

D3 – Appendix 1: ST2 – Additional information about the original papers

December 2025

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Published by INIVE, Sint-Pietersnieuwstraat 41, B-9000 Ghent, Belgium.

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ISBN 978-2-930471-81-5

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Preface

The International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster international cooperation among the 30 IEA participating countries and to increase energy security through energy research, development and demonstration in the fields of technologies for energy efficiency and renewable energy sources.

The IEA Energy in Buildings and Communities Programme

The IEA co-ordinates international energy research and development (R&D) activities through a comprehensive portfolio of Technology Collaboration Programmes (TCPs). The mission of the IEA Energy in Buildings and Communities (IEA EBC) TCP is to support the acceleration of the transformation of the built environment towards more energy efficient and sustainable buildings and communities, by the development and dissemination of knowledge, technologies and processes and other solutions through international collaborative research and open innovation. (Until 2013, the IEA EBC Programme was known as the IEA Energy Conservation in Buildings and Community Systems Programme, ECBCS.).

The high priority research themes in the EBC Strategic Plan 2019-2024 are based on research drivers, national programmes within the EBC participating countries, the Future Buildings Forum (FBF) Think Tank Workshop held in Singapore in October 2017 and a Strategy Planning Workshop held at the EBC Executive Committee Meeting in November 2017. The research themes represent a collective input of the Executive Committee members and Operating Agents to exploit technological and other opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy technologies, systems and processes. Future EBC collaborative research and innovation work should have its focus on these themes.

At the Strategy Planning Workshop in 2017, some 40 research themes were developed. From those 40 themes, 10 themes of special high priority have been extracted, taking into consideration a score that was given to each theme at the workshop. The 10 high priority themes can be separated in two types namely 'Objectives' and 'Means'. These two groups are distinguished for a better understanding of the different themes.

Objectives: The strategic objectives of the EBC TCP are as follows:

- reinforcing the technical and economic basis for refurbishment of existing buildings, including financing, engagement of stakeholders and promotion of co-benefits;
- improvement of planning, construction and management processes to reduce the performance gap between design stage assessments and real-world operation;
- the creation of 'low tech', robust and affordable technologies;
- the further development of energy efficient cooling in hot and humid, or dry climates, avoiding mechanical cooling if possible; the creation of holistic solution sets for district level systems taking into account energy grids, overall performance, business models, engagement of stakeholders, and transport energy system implications.

Means: The strategic objectives of the EBC TCP will be achieved by the means listed below:

- the creation of tools for supporting design and construction through to operations and maintenance, including building energy standards and life cycle analysis (LCA);
- benefitting from 'living labs' to provide experience of and overcome barriers to adoption of energy efficiency measures;
- improving smart control of building services technical installations, including occupant and operator interfaces;
- addressing data issues in buildings, including non-intrusive and secure data collection;
- the development of building information modelling (BIM) as a game changer, from design and construction through to operations and maintenance.

The themes in both groups can be the subject for new Annexes, but what distinguishes them is that the 'objectives' themes are final goals or solutions (or part of) for an energy efficient built environment, while the 'means' themes are instruments or enablers to reach such a goal. These themes are explained in more detail in the EBC Strategic Plan 2019-2024.

The Executive Committee

Overall control of the IEA EBC Programme is maintained by an Executive Committee, which not only monitors existing projects, but also identifies new strategic areas in which collaborative efforts may be beneficial. As the Programme is based on a contract with the IEA, the projects are legally established as Annexes to the IEA EBC Implementing Agreement. At the present time, the

following projects have been initiated by the IEA EBC Executive Committee, with completed projects identified by (*) and joint projects with the IEA Solar Heating and Cooling Technology Collaboration Programme by (☼):

- Annex 1: Load Energy Determination of Buildings (*)
- Annex 2: Ekistics and Advanced Community Energy Systems (*)
- Annex 3: Energy Conservation in Residential Buildings (*)
- Annex 4: Glasgow Commercial Building Monitoring (*)
- Annex 5: Air Infiltration and Ventilation Centre
- Annex 6: Energy Systems and Design of Communities (*)
- Annex 7: Local Government Energy Planning (*)
- Annex 8: Inhabitants Behaviour with Regard to Ventilation (*)
- Annex 9: Minimum Ventilation Rates (*)
- Annex 10: Building HVAC System Simulation (*)
- Annex 11: Energy Auditing (*)
- Annex 12: Windows and Fenestration (*)
- Annex 13: Energy Management in Hospitals (*)
- Annex 14: Condensation and Energy (*)
- Annex 15: Energy Efficiency in Schools (*)
- Annex 16: BEMS 1- User Interfaces and System Integration (*)
- Annex 17: BEMS 2- Evaluation and Emulation Techniques (*)
- Annex 18: Demand Controlled Ventilation Systems (*)
- Annex 19: Low Slope Roof Systems (*)
- Annex 20: Air Flow Patterns within Buildings (*)
- Annex 21: Thermal Modelling (*)
- Annex 22: Energy Efficient Communities (*)
- Annex 23: Multi Zone Air Flow Modelling (COMIS) (*)
- Annex 24: Heat, Air and Moisture Transfer in Envelopes (*)
- Annex 25: Real time HVAC Simulation (*)
- Annex 26: Energy Efficient Ventilation of Large Enclosures (*)
- Annex 27: Evaluation and Demonstration of Domestic Ventilation Systems (*)
- Annex 28: Low Energy Cooling Systems (*)
- Annex 29: ☼ Daylight in Buildings (*)
- Annex 30: Bringing Simulation to Application (*)
- Annex 31: Energy-Related Environmental Impact of Buildings (*)
- Annex 32: Integral Building Envelope Performance Assessment (*)
- Annex 33: Advanced Local Energy Planning (*)
- Annex 34: Computer-Aided Evaluation of HVAC System Performance (*)
- Annex 35: Design of Energy Efficient Hybrid Ventilation (HYBVENT) (*)
- Annex 36: Retrofitting of Educational Buildings (*)
- Annex 37: Low Exergy Systems for Heating and Cooling of Buildings (LowEx) (*)
- Annex 38: ☼ Solar Sustainable Housing (*)
- Annex 39: High Performance Insulation Systems (*)
- Annex 40: Building Commissioning to Improve Energy Performance (*)
- Annex 41: Whole Building Heat, Air and Moisture Response (MOIST-ENG) (*)
- Annex 42: The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (FC+COGEN-SIM) (*)
- Annex 43: ☼ Testing and Validation of Building Energy Simulation Tools (*)
- Annex 44: Integrating Environmentally Responsive Elements in Buildings (*)
- Annex 45: Energy Efficient Electric Lighting for Buildings (*)
- Annex 46: Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) (*)
- Annex 47: Cost-Effective Commissioning for Existing and Low Energy Buildings (*)
- Annex 48: Heat Pumping and Reversible Air Conditioning (*)
- Annex 49: Low Exergy Systems for High Performance Buildings and Communities (*)
- Annex 50: Prefabricated Systems for Low Energy Renovation of Residential Buildings (*)
- Annex 51: Energy Efficient Communities (*)
- Annex 52: ☼ Towards Net Zero Energy Solar Buildings (*)

Annex 53: Total Energy Use in Buildings: Analysis and Evaluation Methods (*)

Annex 54: Integration of Micro-Generation and Related Energy Technologies in Buildings (*)

Annex 55: Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance and Cost (RAP-RETRO) (*)

Annex 56: Cost Effective Energy and CO₂ Emissions Optimization in Building Renovation (*)

Annex 57: Evaluation of Embodied Energy and CO₂ Equivalent Emissions for Building Construction (*)

Annex 58: Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements (*)

Annex 59: High Temperature Cooling and Low Temperature Heating in Buildings (*)

Annex 60: New Generation Computational Tools for Building and Community Energy Systems (*)

Annex 61: Business and Technical Concepts for Deep Energy Retrofit of Public Buildings (*)

Annex 62: Ventilative Cooling (*)

Annex 63: Implementation of Energy Strategies in Communities (*)

Annex 64: LowEx Communities - Optimised Performance of Energy Supply Systems with Exergy Principles (*)

Annex 65: Long-Term Performance of Super-Insulating Materials in Building Components and Systems (*)

Annex 66: Definition and Simulation of Occupant Behavior in Buildings (*)

Annex 67: Energy Flexible Buildings (*)

Annex 68: Indoor Air Quality Design and Control in Low Energy Residential Buildings (*)

Annex 69: Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings (*)

Annex 70: Energy Epidemiology: Analysis of Real Building Energy Use at Scale (*)

Annex 71: Building Energy Performance Assessment Based on In-situ Measurements (*)

Annex 72: Assessing Life Cycle Related Environmental Impacts Caused by Buildings (*)

Annex 73: Towards Net Zero Energy Resilient Public Communities (*)

Annex 74: Competition and Living Lab Platform (*)

Annex 75: Cost-effective Building Renovation at District Level Combining Energy Efficiency and Renewables (*)

Annex 76: ☼ Deep Renovation of Historic Buildings Towards Lowest Possible Energy Demand and CO₂ Emissions (*)

Annex 77: ☼ Integrated Solutions for Daylight and Electric Lighting (*)

Annex 78: Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications (*)

Annex 79: Occupant-Centric Building Design and Operation (*)

Annex 80: Resilient Cooling (*)

Annex 81: Data-Driven Smart Buildings (*)

Annex 82: Energy Flexible Buildings Towards Resilient Low Carbon Energy Systems (*)

Annex 83: Positive Energy Districts

Annex 84: Demand Management of Buildings in Thermal Networks (*)

Annex 85: Indirect Evaporative Cooling

Annex 86: Energy Efficient Indoor Air Quality Management in Residential Buildings (*)

Annex 87: Energy and Indoor Environmental Quality Performance of Personalised Environmental Control Systems

Annex 88: Evaluation and Demonstration of Actual Energy Efficiency of Heat Pump Systems in Buildings

Annex 89: Ways to Implement Net-zero Whole Life Carbon Buildings

Annex 90: EBC Annex 90 / SHC Task 70 Low Carbon, High Comfort Integrated Lighting

Annex 91: Open BIM for Energy Efficient Buildings

Annex 92: Smart Materials for Energy-Efficient Heating, Cooling and IAQ Control in Residential Buildings

Annex 93: Energy Resilience of the Buildings in Remote Cold Regions

Annex 94: Validation and Verification of In-situ Building Energy Performance Measurement Techniques

Annex 95: Human-centric Building Design and Operation for a Changing Climate

Annex 96: Grid Integrated Control of Buildings

Annex 97: Sustainable Cooling in Cities

Annex 98: Flexibilization and Optimization of Heat Pump Systems in Existing Buildings through Secondary-Side Digitalization

Annex 99: Air Cleaning for Sustainable and Resilient Buildings

Working Group – Energy Efficiency in Educational Buildings (*)

Working Group – Indicators of Energy Efficiency in Cold Climate Buildings (*)

Working Group – Annex 36 Extension: The Energy Concept Adviser (*)

Working Group – HVAC Energy Calculation Methodologies for Non-residential Buildings (*)

Working Group – Cities and Communities (*)

Working Group – Building Energy Codes

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ST2 – Additional information about the original papers

The following tables provide additional information about the studies like the studied sources, the experimental chamber dimensions, the environmental conditions and fresh air supply rate, the duration of the measurement, the selected pollutant along with the measurement system employed and the kind of emission rate data that is provided by the authors.

Table S 1. Construction and Decoration Materials (1/4)

| Reference | (Bluyssen, 1997) | (Oliveira Fernandes, 2001) | (Alevantis, 2003) | (Afshari, Lundgren, and Ekberg, 2003) |
|--------------------------------------|--|---|---|--|
| Category | Construction and Decoration Materials | Construction and Decoration Materials | Construction and Decoration Materials | Construction and Decoration Materials |
| Sub-Category | Finishes, Flooring | Acoustic Materials, Carpeting, Finishes, Flooring, Installation Materials, Insulation Materials, Interior Panels, Openings, Structural Materials, Wall Covering | Acoustic Materials, Carpeting, Finishes, Flooring, Insulation Materials, Interior Panels, Structural Materials | Finishes |
| Sources | Solid flooring materials | Building materials (SOPHIE database) | Construction and Decoration Materials (BUMA database) | Solvent-based alkyd paint |
| Exp. Chamber | Small test chambers ($\leq 2 \text{ m}^3$) | Various (from small chambers to rooms) | Large chamber (85 x 131 x 82 in) and 11.5-L stainless-steel canisters for specimen testing | Three types of chambers: a 1-m ³ chamber, a Field and Laboratory Emission Cell (FLEC), and a CLIMPAQ (chamber for laboratory investigation of materials pollution and air quality). |
| Controlled Temperature and RH | 23 \pm 0.5 °C, 45 \pm 5 %RH | 23 \pm 1 °C, 45 \pm 5 %RH | 23 \pm 2 °C, 50 \pm 10 %RH | 23 \pm 1 °C, 49 \pm 2 %RH |
| Fresh air supply rate (ACH) | 0.5 ACH for standard tests | Various | 0.625, 1.25 or 2.5 m ³ /(h.m ² _{sample}) | 0.5 – 4.0 ACH |
| Duration of measurement | 24 h, 72 h, and 28 d after placing the samples in the chambers | 1, 3 and 30 d | 24, 48, and 96 h intervals after placing the samples in the mini chambers | 24 h |
| Pollutants | Total VOCs (TVOC), individual VOCs | Various COVs and aldehydes | VOCs (up to C-15—pentadecane) and aldehydes (up to C10—decanal). | Pentanal, hexanal, octanal, and decanol |
| PM measurement system | - | - | - | - |
| VOC measurement system | GC-FID and GC-MS for VOC detection | Gas chromatography and mass spectrometry (GC/MS/FID) for VOCs, a specific formaldehyde analyzer | Stainless-steel desorption tube filled with Tenax™ sorbent for VOCs, and Waters Sep-Pak® XpoSure™ Aldehyde Sampler cartridges for aldehydes | Tenax tubes followed by GC-MS (Gas Chromatography-Mass Spectrometry) analysis |
| Other gas measurement system | - | - | - | - |
| Emission Rate Data | Model #11 | Model #11 | Model #11 | Model #03 |

Table S 2. Construction and Decoration Materials (2/4)

| | | | | |
|--------------------------------------|--|---|---|--|
| Reference | (Won and Shaw, 2004) | (Berrios <i>et al.</i> , 2005) | (Bartekova <i>et al.</i> , 2006) | (Barrero, 2009) |
| Category | Construction and Decoration Materials | Construction and Decoration Materials | Construction and Decoration Materials | Construction and Decoration Materials |
| Sub-Category | Acoustic Materials, Carpeting, Finishes, Flooring, Furnishing Materials, Installation Materials, Interior Panels, Structural Materials | Carpeting, Furnishing Materials | Structural Materials | Finishes, Flooring, Furnishing Materials, Structural Materials |
| Sources | Building materials in Canada (NSC-NRC database) | Partition panels, carpet | Coated and uncoated oriented strandboard | Finishes, Flooring, Furnishing Materials, Structural Materials |
| Exp. Chamber | 0.0063 – 33.6 m ³ | Mid- and full-scale stainless-steel chambers | 55L chamber | - |
| Controlled Temperature and RH | 23 °C, 50 %RH | 23 °C, 50 %RH | 23 °C ± 5 %, 50 %RH ± 5% | - |
| Fresh air supply rate (ACH) | 0.25 – 2 ACH (max 53 ACH for small chamber) | 0 – 1 ACH | 1 ACH | - |
| Duration of measurement | 4 h – several weeks | Each test was 120 h (samples every 24 h) | 28 d (only 3 d reported for all pollutants) | 1, 3, 7, 14, 21 and 28 d |
| Pollutants | 90 target VOCs | VOCs: m-xylene, p-xylene, pentadecane, phenol, toluene, styrene, d-limonene | Most prevalent VOCs | VOCs |
| PM measurement system | - | - | - | - |
| VOC measurement system | Multi-sorbent tubes and DNPH cartridges. Chromatographs obtained from GC/MS and HPLC | Thermal desorber - GC/MS system | Activated charcoal tubes attached to personal sampling pumps at the chamber outlets. Analysis using GC/MS | - |
| Other gas measurement system | - | - | - | - |
| Emission Rate Data | Models #03, #14 and #15 | Model #11 | Model #11 | Model #11 |

Table S 3. Construction and Decoration Materials (3/4)

| | | | | |
|--------------------------------------|--|--|--|--|
| Reference | (Plaisance <i>et al.</i> , 2014) | (Maupetit, 2014) | (Kozicki <i>et al.</i> , 2018) | (Kozicki and Guzik, 2021) |
| Category | Construction and Decoration Materials | Construction and Decoration Materials | Construction and Decoration Materials | Construction and Decoration Materials |
| Sub-Category | Acoustic Materials, Flooring, Installation Materials, Insulation Materials, Interior Panels, Wall Covering | Carpeting, Finishes, Flooring, Installation Materials, Interior Panels | Installation Materials | Installation Materials |
| Sources | Building materials and furnishings (e.g., chipboards, MDF, OSB, plywood, finishing plaster) | Construction and Decoration Materials | Waterproofing products used in construction | Adhesives: flooring, finishing walls and ceilings, and for other applications |
| Exp. Chamber | 35-liter glass cylindrical chamber | 51-liter chamber | 0.1 m ³ stainless steel | 0.1 m ³ chamber |
| Controlled Temperature and RH | 23 ± 2 °C, 50 ± 5 %RH | 23 ± 2 °C, 50 ± 5 %RH | 23 ± 1°C, 50 ± 5 %RH | 23 ± 1°C, 50 ± 5 %RH |
| Fresh air supply rate (ACH) | 0.5 ACH | 1.2 and 2.4 ACH | 0.5 ACH | 0.5 ACH |
| Duration of measurement | Sampling duration varied (typical: 2 h) | 42 d | 3- and 28-day averages | 3- and 28-day averages |
| Pollutants | Formaldehyde, acetaldehyde, acetone, propanal, benzaldehyde, hexanal | Aldehydes and VOCs | Range of VOCs, alcohols, benzene derivatives, aldehydes, ketones, ethers, esters | VOCs |
| PM measurement system | - | - | - | - |
| VOC measurement system | High-performance liquid chromatography (HPLC) for carbonyls | High-performance liquid chromatography (HPLC) for aldehydes, and a thermal desorption system (TDS) combined with GC/FID for VOCs | Sample onto Tenax TA and analyzed using TD-GC/MS | Glass tubes with Tenax TA adsorbent, thermal desorption, GC/MS for separation and analysis |
| Other gas measurement system | - | - | - | - |
| Emission Rate Data | Model #11 | Model #11 | Model #11 | Model #11 |

Table S 4. Construction and Decoration Materials (4/4)

| | | | | |
|--------------------------------------|---|---|--|--|
| Reference | (Caudron <i>et al.</i> , 2022) | (Jung and Mahmoud, 2022) | (de Kort <i>et al.</i> , 2023) | |
| Category | Construction and Decoration Materials | Construction and Decoration Materials | Construction and Decoration Materials | |
| Sub-Category | Insulation Materials, Structural Materials | Wall Covering | Insulation Materials, Interior Panels | |
| Sources | Bio-based materials for construction | Flooring and wallpaper materials | Fully biobased, semi-synthetic and fully synthetic materials | |
| Exp. Chamber | 50 and 225-liter chambers | 35-liter chamber system | 20-liter stainless steel cylinder | |
| Controlled Temperature and RH | 23 ± 1 °C, 50 and 85 ± 5 %RH | 25 °C, 50 %RH | □22 °C, □30 %RH | |
| Fresh air supply rate (ACH) | Not mentioned | 0.5 ACH | - | |
| Duration of measurement | 28 d | Varied by material (typical: 24 h) | Qualitative measurements: 72 h in total (samples at 24/48/72h); quantitative measurements (MDF cork, particle board, EPS only): 28 d | |
| Pollutants | Aldehydes and VOCs | Formaldehyde | Furfural, toluene, acetic acid, phenol, acetone and various terpene emissions. TVOC is the sum of all VOC components between C6- C12-C14/C15 | |
| PM measurement system | - | - | - | |
| VOC measurement system | High-performance liquid chromatography (HPLC) for aldehydes, and a thermal desorption system (TDS) combined with GC/MS/FID for VOCs | HPLC with DNPH derivatization for formaldehyde quantification | Thermal desorption tubes for 10-30 min + GC/MS post-analysis | |
| Other gas measurement system | - | - | - | |
| Emission Rate Data | Model #11 | Model #11 | Model #11 | |

Table S 5. Furniture (1/2)

| | | | | |
|--------------------------------------|---|---|--|--|
| Reference | (Oliveira Fernandes, 2001) | (Berrios <i>et al.</i> , 2005) | (Roux, 2012) | (Yan <i>et al.</i> , 2019) |
| Category | Furniture | Furniture | Furniture | Furniture |
| Sub-Category | Cushions | Printers, Chairs, Drawers, Tables | Day-nursery furniture | Tables |
| Sources | Cushions (vinyl) (SOPHIE database) | Chairs, Drawers, Tables | Pieces of nursery and kindergarten furniture and furniture components | Foot stool made of rubber wood, bedside table made from paulownia wood, MDF and high density board |
| Exp. Chamber | Various small chambers | Mid- and full-scale stainless-steel chambers | 1 m ³ small chamber and 30 m ³ room | stainless steel 1m3 |
| Controlled Temperature and RH | 23 ± 1 °C, 45 ± 5 %RH | 23 °C, 50 %RH | 23 ± 2 °C, 50 ± 5 %RH | 23 ± 1 °C, 45 ± 5 %RH |
| Fresh air supply rate (ACH) | Various | 0 – 1 ach | 0.5 ACH | 1.0 ACH |
| Duration of measurement | 1, 10, 14 and 30 d | Each test was 120 h (samples every 24 h) | 28 d | 3 d |
| Pollutants | Various COVs | VOCs: m-xylene, p-xylene, pentadecane, phenol, toluene, styrene, d-limonene | Aldehydes and VOCs | Benzene, toluene, m-xylene, o-xylene, ethyl benzene, n-undecane, styrene, n-butyl acetate |
| PM measurement system | - | - | - | - |
| VOC measurement system | Gas chromatography and mass spectrometry (GC/MS/FID) for VOCs, a specific formaldehyde analyzer | Thermal desorber - GC/MS system | High-performance liquid chromatography (HPLC) for aldehydes, and a thermal desorption system (TDS) combined with GC/FID for VOCs | Sampled onto Tenax TA, thermally desorbed and analyzed by GC with FID |
| Other gas measurement system | - | - | - | - |
| Emission Rate Data | Model #11 | Model #11 | Model #11 | Model #11 |

Table S 6. Furniture (2/2)

| | | | | |
|--------------------------------------|--|--|--|--|
| Reference | (Zheng <i>et al.</i> , 2024) | | | |
| Category | Furniture | | | |
| Sub-Category | Mattress | | | |
| Sources | New and used mattresses | | | |
| Exp. Chamber | 52.5 m ³ climate chamber | | | |
| Controlled Temperature and RH | □20.5 °C, □45 %RH or □35.7 °C, □62.5 %RH | | | |
| Fresh air supply rate (ACH) | 0.3 – 0.4 ACH | | | |
| Duration of measurement | 6 h | | | |
| Pollutants | Isopropyl Alcohol, Trichloroethylene, n-Hexane, p-Xylene, 1,2,3-Trimethylbenzene, o-Xylene, 2-Butanone, Toluene, Styrene, AcetaldehydeMethyl isobutyl ketone, Ethylbenzene, Benzene, Ethylene oxide, m-Xylene, 1,4-Dichlorobenzene (96 VOCs analyzed in total) | | | |
| PM measurement system | - | | | |
| VOC measurement system | Thermal desorption tubes, GC/MS post-analysis | | | |
| Other gas measurement system | - | | | |
| Emission Rate Data | Model #03 | | | |

Table S 7. Cleaning Products and Air Fresheners (1/2)

| | | | | |
|--------------------------------------|---|--|--|--|
| Reference | (Zhu, Cao, and Beauchamp, 2001) | (Liu <i>et al.</i> , 2004) | (Afshari, Matson, and Ekberg, 2005) | (Singer <i>et al.</i> , 2005) |
| Category | Cleaning Products and Air Fresheners | Cleaning Products and Air Fresheners | Cleaning Products and Air Fresheners | Cleaning Products and Air Fresheners |
| Sub-Category | Cleaning Products | Air Fresheners | Air Fresheners | Air Fresheners, Cleaning Products |
| Sources | Household cleaning products | Pine-scented electrical plug-in air freshener | Air-freshener spray | Cleaning products and air fresheners |
| Exp. Chamber | Small environmental chamber, specific volume not mentioned | 29.8 m ³ chamber | 32 m ³ chamber | 50 m ³ chamber |
| Controlled Temperature and RH | 23 °C, 50 %RH | 23 ± 0.5 °C, 50 ± 5 %RH | No control, 22 – 28 °C | No control, 20.8 – 23.3 °C, 40 – 70 % H |
| Fresh air supply rate (ACH) | 1 ACH | 0.5 ACH | 1.7 ± 0.1 ACH | 0.5 ACH |
| Duration of measurement | 1 – 8 h, varying by product type | 160 h | Until peak decayed, typically around 3-4 h | Various, 10 min – 24 h |
| Pollutants | 2-butoxyethanol | VOC, terpenes (aldehydes and PM also measured but no emission rates were associated) | PM 0.02-1µm (CPC), PM 0.3-1µm (OPC) | Terpene hydrocarbons, terpene alcohols, other VOCs - p-cymene and Eucalyptol |
| PM measurement system | - | - | CPC (TSI P-Trak 8525), OPC (TSI APC 300) | - |
| VOC measurement system | GC-MS (Gas Chromatography-Mass Spectrometry) used for VOC detection | Thermal desorption system (TDS) combined with GC/FID | - | Tenax sorbent TA and carbosieve S111, analyzed by thermal desorption GC with mass selective detection and quantitation |
| Other gas measurement system | - | - | - | - |
| Emission Rate Data | Model #03 | Models #16 and #18 | Models #16 and #18 | Models #02 and #03 |

Table S 8. Cleaning Products and Air Fresheners (2/2)

| | | | | |
|--------------------------------------|---|---|--|--|
| Reference | (Géhin, Ramalho, and Kirchner, 2008) | (Nicolas <i>et al.</i> , 2013) | (Nicolas <i>et al.</i> , 2018) | (Zheng <i>et al.</i> , 2024) |
| Category | Cleaning Products and Air Fresheners | Cleaning Products and Air Fresheners | Cleaning Products and Air Fresheners | Cleaning Products and Air Fresheners |
| Sub-Category | Air Fresheners | Cleaning Products | Cleaning Products | Cleaning Products |
| Sources | Air-freshener spray, cleaning spray | Household products | Household products | Table cleaning activity |
| Exp. Chamber | 2.36 ± 0.05 m ³ chamber | 29-liter chamber | 1 m ³ chamber (x2), 51-liter and 339-liter chamber | 52.5 m ³ climate chamber |
| Controlled Temperature and RH | No control, recorded | 23 ± 1 °C, 50 ± 5 %RH | 23 ± 2 °C, 50 ± 5 %RH | □20.5 °C, □45 %RH or □35.7 °C, □62.5 %RH |
| Fresh air supply rate (ACH) | 47 ± 11 ACH | 2.0 ± 0.3 ACH | 0.25 – 2 ACH | 0.3 – 0.4 ACH |
| Duration of measurement | 10 s – 1 h | 0 – 30 min and 30 – 60 min after product application | 180 min | 6 h |
| Pollutants | PM: 5 – 1000 nm and 0.3 – 20 µm | Various VOCs, PM and secondary organic aerosols (SOAs) | Aldehydes and VOCs | Isopropyl Alcohol, Trichloroethylene, n-Hexane, p-Xylene, 1,2,3-Trimethylbenzene, o-Xylene, 2-Butanone, Toluene, Styrene, AcetaldehydeMethyl isobutyl ketone, Ethylbenzene, Benzene, Ethylene oxide, m-Xylene, 1,4-Dichlorobenzene (96 VOCs analyzed in total) |
| PM measurement system | DMS500 (CAMBUSTION) and a Portable Dust Monitor | Aerosol Mass Spectrometer (AMS) and Scanning Mobility Particle Sizer (SMPS) | - | - |
| VOC measurement system | - | Thermo-desorption, Gas Chromatography, Mass Spectrometry Flame Ionization Detection system (TD/GC/MS/FID) | High-performance liquid chromatography (HPLC) for aldehydes, and a thermal desorption system (TDS) combined with GC/FID for VOCs | Thermal desorption tubes, GC/MS post-analysis |
| Other gas measurement system | - | - | - | - |
| Emission Rate Data | Model #23 | Model #13 | Model #13 | Model #13 |

Table S 9. Occupants and Occupant Activities (1/6)

| | | | | |
|--------------------------------------|--|---|--|---|
| Reference | (Klepeis <i>et al.</i> , 2003) | (He <i>et al.</i> , 2004) | (Lee and Wang, 2004) | (Moser <i>et al.</i> , 2005) |
| Category | Occupants and Occupant Activities | Occupants and Occupant Activities | Occupants and Occupant Activities | Occupants and Occupant Activities |
| Sub-Category | Smoking Cigarettes | Cooking, Sweeping Floor, Using Candles, Using Vacuum Cleaners | Using Incenses | Breathing |
| Sources | Environmental Tobacco Smoke (ETS) particles from cigars and cigarettes | Various occupant activities | Various types of incense | Exhaled breath |
| Exp. Chamber | 20 m ³ stainless steel chamber | Residential homes | 18 m ² stainless steel chamber | No chamber (sample bag for exhalation) |
| Controlled Temperature and RH | No control, but recorded | No control, but recorded | 23 ± 0.5 °C, 50 %RH | No control |
| Fresh air supply rate (ACH) | 0.03 – 0.1 ACH | Measured using tracer gas technique (CO ₂) but not reported | 0.5 ACH | - |
| Duration of measurement | 12 – 24 h | 48 h (mostly) | 0.5 – 1 h (VOC, carbonyls), 25 – 50 min (PM during burning) | - |
| Pollutants | PM: 12 aggregated sizes from about 0.009 to 1.154 µm. CO | PM _{2.5} (DustTrak), PM 0.007-0.808µm (CPC) | CO ₂ , CO, NO _x , CH ₄ , NMHC, PM _{2.5} , PM ₁₀ carbonyls | Aldehydes and VOCs |
| PM measurement system | Differential Mobility Particle Sizer (DMPS) and a LASAIR particle counter. | DustTrak (TSI 8520), CPC (TSI 3022A) | TSI Dust Trak air monitors Moduel 8520 | - |
| VOC measurement system | - | - | TVOC - GC/MSD | Proton transfer reaction-mass spectrometry (PTR-MS) |
| Other gas measurement system | Langan CO Personal Measurer connected to a Langan DataBear digital logger. | - | Methane - FID, TSO Q-TRak Model 8550 for CO ₂ , Chemiluminescence for NO _x , carbonyls - silica gel - HPLC | - |
| Emission Rate Data | Model #24 | Models #20 and 22 | Models #19 and 25 | Model #05 |

Table S 10. Occupants and Occupant Activities (2/6)

| | | | | |
|--------------------------------------|--|--|--|---|
| Reference | (Afshari, Matson, and Ekberg, 2005) | (Wallace, 2006) | (Health Canada, 2006) | (Zai, Zhen, and Jia-song, 2006) |
| Category | Occupants and Occupant Activities | Occupants and Occupant Activities | Occupants and Occupant Activities | Occupants and Occupant Activities |
| Sub-Category | Cooking, Smoking Cigarettes, Using Candles, Using Irons, Using Vacuum Cleaners | Cooking | Smoking Cigarettes | Using Candles |
| Sources | Cigarette side-stream smoke, pure wax candles, scented candles, vacuum cleaner, ironing a cotton sheet | Cooking events (Tea, toast, tortillas and broiled fish) | Mainstream and side stream cigarette smoke | Paraffin candles in various burning modes (steady, unsteady, smoldering) |
| Exp. Chamber | 32 m ³ chamber | House | - | 1.07 m ³ wooden chamber |
| Controlled Temperature and RH | No control, 22 – 28 °C | No control, recorded | - | 20 – 24.7 °C, 48 – 66 %RH |
| Fresh air supply rate (ACH) | 1.7 ± 0.1 ACH | Regularly measured using tracer gas technique (SF6) but not reported | - | Ventilation not specified; chamber airflow maintained via calibrated air pump |
| Duration of measurement | Until peak decayed, typically around 3-4 h | 37 months | - | Varies by mode (steady burn: 10 min, unsteady: 6 min, smoldering: 10 s) |
| Pollutants | PM 0.02-1µm (CPC), PM 0.3-1µm (OPC) | PM: 0.01 – 0.95 µm | VOCs and particles | PM ₁₀ , ultrafine particles in specific size ranges (10 – 500 nm) |
| PM measurement system | CPC (TSI P-Trak 8525), OPC (TSI APC 300) | SMPS (TSI 3077) | - | DustTrak (PM ₁₀) calibrated against TEOM |
| VOC measurement system | - | - | - | - |
| Other gas measurement system | - | - | - | - |
| Emission Rate Data | Model #20 | Models #20 and #22 | Models #01 and #21 | Models #20 and #22 |

Table S 11. Occupants and Occupant Activities (3/6)

| | | | | |
|--------------------------------------|--|---|---|---|
| Reference | (Yeung and To, 2008) | (Evans, Peers, and Sabaliauskas, 2008) | (Kurosawa <i>et al.</i> , 2008) | (Géhin, Ramalho, and Kirchner, 2008) |
| Category | Occupants and Occupant Activities | Occupants and Occupant Activities | Occupants and Occupant Activities | Occupants and Occupant Activities |
| Sub-Category | Cooking | Cooking | Televisions, Shoes | Using Candles, Using Incenses, Using Insecticidal Spray, Using Vacuum, Cleaners |
| Sources | Different cooking processes (Chinese style, western style and heating oil) | Frying various foods (bacon, eggs, vegetables) and vegetable oil | Televisions, shoes | Burning candles or incense, cooking (frying meat or fish, cooking pasta, meat or fish), insecticidal spray, vacuum cleaning |
| Exp. Chamber | 168 m ³ commercial kitchen mock-up | Real Homes | 1 m ³ chamber | 2.36 ± 0.05 m ³ chamber |
| Controlled Temperature and RH | No control | No control | 23 ± 1 °C, 50 ± 5 %RH | No control, recorded |
| Fresh air supply rate (ACH) | 24 ACH | - | 0.5 ACH | 47 ± 11 ACH |
| Duration of measurement | □ 5 min | - | 24 h | 10 s – 1 h |
| Pollutants | PM: 0.016 – 0.674 µm | UFP and PM _{2.5} | Aldehydes, VOCs and SVOCs | PM: 5 – 1000 nm and 0.3 – 20 µm |
| PM measurement system | SMPS (TSI 3734) | TSI 8520 DUSTTRAK Aerosol Monitors TSI 8525 P-TRAK Ultrafine Particle Counters | - | DMS500 (CAMBUSTION) and a Portable Dust Monitor |
| VOC measurement system | - | - | Sampling + Thermal Desorption for VOCs and SVOCs + High-performance liquid chromatography (HPLC) Sampling + solvent extraction for Aldehydes + High-performance liquid chromatography (HPLC) | - |
| Other gas measurement system | - | - | - | - |
| Emission Rate Data | Model #24 | Model #24 | Model #10 | Model #23 |

Table S 12. Occupants and Occupant Activities (4/6)

| Reference | (Pagels <i>et al.</i> , 2009) | (Riess <i>et al.</i> , 2010) | (Derbez and Solal, 2014) | (Tang <i>et al.</i> , 2016) |
|--------------------------------------|---|--|--|---|
| Category | Occupants and Occupant Activities | Occupants and Occupant Activities | Occupants and Occupant Activities | Occupants and Occupant Activities |
| Sub-Category | Using Candles | Breathing | Painting, drawing, doing plastic arts | Body |
| Sources | Candles (different types and burn modes) | Exhaled breath | School supplies and cleaning products | Exhaled breath and skin |
| Exp. Chamber | 22 m ³ stainless-steel chamber | Glass cylinder connected to a face mask for exhalation | 51-liter chamber | Classroom |
| Controlled Temperature and RH | 23 – 28 °C, 30 ± 5 %RH | 42 °C | 23 ± 2 °C, 50 ± 5 %RH | No control, monitored |
| Fresh air supply rate (ACH) | 0.5 ACH | - | 0.06 – 1.67 ACH | 5 ± 0.5 ACH |
| Duration of measurement | 10 – 20 min (sooting), 60 – 80 min (steady) and 45 min (smoldering) | 10 – 30 min | 120 min | 12 h daily |
| Pollutants | UFP and PM _{2.5} | Formaldehydes and VOCs | Aldehydes and VOCs | Aldehydes and VOCs |
| PM measurement system | Electrical mobility spectrometer – SMPS (16-1000µm) + Tapered Element Oscillating Microbalance (TEOM) for PM _{2.5} | - | - | - |
| VOC measurement system | - | Proton transfer reaction-mass spectrometry (PTR-MS) | High-performance liquid chromatography (HPLC) for aldehydes, and a thermal desorption system (TDS) combined with GC/FID for VOCs | Proton transfer reaction-mass spectrometry (PTR-MS) |
| Other gas measurement system | - | NO and CO ₂ | - | CO ₂ , O ₃ |
| Emission Rate Data | Model #22 | Model #05 | Models #12 and #13 | Model #05 |

Table S 13. Occupants and Occupant Activities (5/6)

| | | | | |
|--------------------------------------|-----------------------------------|---|--|---|
| Reference | (Persily and De Jonge, 2017) | (Nicolas <i>et al.</i> , 2017) | (O'Leary <i>et al.</i> , 2019) | (Zhao <i>et al.</i> , 2021) |
| Category | Occupants and Occupant Activities | Occupants and Occupant Activities | Occupants and Occupant Activities | Occupants and Occupant Activities |
| Sub-Category | Breathing | Using Candles, Using Incenses | Cooking | Cooking, Fireplace, Using Candles, Using Vacuum Cleaners |
| Sources | Exhaled breath | Incense products and scented candles | Complete meals | Houses |
| Exp. Chamber | Data from literature | 1 m ³ chambers | 26 m ³ chamber | - |
| Controlled Temperature and RH | Temperature correction possible | 23 ± 2 °C, 50 ± 5 %RH | No control | No control |
| Fresh air supply rate (ACH) | - | 0.7 ACH | 3 and 12 ACH | - |
| Duration of measurement | - | 60 min | 17 – 28 min | 3 – 25 d (per house) |
| Pollutants | CO ₂ | Aldehydes and VOCs | PM _{2.5} | PM: particle number size distribution for 10 – 800 nm and total particle number concentration |
| PM measurement system | - | - | Optical particle counter (OPC), and gravimetric sampling | TROPOS-type mobility particle size spectrometer (MPSS) |
| VOC measurement system | - | High-performance liquid chromatography (HPLC) for aldehydes, and a thermal desorption system (TDS) combined with GC/MS/FID for VOCs | - | - |
| Other gas measurement system | - | - | - | - |
| Emission Rate Data | Model #08 | Model #19 | Model #22 | Model #20 |

Table S 14. Occupants and Occupant Activities (6/6)

| | | | | |
|--------------------------------------|---|--|--|--|
| Reference | (Wang <i>et al.</i> , 2022) | (Zheng <i>et al.</i> , 2024) | | |
| Category | Occupants and Occupant Activities | Occupants and Occupant Activities | | |
| Sub-Category | Body, Breathing | Painting, drawing, doing plastic arts | | |
| Sources | Exhaled breath and skin | Liquid and stick gluing, acrylic and poster painting, sand and plasticine modeling | | |
| Exp. Chamber | 22.5 m ³ stainless-steel chamber | 52.5 m ³ climate chamber | | |
| Controlled Temperature and RH | Set points: 25 and 31 °C and 25 % and 65 % | □20.5 °C, □45 %RH or □35.7 °C, □62.5 %RH | | |
| Fresh air supply rate (ACH) | 3.2 ± 0.11 ACH | 0.3 – 0.4 ACH | | |
| Duration of measurement | 3 h or 2.5 h | 6 h | | |
| Pollutants | Aldehydes and VOCs | Isopropyl Alcohol, Trichloroethylene, n-Hexane, p-Xylene, 1,2,3-Trimethylbenzene, o-Xylene, 2-Butanone, Toluene, Styrene, AcetaldehydeMethyl isobutyl ketone, Ethylbenzene, Benzene, Ethylene oxide, m-Xylene, 1,4-Dichlorobenzene (96 VOCs analyzed in total) | | |
| PM measurement system | - | - | | |
| VOC measurement system | Proton transfer reaction-mass spectrometry (PTR-MS) | Thermal desorption tubes, GC/MS post-analysis | | |
| Other gas measurement system | OH reactivity, CO ₂ , ammonia, CO, CH ₄ , water vapor, O ₃ | - | | |
| Emission Rate Data | Model #05 | Model #13 | | |

Table S 15. Heating and Cooking Appliances (1/3)

| | | | | |
|--------------------------------------|--|---|--|---|
| Reference | (Traynor, Anthon, and Hollowell, 1982) | (Girman <i>et al.</i> , 1982) | (Cáceres <i>et al.</i> , 1983) | (Borrazzo <i>et al.</i> , 1987) |
| Category | Heating and Cooking Appliances | Heating and Cooking Appliances | Heating and Cooking Appliances | Heating and Cooking Appliances |
| Sub-Category | Cooking Appliances | Heaters | Heaters | Cooking Appliances |
| Sources | Gas stoves (oven and top burners) | Gas stoves, kerosene heaters, natural gas heaters, side stream cigarette smoke | Kerosene fired heaters (radiant and wick type), liquified gas heaters (radiant) | Gas-fired appliances |
| Exp. Chamber | 27 m ³ environmental chamber | 27 m ³ environmental chamber | Combustion exhaust measured directly from burner using high volume pump. Modelled concentrations in 20 m ³ room and 150 m ³ house. | No |
| Controlled Temperature and RH | No control, measured | No control, measured | No | No control |
| Fresh air supply rate (ACH) | 0.24 – 0.42 ACH (infiltration), 7.0 ACH (range hood) | < 0.5 ACH (infiltration), up to 1.9 ACH (infiltration), and specific tests at 0.3 – 0.5 ACH | 0.5 and 2 ACH | 0.15 to 1.4 ACH |
| Duration of measurement | 1 hour (variable) | □1 hour (variable) | - | 60 – 90 min + several hours after end of emission |
| Pollutants | CO, CO ₂ , NO, NO ₂ , SO ₂ , formaldehyde, and particulates (primarily carbon-based) | CO, CO ₂ , NO, NO ₂ , SO ₂ , formaldehyde, and particulate matter from side stream smoke | CO, NO, NO ₂ , formaldehyde | CO, NO, NO ₂ |
| PM measurement system | Electrical aerosol analyzer and tandem filtration for particulates < 0.5 µm | 10-stage piezoelectric cascade impactor for measuring particulate sizes from cigarette smoke | - | - |
| VOC measurement system | Measurements for formaldehyde used a modified pararosaniline method | CO and other gases were measured at different chamber points using Lawrence Berkeley Laboratory's Mobile Atmospheric Research Laboratory (MARL) | Formaldehyde measured by chromotropic acid method | - |
| Other gas measurement system | MARL (Mobile Atmospheric Research Lab) with probes for various gases including CO, CO ₂ , SO ₂ , and NO _x | MARL (Mobile Atmospheric Research Lab) with probes for various gases including CO, CO ₂ , SO ₂ , and NO _x | NO/NO ₂ : Saltman's method. CO: directly with Ecolyzer CO meter. SO ₂ : West and Gaeke's method | Teflon tubing, Thermo-Electron 4B/E chemiluminescent NO/NO _x analyzer and a Bendix 8501.5CA infrared CO analyzer |
| Emission Rate Data | Models #02 and #22 | Models #02 and #22 | Model #02 | Model #02 |

Table S 16. Heating and Cooking Appliances (2/3)

| | | | | |
|--------------------------------------|--|---|---|---|
| Reference | (McCrillis and Burnet, 1990) | (Afshari, Matson, and Ekberg, 2005) | (Géhin, Ramalho, and Kirchner, 2008) | (Tissari <i>et al.</i> , 2008) |
| Category | Heating and Cooking Appliances | Heating and Cooking Appliances | Heating and Cooking Appliances | Heating and Cooking Appliances |
| Sub-Category | Heaters | Cooking Appliances, Heaters | Cooking Appliances, Cooking | Heaters |
| Sources | Conventional and catalytic wood-fired space heaters (radiant type) at different burn rates | Electric radiators, electric stove, gas stove | Electric stove, electric oven, pyrolysis cleaning of oven | Conventional masonry heaters under normal and smoldering conditions |
| Exp. Chamber | Laboratory | 32 m ³ chamber | 2.36 ± 0.05 m ³ chamber | Laboratory setup with a flue gas fan and controlled exhaust |
| Controlled Temperature and RH | No control | No control, 22 – 28 °C | No control, recorded | Temperature monitored, no specific RH control |
| Fresh air supply rate (ACH) | - | 1.7 ± 0.1 ACH | 47 ± 11 ACH | Not specified; airflow was controlled via a flue gas fan. |
| Duration of measurement | 8 h | Until peak decayed, typically around 3-4 h | 10 s – 1 h | 75 – 85 min per combustion test |
| Pollutants | Naphthalene, Pyrene and Benzo(a)pyrene | PM 0.02-1µm (CPC), PM 0.3-1µm (OPC) | PM: 5 – 1000 nm and 0.3 – 20 µm | CO, CO ₂ , PM ₁ , PM ₁₀ , VOCs including methane, ethylene, benzene, and acetylene |
| PM measurement system | - | CPC (TSI P-Trak 8525), OPC (TSI APC 300) | DMS500 (CAMBUSTION) and a Portable Dust Monitor | Electrical Low-Pressure Impactor (ELPI) and Dekati Low Pressure Impactor (DLPI) |
| VOC measurement system | Liquid Chromatography | - | - | FTIR for VOCs and OGC analysis |
| Other gas measurement system | - | - | - | ABB Cemas gas analyzing rack for CO, CO ₂ , and O ₂ |
| Emission Rate Data | Model #02 | Model #20 | Model #23 | Models #02, #22 and #23 |

Table S 17. Heating and Cooking Appliances (3/3)

| | | | | |
|--------------------------------------|---|--|--|--|
| Reference | (Carteret, Pauwels, and Hanoune, 2012) | | | |
| Category | Heating and Cooking Appliances | | | |
| Sub-Category | Heaters | | | |
| Sources | Kerosene space heaters (wick and injector) with different fuels | | | |
| Exp. Chamber | 8 m ³ environmental chamber | | | |
| Controlled Temperature and RH | Setpoint: 28 °C | | | |
| Fresh air supply rate (ACH) | 7.4 ACH | | | |
| Duration of measurement | 120 min | | | |
| Pollutants | CO ₂ , CO, NO, NO ₂ , and VOCs | | | |
| PM measurement system | | | | |
| VOC measurement system | Tenax TA 60/80 sampling tubes | | | |
| Other gas measurement system | Chemiluminescence analyzer (NO _x), Fluorescence analyzer (SO ₂), Infrared absorption analyzer (CO), NDIR (CO ₂) | | | |
| Emission Rate Data | Model #04 | | | |

Table S 18. Electrical equipment (1/3)

| | | | | |
|--------------------------------------|---|--|--|---|
| Reference | (Hetes, Moore, and Norheim, 1995) | (Black, 1999) | (Brown, 1999) | (Lam and Lee, 2000) |
| Category | Electrical Equipment | Electrical Equipment | Electrical Equipment | Electrical Equipment |
| Sub-Category | Computers, Copy Machines, Printers | Computers, Copy Machines, Printers | Copy Machines | Printers |
| Sources | Dry and wet process photoimaging machines (copiers, printers, faxes), spirit duplicators, mimeograph machines, digital duplicators, diazo blueprint machines, computers and computer terminals, impact matrix printers, other equipment types | Laser printers, photocopiers, computers | Dry process photocopiers | Laser printers, ink-jet printers, all-in-one office machine |
| Exp. Chamber | Data from literature | 6 m ³ chamber | 33 m ³ room | 2.4 m ³ room |
| Controlled Temperature and RH | - | 23 ± 2 °C , 50 ± 5 %RH | 23, 26 and 32 ± 0.5 °C/ 50 ± 5 %RH | 23.0 °C ± 0.5 °C, 55 ± 5 %RH |
| Fresh air supply rate (ACH) | - | 1.0 ACH | 2.0 ± 0.05 ACH | - |
| Duration of measurement | - | 45 min for printers/photocopiers, 4h for computers | off for 2 h and on "idle" for 2 h | Few hours |
| Pollutants | Ozone, particulate, TVOC, heavy and light naphthenic distillate, ammonia, CO, methanol, ethanol, trinitrofluorene, trichloroethane, aliphatic HCs | TVOC, PM ₁₀ and Ozone | Ethylbenzene, 1,4-Dimethylbenzene, Styrene, TVOC, Ozone, PM ₁₀ and Nitrogen dioxide | VOCs, TVOC, PM ₁₀ |
| PM measurement system | - | Continuous (OPC) | Aerosol Monitor | Aerosol monitor with 100mm cellulose ester filter |
| VOC measurement system | - | Passive (multisorbent tubes) + GC/MS post-analysis | Gas Chromatography-Flame Ionization Detector (GC- FID) | Canister and cryogenic preconcentrator with gas chromatograph / mass spectrometry |
| Other gas measurement system | - | Continuous (UV absorbance) | Ozone Analyzer and Nitrogen dioxide by UV spectrophotometer analysis of sampling | Ozone was monitored continuously by Thermo Environmental Instruments ozone analyzer |
| Emission Rate Data | Models #01, #02 and #22 | Models #02 and #22 | Models #01 and #21 | Models #01 and #21 |

Table S 19. Electrical equipment (2/3)

| | | | | |
|--------------------------------------|--|---|--|---|
| Reference | (Wensing, 2002) | (Nakagawa <i>et al.</i> , 2003) | (Funaki <i>et al.</i> , 2003) | (Berrios <i>et al.</i> , 2005) |
| Category | Electrical Equipment | Electrical Equipment | Electrical Equipment | Electrical Equipment |
| Sub-Category | Monitors, Printers | Computers | Computers, Telephones, Televisions, Books | Computers, Copy Machines, Printers |
| Sources | Computer monitors, laser printers | Personal computers with cathode-ray tube (CRT) or thin-film transistor (TFT) monitors | Portable PC, TV remote controller, low-frequency current massager, cellular phone, photo journal | Office equipment (computers, printers, copiers) |
| Exp. Chamber | 1 m ³ emission test chamber with inner walls of electropolished stainless-steel. | 1 m ³ glass chamber | 20-liter chamber | Mid and full-scale stainless-steel chambers |
| Controlled Temperature and RH | 23 °C, 50 %RH | 22 °C | 25 ± 1 °C, 50 ± 4 %RH | 23 °C, 50 %RH |
| Fresh air supply rate (ACH) | 0.5 ACH | 1 ACH | 0.5 ACH | 0-1 ach |
| Duration of measurement | Monitors: acclimatized in standby mode overnight (16 h). Air samples taken after 6 h of operation. Laser Printers: samples taken after 30 min of continuous printing at a speed of approximately 4 pages/min | - | >20h | Computer (2 periods each of 12 h, on /off); copier and printers (3 periods, 1-2 of 12h and 3 of 4h (off/idle) |
| Pollutants | TVOC, Toluene, Phenol | Formaldehyde, Acetaldehyde, Propionaldehyde, n-Butyraldehyde, Valeraldehyde, Hexaldehyde Aromatic hydrocarbons, TVOC. Specific VOCs such as benzene, toluene, ethylbenzene, xylene, and styrene | Aldehydes and VOCs | Benzene, toluene, m-xylene, o-xylene, ethyl benzene, n-undecane, styrene, n-butyl acetate |
| PM measurement system | - | - | - | - |
| VOC measurement system | Enrichment with Tenax TA, Thermal desorption (PE-ATD 400), Gas Chromatography/Mass Spectrometry (GC/MS) with a DB-5MS separation column | Sampling tubes: Sep-Pak DNPH-Silica for aldehydes and Tenax TA for VOCs. Analysis: Gas Chromatography/Mass Spectrometry (GC/MS) for VOCs, High-Performance Liquid Chromatography (HPLC) for Aldehydes | Thermal Desorption System (TDS) combined with GC/MS, High-Performance Liquid Chromatography (HPLC) for aldehydes | Sampled onto Tenax TA, thermally desorbed and analyzed by GC with FID |
| Other gas measurement system | Toluene: enrichment with activated carbon type NIOSH, solvent desorption (CS ₂) and GC/MS evaluation. Phenol: enrichment with silica gel type, solvent desorption (acetone) and GC/MS evaluation. | - | - | - |
| Emission Rate Data | Model #02 | Model #02 | Model #02 | Model #02 |

Table S 20. Electrical equipment (3/3)

| | | | | |
|--------------------------------------|---|---|--|--|
| Reference | (He, Morawska, and Taplin, 2007) | (Géhin, Ramalho, and Kirchner, 2008) | | |
| Category | Electrical Equipment | Electrical Equipment | | |
| Sub-Category | Printers | Printers | | |
| Sources | Printers | Laser printer | | |
| Exp. Chamber | 1 m ³ | 2.36 ± 0.05 m ³ chamber | | |
| Controlled Temperature and RH | - | No control, recorded | | |
| Fresh air supply rate (ACH) | 0.138 ACH | 47 ± 11 ACH | | |
| Duration of measurement | - | 10 s – 1 h | | |
| Pollutants | UFP (and PM _{2.5}) | PM: 5 – 1000 nm and 0.3 – 20 µm | | |
| PM measurement system | Condensation Particle Counter – CPC (0.007 to 3 µm, sample time of 20s) and a Scanning Mobility Particle Sizer – SMPS (0.015 to 0.685 µm, sample time of 180s). | DMS500 (CAMBUSTION) and a Portable Dust Monitor | | |
| VOC measurement system | - | - | | |
| Other gas measurement system | - | - | | |
| Emission Rate Data | Model #20 | Model #23 | | |

Table S 21. Whole room or building (1/1)

| | | | | |
|--------------------------------------|--|---|---|--|
| Reference | (Offermann <i>et al.</i> , 2009) | (Blondel and Plaisance, 2011) | (Chan <i>et al.</i> , 2020) | (Zhao <i>et al.</i> , 2022) |
| Category | Whole room or building | Whole room or building | Whole room or building | Whole room or building |
| Sub-Category | Homes | Bedrooms | Homes | Homes |
| Sources | Various detached homes | Bedroom materials: floor, walls, ceiling, desks, doors, closets, shelves, bed and chair | Houses with gas appliances (natural gas stoves, ovens, water heaters, and furnaces), cooking activities, and building materials | Building materials and furnishings in homes |
| Exp. Chamber | - | Dorm room (average 26m ³) | - | 63 single-family homes in California |
| Controlled Temperature and RH | - | Measured but not controlled | - | Variable, 18 – 27 °C, 28 – 63 %RH |
| Fresh air supply rate (ACH) | - | Variable | Variable | 0.08 - 1.14 ACH |
| Duration of measurement | 24 h period in different seasons | 6 h | 1 week per home | 1 week per home |
| Pollutants | 22 VOCs, PM _{2.5} , NO ₂ , CO ₂ , CO | Formaldehyde | PM _{2.5} , VOCs, CO ₂ , CO, NO ₂ , Formaldehyde | Formaldehyde |
| PM measurement system | Particulate matter (PM _{2.5}) was collected using gravimetric analyses according to NIOSH 500 | | MetOne BT-645 for real-time measurement in indoor locations and MetOne ES-642 for outdoor monitoring | - |
| VOC measurement system | Thermal Desorption System (TDS) combined with GC/MS, High-Performance Liquid Chromatography (HPLC) for aldehydes | Passive flux sampler and active sampling using DNPH-silica Sep-Pack cartridges | Shinyei formaldehyde monitors and passive DNPH cartridges | Real-time photoelectric photometry meters and passive samplers |
| Other gas measurement system | Chemiluminescence analyzer (NO _x), Infrared absorption analyzer (CO), NDIR (CO ₂) | | CO ₂ Extech SD-800 sensors; CO Lascar USB-EL-300 sensors; Aeroqual NO ₂ monitors | - |
| Emission Rate Data | Model #03 | Model #03 | Model #03 | Model #09 |

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