.02	0.16	0.02	0.03	
63		10	108-67-8	1,3,5-Trimethylbenzene	0.03							0.28	0.00	0.13		0.02	0.86
64		11	108-38-3	1,3-Dimethylbenzene	1.00	0.53	0.13	1.13	0.39	0.37	0.09	1.15	0.05	0.53	0.10	0.12	
65		12	106-42-3	1,4-Dimethylbenzene	0.68	0.36	0.09	0.77	0.27	0.25	0.07	0.79	0.04	0.36	0.07	0.08	
66		13	98-82-8	Isopropylbenzene							0.03			0.05		0.03	0.14
67		14	103-65-1	Propylbenzene								0.14		0.07		0.01	0.29
68		15	100-41-4	Ethylbenzene	0.14	0.12	0.05	0.10	0.09	0.06	0.02	0.18	0.01	0.12	0.02	0.03	
69		16	91-20-3	Naphthalene	0.05					0.05		1.60	0.14	6.18	0.08	0.17	0.41
70		17	99-87-6	4-Isopropyltoluene			0.31	33.40	23.06	2.29	12.42	0.20				0.01	
71		18	100-42-5	Styrene	0.04		0.08					0.53		0.24			
72		19	108-88-3	Toluene	0.73	0.23	0.11	1.37	2.16	0.56	0.33	1.28	0.02	0.72	0.07	0.13	0.32

Table 5 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (μg/m³) at 24 h												
					DRY MATERIALS (CMEIAQ-I) [9]												
					OSB1	OSB2	OSB3	PIN1	PLY1	PLY2	PLY3	UP1	UP2	UP3	VIN1	VIN2	VIN3
73	Cyclo-Alkanes	1	110-82-7	Cyclohexane	0.10			0.76						0.02			
74		2	1678-93-9	Butylcyclohexane													0.54
75		3	1678-91-7	Ethylcyclohexane													
76		4	1678-92-8	Propylcyclohexane													
77		5	91-17-8	Decahydronaphthalene													
78	Terpenes	1	80-56-8	alpha-Pinene	2.44	2.37	6.55	1027.55	133.44	22.30	17.45						
79		2	99-86-5	alpha-Terpinene				16.41	9.42		2.95						
80		3	127-91-3	beta-Pinene			4.08	574.55	44.79	18.53	24.91						
81		4	99-85-4	gamma-Terpinene				11.76	2.25	0.12	0.51						
82		5	13466-78-9	3-Carene	0.37		1.03	4.66	82.74	6.09	17.65						
83		6	79-92-5	Camphene	0.23		0.40	148.76	19.39	3.00	3.51						
84		7	138-86-3	Limonene	0.60		0.70	228.89	44.58	6.29	14.98	1.61	0.09	0.96			
85	Other	1	3777-69-3	2-Pentylfuran	3.70	45.15	19.82			1.18	2.02						
86		2	872-50-4	1-Methyl-2-pyrrolidinone													
87		3	64-19-7	Acetic acid		74.87		23.26		10.56	6.24	1.77	0.31	1.35	0.34	0.55	
88		4	142-62-1	Hexanoic acid													
89		5	142-96-1	n-Butyl ether											0.02		
90		6	109-52-4	Pentanoic acid													
				TVOC *	129	194	469	1688	245	156	281	214	72	186	19	104	2750

* Compounds calibrated against toluene.

**2,2,4-Trimethyl-1,3-pentanediol diisobutyrate

[9] **Materials**

OSB1: Oriented strand board (wafferboard)
OSB2: Oriented strand board (7/16")
OSB3: Oriented strand board (5/8")
PIN1: Solid pine
PLY1: Plywood (3/4", face/back: douglas fir, resin: phenol formaldehyde)
PLY2: Plywood (5/8", sheathing)
PLY3: Plywood (1/2", sheating, spruce, phenolic resin)
UP1: Underpad (foam chip)
UP2: Underpad (polyurethane foam)
UP3: Underpad (polyurethane foam)
VIN1: Vinyl tile (residential)
VIN2: Vinyl tile (commercial)
VIN3: Vinyl sheet (residential)

Table 6. Chamber air concentration at 24 h (CMEIAQ-II).

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (µg/m^3) at 24 h											
					MATERIALS (CMEIAQ-II) [10]											
					CT1	CT2	CRP7	CRP7a	HWF1	LAM1	LAM2	LAM3	LIN1	LIN2	MDF2	VWB1
1	Aldehydes	1	75-07-0	Acetaldehyde *	0.46	28.97	4.11	8.70	11.69	1.50	4.79	2.00	11.87	8.10	37.50	0.11
2		2	107-02-8	Acrolein												
3		3	100-52-7	Benzaldehyde *		3.11	2.20	10.26								
4		4	123-72-8	Butanal *		4.31						0.97			2.51	
5		5	112-31-2	Decanal			0.22					0.20	0.19	0.32	0.47	
6		6	50-00-0	Formaldehyde *	1.53	39.39	5.80	8.91	2.03	15.80	5.11	0.55	5.46	7.93	184.14	0.56
7		7	98-01-1	Furfural												
8		8	111-71-7	Heptanal		3.54				0.03		0.60	0.31	0.53	0.65	
9		9	66-25-1	Hexanal *		31.00						5.28	9.03	10.93	56.58	
10		10	124-19-6	Nonanal		1.66	0.38			0.13		0.18	0.57	0.55	1.39	
11		11	124-13-0	Octanal		1.22						0.11	0.51	0.57	1.45	
12		12	110-62-3	Pentanal *		44.30						3.21	6.48		12.11	
13	Ketones	1	78-93-3	Methyl ethyl ketone												
14		2	67-64-1	Acetone *	22.33	20.40	12.34	37.17	93.98	61.20	121.00	8.93	48.08		3.26	3.64
15		3	98-86-2	Acetophenone			0.39									
16		4	108-94-1	Cyclohexanone												
17		5	108-10-1	Methyl isobutyl ketone												0.16
18	Alcohols, Glycols, GlycoEthers	1	107-21-1	1,2-Ethanediol							0.27	0.56				
19		2	57-55-6	1,2-Propanediol												
20		3	71-36-3	1-Butanol												
21		4	107-98-2	1-Methoxy-2-propanol												
22		5	71-23-8	1-Propanol												0.21
23		6	111-76-2	2-Butoxyethanol												
24		7	112-34-5	2-(2-Butoxyethoxy)ethanol												
25		8	110-80-5	2-Ethoxyethanol												0.16
26		9	104-76-7	2-Ethyl-1-hexanol			2.12			0.10		0.68	0.16	0.80	0.83	
27		10	109-86-4	2-Methoxyethanol												
28		11	75-65-0	2-Methyl-2-propanol												
29		12	67-63-0	2-Propanol												
30		13	64-17-5	Ethanol					0.34							
31		14	108-95-2	Phenol												
32	Esters	1	108-21-4	1-Methylethyl acetate												
33		2	111-15-9	2-Ethoxyethyl acetate												
34		3	123-86-4	Butyl acetate												
35		4	141-78-6	Ethyl acetate					0.06							
36		5	6846-50-0	TM-PD-DIB**												

Table 6 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (µg/m³) at 24 h											
					MATERIALS (CMEIAQ-II) [10]											
					CT1	CT2	CRP7	CRP7a	HWF1	LAM1	LAM2	LAM3	LIN1	LIN2	MDF2	VWB1
37	Halo-Carbons	1	95-50-1	1,2-Dichlorobenzene												
38		2	106-46-7	1,4-Dichlorobenzene						0.04		0.03	0.02	0.12	0.02	
39		3	75-09-2	Dichloromethane												
40		4	79-01-6	Trichloroethylene												
41	Aliphatic Hydrocarbons	1	107-83-5	2-Methylpentane												
42		2	96-14-0	3-Methylpentane												
43		3	124-18-5	Decane			0.41	28373		0.045	0.00	0.13	0.05	0.02	0.08	0.07
44		4	112-40-3	Dodecane			0.07	172				0.07		0.02	0.05	0.03
45		5	142-82-5	Heptane		0.74	0.10		0.01		0.22	6.88	0.16	21.43	0.30	
46		6	544-76-3	Hexadecane						0.04			0.04			
47		7	110-54-3	Hexane								1.02				
48		8	111-84-2	Nonane			0.08	12340				1.32	0.05	0.02	0.05	
49		9	111-65-9	Octane		0.73	0.13	88				11.37	0.27	0.15	0.04	
50		10	629-62-9	Pentadecane			0.07			0.19			0.02			
51		11	629-59-4	Tetradecane			0.07								0.11	0.11
52		12	629-50-5	Tridecane												
53		13	1120-21-4	Undecane		0.62	0.29	10303				0.04	0.02	0.02	0.11	0.07
54	Aromatic Hydrocarbons	1	95-93-2	1,2,4,5-Tetramethylbenzene		0.12		207								
55		2	611-14-3	2-Ethyltoluene		0.14	0.21	2004				0.02			0.01	0.01
56		3	620-14-4	3-Ethyltoluene		0.07	0.44	562				0.02			0.01	0.01
57		4	622-96-8	4-Ethyltoluene		0.05	0.61	4036							0.06	0.01
58		5	4994-16-5	4-Phenylcyclohexene			0.04									
59		6	71-43-2	Benzene					0.00		0.03	1.08	0.08	2.94	0.51	0.17
60		7	526-73-8	1,2,3-Trimethylbenzene		0.10	0.14	2762		0.00		0.00				0.008
61		8	95-63-6	1,2,4-Trimethylbenzene		0.11	0.46	6522		0.01		0.01	0.01		0.02	0.02
62		9	95-47-6	1,2-Dimethylbenzene		0.21	0.12	863	0.00	0.007	0.00	0.05	0.05	0.01	0.03	0.02
63		10	108-67-8	1,3,5-Trimethylbenzene		0.16	0.39	2176		0.00		0.01	0.02		0.013	0.011
64		11	108-38-3	1,3-Dimethylbenzene		0.27	0.15	688	0.00	0.01	0.01	0.11	0.06	0.01	0.02	0.04
65		12	106-42-3	1,4-Dimethylbenzene		0.14	0.13	242	0.00	0.01		0.04	0.040	0.00	0.03	
66		13	98-82-8	Isopropylbenzene			0.04	2809								0.003
67		14	103-65-1	Propylbenzene			0.20	2065				0.02	0.01			
68		15	100-41-4	Ethylbenzene		0.10	0.08	148	0.002	0.00		0.08	0.02	0.01	0.036	0.015
69		16	91-20-3	Naphthalene			0.07	74		0.00				0.02		
70		17	99-87-6	4-Isopropyltoluene		0.08		484		0.021	0.00	0.01			0.03	
71		18	100-42-5	Styrene			0.07					0.02				
72		19	108-88-3	Toluene	0.36	3.77	0.88		0.00	0.06	0.06	0.49	0.17	0.10	0.51	0.22

Table 6 (cont'd)

VOC #	Group	#	CAS #	Chemical Compound	Chamber Air Concentration (µg/m³) at 24 h											
					MATERIALS (CMEIAQ-II) [10]											
					CT1	CT2	CRP7	CRP7a	HWF1	LAM1	LAM2	LAM3	LIN1	LIN2	MDF2	VWB1
73	Cyclo-Alkanes	1	110-82-7	Cyclohexane					0.02		0.79	0.96		72.09		
74		2	1678-93-9	Butylcyclohexane				4071.2								0.02
75		3	1678-91-7	Ethylcyclohexane				281.1								0.02
76		4	1678-92-8	Propylcyclohexane				4549.8								0.02
77		5	91-17-8	Decahydronaphthalene				1398.1								0.01
78	Terpenes	1	80-56-8	alpha-Pinene		9.36	0.05			2.47	0.47	3.02			0.05	0.01
79		2	99-86-5	alpha-Terpinene												
80		3	127-91-3	beta-Pinene		3.17				0.30	0.13	0.73			0.08	
81		4	99-85-4	gamma-Terpinene						0.06						
82		5	13466-78-9	3-Carene		1.10				0.37	0.12	0.38			0.05	
83		6	79-92-5	Camphene		0.26				0.08		0.11				
84		7	138-86-3	Limonene		0.45	0.26			0.25		0.11			0.15	
85	Other	1	3777-69-3	2-Pentylfuran		1.24						1.61	0.02	0.03	0.35	
86		2	872-50-4	1-Methyl-2-pyrrolidinone									0.26	0.81		
87		3	64-19-7	Acetic acid							0.50	1.01	5.19	15.43	60.42	
88		4	142-62-1	Hexanoic acid										5.00		
89		5	142-96-1	n-Butyl ether												
90		6	109-52-4	Pentanoic acid												
				TVOC ***	18	233	26	380921	1	27	6	183	17	133	81	10

* Measured by HPLC.

**2,2,4-Trimethyl-1,3-pentanediol diisobutyrate

*** TVOC calibrated against toluene.

[10] **Materials**

CT1: Counter top (upper laminate surface)
CT2: Counter top (all surfaces exposed)
CRP7: Carpet
CRP7a: Carpet + Adhesive + Concrete
HWF1: Hard wood flooring
LAM1: Laminate flooring
LAM2: Laminate flooring + Underlay
LAM3: Laminate flooring + Underlay + OSB
LIN1: Linoleum tile
LIN2: Linoleum tile + Adhesive + Plywood
MDF2: Medium density fiberboard
VWB1: Vinyl-faced gypsum panel