# Indoor Air Toxicology

16–18th September 2018

## International Conference on Risk Assessment of Indoor Air Chemicals

**September 16 – 18, 2018**
Umweltforum
Berlin, Germany

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

Umwelt Bundesamt

It is a pleasure to welcome you to the International Conference on **Risk Assessment of Indoor Air Chemicals** in Berlin.

We spend most of our time indoors. With every breath, we take up pollutants present in our indoor environment. Thus, the importance of good indoor air quality is a crucial task of everyone who is responsible for the protection of public health.

With this conference we focus on the impact of the indoor environment on health and wellbeing. A variety of activities designed to ensure and maintain good indoor air quality will be presented and discussed during this conference by international experts from science, policy, and industry. We want to address current issues of indoor air quality with stakeholders, scientists, and decision-makers and develop proposals for improvement.

We are also planning effective actions to promote and strengthen networking and cooperation between all stakeholders engaging in research, monitoring and risk assessment.

Let's work together for better indoor air quality!

**Maria Krautzberger**
*President of the*
*German Environment Agency*

**Dr. Axel Vorwerk**
*Head of Directorate IG II,*
*Environmental Health, Chemical Safety*
*Federal Ministry for the Environment,*
*Nature Conservation and Nuclear Safety*

# Program

## Sunday, September 16, 2018

| | |
|---|---|
| 4:00 pm – 6:00 pm | **Registration** |
| 5:00 pm – 6:30 pm | **Opening ceremony**<br>including<br><br>**Welcome**<br>**Maria Krautzberger**<br>President of the German Environment Agency (UBA), Germany<br><br>**Axel Vorwerk**<br>Federal Ministry of the Environment,<br>Nature Conservation and Nuclear Safety (BMU), Germany<br><br>**Keynote lecture I**<br>**Pawel Wargocki**<br>Technical University of Denmark, Denmark<br>**Improving indoor air quality is a prerequisite for health and sustainable growth** |
| 6:30 pm – 8:00 pm | **Welcome reception** |

## Monday, September 17, 2018

| | |
|---|---|
| 8:00 am – 9:00 am | **Registration** |
| 9:00 am – 10:00 am | **Panel discussion I**<br>**Toxic substances in indoor air: is there a need for political action?**<br><br>Moderation: **Lilian Busse**, German Environment Agency (UBA), Germany<br><br>Panelists:<br>**Erwin Annys**, European Chemical Industry Council (CEFIC)<br><br>**Birger Heinzow,** German Committee on Indoor Guide Values (AIR), Germany<br><br>**Dorota Jarosinska,** WHO European Centre for Environment and Health<br><br>**Eduardo de Oliveira Fernandes,** Emeritus Professor University of Porto, Portugal<br><br>**Rolf Buschmann,** Bund für Umwelt und Naturschutz, Germany |
| 10:00 am – 10:20 am | Coffee break |

# Monday, September 17, 2018

| | |
|---|---|
| 10:20 am – 11:00 am | **Keynote lecture II**<br>**Dorota Jarosinska**<br>WHO European Centre for Environment and Health<br>**WHO indoor air quality guidelines**<br><br>Chair:<br>**Birgit Wolz,** Federal Ministry of the Environment,<br>Nature Conservation and Nuclear Safety (BMU), Germany |
| 11:00 am – 12:15 pm | **Session 1**<br>**Risk assessment concepts for indoor air pollutants, Part I**<br><br>Chair:<br>**Tunga Salthammer,** Fraunhofer Institute for Wood Research,<br>Wilhelm-Klauditz-Institut (WKI), Germany<br><br>**Martin Kraft**<br>North Rhine-Westphalia State Agency for Nature, Environment and<br>Consumer Protection, Germany<br>**German health based guidance values for pollutants**<br>**in indoor air**<br><br>**Kenichi Azuma**<br>Kindai University Faculty of Medicine, Japan<br>**Japanese indoor air quality guidelines for selected pollutants:**<br>**past approach, current status, and future issues**<br><br>**Katleen De Brouwere**<br>Flemish Institute for Technological Research VITO, Belgium<br>**Flemish indoor air quality decree** |
| 12:15 pm – 1:15 pm | Lunch and poster viewing |

# Monday, September 17, 2018

| | | |
|---|---|
| 1:15 pm – 2:30 pm | **Session 2**<br>**Risk assessment concepts for indoor air pollutants, Part II**<br><br>Chairs:<br>**Stylianos Kephalopoulos,** European Commission, DG JRC<br>**Helmut Sagunski,** German Committee on Indoor Guide Values (AIR), Germany<br><br>**Maria Uhl**<br>Environment Agency Austria, Austria<br>**Austrian risk assessment concept for indoor air chemicals**<br><br>**Sani Dimitroulopoulou**<br>Public Health England, UK<br>**Indoor air quality: actions and policy in the UK**<br><br>**Colin Ehnes**<br>BASF, Germany<br>**Indoor air from perspective of the industry** |
| 2:30 pm – 2:45 pm | Break |
| 2:45 pm – 4:00 pm | **Session 3**<br>**Particulate matter**<br><br>Chairs:<br>**Wolfram Birmili**, Germany Environment Agency (UBA), Germany<br>**Saul García Dos Santos-Alves,** Institute of Health Carlos III, Spain<br><br>**Heli Lehtomäki**<br>National Institute for Health and Welfare, Finland<br>**Exposure-response relationship and environmental burden of disease**<br><br>**Michael Riediker**<br>The Swiss Centre for Occupational and Environmental Health (SCOEH), Switzerland<br>**Particulate matter: Identification, mitigation, and assessment**<br><br>**Gerhard Wiesmüller**<br>Public Health Department Cologne, Germany<br>**Indoor bioaerosols** |
| 4:00 pm – 4:30 pm | Coffee break |

# Monday, September 17, 2018

| | |
|---|---|
| 4:30 pm – 6:30 pm | **Session 4**<br>**Risk mitigation for indoor air quality on example of construction products**<br><br>Chair:<br>**Frank Kuebart,** eco-INSTITUT Germany GmbH, Germany<br><br>**Jorma Säteri**<br>Finnish Society of Indoor Air Quality and Climate and<br>Helsinki Metropolia University of Applied Sciences, Finland<br>**Experiences of voluntary approach – M1 classification in Finland**<br><br>**Thomas Witterseh**<br>Danish Technological Institute, Denmark<br>**25 years of material emission labeling in Denmark – experiences and development**<br><br>**Marilyn Black**<br>Underwriters Laboratories Inc., Founder GREENGUARD, USA<br>**Progress and Challenges in US VOC Emissions: A 20 Year Review**<br><br>**Ana Maria Scutaru**<br>German Environment Agency (UBA), Germany<br>**Challenges and chances of a harmonized European health evaluation for building products emissions** |
| | **Panel discussion II**<br>**Mandatory requirements vs. voluntary labeling schemes for the assessment of building products emissions: Which is the better way to achieve good indoor air quality?** |
| 7:15 pm – 8:15 pm | **River cruise** on the Spree along some of Berlin's main sightseeing attractions and the government quarter. |

# Tuesday, September 18, 2018

| | | |
|---|---|---|
| 9:00 am – 10:15 am | **Session 5**<br>**Risk assessment concepts for indoor air pollutants, Part III**<br><br>Chair:<br>**Gunnar Johanson,** Karolinska Institutet, Sweden<br><br>**Vanessa Beaulac**<br>Health Canada, Canada<br>**Health Canada's regulatory approach to indoor air contaminants**<br><br>**Marion Keirsbulck**<br>French Agency for Food, Environmental and Occupational Health & Safety (ANSES), France<br>**ANSES guidelines for indoor air quality: health-based values for selected pollutants**<br><br>**Carsten Kneuer**<br>German Federal Institute for Risk Assessment (BfR), Germany<br>**Human health hazard charcterisation for biocides – current practice under EU Reg 528/2012** |
| 10:15 am – 10:35 am | Coffee break |
| 10:35 am – 11:05 am | **Keynote lecture III**<br>**Tunga Salthammer**<br>Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut (WKI), Germany<br>**Indoor air contaminants – emerging substances**<br><br>Chair:<br>**Marike Kolossa-Gehring,** German Environment Agency (UBA), Germany |
| 11:05 am – 11:55 am | **Session 6**<br>**Indoor air chemicals and monitoring**<br><br>Chairs:<br>**Katleen De Brouwere,** Flemish Institute for Technological Research VITO, Belgium<br>**Lars Gunnarsen,** Danish Building Research Institute, Denmark<br><br>**Peder Wolkoff**<br>The National Research Centre for the Working Environment, Denmark<br>**Indoor air chemistry: reaction products and airway effects** |

# Tuesday, September 18, 2018

| | |
|---|---|
| | Continuation **Session 6**<br><br>**Pawel Rostkowski**<br>Norwegian Institute for Air Research, Norway<br>**Target and non-target/suspect screening analyses for emerging substances in air and dust from various indoor environments**<br><br>**Stylianos Kephalopoulos**<br>European Commission, DG JRC<br>**The European Commission's Information Platform for Chemical Monitoring data (IPCHEM): a reference gateway for searching, accessing, retrieving, assessing and sharing indoor air Monitoring data in EU** |
| 11:55 pm – 1:00 pm | Lunch and poster viewing |
| 1:00 pm – 2:40 pm | **Session 7**<br>**Indoor air environment and children's health**<br><br>Chairs:<br>**Vanessa Beaulac,** Health Canada, Canada<br>**Ana Maria Scutaru,** German Environment Agency (UBA), Germany<br><br>**Ruth A. Etzel**<br>Office of Children's Health Protection, U.S. Environmental Protection Agency (EPA), USA<br>**The special vulnerability of children**<br><br>**Lars Gunnarsen**<br>Danish Building Research Institute, Denmark<br>**Exposure to toluene and other neurotoxic substances in Danish children's bedrooms**<br><br>**Marike Kolossa-Gehring**<br>German Environment Agency (UBA), Germany<br>**How to consider children by risk assessment of indoor air chemicals?**<br><br>**Eduardo de Oliveira Fernandes**<br>Emeritus Professor University of Porto, Portugal<br>**Health driven IAQ: The children case** |
| 2:40 pm – 3:00 pm | Coffee break |

# Tuesday, September 18, 2018

| | |
|---|---|
| 3:00 pm – 5:05 pm | **Session 8**<br>**Indoor air toxicology: challenges and upcoming tasks**<br><br>Chairs:<br>**Kenichi Azuma**, Kindai University Faculty of Medicine, Japan<br>**Birger Heinzow,** German Committee on Indoor Guide Values (AIR), Germany<br><br>**Gunnar Johanson**<br>Karolinska Institutet, Sweden<br>**Are asthmatics more sensitive to irritants?**<br><br>**Wenjuan Wei**<br>Scientific and Technical Centre for Building (CSTB), France<br>**Bioaccessibility and bioavailability of environmental semi-volatile organic compounds via inhalation**<br><br>**Steven Nordin**<br>Umea University, Sweden<br>**Neurogenic inflammation and sensitization**<br><br>**Josje Arts**<br>Akzo Nobel Chemicals B.V., Arnhem, The Netherlands<br>**How to assess respiratory sensitization?**<br><br>**Carl-Gustaf Bornehag**<br>Karlstad University, Sweden and Icahn School of Medicine at Mount Sinai, New York, USA, Sweden<br>**A novel approach for risk assessment of chemical mixtures – linking data from population based epidemiology and experimental toxicology by the use of new statistical tools** |
| 5:05 pm | **Summary and conclusions**<br>**Wolfgang Straff**<br>German Environment Agency (UBA), Germany |

# Keynote lectures

# Improving indoor air quality is a prerequisite for health and sustainable growth

**Pawel Wargocki**
**Technical University of Denmark, Denmark**

It is beyond any discussion that exposures to pollutants indoors have consequences for human health. They originate outdoors and are transported indoors through the building envelope, by opening of windows or by ventilation, have their origin indoors, and can be products of different chemical transformations occurring indoors. The burden of disease attributed to these exposures has been estimated to 2 million healthy life years lost annually in EU-26. Although only an estimate it is quite disturbing considering that these exposures can entail significant socio-economic impact and taking into account that they have also been shown to reduce considerably productivity and learning (up to 15%), not to mention reduced wellbeing and recent reports implying their negative effects on sleep quality. This evidence, surprisingly, contradicts what creates one of the core reason for built environment – buildings should provide shelter and the appropriate conditions for working, learning, leisure and comfortable living, they should be safe, with no health hazards for its users, due to either poor design and construction, or inadequate operation, maintenance and performance. A comprehensive and integrated approach for creating and maintaining good indoor environmental quality in buildings is therefore required in the relevant disciplines, policies, regulations and standards to change the current state of affairs. Numerous factors should be considered as determinants of indoor air quality and its effects on safety, energy efficiency, health, comfort and productivity. They include outdoor air pollution and climate, the construction materials and consumer products used indoors, ventilation technologies, practices, and the behavior of occupants. The approach should also take into account potential constraints, e.g. the availability of appropriate technologies and the required energy resources. Only by implementing this integrated approach, the sustainable growth can be secured.

# Indoor air quality and health - the WHO perspective

**Dorota Jarosinska, Irina Zastenskaya**
**WHO European Centre for Environment and Health**

The quality of air inside homes, offices, schools, kindergartens, health care facilities or other private and public buildings is an important determinant of health. Despite substantial improvements over the last decades, many health risks related to biological and chemical indoor air pollution remain. Of particular concern are hazardous chemicals emitted from building and finishing materials, indoor equipment or due to human activities. Combined exposure to a mixture of chemicals indoors can affect human health, especially in vulnerable groups, such as children.

To guide policies and actions in Member States, WHO has developed air quality guidelines (currently subject to an update), as well as a series of indoor air quality guidelines, including on dampness and moulds, selected chemicals, and on household fuel combustion. WHO supports Member States through developing tools and strengthening national capacities. The evidence gathered by the WHO Regional Office for Europe has shown that implementation of the policies for healthy indoor environments for children in schools remains a challenge. Data on exposure to indoor air pollutants are largely lacking in the Region, and much effort is needed to reduce emissions, improve enforcement of smoking bans, provide adequate ventilation, etc.

The public health relevance of hazardous chemicals in indoor air, and the needs of Member States provide a solid basis for further actions. Instruments, such as WHO Framework for Assessment of Risks of Combined Exposure to Multiple Chemicals facilitate the development of tools to assess health risks posed by chemicals in indoor air. WHO is currently working on a tool to support experts and decision makers to assess the combined risks of chemicals for children's health, focusing on chemicals commonly present in schools and other public buildings for children, and the relevant health end-points.

# Indoor air contaminants – emerging substances

**Tunga Salthammer**
**Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut (WKI), Germany**

The indoor environment is a multidisciplinary scientific field involving chemistry, physics, biology, health sciences, building sciences and civil engineering. Building products, furnishings, household appliances and other indoor materials often emit very volatile, volatile and semi volatile organic compounds as well as particulate matter. Consequently, the reliable assessment of human exposure to indoor pollutants requires a detailed understanding of the relevant compounds, their sources, their distribution among the gas phase, airborne particles and settled dust and of course of the relevant exposure pathways through inhalation, oral intake and dermal intake. Today, it has been recognized that both primary and secondary emissions may affect indoor air quality. The problem becomes dominant when components react with each other or when catalytic materials are applied. Moreover, there is an increasing use of so-called “emerging substances” or “substances of emerging concern”. These terms describe the replacement of commonly used chemicals in formulations by supposedly less harmful chemicals. A well-known example is the shift from low-molecular weight phthalates to high-molecular weight phthalates and later the shift from phthalates to DINCH, adipates, terephthalates, etc. Similar trends can be observed in case of solvents and flame retardants. Over the years, new compound groups like perfluorocarbons, UV-filters and drug residues also appeared on the scene. The classical way for detecting emerging compounds is air and dust analysis and therefore, the spectrum of analytical techniques needs to be continuously broadened. However, there is also a demand for human biomarkers, preferably in urine, because some chemicals might resist classical analysis. A further important aspect is the post hoc analysis of house dust and urine samples, which are stored in environmental specimen banks. The identification and temporal tracking of emerging chemicals is thereby enabled.

# Session 1

Risk assessment concepts for indoor air pollutants, Part I

## German health based guidance values for pollutants in indoor air

**Martin Kraft**
**North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection, Germany**

Pollutants in indoor air may pose a risk for human health. But above which concentration of pollutants in indoor air human health is at risk? And when is there a need for action? For more than 25 years, the German Committee on Indoor Air Guideline Values has been deriving assessment values for indoor air. These values do not have the character of limit values but they are often used to assess the effects of indoor air pollutants on human health. Consequently they are frequently used in legal proceedings, too. The derivation of the indoor air guidelines is based on the legal requirement of the German States that the stay in buildings must not cause any chemical or biological damage to human health. For this reason, specific assessment values for chemicals are needed to indicate an impact on human health.

Therefore the German Committee on Indoor Air Guide Values derives effect related values, based on current toxicological and epidemiological data. If these values (guide value II) are exceeded immediate measures must be taken to protect people from the harmful effects of substances detected in indoor air. On the other hand additional values are required that show that even a lifetime exposure to indoor air pollutants has no health impact on humans. Such precautionary values (guide value I) represent the concentration of substances in indoor air for which there is no evidence that even lifelong exposure is likely to have any adverse impact on human health.

A special case is the health based assessment of carcinogenic substances in indoor air. For many of these substances, a threshold level without a carcinogenic effect cannot be found. Therefore the application of guide values is not suitable. For this reason, risk based concepts are applied to ensure that people are adequately protected from the potential risk of these substances in indoor air.

## Japanese indoor air quality guidelines for selected pollutants: past approach, current status, and future issues

**Kenichi Azuma**
**Kindai University, Faculty of Medicine, Japan**

Individuals living in housing environments are exposed to a greater variety of pollutants, albeit at lower concentrations, compared with industrial workers in occupational environments. These pollutants can result in a variety of adverse health effects, including those affecting the respiratory, neurological, reproductive, dermatologic, and cardiovascular systems. In the past few decades, indoor air pollution has become a major public health concern in Japan. After conducting extensive exposure assessments, the Ministry of Health, Labour and Welfare of Japan established indoor air quality guidelines for 13 chemicals, including formaldehyde and toluene from 1997 to 2002, based on scientific discussions in the Committee on Indoor Air Pollution (CIAP). However, the types and concentrations of these pollutants have been inconsistent over time due to lifestyle changes and the development of novel household products and building materials. Adverse health effects caused by semivolatile organic compounds (SVOCs) have been reported over the past decade. Therefore, the CIAP was reconvened to newly establish or update the guidelines from 2012. In addition, extensive exposure assessments in housing were restarted in Japan. The committee proposed a new approach to establish guidelines based on the health risk assessment. In this presentation, a summary of the past approaches and current status are presented. In indoor environments, there are multiple media by which humans come in contact with SVOCs, particularly phthalates, including indoor air, indoor dust, and certain foods, with three exposure pathways (inhalation, ingestion, and dermal exposure) that can affect human health. Furthermore, combined exposure to multiple low-level pollutants occurs in indoor environments. An integrated multipollutant and multicompartmental approach may be essential to protect public health in indoor environments. These future issues are also presented.

# Flemish indoor air quality decree

**Katleen de Brouwere**
**Flemish Institute for Technological Research VITO, Belgium**

Indoor air quality has been recognized by the Flemish authorities as an important policy field in view of prevention of public health. In 2004, the Flemish Decree on Indoor Air Quality (IAQ) entered into force in Flanders and is applicable for dwellings and publicly accessible buildings (PAB). The Decree stipulates guidance and intervention values for chemical, physical and biotic factors in the indoor environment. The Decree provides a policy instrument to conduct inspections in dwellings and PAB and facilitates informing interest groups and the general public, and creating awareness about indoor health risks.

Nearly 15 years later, it was time to revise the Decree ('revised Flemish IAQ Decree'): firstly, the list of chemicals has been extended in order to cover chemicals commonly present in Flemish indoor environments; secondly, the guidance and intervention values have been revised in accordance with the nowadays scientific knowledge on health effects of those chemicals, and thirdly, the spectrum of remediation actions when exceeding intervention values has been broadened.

The indoor air guidance and intervention values for chemicals are based on chronic exposure since they are designed to be health protective for prolonged use of the indoor environments by the public, including vulnerable populations.

The guidance values are based on NOAEC values for threshold effects and on concentrations corresponding to a lifetime risk of 1.10-6 for carcinogenic substances without a threshold; the guidance values thus correspond to indoor air quality levels being protective against adverse health effects from indoor pollutants.

The intervention values are based on LOAEC values and on concentrations corresponding to a lifetime risk of 1.10-5 carcinogenic substances without a threshold. When reaching or exceeding intervention values, remediation actions are required to safeguard the health of the occupants.

# Session 2

Risk assessment concepts for indoor air pollutants, Part II

## Austrian risk assessment concept for indoor air chemicals

**Maria Uhl**
**Environment Agency Austria, Austria**

The Austrian Working Group on Indoor Air (AWGIA) at the Federal Ministry of Sustainability and Tourism (BMNT, formerly BMLFUW) was founded in 1999 in order to establish guidance for the assessment of indoor air quality. Its members are experts from the technical and medical sciences and from administration, e.g. from the Austrian Institute for Healthy and Ecological Building, the Medical University of Vienna, the Climate and Air Quality Commission of the Austrian Academy of Sciences, the Austrian Social Insurance for Occupational Risks, experts from the Austrian Federal States and the Environment Agency Austria.

Following a long tradition of establishing guideline and limit values for air pollutants - originally for outdoor air - guideline documents for selected pollutants are produced. The guideline documents provide a detailed description of the measurement settings (e.g. averaging time, worst-case scenarios regarding air exchange rate) and measurement techniques. Regarding health relevance comprehensive background information is provided based on an extensive literature research. Limit values are based on the most sensitive health endpoints. To derive limit values NOAELs plus standard safety factors are usually applied.

Besides the development of guideline values for different important indoor pollutants the Working Group issued statements on current issues in the field of indoor climate. These position papers serve as a fast response to urgent indoor air problems such as mechanical ventilation in schools or protection from passive smoking in bars and restaurants.

## Indoor air quality: actions and policy in the UK

**Sani Dimitroulopoulou**
**Public Health England, UK**

Indoor air quality (IAQ) has gradually received considerable political and public attention over the last five years in the UK. The aim of this paper is to provide a comprehensive summary of policy and actions related to IAQ in the UK.

The first part summarises the current regulatory framework on air quality in the UK. Although national ambient air quality standards and objectives have been set by the Department for Environment (DEFRA), there is no comprehensive regulatory framework for IAQ in the UK. The UK Building Regulations by the Ministry of Housing (MHCLG), known as Approved Documents (ADF) for ventilation in England and Wales, recommend ventilation provisions to control moisture and air pollutants in buildings. For this purpose, a set of acceptable levels needs to be defined. PHE is working to provide an updated set of performance criteria for indoor air pollutants that may be used in AD F. The Department for Education's (DfE) BB101 is guidance on ventilation, thermal comfort and indoor air quality in schools and can be an input to ADF. The WHO IAQ guidelines have been used for the first time in the UK as the basis of the DfE guidelines. There is also voluntary guidance by CIBSE for the building industry.

Apart from the guidelines aiming to protect the general population's health, there is health and safety legislation for occupational health: Control of Substances Hazardous to Health Regulations and maximum Workplace Exposure Limits EH40/2005 by HSE. These are legally binding short and long term exposure limits.

The second part refers to activities in the UK, aiming to review the evidence of the health effects from exposure to indoor air pollutants; for example, the work by the National Institute for Care and Health and Care Excellence on interventions, the Royal College of Physicians on children's exposure and the UK Indoor Environments Group, a network of professionals on raising awareness of IAQ issues. PHE actively participates in all these activities.

# Session 3

Particulate matter

# Exposure-response relationship and enviromental burden of disease

**Heli Lehtomäki, Otto Hänninen**
**National Institute for Health and Welfare, Finland**

Environmental pollution was recently estimated to cause globally 9 million annual deaths, more than tobacco smoking alone, and comparable number to the deaths caused by AIDS, malaria, tuberculosis, alcohol use, malnutrition, road accidents, drug use, wars and violence together. Air pollution and particulate matter are responsible for two thirds of these deaths (Landrigan et al. 2017). Environmental burden of disease methods (e.g. Hänninen et al., 2014, Prüss-Ustün et al., 2016) allow for richer characterization of the disease burden than merely estimating the number of premature deaths, including accounting for years of life lost (YLL) due to mortality, but especially the burden associated with morbidity.

Development of the global estimates has faced challenges in estimating the exposure-response relationship in high pollution levels of the developing countries. The current estimates are based on probabilistic simulations and data from household air pollution and ambient epidemiological studies (e.g. Burnett et al., 2014, Cohen et al. 2017). In the developed world special interest is raised by the simulation of the lower end of the exposure response curve. The Global Burden of Disease (GBD) study applies a theoretical minimum risk exposure distribution value (2.4 – 5.9 µg m-3), suggesting that in the cleanest countries such as Finland the air pollution problem has in practice been already solved. However, the alternative log-linear zero threshold method is still strongly supported by many experts and there is great interest in looking into the impacts of air pollution also at low exposure levels. To that extent WHO working groups are also working on reviewing scientific evidence on health impacts below the current PM2.5 air quality guideline of 10 µg m-3 to evaluate the need of guideline updates.

# Particulate matter: Identification, mitigation, and assessment

**Michael Riediker**
**The Swiss Centre for occupational and Enviromental Health (SCOEH), Switzerland**

Particulate Matter (PM) is known to influence human health in function of PM properties such as size, shape, chemical and biological composition, reactivity and solubility. PM can get directly emitted from natural and man-made sources, but PM can also form in the air from gaseous precursors. Furthermore, emitted PM can change many of its properties over time after it was released or formed. To define effective protective strategies against PM's ill-health effects, it is thus necessary to understand where and how PM can be released and formed, how this release can lead to exposure of workers, consumers, inhabitants and the environment, and what properties PM will have at the time of exposure. Once we understand release, transmission and exposure, we can better design and implement adequate mitigation measures to protect humans and the environment from PM ill-health effects. This talk will review some of the most important concepts with a focus on indoor air quality challenges.

# Indoor bioaerosols

**Gerhard Wiesmüller**
**Public Health Department Cologne, Germany**

Gerhard A. Wiesmüller 1,2
1 Division of Infectious and Environmental Hygiene, Public Health Department Cologne, Germany
2 Institute of Occupational, Social and Environmental Medicine, RWTH Aachen University, Germany

Principally, indoor exposures to dampness and mould can result in the following health effects:

- Infections,
- Sensitization and allergies,
- Toxic reactions,
- Olfactory effects,
- Impairment of well-being.

In individual cases, no causality between a specific mould exposure indoors and specific health problems or diseases can be determined without doubt. Individual health risk of mould exposure indoors can only be judged validly by a physician based on the assessment of men's disposition as disposition-based risk-assessment.

Specially protected risk groups are:
a) Individuals with immunosuppression according to the 3 risk groups of the Commission for Hospital Hygiene and Infection Prevention at the Robert Koch Institute (RKI),
b) Individuals with cystic fibrosis,
c) Individuals with bronchial asthma.

In Germany, a "Medical Guideline of Clinical Diagnostics in Case of Mould Exposure Indoors" was developed (https://www.awmf.org/leitlinien/detail/ll/161-001.html). The main statements will be presented. Supposed technical measurement objectification of mould exposure is neither quantitatively nor qualitatively possible. At the best, this can be estimated in case of dampness and mould damages. Factual and professional risk assessment of mould infestation indoors is only possible by interdisciplinary cooperation between physician, environment mycologists, indoor environment specialists, handcrafters, architect, building surveyor amongst other involved experts.

# Session 4

Risk mitigation for indoor air quality on example of construction products

## Experiences of voluntary approach – M1 classification in Finland

**Jorma Säteri**
**Finnish Society of Indoor Air Quality and Climate, Helsinki Metropolia University of Applied Sciences, Finland**

Jorma Säteri [1], Mervi Ahola [2] and Laura Sariola [3]

[1] Metropolia University of Applied Sciences, Helsinki, Finland
[2] Finnish Society of Indoor Air Quality and Climate, FISIAQ. Espoo, Finland
[3] The Building Information Foundation RTS sr, Helsinki, Finland

The Finnish Society of Indoor Air Quality and Climate (FiSIAQ) introduced a Classification of Indoor Climate, Construction Cleanliness, and Finishing Materials in 1995. After two revised versions, the fourth edition of Classification of Indoor Environment was published in May 2018. Based on the criteria set in the classifications, The Building Information Foundation RTS sr started M1-labelling of building products in 1996, air-handling components were added in 2002.

The criteria for Emission Classification of Building Materials now include the EU-LCI value of single VOCs. Other criteria deal with TVOC, formaldehyde, ammonia, CRM-substances and odour acceptability. The measurement protocol has been updated to align with the EN 16516. Upholstered office chairs is the most recent product group added to the M1-labelling. The chairs have one emission class, M1, and the emissions are measured after 3 days.

Manufacturers have developed low-emitting products to meet the requirements. In August 2018, there are almost 4500 M1-classified low emitting building materials, fixture, furniture and air-handling components. These products are commonly used in residential and commercial buildings in Finland.

The Classification of Indoor Environment 2018 (classes S1, S2) and sub-classifications Cleanliness classification of construction works (P1) and Emission Classification of Building Materials and Cleanliness Classification of Air-handling Components (M1) have been integrated to the new Finnish environmental classification system for building processes called Green Leadership Tool (RTS GLT). mates in certain settings.

## 25 years of material emission labeling in Denmark – experiences and development

**Thomas Witterseh**
**Danish Technological Institute, Denmark**

The voluntary material emission labelling scheme Danish Indoor Climate Labelling was established in 1993 upon a request by the Danish Minister of Housing and Building. The purpose of the labelling scheme is threefold: to improve the air quality in buildings by documenting the impact of products on the indoor air quality, to contribute to the development of indoor friendly products, and to support the selection of indoor friendly products. The first labelling licenses were issued in 1995. The material emissions are evaluated based on chemical analysis of individual VOCs, sensory evaluation of volatile emissions, and release of fibres and particles (ceiling systems only). The labelling scheme was originally intended for building products but covers now also furniture, fixtures and fittings. The active labelling licenses cover more than 3000 individual products.

The presentation will cover the development of the labelling scheme in Denmark and abroad and the experiences gained during 25 years of material emission labelling.
The labelling scheme has proved to be useful in several ways. There is now an increased focus on low emitting materials, there has been a tendency towards generally lowered emission levels over the years among the labelled products, and in many cases test results have been used actively for product development.

The labelling criteria were thoroughly revised early 2018 adopting an evaluation method based on EU LCI-values and thereby supporting the harmonization of material emission test and evaluation methods. The first experiences with the new evaluation method is presented.

## Progress and Challenges in US VOC emissions: A20 Year Review

**Marilyn Black**
**Underwriters Laboratories Inc., Founder GREENGUARD, USA**

There are many potential sources of indoor air pollution in homes and buildings, including building materials, furnishings, cleaners and other products used indoors. Considering that source control is the most effective means of preventing indoor air pollution, reducing VOC emissions from indoor products is a critical aspect of protecting human health. Over the years, third party testing and certification programs have studied the volatile and particle emissions of many materials, finished products, and electronics. A review of primary VOCs emissions from product types -including office furniture, children's furniture, paints and coatings, insulations, adhesives, wall coverings, floor coverings, and electronic equipment show many different VOCs- is discussed. VOC data from specific product categories are grouped by frequency of detection and hazardous risk categories according to VOC regulatory lists. Data trends over time in the US show a reduction in the number of chemicals detected on key health related criteria lists, and reductions in key pollutant levels with defined health risks like formaldehyde. Data also show that numerous odorant and irritants are detected but that the majority of VOCs found are not on key hazard lists. Emissions data is critical is assessing the health impact of indoor materials and seeking steps in reducing risk of human exposure. Concern does exist over the exposure of low dose, complex mixtures of many VOCs, for which we do not yet understand their health impact.

## Challenges and chances of a harmonized European health evaluation for building products emissions

**Ana Maria Scutaru**
**German Environment Agency (UBA), Germany**

A prerequisite for healthy air quality indoors is the use of low emitting materials. In Europe, the Construction Products Regulation sets harmonized conditions for the marketing of construction products with the objective of protecting the building users' health. However, until now only three mandatory systems are in place to evaluate VOC emissions from building products using different lists of substances: Germany focusses on 185 compounds, France defines classes based on 10 compounds and Belgium refers to the list of compounds with European harmonized 'lowest concentrations of interest (EU-LCI)' values.

Besides the mandatory systems there are a number of voluntary, health related quality labels in European countries offering help for the consumer to choose a 'safe' product in regard to controlled emissions. The major European labels had joined an initiative to harmonize the different labelling criteria; the result was a proposal published in 2012 in ECA Report 27. The core of a harmonized evaluation was seen in a harmonized list of assessed substances with so called LCI values for an appropriate number of substances encountered in emission tests.

Subsequently, a group of experts from ten European countries started in 2011 to develop a common European list of substances and associated emission limits (EU-LCI values).

The European Commission recognized the insufficient implementation of the basic requirements for construction products regarding health protection and is therefore currently planning the issue of a delegated act on the communication of VOC emissions from construction products in the form of "VOC classes".

This lecture presents the current state of the EU-LCI harmonization framework, emphasizes some particular challenges associated with the process and highlights practical ways of implementing the EU-LCI values.

# Session 5

Risk assessment concepts for indoor air pollutants, Part III

## Health Canada's regulatory approach to indoor air contaminants

**Vanessa Beaulac**
**Health Canada, Canada**

Health Canada is responsible for helping Canadians maintain and improve their health. The Indoor Air Contaminants Assessment Section (IACAS) was established to generate health-based guidance on actions to improve indoor air quality. IACAS assesses the health risks of inhalation exposure to indoor air pollutants, provides information on pollutant levels and sources in Canadian homes, and recommends ways to reduce exposure. IACAS risk assessments are the foundation for derivation of recommended health-based acute and chronic maximum exposure limits in indoor air, where appropriate. These exposure limits form the basis for *Residential Indoor Air Quality Guidelines*, which are issued as voluntary objectives under the *Canadian Environmental Protection Act, 1999*.

Ms. Beaulac will provide an overview of the process for prioritizing and assessing the risk of indoor air contaminants. She will highlight some new techniques used in IACAS risk assessments, as well as discuss approaches to guideline uptake through various examples. In addition, she till touch upon how IACAS risk assessments provide the scientific basis for actions to reduce exposure and/or protect health (e.g. standards, building codes, regulations, and communications products). Risk assessments done in IACAS also guide in-house research to address identified data gaps or to inform outreach, such as emission testing projects.

The approach taken by Health Canada illustrates the dichotomy between necessary predictability in government risk assessment approaches, and the innovation required when establishing and promoting uptake of non-regulatory guidelines.

## ANSES guidelines for indoor air quality: Health-based values for selected pollutants

**Marion Keirsbulck**
**French Agency for Food, Environmental and Occupational Health & Safety (ANSES), France**

Introduction: The French Agency for Food, Environmental and Occupational Health & Safety (ANSES) has been developing indoor air quality guidelines (IAQGs) since 2005. These guidelines correspond to safe levels below which adverse health effects are not expected for the general population, including sensitive groups.

Methods: To determine IAQG values, a methodological approach is followed based on a common approach to derive a reference value and specifically includes the toxicological profiles, the identification of critical effects and modes of action, the review and analysis of available guideline values or toxicological reference values. A report was published in 2007 and updated twice (2011, 2016). Since 2011, to complement these values, a critical assessment of measurement methods has been proposed based on the general requirements for carrying out procedures for the measurement of chemical agents concerning workplace exposure (NF EN 482, 2006) and on a classification into several validation categories.

Results: After more than 10 years of collective expertise at ANSES, IAQGs have been studied for 13 pollutants: formaldehyde, carbon monoxide, benzene, naphthalene, particulate matter, trichloroethylene, perchloroethylene, hydrogen cyanide, nitrogen dioxide, acrolein, acetaldehyde, ethylbenzene and toluene. IAQG values were set for 11 pollutants in accordance with selected critical effects, modes of action and realistic exposure times. An update of IAQG for formaldehyde was published in 2018 in the framework of the revision of the different reference values for formaldehyde.

Conclusion: As part of its continuing mission of expert assessment, ANSES is studying IAQG values for chemical mixtures. Another methodological question for setting guideline values for indoor dust is raised through the different exposure routes and sources that must be taken into account when setting guideline values to protect public health.

# Human health hazard characterisation for biocides – current practice under EU Reg 528/2012

**Carsten Kneuer**
**German Federal Institute for Risk Assessment (BfR), Germany**

In Europe, biocidal products - which are used to protect humans, animals, materials or articles against harmful organisms like pests or bacteria - are regulated by the Biocidal Products Regulation (BPR, Regulation (EU) 528/2012). Main groups of biocidal products include disinfectants, preservatives, pest-control products, antifoulings and embalming fluids. Active substances used within biocides may be released into the indoor air either from those products or respective treated articles. In many cases, pollution of indoor air with biocidal active substances can also occur from other sources unrelated to biocidal use. Co-exposures through other routes, including oral from residues in food or dermal at workplaces, can occur. Biocidal products may only be authorised if they have, inter alia, no immediate or delayed unacceptable effects themself, or as a result of their residues, on the health of humans, including that of vulnerable groups, directly or indirectly. The BPR requires corresponding human health hazard and risk assessments to be performed, which are based to a large extent on the toxicology of the active substances contained in the product. The assessment process is described in detail in the BPR Guidance and includes the derivation of both external and a range of internal health based guidance values for characterisation of potential local and systemic effects, respectively. The presentation will provide further background information on the BPR, data requirements for biocidal active substances, the approaches to human health risk assessment including derivation reference values as well as on information sources.

BPR Guidance Volume III Part B+C: https://echa.europa.eu/documents/10162/23036412/biocides_guidance_human_health_ra_iii_part_bc_en.pdf/

# Session 6

Indoor air chemicals and monitoring

## Indoor air chemistry: Reaction products and airway effects

**Peder Wolkoff**
**The National Research Centre for the Working Environment, Denmark**

Reactive chemistry is ubiquitous indoors with a wealth of complex oxidation reactions.[1] Common terpene-based fragrances in indoor air should not be of health concern from inhalation (both acute and long-term) due to their low concentrations; however, their gas- and surface reactions with $O_3$ and the OH radical produce a host of products, both gaseous, i.a. formaldehyde, and ultrafine particles formed by condensation processes, e.g.[2,3] These reaction products may be of some health concern.[4,5]

Acute effects like sensory irritation is generally unlikely to occur based on human and rodent exposure studies and reference values. Concentrations of key reaction products are generally too low to cause acute effects and some fragrances and their reaction products may possess anti-inflammatory properties. However, long-term effects of the reaction products, in general, are poorly explored. $O_3$ exposure of material surfaces may have a significant impact on the perceived air quality.[6]

[1] Weschler CJ, Carslaw N. Indoor chemistry. Environ Sci Technol 2018;52:2419-28.
[2] Atkinson R, Arey J. Gas-phase tropospheric chemistry of biogenic volatile organic compounds: a review. Atmos Environ 2003;37 (Suppl 2):S197-S219.
[3] Huang H-L, Tsai SY, Hsu N-Y et al. Effects of essential oils on the formation of formaldehyde and secondary organic aerosols in an aromatherapy environment. Build Environ 2012;57:120-5.
[4] Wells JR, Schoemaecker C, Carslaw N et al. Reactive indoor air chemistry and health-A workshop summary. Int J Hyg Environ Health 2017;220:1222-9.
[5] Wolkoff P, Nielsen GD. Effects by inhalation of abundant fragrances in indoor air - An overview. Environ Int 2017;101:96-107.
[6] Knudsen HN, Nielsen PA, Clausen PA et al. Sensory evaluation of emissions from selected building products exposed to ozone. Indoor Air 2003;13:223-31.

## Target and non-target/suspect screening analyses for emerging substances in air and dust from various indoorenvironments

**Pawel Rostkowski**
**Norwegian Institute for Air Research, Norway**

Although dust is one of the most frequently studied matrices in the indoor environment, due to its complexity, analysis is almost exclusively limited to target analyses. It is anticipated that household dust should be further examined for the presence of other chemicals of human health concern to provide a more complete understanding of chemical exposure indoors. In this talk some results of the screening projects initiated by Norwegian Environment Agency and results of the first Collaborative Trial in the Non-target Screening of the indoor dust will be presented.

# The European Commission's Information Platform for Chemical Monitoring data (IPCHEM): a refernece gateway for searching, accessing, retrieving, assessing and sharing indoor air monitoring data in EU

**Stylianos Kephalopoulos**
**European Commission, DG Joint Research Centre (JRC)**

Directly following-up to the European Commission's Communication "Combined Effects of Chemicals - Chemical mixtures" (EC, 2012), DG JRC has developed the EC's reference Information Platform on Chemical Monitoring data (IPCHEM).

IPCHEM supports a more coordinated approach for searching, accessing, retrieving, assessing and sharing data related to the occurrence of chemicals and chemical mixtures across various media (e.g. environment, humans, food & feed, indoor air and consumer products) (https://ipchem.jrc.ec.europa.eu/).

IPCHEM was designed and implemented as a distributed infrastructure, providing where feasible, remote access to existing relevant information systems and data providers.

European Commission services (DGs ENV, SANTE, JRC, RTD), European Agencies (EFSA, EEA, ECHA) and EU MS are actively involved in IPCHEM's development, promoting its use and engaging new data providers.

IPCHEM's primary objectives are focused on: (1) Assisting policy makers and scientists to discover and access chemical monitoring data on existing, new, emerging and less-investigated chemicals covering a range of matrices and media; (2) Hosting data currently not readily accessible (e.g. outcomes of research projects, off-line stored monitoring data, etc.) that will be searchable and accessible through the platform; (3) Providing chemical monitoring data and information of defined quality in terms of spatial, temporal, methodological and metrological traceability; (4) Facilitating exposure and risk assessment practices in support of EU policies to adequately address the risks from exposure to multiple chemicals from different sources and pathways.

IPCHEM contains already a wealth of data thanks to the contributions of several EU bodies, government agencies and research consortia: more than 38 million of chemical concentration measurements data are accessible, retrievable and downloadable today via IPCHEM.

# Session 7

Indoor air environment and children‘s health

## The special vulnerability of children

**Ruth A. Etzel**
**Office of Children's Health Protection, U.S. Environmental Protection Agency (EPA), USA**

Children are more vulnerable than adults to environmental risks because of a number of factors. First, they are constantly growing. They breathe more air, consume more food, and drink more water than adults do, in proportion to their weight. Second, the central nervous, immune, reproductive, and digestive systems of a child are still developing. During certain critical windows of vulnerability, exposure to environmental toxicants can lead to irreversible damage. Third, children behave differently from adults and have different patterns of exposure to environmental hazards. Young children crawl on the ground where they can be exposed to dust and chemicals that accumulate on floors and soils. Fourth, children have little control over their environments. Unlike adults, they may be both unaware of risks and unable to make choices to protect their health. Because of these unique vulnerabilities, children need special protection from environmental hazards.

## Exposure to toluene and other neurotoxic substances in Danish children's bedrooms

**Lars Gunnarsen**
**Danish Building Research Institute, Denmark**

The purpose of the present study was to investigate risks of adverse effects on the developing central nervous system from exposure to toluene and other volatile substances emitted from toys and materials typically found on Danish market and in Danish children's bedrooms.

Relevant chemical substances and products including furniture, electronics, decoration and toys were selected for small-scale emission measurements. Additionally, full-scale activity measurements were performed during ironing of plastic beads and using permanent markers in child's room mock-up. Finally, air concentrations were measured in 19 bedrooms of children aged 1-18 years. Risk Characterization Ratios, RCR, calculated as the ratio between calculated or measured exposure and a tolerable exposure level or LCI value (Lowest Concentration of Interest) quantified the risks.

The highest emissions occurred 24 hours after painting and lacquering surfaces with a downward trend within 72 hours. The results suggest that many known neurotoxic substances are no longer used or have been substituted. The only product group with more prolonged emission was rubber figures, for which emission of xylenes remained above the detection limit even after 2 weeks.

In the laboratory, all RCR values for the measured individual substances were below 1. The sum of the RCRs (i.e. risk at simultaneously exposure to all the substances) exceeded the value 1 after the first 24 hours of evaporation, but declined substantially after 72 hours

Few children's rooms had slightly elevated concentrations explained by renovating activities taking place in the house, glue and paint for the construction of aircraft models, the presence of many plastic and rubber figures and incorrect storage of petrol/white spirit. The calculated RCR values were below 1, except for one room with incorrect storage of petrol. This room was also the only case where benzene was detected. The concentration of benzene was 20 mg/m3.

## How to consider children by risk assessment of indoor air chemicals?

**Marike Kolossa-Gehring, Wolfram Birmili, Till Weber, Małgorzata Dębiak**
**German Environment Agency (UBA), Germany**

Children are regarded as a generally more sensitive group concerning chemical exposure compared to adults. This needs to be considered by health care provisions. To deliver a solid data base the most current German nationwide population studies (German Environmental Surveys (GerES)) conducted by the German Environment Agency focused on the group of 3 to 17 years old. The main element of the study program is human biomonitoring (HBM). Urine and blood samples have been analyzed for heavy metals, plasticizers, perfluorinated compounds or solvents with the aim of determining environmental pollutant exposure and identifying subgroups with higher exposure. To explore potential exposure pathways indoor air monitoring (IAM) was performed in a subset of households to generate a representative dataset for German indoor air contaminants in private dwellings. The results of GerES IV and GerES V highlight the difference in the internal exposure towards chemicals between adults and children. Particularly the concentration of phthalates was much higher in children compared to adults. Whether the higher concentrations of chemicals in children result from the difference in physiology and behavior or from external exposure is until now not clarified. This underlines the importance of special consideration of sensitive groups by the risk assessment authorities. Usually the standard safety factors for intraspecies variability of 10 are regarded to be sufficient for the whole population. The German Committee on Indoor Guide Values applies in addition a factor of 2 to protect children. This factor is justified by the breathing rate per kg of body weight being about twice as high in children compared to adults. Recently the dermal uptake of substances from indoor air is drawing more attention, arising the question if the physiological differences in the surface body weight ratio has to be compensated by the risk assessment. The detailed assessment of the contribution of inhalative uptake to the overall body burden and pairwise generation of IAM and HBM datasets for relevant substances is needed to address this question. The first such data for N-methyl-2-pyrrolidone, naphthaline and benzene will be available within GerES V.

# Health driven IAQ: The children case

**Eduardo de Oliveira Fernandes**
**Emeritus Professor University of Porto, Portugal**

The WHO edited in 1987 the first set of air quality guidelines. These and successive versions did not address indoor air except in what regards the moisture and molds associated with indoor environments. This approach implies that there is only one air: both outdoor and indoor air quality need to be assessed to allow for the management of the impact on health resulting from human exposure to air pollution.

The concept of 'dose' versus 'health impact' is related to the fact that exposure to a pollutant is the product of the concentration of that pollutant/substance by the exposition time. The most intuitive strategy to control the exposure to air pollution indoors requires one of two actions: to provide clean/fresh incoming air, either continuously - mechanically or naturally by window openings - or by planning periodic breaks defined in tune with the evolution of the level of an adopted critical tracer substance such as the $CO_2$, bearing in mind the level of occupation and the actual air exchange rate.

From a planning perspective, clean indoor air requires a complementary approach in what regards the nature of surfaces of the space and the respective materials as putative sources of pollution of the indoor air through emission/reemission of related pollutants, i.e. a 'source control' strategy. Thereafter, unavoidable pollution, including that directly due to human occupation, which increases with the duration of the occupation, can be capped either by continuous ventilation, intermittent mechanical ventilation or by opening windows after some time of occupation.

Children appear in the context above as a critical case of exposure due to their age and vulnerability, either at home, where they may be exposed to insufficiently ventilated spaces, wall humidity, pets, combustion sources, etc. Several studies have been undertaken in countries of the EU, some of which under the EC initiative. The results from projects such as Sinphonie at the EU level and others at the national level allow to clearly state what ought to be done as policy, with the source control approach preceding remediation or palliative actions while resisting over-rich solutions such as, for instance, the use and abuse of air conditioning with brings its own set of inconveniences for health and well-being.

Forthwith, the assessment of IAQ becomes a strategic criterium for ensuring good levels of indoor air quality, not just by measuring the critical conventionalised parameters but also by controlling all putative emission sources. This both at the design and construction stage and also in terms of post occupancy evaluation, through IAQ audits supported by checklists and measurements.

# Session 8

Indoor air toxicology: challenges and upcoming tasks

## Are asthmatics more sensitive to irritants?

**Gunnar Johnason**
**Karolinska Institutet, Sweden**

Asthma is a chronic inflammatory airway disease, characterized by recurrent attacks of breathlessness and wheezing. It is one of the major noncommunicable diseases with 235-300 million affected worldwide with an increasing trend. The strongest risk factors for developing asthma are inhaled substances and particles that may provoke allergic reactions or irritate the airways. In a PhD project (1), we assessed the scientific basis for differences in sensitivity to irritants between healthy and asthmatic subjects and how this is addressed when setting acute exposure limits and DNELs under REACH.

We found that, for a number of reasons, published experimental asthma studies are inconclusive for most chemicals. Still, the data support that asthmatics are more sensitive than the healthy (holds for 8 of 19 chemicals and 3 of 14 mixtures. The richest data were found for sulfur dioxide, where a benchmark-concentration analysis suggested that the asthmatics react to approximately 9 times lower concentrations. Thus, in the absence of specific data, an assessment factor of 10 to account for asthmatics seems warranted when setting limit values.

We further found that asthma is often omitted or disregarded when setting acute exposure limits and DNELs, expert committees and REACH registrants alike.

We could not demonstrate higher sensitivity to chlorine in the sensitized mice using several endpoints (lung function, metacholine test, inflammatory markers in bronchiolar lavage fluid, lung histopathology). However, all OVA mice showed moderate to severe lung injury suggesting that this animal model is unsuitable.

1. Johansson M. Asthmatics as a susceptible population in health risk assessment of airborne chemicals. Thesis for doctoral degree. Karolinska Institutet, 2016

## Bioaccessibility and bioavailability of anvironmental semi-volatile organic compounds via inhalation

**Wenjuan Wei**
**Scientific and Technical Centre for Building (CSTB), France**

Abstract: Semi-volatile organic compounds (SVOCs) are known to cause adverse health effects, such as endocrine disrupting and carcinogenic effects. Indoor environmental SVOCs can exist in different phases (gas phase and absorbed onto airborne particles, settled dust and material surfaces), leading to multiple routes of exposure (inhalation, dermal absorption and ingestion). The inhalation route is important for a number of SVOCs with high volatility, such as some phthalates, polybrominated diphenyl ethers, polychlorinated biphenyls, pesticides and musks. SVOC concentrations are commonly used for the estimation of human exposure to environmental SVOCs. However, the use of rough concentrations may overestimate the uptake of SVOCs because a fraction of the SVOCs may not be bioaccessible or bioavailable.

In this study, we (1) reviewed the existing measurement methods and mathematical models addressing the bioaccessibility and bioavailability of SVOCs via inhalation, and (2) identified the key challenges to determining the SVOC bioaccessibility and bioavailability via inhalation.

Results showed that the existing in vitro, in vivo, and ex vivo measurements in the literature were carried out for 2,3,7,8-tetrachlorodibenzo-p-dioxin and a few polycyclic aromatic hydrocarbons. We suggest developing valid methods for the quantification of other SVOCs. Regarding the modeling approaches, we suggest (1) considering the whole respiratory system, (2) taking into account the gas- and particle-phase SVOC mass transfer, particle deposition, gas- and particle-phase SVOC absorption to the respiratory tract, and respiratory cycle period, and (3) accounting for individual differences, such as the lung morphology and breathing pattern. Moreover, the model and the measurement method of bioaccessibility should be validated using data from in vivo studies.

## Neurogenic inflammation and sensitization

**Steven Nordin**
**Umea University, Sweden**

Persons with chemical intolerance report symptoms from everyday substances, such as perfumed products, cleaning agents and newly printed newspapers at very low doses. The symptoms range from airway, mucosae and skin symptoms to head-related, gastrointestinal, cognitive, emotional and general symptoms, with considerable impact on quality of life in severe cases. Depending on definition, the prevalence in the general population ranges from about 3 to 12%. Studies suggest that chemical intolerance cannot be referred to a toxicological effect in a strict manner, nor to an allergic effect. Instead the intolerance may be explained by psychobiological mechanisms, such as neurogenic inflammation, sensitization, classical conditioning, nocebo effect and symptom misattribution. The chemical senses, thus olfaction and chemesthesis, seem to play particularly important roles in chemical intolerance by acting as mediators between chemical exposure and symptoms. The aim of the present presentation is partly to describe the mechanisms of neurogenic inflammation and sensitization in a general respect, partly to illustrate empirical support for these mechanisms contributing to chemical intolerance by mediation of the chemical senses.

## How to assess respiratory sensitization?

**Josje Arts**
**Akzo Nobel Chemicals B. V., Arnhem, The Netherlands**

Respiratory sensitizers are considered agents that will lead to hypersensitivity of the airways following inhalation exposure. In contrast to skin sensitization, asthma and other related respiratory conditions (rhinitis, extrinsic allergic alveolitis) are described within the GHS/CLP classification systems irrespective of the mechanism (immunological or non-immunological) by which they are caused. The difficulty that this definition causes is that it serves to embrace both true respiratory allergens which, by definition, induce effects via immunological mechanisms, and non-allergenic asthmagens in which case adverse effects are caused by non-immunological mechanisms (Kimber et al., 2001).

True chemical respiratory allergy is characterized by immunological priming that results in allergic sensitization of the respiratory tract. If the sensitized subject is exposed subsequently by inhalation to the same chemical then an accelerated and more aggressive secondary immune response will be provoked that elicits a respiratory reaction recognized clinically as respiratory allergy. Reactions may become more severe with repeated exposure as the level of sensitization increases (Kimber et al., 2011).

There is a pressing need to understand whether chemicals that are associated with respiratory effects are true allergens that induce immunological priming and allergic sensitization, or whether the symptoms recorded are due to some other non-allergic mechanism.
The presentation will focus on (animal) methods to assess respiratory sensitization/allergy and the clinical diagnosis of chemical respiratory allergy.

References

Kimber I, Basketter DA, Gerberick GF, Ryan CA, Dearman RJ (2011) Chemical allergy: translating biology into hazard identification and characterization. Toxicol. Sci. 120 (S1), S238-S268

Kimber I, Basketter DA, Roggeband R (2001). Chemical respiratory allergy: classification and labelling. Toxicol. 167, 159-162

# A novel approach for risk assessment of chemical mixtures  linking data from population based epidemiology and experimental toxicolology by the use of new statistical tools

**Carl-Gustaf Bornehag**
**Karlstad University, Sweden and Icahan School of Medicine at Mount Sinai, New York, USA, Sweden**

Humans are continuously exposed to chemicals with endocrine disrupting properties (EDCs). Risk management of EDCs presents a major unmet challenge due to the fact that the available data about adverse health effects are generated by examining one compound at a time, while real life exposures are to mixtures of chemicals. Herein we integrate epidemiological and experimental evidence towards a whole mixture strategy for risk assessment. To illustrate, we conduct the following four steps in a case study: (1) identification of single EDCs ("bad actors") - measured in prenatal blood/urine in the SELMA study - that are associated with a shorter anogenital distance (AGD) in baby boys; (2) definition and construction of a "typical" mixture consisting of the "bad actors" identified in step 1; (3) experimentally testing this mixture in an in vivo animal model to estimate a dose response relationship and determine a point-of-departure (i.e., reference dose) associated with an adverse health outcome; and (4) use a statistical measure of "sufficient similarity" to compare the experimental reference dose (from step 3) to the exposure measured in the human population and generate a "similar mixture risk indicator" (SMRI). The objective of this exercise is to generate proof of concept for the systematic integration of epidemiological and experimental evidence with mixture risk assessment strategies. With such a whole mixture approach, we could find a higher rate of pregnant women under risk when comparing with more traditionally models of additivity, or a compound-by-compound strategy, which is the most used risk assessment procedure.

# Curricula vitae of chairs, speakers and panelists

## Erwin Annys

**European Chemical Industry Council (CEFIC)**

Erwin Annys obtained a PhD in Chemistry from the University of Ghent, where he graduated on nitrosamines in rubber. He worked sixteen years in the chemical industry in different positions in production, technical services, research and development and regulatory affairs.

In 2001 with the publication of the white book, he was confronted for the first time with the new chemical legislation on chemical substances, REACH. Since then he follows this very closely and this legislation brought him to the Belgian federation of the chemical industry and the life sciences, Essenscia in 2004, where he was responsible for product and innovation policy.

Since 2008 he is working for Cefic, the European Chemical Industry Council where he is director REACH/Chemicals policy. He is an observer in the Competent Authorities Meeting for REACH and Classification and Labelling, as well in different Committees of ECHA.



## Josje Arts

**Akzo Nobel Chemicals B. V., Arnhem, The Netherlands**

Josje Arts studied Human Nutrition with Toxicology as main subject at the Wageningen University (The Netherlands). After graduation in 1986, she started working as Inhalation Toxicologist at TNO (now Triskelion) in Zeist; in this period she also worked on her PhD thesis on respiratory allergy (Utrecht University, The Netherlands, 2001). Since 2008 she is working at AkzoNobel as Senior Toxicologist and PSRA manager.

## Kenichi Azuma

**Kindai University Faculty of Medicine, Japan**

Dr. Azuma is an Associate Professor of Environmental Medicine and Behavioral Science at Kindai University Faculty of Medicine. Dr. Azuma earned a PhD in Environmental Health from Kyoto University. He has been working as visiting fellow of the National Institute of Public Health and the Louis Pasteur Center for Medical Research. His research has focused on human physiological and psychological responses to environmental factors, the epidemiology of cardiovascular and respiratory diseases, cancer, building-related symptoms/illnesses, and hypersensitivity to chemicals, and the health risk assessment for environmental pollutants. Dr. Azuma is currently a member of the Board of Trustees of the Japanese Society for Hygiene, the Japanese Society of Public Health, the Japanese Society of Clinical Ecology, and the Japanese Society of Indoor Environment. Furthermore, Dr. Azuma has been contributing to the development of the World Health Organization (WHO) guidelines for indoor air quality: selected pollutants and the WHO Housing and Health Guidelines. He has been also contributing to the development of the Japanese air quality guidelines for ambient air provided by the Ministry of the Environment, the Japanese indoor air quality guidelines provided by the Ministry of Health, Labour and Welfare, and the occupational exposure limits provided by the Japan Society for Occupational Health.

## Vanessa Beaulac

**Health Canada, Canada**

Since 2008, Vanessa has worked for Health Canada evaluating and regulating both indoor and outdoor air contaminants as a risk assessor, with a personal interest in dosimetry and biochemical mechanisms of air pollution.

Vanessa is currently Section Head for the Indoor Air Contaminants Assessment Section (IACAS) of Health Canada. The IACAS is a multi-disciplinary team that conducts risk assessment for air contaminants relevant to indoor air; provides outreach to Canadians; and contributes to research on indoor air quality. The IACAS is also responsible for producing Canadian Residential Indoor Air Quality Guidelines.

Prior to working with the IACAS, Vanessa managed the Exposure Assessment Section of Health Canada, a national field research program, which investigates the spatial distribution and chemical composition of air pollutants in both indoor and outdoor environments. Vanessa received a B.Sc.H in Biomedical toxicology from the University of Guelph, and holds a M.Sc. in Respiratory toxicology from the University of Saskatchewan.

## Wolfram Birmili

**German Environment Agency (UBA), Germany**

Wolfram Birmili is head of the German Environment Agency (UBA) Division "Indoor hygiene and health-related environmental impacts" in Berlin. He studied physics at the Eberhard Karls University of Tübingen, Germany from 1989-1994. He then moved to the Leibniz Institute for Tropospheric Research (TROPOS) in Leipzig, Germany, where he completed a PhD in meteorology on the subject "New particle formation of ultrafine aerosol particles" in 1998. He continued to be a researcher at TROPOS between 1998-2001 and 2003-2015. He was awarded a EU Marie Curie Fellowship to investigate the health-related aspects of environmental particulate matter at the University of Birmingham, UK, between 2001-2003. In 2006 he lectured at the University of Helsinki, Division of Atmospheric Physics, Finland. Between 2008 and 2015 Wolfram coordinated the German Ultrafine Aerosol Network (GUAN), a research activity to investigate the abundance and effects of ultrafine particles in the atmosphere. His research interests include all aspects of indoor air quality, sources of indoor pollutants, particulate matter, ultrafine particles, and atmospheric pollution control. He is the author or co-author of more than 150 peer-reviewed journal articles on indoor air and atmospheric science.

## Marilyn Black

**Underwriters Laboratories Inc.,**
**Founder GREENGUARD, USA**

Dr. Marilyn Black is currently Vice President, Sr. Technical Advisor, and Fellow of Underwriters Laboratories. She is founder and former chairperson for both UL Air Quality Sciences, a leading testing and research organization focused on chemical and biological air pollution and the GREENGUARD Environmental Institute, which provides a third party indoor air quality certification program for building materials, electronics and furnishings.

Dr. Black is a leader in the study of low dose chemical exposure on human health, and in finding ways to reduce that exposure.

She is an active participant in national and international scientific organizational initiatives, research projects and community outreach programs. She has presented and published over 200 papers on indoor air quality and environmental exposure with a special interest in children's health, and was recently awarded the prestigious national Keystone Center Leadership in Environment Award.

Dr. Black received a Ph.D. from the Georgia Institute of Technology, M.S. from the University of Florida, and B.S. from the University of Virginia. She is the recent founder of the Khaos Foundation, forwarding a mission of research and education for the betterment of children's health and wellbeing.

## Carl-Gustaf Bornehag

**Karlstad University, Sweden and Icahan School of Medicine at Mount Sinai, New York, USA, Sweden**

My research focuses is on early life exposure for environmental factors (e.g., EDCs, food and nutrition, life styles etc.) and the importance for children´s health and development including better risk assessment of chemical mixture exposure. Our empirical base is two major epidemiological studies in Sweden, the Dampness in Buildings and Health (DBH) study following more than 10,000 children from childhood up in adulthood and the SELMA study following more than 2,000 mother-child pairs from early pregnancy, over birth and up in school age. I am co-investigator in three EU-projects (EDC-MixRisk, ENDpoiNTs, ATHENA) awarded with €6 million each and one US project (PRIME) awarded by NIH with $2 million. Published 92 peer review articles due to Web of Science.



## Rolf Buschmann

**BUND für Umwelt und Naturschutz Deutschland (FoE Germany), Germany**

After additional qualification as European environmental expert, he worked over 10 years at the KATALYSE Institute for applied environmental research in Cologne specialized on chemistry, toxicology and product assessment.

From 2004 until 2013 he worked as policy officer for Environment & Health of the consumer association of Northrhine-Westfalia in Düsseldorf responsible for chemicals policy and product safety. Key aspects were for example: indoor air quality, electromagnetic fields and nanotechnologies.

Since 2013 he is policy officer for Technology & Environment at Friends of the Earth Germany responsible for topics as waste & raw materials, resources, nanotechnologies and environmental pollution.

## Lilian Busse

**German Environment Agency  (UBA), Germany**

Since April 2015, Dr. Lilian Busse is leading the Division of Environmental Health and the Protection of Ecosystems at the German Environment Agency. From 2006-2015, Dr. Busse was a lead scientist at the California Environmental Protection Agency, USA. She worked as a scientist at the Scripps Institution of Oceanography in San Diego from 2002-2006. From 2000-2002, Dr. Busse received a postdoctoral fellowship to conduct research at the University of California in Santa Barbara. She received her Ph.D. in Freshwater Ecology at the Technical University Berlin, Germany, and holds a M.S. in Biology from the Technical University Munich, Germany.

## Katleen De Brouwere

**Flemish Institute for Technological Research VITO, Belgium**

Dr. Katleen De Brouwere, expert working the team Environment and Health at VITO, is a bio-engineer by training and obtained a PhD in environmental sciences at the Catholic University of Leuven in 2006. She joined VITO in 2005, and has gained expertise in exposure and risk assessment during more than 10 years. She is involved in several completed and ongoing research and consultancy projects and expert working groups for regional, national and European Authorities (Flemish Agency for Health And Care, Flemish Environment Agency, Federal Public Service Health, Food Chain Safety and Environment, EC DG Environment, EC DG Grow, etc.). Several of these projects deal with exposure and risk assessment of indoor sources (including construction materials and consumer products) and indoor air quality, including mixtures.

She is currently coordinating the Flemish Partner Organisation Environmental HealthCare (2016-2020), being a consortium of 3 Flemish Institutes (VITO, PIH and GezondLeven). The Flemish Partner Organisation Environmental HealthCare has the mandate to provide technical and scientific support to the Flemish Agency for Health and Care in the domain of preventive environmental healthcare, including domains of risk assessment, indoor air quality, environmental hotspots and traffic related environmental pollution.

## Sani Dimitroulopoulou

**Public Health England, UK**

Sani is Principal Environmental Public Health Scientist on Indoor Environments, at Public Health England (PHE) in the UK. She is also an Honorary Senior Lecturer at the UCL Bartlett School. Her research interests include exposure assessment to air pollution, based on modelling and monitoring of indoor and outdoor air pollution and ventilation, health impact assessments and development of environmental public health indicators. She has published more than 70 peer-reviewed papers in international scientific journals and conferences and more than 50 technical research and consulting reports. She was the Editor of the State of the Environment Report 2008, for Greece.

Sani is the PHE Topic Advisor for the development of the National Institute for Health and Care Excellence (NICE) Guidance on indoor air pollution at home. She is also Vice-Chair of the UK Indoor Environments Group, Member of the Cross Government Group on Gas Safety and Carbon Monoxide Awareness, Member of the British Standards Committee on Indoor Air and Member of the Executive Committee of MESAEP (Mediterranean Scientific Association of Environmental Protection). She works closely with colleagues from Government Departments (e.g. DfE, MHCLG) or organisations (e.g. NICE, CIBSE, RCP) to provide expert advice on indoor air quality and health.

## Ruth Etzel

**Office of Children´s Health Protection,**
**U.S. Environmental Protection Agency (EPA), USA**

Professor Ruth Etzel, MD, PhD is the Director of the Office of Children's Health Protection at the US Environmental Protection Agency in Washington, D.C. She is a pediatrician, epidemiologist, and specialist in preventive medicine and public health.

During her career, which spans over 30 years, she has worked at the tribal, national and international level to protect children from hazards in the environment. Dr. Etzel has received numerous awards, including the Distinguished Service Medal from the US Public Health Service, the Don C. Mackel Memorial Award from Centers for Disease Control and Prevention, the Arthur S. Flemming Award, and the Clinical Society Award from the US Public Health Service Commissioned Officers Association.

She is the founding editor of the popular book Pediatric Environmental Health (a 4th edition of this book will be published in November 2018) and the co-editor of the Textbook of Children's Environmental Health.

## Saul García Dos Santos-Alves

**Institute of Health Carlos III, Spain**

Bachelor of Pharmacy (1981).

From 1988 to 1990 made continuing training in Environmental Sciences and atmospheric pollution in the College of Environment & Forestry Science (CEFS) at State University of New York (SUNY), Syracuse (US). From 1991 to 1996 was a civil servant in the Atmospheric Pollution Department (ACA) of the Institute of Health Carlos III (ISCIII), becoming Head of Particulate Service from 1996 to the present. In 2011, the ISCIII was designated as the National Reference Laboratory for Air Quality (Directive 2008/50/CE)

The ACA gives traceability to the Spanish network of Air Quality and research of air pollution in both outdoor and indoor environments. During this period was head of gravimetric and particle sampler laboratories. Moreover, it was selected as the Spanish expert in the Technical Comities for Standardization (TCS) CEN/TC 264 “air quality” and ISO/TC 146/sc 3 “air quality” and Sc/6 “indoor air”. So, he collaborate in the development 6 air quality standards (PM10 and PM2,5 particles, heavy metals, BaP, OC+EC and ions. Also, he is the secretary of the Spanish TCS (AEN/CTN 77/sc 2 "air").

Finally, he participates in research projects which produced a number of Scientific Publications. https://www.researchgate.net/profile/Saul_Garcia_Dos_Santos-Alves
Nowadays, is the Madrid IP of the H2020 “ICARUS project”.



## Lars Gunnarsen

**Danish Building Research Institute, Denmark**

Lars Gunnarsen is professor mso of Health in Buildings at Danish Building Research institute, Aalborg University. The starting point of his career was a strong engagement in the improvement of the indoor climate in homes, offices and schools. He designed building service installations as consulting engineer and struggled with rudimentary indicators of human needs inside buildings. The lack of design criteria and methods to rationally select construction products sparked Lars’s keen interest in creating research-based knowledge enabling the production and maintenance of inspiring, productive, comfortable and healthy indoor climates. The relevance and due attention to impact on environment, energy use and expenditures is obvious in his applied research. Special focus points are development of assessment methods for indoor air quality, characterization of air pollution sources and the impact on man of exposures indoors. He has special qualifications in research management, sensory perception, moisture problems, chemicals and particles in indoor air, human requirements for comfort and international collaboration. He has spent three years in the Phillippines managing two participatory research projects on indoor climate. Lars Gunnarsen is the author of more than 200 scientific publications. More than 40 of these are in international journals with peer review.

## Birger Heinzow

**German Committee on Indoor Guide Values (AIR), Germany**

| | |
|---|---|
| **1970-1976** | Medical School: University Hamburg and Kiel |
| **1977** | Medical approbation |
| **1979** | M.D. University Kiel (Dr. med.) |
| **1978 -1984** | Dept. Pharmacology and Toxicology University Kiel |
| **1980 -1982** | Visiting Scientist ( Fellow of the German Research Council) Monash-University/ Baker Institute, Melbourne/Australia# Research area: liver physiology, pharmacokinetics |
| **1984.** | Head of Institute of Environmental Toxicology in Kiel |
| **1995-2001** | Head of the Department for Environmental Toxicology of the State Agency for Nature and the Environment ( LANU 2) |
| **2002-2016** | Head of Department of Envionmental Health, State Agency for Health and Occupational Safety of the Land Schleswig-Holstein |
| **2006-2012** | Adjunct Professor for Toxicology and Environmental Health, University of Notre Dame Australia, Sydney Medical School |
| **2006** | Fellow (Emeritus) of the Collegium Ramazzini |
| **2016** | Retirement |

## Dorota Jarosinska

**WHO European Centre for Environment and Health**

Dorota Jarosinska MD, PhD is a specialist in public health with 25 years of experience in environmental health at national and international levels. At the WHO Regional Office for Europe, European Centre for Environment and Health in Bonn, she leads a programme on Living and Working Environments, covering the health aspects of air quality, chemical safety, noise, and workers' health. She completed a postgraduate training on Advanced Environmental Sanitation in the Netherlands, and a training in environmental health for physicians in Poland. For ten years, she was leading the first unit of environmental medicine in Poland. She was a Fulbright scholar at the National Institute of Environmental Health Sciences, US. For nine years, she worked at the European Environment Agency on environment and health issues. Authored several scientific papers and contributed to the reports by EEA, WHO, and UNEP, including Synthesis of the European Environment State and Outlook, and the EEA/JRC Environment and Health report. She is a Fellow of the Collegium Ramazzini.

## Gunnar Johanson

**Karolinska Institutet, Sweden**

Gunnar Johanson is a senior professor of occupational toxicology and risk assessment at the Institute of Environmental Medicine, Karolinska Institutet (KI), in Stockholm, Sweden. His research interests cover several areas in toxicology, occupational hygiene, toxicokinetics and health risk assessment, from indoor air quality to ventilation of ocean freight containers, from in silico to in vitro, zebrafish embryos and human volunteers. Much focus is on experimental and computer modelling studies of dermal and inhalation exposures and on acute effects of inhaled chemicals. Johanson chairs the Nordic Expert Group for Criteria Documentation of Health Risks from Chemicals (NEG) and has served on several expert committees in toxicology, including the Scientific Committee on Occupational Exposure Limits (SCOEL), the US NRC Acute Exposure Guideline Levels (AEGL) committee, and the Subgroup on EU-LCI Values. In 2001, he received the Herbert E. Stokinger Award for outstanding achievement in industrial toxicology by the American Conference for Industrial Governmental Hygienists (ACGIH).

## Marion Keirsbulck

**French Agency for Food, Environmental and Occupational Health & Safety (ANSES), France**

Marion Keirsbulck is scientific coordinator at the French Agency for food, environmental and occupational health & safety (ANSES). She supports and coordinates expertise carried out within ANSES concerning in particular the assessment of risks of exposure to air environments. She is involved in different projects dealing with indoor air or ambient air pollution.

## Stylianos Kephalopoulos

**European Commission, DG Joint Research Centre (JRC)**

Dr. Stylianos Kephalopoulos is scientific officer of the European Commission. He works for JRC's Directorate 'Health, Consumers and Reference Materials' and is/has been coordinator of the: a) EC's Information Platform for Chemical Monitoring data (IPCHEM); b) ECA on "Urban Air, Indoor Environment and Human Exposure"; c) Development of the harmonization frameworks for indoor material emissions labelling schemes, the indoor air monitoring and the health based evaluation of the indoor product emissions in the EU (PILOT INDOOR AIR MONIT & EU-LCI projects); e) Common Noise Assessment Methods in Europe project (CNOSSOS-EU); f) DG ENER Task 13.3 on Energy Efficient and Healthy Buildings in the EU. He is/has been: (a) member of various EC Inter-service groups on environment and health: the EU Policy Board, DG SANCO's Indoor Air Expert Group, DG EMPL's Steering group on risks from hazardous chemicals in occupational environments, DG ENV's Steering Group on the Evaluation of the Environmental Noise Directive; (b) contributor to the conception/implementation of several EC funded projects (EU-INDEX, EnVIE, INDOOR-EXPO, HEALTHVENT, SINPHONIE, EPHECT, HARMONOISE, IMAGINE) or WHO funded projects (IAQ guidelines, community noise and nighttime noise guidelines). Dr. Kephalopoulos has been authored/ co-authored more than 160 papers, 70 of them have been published in peer-reviewed literature.

## Carsten Kneuer

**German Federal Institute for Risk Assessment (BfR), Germany**

Carsten Kneuer studied Toxicology at the Universities Greifswald and Birmingham and holds a Ph.D. from Saarland University. From 2001 to 2007, he was lecturer at the Department of Pharmacology, Toxicology and Pharmaceutics at Leipzig University before joining BfR, the German Federal Institute for Risk Assessment in the same year. Since then, Dr. Kneuer has been working on human health hazard characterisation of pesticides and biocides and became member of the Working Group Human Health of the Biocidal Products Committee at ECHA. Currently, he is Head of Unit Toxicology of Actives Substances and Their Metabolites at BfR, which is responsible for derivation of Health Based Guidance Values for biocidal active substances.

## Marike Kolossa-Gehring

**German Environment Agency (UBA), Germany**

HBM4EU coordinator. She got her PhD from the Christian-Albrechts-University Kiel. In the German Environment Agency she is in charge of the scientific lead and management of the German Human Biomonitoring Program (German Environmental Survey GerES, the German Environmental Specimen Bank ESB, the German Human Biomonitoring Commission, and the HBM cooperation between the German Chemical Industry Association (VCI) and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)). She was involved in the development of assessment strategies and guidelines at the national, EU and OECD level and from 2006 to 2010 vice-chair and chair of the OECD Endocrine Disruptor and Assessment Task Force. She was work package leader in the EU HBM projects ESBIO, DEMOCOPHES and COPHES, the Consortium to Perform Human Biomonitoring on a European Scale preparing and piloting a European human biomonitoring study and form 2011 to 2014 Governmental Councillor of the International Society of Exposure Science (ISES).

## Martin Kraft

**North Rhine Westphalia State Agency for Nature, Environment and Consumer Protection, Germany**

Since 2009, Dr. rer. nat. Martin Kraft is head of the unit for Environmental Medicine, Toxicology and Epidemiology at the State Agency for Nature, Environment and Consumer Protection North Rhine-Westphalia, Germany. His focus is on the assessment of environmental health risks.

He started his scientific career at the Ruhr-University Bochum where he studied the bioavailability of metals in the human gastrointestinal tract. From 2003 to 2009 he was Scientific Consultant for Environmental Medicine at the Ministry for Environment, Conservation, Agriculture and Consumer Protection of the State of North Rhine-Westphalia. The main focus of his work was the health assessment of pollutants in indoor air. In 2003 he became a member of the German Committee on Indoor Air Guide Values. Since 2015 he is chairman of the Committee.

Martin Kraft conducted several human-biomonitoring studies to determine the human exposure to Polychlorinated Biphenyls (PCBs), Phthalates, Pesticides and other harmful substances which are used in consumer products. Since 2005 he is representative of the German States (Länder) in the Human Biomonitoring Commission.

## Maria Krautzberger

**President German Environment Agency (UBA), Germany**

Maria Krautzberger has been the President of the German Federal Environmental Agency (UBA) since 2014. UBA is the central scientific authority for environmental protection in Germany and provides the scientific basis for environmental policy in Germany and advises the German Environment Ministry and other governmental institutions on environmental matters. Before joining UBA, she served as Permanent State Secretary for Urban Development and the Environment at the Berlin Senate. Prior to that, she was Senator for the Environment of the Free Hanseatic City of Luebeck. Maria Krautzberger has launched numerous environmental policy initiatives, such as the "Stadtentwicklungsplan Klima Berlin" – a climate-related urban development plan for Berlin; certification of forests; and played a key role in establishing Germany's first low-emission, environmental zone in Berlin. She holds a Master´s degree in administrative science from Constance University and studied sociology at the University of Munich.

## Frank Kuebart

**eco-INSTITUT Germany GmbH, Germany**

Dr. Frank Kuebart is in charge for the chemical testing of construction products and consumer goods. The main objective of his activity is the compilation and evaluation of criteria and measuring procedures for the development of materials for non-hazardous indoor spaces.

**Qualification and professional career**

Sc.D. in organic chemistry at University of Cologne, Germany

Co-founder and general manager of eco-INSTITUT GmbH since 1987. Purchase of eco-INSTITUT GmbH by UL (Underwriters Laboratories (USA).

Release (MBO) of eco-INSTITUT Germany GmbH from UL in January 2015, continuously in charge as managing director.

**Memberships and activities**

VDI (Verein Deutsche Ingenieure, Association of German Engineers)

DIN (Deutsches Institut für Normung, National standardisation bodies) and GDCh (Gesellschaft Deutscher Chemiker, German Chemical Society) / Chairing Seminars of VDI Wissensforum, 'Hazardous components in indoor air') / Standardisation activities in Indoor Air Quality in DIN and CEN: CEN/TC 264/WG 7, "Construction products – regulations of emissions from volatile organic compounds" / CEN/TC 351/WG 2 and WG 5, "EN 16516 – Construction products – Assessment of release of dangerous substances – Determination of emissions into indoor air" CEN/TC 421, 'Emission safety of combustible air fresheners and similar products' ISO/TC 146/SC 6 "Indoor Air"

**Expertise**

Emission testing and assessment of construction products, furniture, consumer goods, textiles and interiors

Surveillance and auditing of production facilities

**Publications**

Lectures about emissions of hazardous components from construction products and consumer goods.

## Heli Lehtomäki

**National Institute for Health and Welfare, Finland**

Lehtomäki is a researcher working on public health impacts of air pollution and other environmental risk factors. In her work she applies burden of disease and population attributable fraction methods to quantify environmental risks and to provide necessary information for prioritization and comparative risk analyses. In her Master's Theses she investigated and quantified the uncertainties related to national health impact estimates for air pollution that were updated for the latest non-discounted and non-age weighted international methods in 2015. Her MSc thesis was rewarded by the Finnish Air Pollution Prevention Society. Currently Lehtomäki is a second year PhD student in the faculty of Health Sciences in the University of Eastern Finland.

Lehtomäki is actively involved in international collaborations including Nordforsk –funded NordicWelfAir and European Union LIFE+ project Index Air. She has worked as a Temporary Advisor for World Health Organization related to development of AirQ+ software tool for health risk assessment of air pollution.



## Steven Nordin

**Umea University, Sweden**

**Education**
**1992** PhD, Stockholm University, Sweden
**Positions**
**2007 -** Full professor in psychology, Umeå University
**1998 - 2007** Senior lecturer, Umeå University
**1996 - 1998** Assistant professor, Umeå University
**1994 - 1996** Postdoctoral fellow, San Diego State University
**1992 – 1994** Postdoctoral fellow, University of California Medical Center, San Diego
**Awards**
Best Paper Award 2008-10 and 2014-16, Indoor Air; Fulkner Award; Moskowitz-Jacobs Award
**Supervision**
4 Postdoctoral fellows; 13 PhD students; 71 master students
**Institutional Responsibilities** (selected)
2016 – Member, Board of the Faculty of Social Sciences, Umeå University
2011 – 2014 Chairman, Board of Umeå University Graduate School in Population Dynamics and Public Policy
1999 – 2006 Director of Graduate Studies, Department of Psychology, Umeå University, Sweden
2003 – 2004 Deputy Department Head, Department of Psychology, Umeå University, Sweden
1996 – 1998 Director of Undergraduate Studies, Department of Psychology, Umeå University, Sweden
**Commissions of Trust** (selected)
2017 – Member of the Swedish National Committee for Psychological Sciences
2009 – 2012 Review panel member, National Allergy and Asthma Research Fund
2012 Evaluator of the Danish Research Centre for Chemical Sensitivities
**Publications**
143 peer-review journal publications, 9 book chapters and 1 book

## Eduardo de Oliveira Fernandes

**Emeritus Professor University of Porto, Portugal**

PhD, EPFL (Lausanne, CH) in 1973, 45 years of teaching, research and extension activities on topics related to energy and environment mainly applied to buildings thermal physics and indoor air quality. Founder and leader of the regulation process of Energy in Buildings for Portugal (1986-2006). Involved (1994-2018) at the EC level (DG Research, DG Sanco, JRC Ispra) on solar buildings and IAQ through co-leadership with many prominent colleagues in EU and in the World. Temporary Consultant the WHO (Air Quality Guidelines and other). since 1986; responsible for the concept Energy/ Environment of EXPO'98 site in Lisbon (1993-1998); Chair of the Department of Mechanical Engineering (1980-82); vice-rector of the University of Porto (1986-91); vice-president of PLEA (Passive and Low Energy Architecture) (1987-91); vice-president (1991-1995) and president of ISES (International Solar Energy Society (1995-97); member of the Portuguese Cabinet as Secretary of State for Environment (1984-5) and for Energy (2001-2).

Member of AWPA since 1976; ASHRAE (since 1981) and Fellow (1997); ISIAQ since 1993; Member of ECA, JRC Ispra – (1999 -..).

Author of over hundred scientific papers and many documents of intervention, diffusion of academic nature (Mendeley, Researchgate).

## Michael Riediker

**The Swiss Centre for Occupational and Environmental Health (SCOEH), Switzerland**

Michael Riediker is director of SCOEH, the Swiss Centre for Occupational and Environmental Health and an adjunct assistant professor at MSE, Nanyang Technological University, Singapore. He is an expert on occupational and environmental risks resulting from exposure to particulate matter and airborne pollutants, and strategies to assess and manage these risks. Michael obtained his MSc and PhD at ETH Zurich, Switzerland. In his doctoral thesis he investigated the combined health effects of pollen allergens and air pollutants on rhinoconjunctival symptoms in allergic subjects. During his post-doc in the USA he assessed the cardiovascular responses of exposure to traffic pollutants in highway patrol troopers. In 2004 he joined the Institute for Work and Health at Uni Lausanne, Switzerland where he built up a research group. His group investigated health effects of environmental and industrial particles in lab and field settings, indoors and outdoors, and provided advise to governments and industry on managing the risks of nanomaterials. From 2013 to 2018, he helped build the institute of occupational medicine, IOM Singapore Pte Ltd, where he became Director of Research (2017–2018). In early 2018, Michael returned to Switzerland and became the founding director of SCOEH.

## Pawel Rostkowski

**Norwegian Institute for Air Research, Norway**

Dr. Pawel Rostkowski, (male), senior scientist, PhD with an extensive experience in environmental and analytical chemistry. Research interests include new and emerging contaminants, application of target, suspect, non-target screening in identification of environmental contaminants, exposomics, metabolomics and linking toxic effects with chemical methods through effect-based approaches. He is a member of Norman Working Group Non-Target Screening, Effect Directed Analysis and Emerging Contaminants in the Indoor Air Environment. His work was cited over 1100 times and his h-index is 14 (Google Scholar). Since 2015 he is appointed as a scientific expert in the ISO Technical Committee 146 (Indoor Air). He was appointed as a reviewer in a number of journals for example: Environmental Science and Technology, Science of Total Environment, Environment International and Environmental Science Pollution and Research



## Jorma Säteri

**Finnish Society of Indoor Air Quality and Climate, Helsinki Metropolia University of Applied Sciences, Finland**

Mr Jorma SÄTERI received his MSc (Tech) degree from Helsinki University of Technology in 1989. His specialization was HVAC-technology. Since then, he was work actively with research, development and dissemination of topics related to the quality of indoor environment. He has been employed by Helsinki University of Technology, Technical Research Centre of Finland VTT and Finnish Society of Indoor Air Quality and Climate FiSIAQ. Currently, he is Head of the Real Estate and Building Services Department at Metropolia University of Applied Sciences.

Jorma Säteri has been responsible for the development of the Finnish Classification of Indoor Environment since 1998. During that time, three updates of the Classification have been published (2001, 2008 and 2018). He has been an active participant in the EU JRC project on Harmonization of material emission labelling schemes in Europe, 2007-2012. He participated to the for EU JRC project on Definition of EU LCI-values, 2013-2015 and since 2015, Säteri has has been invited expert in the Advisory Group on EU-LCI values. (RTS GLT).

## Helmut Sagunski

**German Committee on Indoor Guide Values (AIR), Germany**

- Studies of chemistry and medicine at the Universities of Kiel and Hamburg, Germany
- Diploma in chemistry, thesis in technical chemistry, qualified physician
- **1985-1986** Assistant doctor at the Hygiene-Institute Düsseldorf, Germany
- **1986-2015** Regulatory toxicologist with the Hamburg Ministry of Health and Consumer Protection, Hamburg, Germany
- **Since 2015** Consultant / lecturer
- **Since 1990** Member of the Indoor Air Hygiene Committee at the German Federal Environment Agency
- **Since 1993** Member of the Ad-hoc Working Group Indoor Guide Values, 2006-2015 chairman, 2015 renamed as German Committee on Indoor Guide Values
- **2008-2010** Senior adviser of the World Health Organization´s Expert Group on WHO guidelines for indoor air quality: selected pollutants

## Tunga Salthammer

**Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut (WKI), Germany**

Tunga Salthammer earned a Doctor of Natural Science degree in Physical Chemistry from the Technical University of Braunschweig, Germany. He joined the Fraunhofer WKI in 1990 and was appointed as head of the Department of Material Analysis and Indoor Chemistry in 1996. From January 2010 until October 2010, he was the acting director of WKI, and since March 2011, he is the deputy director of the institute. From 2003–2009, he was a Professor of Indoor Hygiene at the University of Applied Sciences Braunschweig/Wolfenbuettel. Since 2007, Salthammer has been an Adjunct Professor at the Queensland University of Technology in Brisbane, Australia. In June 2008, he received his habilitation from the Faculty of Life Sciences at the Technical University of Braunschweig and was appointed as a Professor in December 2012. Salthammer has been a Visiting Professor at the Technical University of Denmark (2006-2007) and at Tsinghua University (May 2007 and May 2017). He is a member (currently chairman) of the Indoor Air Hygiene Commission of the German Federal Environment Agency. Since 2008, he has been serving as an officer of the ISIAQ Academy of Fellows (President 2014-2016). His research interests include analytical chemistry, VOC/SVOC emission studies on indoor materials using test chambers and cells, indoor chemistry, airborne particles, and settled dust.

## Ana Maria Scutaru

**German Environment Agency (UBA), Germany**

Scientific employee at the German Environment Agency (UBA) in Berlin
Section II 1.3 „Indoor hygiene, health-related environmental impacts“

### Tasks

- Health-related assessment of emissions from construction products
- Secretariat Committee for Health Evaluation of Building Products (AgBB) and several sub-working groups
- AgBB's representation at international level

### Career

- Study of organic chemistry at the Technical University of Iasi, Romania
- Research assistant at the Institute of Pharmacy of the Free University Berlin (2004-2009), accompanying the doctoral thesis
- Defence of doctoral thesis; topic "Synthesis and testing of new dendrimer-cytostatics-conjugates" (2011)
- Since 2009 employee of UBA



## Wolfgang Straff

**German Environment Agency (UBA), Germany**

Wolfgang Straff, born in 1972, studied medicine and completed his thesis at the RWTH Aachen in the field of environmental medicine with a focus on human biomonitoring. Subsequently occupation as medical assistant at the Clinic for Dermatology and Allergology at the University Hospital of the RWTH Aachen. Research activities in the field of cytokine secretion of activated T lymphocytes.

Since 2003 postdoctoral assistant in the section „Environmental Medicine and Health Effects Assessment" of the German Environment Agency. Since 2008 head of this section. Since Dec 2017 acting head of the department of "Environmental Hygiene".

Areas of interest: susceptible groups, human biomonitoring in Environmental Medicine, Environmental Hygiene, health effects of fragrances, allergic reactions to substances in the environment, risk communication.

## Maria Uhl

**Environment Agency Austria, Austria**

Dr. Maria Uhl is a toxicologist with more than 15 years of experience in the field of environmental health. She holds a Master's degree in biology from the University of Vienna and a PhD and Master's degree in toxicology from the Medical University of Vienna. Maria Uhl is Austria's national coordinator within the European Human Biomonitoring Initiative HBM4EU and she also coordinates the Austrian platform for Human Biomonitoring. She is leader of the working group Pollutants and Impacts in the department of Chemicals and Biocides. Maria Uhl is involved in risk assessment and evaluation processes according to Chemicals legislation and International treaties (e.g. REACH, UNEP: Stockholm Convention on Persistent Organic Pollutants, Minamata Convention). Maria Uhl is a member of the Austrian Working group for Indoor Air at the Federal Ministry of Sustainability and Tourism. She was a member of the EU-LCI group, which was established by EC-JRC, Ispra, in 2011 to derive EU-wide harmonised health based reference values for the assessment of product emissions. This group is now working as a subgroup within the larger committee structure of the EC Advisory Group on Construction Products. As senior scientist, Maria Uhl contributed to several projects for the European Commission and was project leader of several national and international projects in the context of environmental health.

## Axel Vorwerk

**Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU), Germany**

**Professional Experience**

**Since September 2016** Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), Head of Directorate IG II, Environmental Health, Chemical Safety, Deputy Director General

**2011 - 2016** Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Head of Directorate RS I, Safety of Nuclear Installations, Deputy Director General

**2010 - 2011** BMU, Head of Directorate RS II, Radiological Protection, Deputy Director General

**1998 - 2010** BMU, Head of Division (Nuclear Legislation)

**1995 - 1998** BMU, Personal Assistant to the Permanent State Secretary

**1991 - 1995** BMU, Division Strategic Aspects of Environmental Legislation, Environmental Assessment Legislation

**1991** Lawyer, Weiss & Hasche, Munich

**1987 - 1991** Junior Lawyer, Munich

**1989** Doctorate of Law at Ludwigs-Maximilians-Universität Munich (Doctoral Thesis on the Competences of the European Community in the field of Environmental Policy)

**1981 - 1987** Study of Law and History at the Universities of Freiburg and Munich

## Pawel Wargocki

**Technical University of Denmark, Denmark**

Assoc. Prof. Pawel Wargocki graduated from Warsaw University of Technology. He received his PhD from the Technical University of Denmark, where he has been teaching and performing research ever since. He has more than 20 years of experience in research on human requirements in indoor environments. He is best known for his seminal work demonstrating that poor indoor environmental quality affects performance of office work and learning. Other work influenced requirements for ventilation and air cleaning. Recent research includes studies on emissions from humans, on sleep quality and on performance of green buildings. He has collaborated with leading research institutions, universities, and industrial partners around the world such as National University of Singapore, Jiaotong University in Shanghai, Syracuse Center of Excellence, United Technologies and Google. He was President and long-standing board member of the International Society of Indoor Air Quality and Climate (ISIAQ), Vice President of Indoor Air 2008, and Chair of ASHRAE committees. He has received several awards for his work including Rockwool Award for Young Researchers, ASHRAE Ralph Nevins Award, ISIAQ's Yaglou Award and Best Paper Award in Indoor Air. He is the secretary of Academy of Indoor Air Sciences. Published extensively.

## Wenjuan Wei

**Scientific and Technical Centre for Building (CSTB), France**

### Professional Experience

- **2014.10 – present**, Scientific and Technical Center for Building (CSTB), Marne-La-Vallée, France: Research Engineer
    - Marie-Curie Fellow of the European Commission, Prestige Fellow of the Campus France
    - Modeling of the concentration of semi-volatile organic compounds (SVOCs) in indoor environment
    - Modeling of the bioaccessibility and bioavailability of SVOCs following inhalation
    - Development of the indoor air quality index and Green Building Certification

- **2011.06 – 2012.06**, National Institute of Standards and Technology (NIST), Gaithersburg, Maryland, USA: Guest Researcher
    - Development of volatile organic compound (VOC)/formaldehyde emission reference samples

- **2009.09 – 2014.07**, Tsinghua University, Beijing, China: Ph.D Student, Teaching Assistant
    - Research on VOC emission reference samples for environmental chambers: design principle and application (Ph.D thesis)
    - Development of the furniture labeling for VOC/formaldehyde emissions

### Education

- **2009.09 – 2014.07**: Ph.D. of Civil Engineering (Heating, Ventilation and Air Conditioning), Tsinghua University, Beijing, China

## Gerhard A. Wiesmüller

**Public Health Department Cologne, Germany**

**2006** Associate Prof., RWTH Aachen Univ., GER
**2002** Habilitation, RWTH Aachen Univ., GER
**1999** North Rhine State Med. Board, Düsseldorf, GER: License as specialist in Hygiene and Environmental Medicine
**1997** North Rhine State Med. Board, Düsseldorf, GER: License for Clincial Environmental Medicine
**1992** PhD (Dr. med.), Univ. of Cologne, GER
Since 2010 Head of the Devision of Infectious and Environmental Hygiene, Public Health Department Cologne
**2006-2010** Head of the Environmental Specimen Bank for Human Tissues and Databank, Med. Faculty, Univ. Münster, GER
**2002-2006** Senior Research Assistant, Inst. of Hyg. and Environ Med., Med. Faculty, RWTH Aachen Univ., GER
**1999-2002** Research Assistant, Inst. of Hyg. and Environ Med., Med. Faculty, RWTH Aachen Univ., GER
**1999** Research Employee, Inst. of Hyg. and Environ Med., Med. Faculty, RWTH Aachen Univ., GER
**1998-1999** Intern, Medical Clinic III (Gastroenterology), Med. Faculty, RWTH Aachen Univ., GER
**1997-1998** Research Employee, Inst. of Hyg. and Environ Med., Med. Faculty, RWTH Aachen Univ., GER
**1992-1997** Research Employee, Med. Inst. of Environ. Hyg., Univ. Düsseldorf, GER
**1991-1992** Resident, Med. Inst. of Environ. Hyg., Univ. Düsseldorf, GER
**Memberships:** German Society for Hygiene, Environmental Medicine and Preventive Medicine (GHUP), International Society of Indoor Air Quality and Climate (ISIAQ)

## Thomas Witterseh

**Danish Technological Institute, Denmark**

Thomas Witterseh, MSc PhD, is working at the Centre for Buildings & Environment at the Danish Technological Institute. Thomas performs indoor and working environment measurements and investigations on a daily basis and has 20 years of experience with indoor environment, indoor air quality and material emission and its impact on human health and well-being. Has since 2001 served as certification manager to the Danish Indoor Climate Labelling – a voluntary material emission labelling scheme for building products, furniture and interior furnishings. Thomas is active in European standardization work in CEN/TC 351 Dangerous Substances and its WG2 Indoor Air and is member of the EC Subgroup on EU-LCI Values.


## Peder Wolkoff

**The National Research Centre for the Working Environment, Denmark**


Peder Wolkoff (PW) is senior researcher, former research professor in indoor environmental science (2004-2012), at National Research Centre for the Working Environment (NRCWE), Denmark, and adjunct professor at University of Copenhagen since 2009. PW received M.Sc. and Ph.D. degrees in organic chemistry from Faculty of Natural Science at University of Copenhagen in 1972 and 1976. PW earned a doctoral of science degree in occupational hygiene (D.Sc. Med) from Faculty of Medicine, University of Copenhagen in 1996. PW has 35 years of experience in IAQ/chemistry/health.

PW held a NATO Science Fellowship at University of Amsterdam (Prof NNN Nibbering) and continued as post-doctoral fellow at University of Ottawa (Prof JL Holmes) with mass spectrometry (1976-1978). He held a senior research scholarship at University of Copen¬hagen, 1979 - 1982. He joined the National Institute of Occupational Health (NRCWE) in 1982 as scientist, later as senior researcher and PI in 1990. Dr Wolkoff was temporary expert for WHO developing the IAQ guideline for formaldehyde (2010). PW is member of the EU LCI harmonization group deriving health-based emission values for construction products and chairman for SC “IAQ and Health” (Int Comm Occup Med).
PW has published 157 peer-reviewed publications. His h-index is 40 and 53 in ISI (Thompson Reuters) and Google Scholar, respectively, per July 2018.


## Birgit Wolz

**Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU), Germany**


Birgit Wolz holds a PhD in Law and a Master Degree in Public Administration (Harvard). She has worked for the University of Kiel/Germany and the European Bank for Reconstruction and Development/London.

As Director in the Ministry for the Environment since 1999, she has been covering a range of issues in nature conservation, radiation protection, transport and environment policies, water management as well as international environmental policies.

Since early 2008, she is heading the unit “Environment and Health” where her responsibilities cover i.a. human-biomonitoring, indoor air quality, environmental food contaminants, and the German Environmental Specimen Bank. In 2010, she started a ten-year-cooperation project with the German Chemical Industry Association to develop new HBM methods for modern chemicals of concern.

She is engaged in a number of international processes relevant for environment and health involving i.a. the World Bank, WHO and the Children’s Environmental Health Birth Cohort Group (ECHIBCG). She is a member of the Board of Trustees of the Fraunhofer Wilhelm-Klauditz-Institute. Within the EU-human biomonitoring programme “HBM4EU” she is a member of the Governing Board.

# Poster Abstracts

## P01 - Ambient monitoring of arsenic, mercury and organic pesticides in natural history collections taking the example of the Museum für Naturkunde, Berlin

**Katharina Deering [1], Elise Spiegel [2], Christiane Quaisser [3], Dennis Nowak [1], Rudolf Schierl [1], Stephan Bose-O´Reilly [1], Mercé Garí [1]**

[1] **Institute and Clinic for Occupational, Social and Environmental Medicine, University Hospital,** LMU Munich, Germany, [2] **Care for Art,** Grünwald, Germany, [3] **Museum für Naturkunde, Leibniz Institute for Research on Evolution and Biodiversity,** Berlin, Germany

**Introduction:** Pesticides have been extensively used as preservative treatments in the past to protect museal collections from pest and mould infestations. They are for the most part carcinogenic, mutagenic and toxic for reproduction and pose a potential risk to employee's health as they are exposed to contaminated objects, dust or air. The Museum für Naturkunde Berlin (MfN) hosting objects conserved with a wide range of pesticides. Preliminary ambient air and dust measurements showed high loads of γ-HCH and its degradation product γ-PCH in air. This museum serves as a perfect model organization to determine the indoor pollution to evaluate exposure pathways and prevent health risks through process optimizations. **Methods:** o,p'-DDT, p,p'-DDT and its metabolites (o,p'-DDE; p,p'-DDE; p'-DDD; p,p'-DDD), HCB, 3 isomers of HCH (α-HCH, β-HCH, γ-HCH), the degradation product of γ-HCH with similar toxicological profile, γ-PCH, PCP and arsenic and mercury in dust deposits, particulate matter and air were collected at several areas of the MfN. Gas chromatography and mass spectrometry techniques were used to quantify organochlorine pesticides. Atomic absorption spectrometry was used to analyze arsenic and mercury. To understand the pathways of contamination with pesticides in dust, particle number concentrations (PNC) during individual daily work activities were measured. **Results:** The organochlorine compounds are represented in smaller quantities than the heavy metals concentrations. The highest concentration of arsenic and mercury in dust was 3507 As mg/kg and 32 Hg mg/kg. The maximum concentration of arsenic and mercury in air was 48 As ng/m³ and 1.6 Hg ng/m³. The maximum concentration of the sum of DDT´s in dust was 2 mg/kg and in air LOD ng/m³, max PCP in dust was 0,65 mg/kg and in air was 10 ng/m³, max γ-HCH in dust was 130 mg/kg and in air was 320 ng/m³, max γ-PCH in dust was 2,1 mg/kg and in air was 230 ng/m³. PNCs were very differently represented between the work activities. High PNC were associated with activities such as opening storage boxes with prepared animals, reading old books or handling objects. **Conclusions:** This is the first study that systematically measured and described the indoor air and dust concentrations of several chemical compounds by using the example of the MfN. 12% of the analyzed samples exceeded the reference values by several organizations with deviations up to a factor of 1000. This study has shown that objects in museum collections may be a cause for exposure of hazardous pesticides during handling of objects. More research is needed to establish guidelines and limit values especially for museums.

---

## P02 - Assessment of polycyclic aromatic hydrocarbon (PAH) levels in indoor and outdoor air in Madrid City

**Regina Muñoz Úbeda [1], Saul García Dos Santos [1], June Mérida Terroba [1], Jesús Pablo García-Cambero [2] and David Galán Madruga [1]**

[1] **Area of Atmospheric Pollution,** [2] **Area of Environmental Toxicology, National Center for Environmental Health, Institute of Health Carlos III,** Majadahonda, Spain

**Introduction:** Air pollution is a negative factor for public health. PM10 particles are linked to possible toxic effects due to their chemical composition PAHs, because of their carcinogenic, mutagenic and teratogenic effects, justify the need to measure them in both ambient and indoor air. The objective was to compare the PAH levels on PM10 inside and outside of an administrative building located in an urban background zone of Madrid. **Methodology:** Atmospheric particles were collected in both sites of the building, using a PM10 high-volume reference sampler (EN 12341: 2014) on quartz fiber filters with a 30 m3/h flowrate. Every three days a samplig period of 24 h was performed from May 2017 to April 2018. The conditions of the particles extraction and analysis process (GC-MS) were set according the EN 15549: 2008 standard (Σ17HAP). **Results:** The average ΣPAHs concentration was 0.23 ng/m3 and 0.60 ng/m3 in indoor and in outdoor air, respectively. Indoor and outdoor air was characterized by a same contribution to ΣPAHs of high, medium and low molecular weight PAHs. The higher average ΣPAHs concentrations were identified during winter. Average monthly PAH concentrations in outdoor versus indoor air showed a high correlation ($r=0.9481$, $N=14$, $p<0.001$). BbjF, BghiP and IcdP were identified as major compounds in both environments, and lower for Nap and Acp. The average concentration of BaP was 1.8 times higher in ambient than in indoor air. Average BaP concentrations were 0.016 and 0.029 ng/m3 in indoor and outdoor, respectively. All I/O ratios were less than 1 except for Nap, Acp and Ant. Conclusion: PAHs concentrations were lower in indoor except for the LMWPAHs, so, external sources were predominant. Contribution to ΣPAHs as a function of the aromatic rings and qualitative profiles in both environments were quite similar and the measured annual BaP levels were below the EC target value of 1 ng/m3. Therefore, lower carcinogenic toxicity is expected for the indoor occupants with respect to people with main outdoor activity. **Acknowledgments:** The authors thank the ISCIII for the financing of this project and Madrid Council for the facilities provided for it.

## P03 - Indoor air quality in primary school buildings across Central Europe – The InAirQ study

**Máté Szabados [1], Zsófia Csákó [1], Anna Kozajda [2], Andreja Kukec [3], Anja Jutraz [3], Peter Otorepec [3], Bohumil Kotlik [4], Helena Kazmarová [4], Arianna Dongiovanni [5], Andrea Di Maggio [5], Péter Rudnai [1], Tamás Szigeti [1]**

[1] **National Public Health Institute,** Budapest, Hungary, [2] **Nofer Institute of Occupational Medicine,** Lodz, Poland, [3] **Slovenian National Institute of Public Health,** Ljubljana, Slovenia, [4] **National Institute of Public Health,** Prague, Czech Republic, [5] **SiTI - Higher Institute on Territorial Systems for Innovation,** Turin, Italy

The quality of the school environment, especially indoor air quality (IAQ), plays a key role in the healthy child development as well as in the well-being and performance of the pupils at school. Children aged 6-14 spend about 6-9 h in school buildings per a weekday, thus there is still an increasing concern on IAQ in these microenvironments. InAirQ is an international project aiming to assess the health risk of indoor air pollutants on pupils and to take actions to improve the indoor environment in school buildings in Central Europe (Czech Republic, Hungary, Italy, Poland, Slovenia).

The air quality was investigated in 64 primary school buildings during the heating period of 2017/2018. In each school, air quality was monitored in one classroom and at an outdoor location from Monday morning to Friday afternoon; however, the sampling took place only when the classroom was occupied in order to provide a better estimate of IAQ. The concentration of ten volatile organic compounds, five aldehydes, PM2.5 mass, carbon dioxide, radon as well as temperature and relative humidity were investigated.

Similar results were obtained for volatile organic compounds (except for benzene) and aldehydes for all countries both indoors and outdoors. The concentration of benzene was higher than 5 µg m-3, the annual limit value set for the ambient air by the European Commission, in 10 out of the 12 school buildings investigated in Italy. It must be noted that the concentration of benzene indoors was similar to that obtained for outdoors in all cases which indicates the lack of indoor sources. The concentration of formaldehyde was always higher indoors than outdoors with a median indoor/outdoor ratio of 4.1. However, the concentration of formaldehyde never reached the WHO guideline. In general, the PM2.5 mass concentration was higher indoors than outdoors and showed spatial pattern. The carbon-dioxide concentration was high in the majority of the classrooms indicating the inappropriate ventilation. In contrast, the relative humidity was below the healthy range (i.e. 40-60%) in many cases. The radon level was around or below 100 Bq m-3, except for some locations in Hungary, Poland and Slovenia.

# P04 - A pilot indoor air PM2.5 monitoring program in the university research building, Chiang Mai City, Thailand

**Tippawan Prapamontol [1], Pisith Singjai [2], Sawaeng Kawichai [1], Pitakchon Pornsawansong [1], Natwasan Jeytawan [1], Wiroth Kaewtue [1], Khuanchai Supparatpinyo [1]**

[1] **Research Institute for Health Sciences (RIHES), Chiang Mai University,** Chiang Mai, Thailand, [2] **Department of Physics and Materials Science, Chiang Mai University,** Chiang Mai, Thailand

**Introduction:** In recent years, Chiang Mai City has faced severe ambient biomass-burning smoke pollution in February to April. The daily average level of PM10 from air quality monitoring station often exceeded Thailand Standard of 120 µg/m3 for several fold while WHO guideline is set at 50 µg/m3. Indoor air quality has increased concern during this smoke pollution. Chiang Mai University Research Institute for Health Sciences (RIHES) is a four- storey and centralized air-conditioned building so indoor PM2.5 monitoring program was conducted. During working day HEPA filters' air cleaners were operated over working hours during smoke pollution. Hence, we present the investigation of indoor and outdoor PM2.5 levels in RIHES building during smoke pollution in Chiang Mai City. **Method:** A monitoring program of indoor and outdoor PM2.5 was launched at Chiang Mai University Research Institute for Health Sciences (RIHES) in April 2018 using commercial small PM2.5 sensors. These sensors were calibrated against MiniVol samplers (Air Matrics, USA) and real-time monitor E-Samplers (Met One Instruments, USA). The indoor monitoring program was conducted from April to May 2018. Levels of indoor PM2.5 contributed by outdoor PM2.5 levels were estimated. **Results:** Mean±SD levels of indoor PM2.5 in April, May and June 2018 were 34.6±22.4 (n=27), 9.7±6.6 (n=31) and 4.8±4.5 (n=29) µg/m3 while outdoor PM2.5 levels were 54.2±28.4 (n=29), 15.4±8.6 (n=31), and 9.4±6.7 (n=29) µg/m3, respectively. Indoor PM2.5 level was significantly contributed by outdoor PM2.5 (R2= 0.952, p 0.000). **Conclusion:** Indoor PM2.5 level of a centralized air-conditioned building was demonstrated that outdoor PM2.5 level contributed significantly to indoor PM2.5 level. Therefore, controlled ventilation and indoor-air cleaner during biomass-burning smoke pollution should be considered for installation and operation in order to protect the health of dwellers.

---

# P05 - The PM2.5 compositions and health risks assessment of fine particulate matter exposure among children in naturally ventilated school in a tropical environment

**Azwani Alias [1], Mohd Talib Latif [1], Murnira Othman [1], Md Firoz Khan [2]**

[1] **School of Environmental and Natural Resource Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia,** Bangi, Selangor, Malaysia, [2] **Centre for Tropical Climate Change System, Institute for Climate Change, Universiti Kebangsaan Malaysia,** Bangi, Selangor, Malaysia

**Introduction:** The indoor air quality is crucial since children spend nearly one third of their time in school buildings. Due to the higher breathing rate and more frequent mouth breathing compared to adults, children are categorized as vulnerable group to air pollutants. The aims of this study were to examine the composition of PM2.5 and the sources influencing the indoor and outdoor school environments. **Method:** The PM2.5 sampling was performed using a mini-vol portable sampler at three sampling sites from May to October 2016 for daily 8 h sampling. The concentrations of water soluble ionic species (Mg, Ca, K, Na, NH4, Cl-, NO3-, SO42-) were analysed using ion chromatography (IC). The PM2.5 samples on the filter paper were digested for trace metal analysis using the wet digestion technique. The first quarter of the filters exposed to PM2.5 samples were cut into small pieces with clean scissor in the laminar flow hood. The filter papers were then dissolved in a mixture of nitric acid (65%) and hydrogen peroxide (30%) (v/v, 12:3). The analytical reagent was placed in a conical flask and gently boiled on a hot plate for approximately 1 h. After the particles on the filter paper were completely dissolved in acid solution, the digested samples were filtered using a vacuum filter pump (Millipore, Billerica, MA, USA) to eliminate any leftover particles. The samples then were

diluted to 50 mL with deionized water. The diluted solution was transferred to a polyethylene bottle and refrigerated at 4ºC until further analysis. The trace metals found (Mn, Ni, Fe, Cu, Zn, Pb, Cr, Cd, Co, As, Al) were analysed using inductively coupled plasma mass spectrometry (ICP-MS). The total excess life time carcinogenic value (ELCR) is defined in equation:

Carcinogenic Risk = IUR x EC; where
IUR (µg/m3)-1 = Inhalation Unit Risk; and
EC (µg/m3) = Exposure Concentration

**Results:** The results showed that the average concentrations of PM2.5 were 17.4 µg/m3 (indoor) and 16.6 µg/m3 (outdoor) with an indoor/outdoor ratio value of ⇢ 1. The potential health risks for trace elements in PM2.5, via inhalation exposure to the indoor classrooms show that the total hazard quotient (HQ) value was slightly higher than acceptable limits (1.0). The total excess life time carcinogenic risk (ELCR) value for all sampling stations was higher than the acceptable limit, suggesting a high exposure to carcinogenic risk. **Conclusion:** Result suggests that the concentrations of PM2.5 were still below the recommended values suggested by the Malaysian Department of Safety and Health (DOSH) and the Hong Kong IAQ Guidelines for Offices and Public Places. This study suggests there is a high contribution of outdoor sources to the indoor school environment where PM2.5 can significantly affect the indoor air quality and children's health.

---

## Po6 - Fine particle deposition and dust chemical composition in school environment located at Kuala Lumpur City center

**Murnira Othman [1], Mohd Talib Latif [1]**

[1] **School of Environmental and Natural Resource Sciences, Faculty of Science and Technology, Universiti Kebangsaan Malaysia,** Bangi, Selangor, Malaysia

**Introduction:** School children exposure to airborne particle and dust chemical composition is continuing concern due to potential health hazard. This study aims to determine the deposition of fine particle in the respiratory tract of school children and dust chemical composition in indoor and outdoor school environments. **Method:** Multiple-Path Particle Dosimetry (MPPD) model was used to determine fine particle deposition in school children's lung based on indoor and outdoor school classroom scenarios. Aerosol deposition of polydisperse particle in indoor and outdoor classroom were simulated with different body orientation and breathing frequency. For indoor and outdoor particle deposition, the input age-specific 5-lobe for child with age nine year was selected to show the impact of particle for primary school children. Indoor and outdoor dust was also collected from a primary school located at Kuala Lumpur City Center where ions and trace metals concentrations were analyzed using ion chromatography (IC) and inductively couple plasma-mass spectroscopy (ICP-MS) respectively. **Results:** Higher total particle deposition was determined for indoor classroom scenario compared to outdoor classroom scenario with value of 0.73 and 0.69 respectively. For indoor scenario, highest deposition of fine particle was in pulmonary (0.39), followed by head (0.27) and tracheobronchial (TB) (0.05). Same sequence of deposition was observed for outdoor scenario with value of 0.31, 0.30 and 0.07 for pulmonary, head and TB respectively. Indoor and outdoor dust composition was dominated with Ca2+, Al, Fe and Zn. Major source of indoor dust contribution was from fuel combustion while outdoor dust contribution was from earth crust. Hazard quotient (HQ) value for non-carcinogen elements for indoor and outdoor dust was below than acceptable limit (1.0) which indicates that non-carcinogen risk posed by those elements to school children is acceptale. The total cancer risk (CR) value for dermal, ingestion and inhalation pathways was lower than acceptable limit (1E-06) suggesting low risk of school children health towards carcinogen elements. **Conclusion:** Deposition of fine particle in school children respiratory tract was found mainly deposited in pulmonary region with higher total particle deposition for indoor classroom compared to outdoor classroom. This study suggests that there is higher risk of particle concentration and harmful effect in indoor school environment compared to outdoor. Thus, mitigation measures on indoor air quality performance and improving ventilation are crucially needed especially for schools located in urban area.

---

## P07 - Toxicity of PM10 bound PAH extracts from an indoor and ambient air of Madrid City on the zebrafish embryo development

**Jesús Pablo García-Cambero [2], Regina Muñoz Úbeda [1], Saul García Dos Santos-Alves [1], June Mérida Terroba [1], David Galán Madruga[1]**

[1] **Area of Atmospheric Pollution** [2] **Area of Environmental Toxicology**
**National Center for Environmental Health. Carlos III Health Institute,** Majadahonda, Spain

**Introduction:** At present, most studies evaluate PAHs in ambient air and, by evaluating the concentration of BaP, estimate the increased carcinogenic risk. However, little studies evalute the presence of PAHs in indoor air and the associated short-term toxicity. The objective of this study was to determine the toxicity of $PM_{10}$-bound PAHs, obtained from indoor/outdoor locations, in the development of the zebrafish embryo. **Methodology:** $PM_{10}$ were collected in indoor and outdoor air in two adjacent locations of the city of Madrid, from June to August 2017. PAHs (n=16) were then extracted according to EN 15549:2008 standard, and zebrafish embryos were exposed (3h-144h post fertilization) to these $PM_{10}$ extracts (dilutions 1:1000, 1:2000, 1:4000) dissolved in eggwater. Mortality, developmental effects, cardiotoxicity, development and neurotoxicity was assessed. In addition, the same PAHs mixtures found in the $PM_{10}$ extracts were prepared in the laboratory to test whether the toxicity could be solely ascribed to PAHs extracted from $PM_{10}$. **Results:** The indoor/outdoor $PM_{10}$ extracts (dilutions 1:1000) resulted to be toxic for the development of zebrafish embryos, producing mortality, developmental effects (lower length, tail malformations) and cardiotoxicity (decreased heart rate, increase incidence of edemas). In the laboratory study, the PAH mixtures -quantified in $PM_{10}$ extracts- did not produce any sign of toxicity. An ongoing work is still be doing in order to identify and quantify other active ingredients in the $PM_{10}$ extracts responsible for zebrafish embryo toxicity. **Conclusions:** Indoor and outdoor $PM_{10}$ extracts exhibited similar qualitative toxicity profile for the zebrafish embryo development, although the indoor PM10 extracts showed more marked effects. Nevertheless, toxicity of the $PM_{10}$ extracts were not potentially ascribed to PAH mixtures, but other extracted compounds. The bioassay resulted to be sensitive to discriminate toxicity to $PM_{10}$ extracts between locations and months.
**Acknowledgments:** The authors would like to thank the Carlos III Health Institute for the funds to this project, and the Madrid City Council for the facilities provided during the sampling development.

---

## P08 - Monitoring of indoor air quality in Cyprus

**Nicos Michael [1], Eleni Demetriou [1], Andromachi Katsonouri [1], Ero Rossidou [1], Sophia Kozakou [1], Konstantina Poulli [1], Maria Aletrari [1], Maria Christofidou [1]**

[1] **State General Laboratory, Environmental Chemistry and Treated Wastes Laboratory Kimonos,** Nicosia, Cyprus

**Introduction:** The quality of the indoor environment is a major health concern due to the fact that most of the indoor air is merely outdoor air with additional pollutants emitted from building materials and consumer products. The indoor environment forms the basic breathing and dermal exposure background for 90% of the lifetime of the European population. For this reason, two field studies were conducted in Nicosia. The first study aims in assessing the exposure for emitted compounds in indoor air while the second investigates the exposure in indoor air quality in school buildings since children are more vulnerable to the adverse health effects of indoor air pollution. **Methods:** The first campaign covered a weekly winter and summer concentration measurements, in two public buildings and two private houses. BTEX, terpenes (a – pinene, d - limonene) were determined using GC/FID and GC-MS after desorption with carbon disulfide (CS2) while carbonyls were determined using HPLC/UV after desorption with acetonitrile. The sampling was carried out using passive samplers in two sites inside the building and one outside. Formaldehyde, benzene, trichloroethylene, tetrachloroethylene, a-pinene, d-limonene, naphthalene, NO2, O3, CO and CO2 were determined using GC/FID, HPLC/UV, ion chromatography and UV VIS spectrophotometry in the second study. These air pollutants were monitored in classrooms of 5 schools, 4 elementary and one kindergarten. **Results:** In the first study, formaldehyde (9.0 - 41.9 µg/m3), acetaldehyde (2.7 - 14.3 µg/m3), toluene (2.2 - 86.9 µg/m3), xylenes (0.2 - 135.9 µg/m3) and acetone (9.4 - 192.2 µg/m3) have shown diversity and relatively significant indoor sources depending on the ventilation rates, building type and age and outdoor environment. In the second study the concentrations of chemical parameters and CO2 ranged from 0.5 µg/m3 to 31.1 µg/m3 and 337 ppm to 2712 ppm, respectively. Trichloroethylene, tetrachloroethylene and naphthalene were not detected. **Conclusion:** In general, indoor air quality in buildings is shown to be a complex function of outdoor air pollution, building characteristics, operation and management practices, cleaning and ventilation strategies. There is a need to integrate exposures occurring in school's environment with home pollution, as children spend more than 60% of their time at home, and also to elaborate and implement holistic and cost-effective approaches concerning prevention, control and remediation and communication strategies for achieving healthy indoor air quality in Europe.

---

## P09 - The sense of indoor contaminants

**Christian Meyer [1], Franziska Naepelt [1], Ronald Schreiber [1], Dave Simpson [2], Uwe Guenther [1]**

[1] **IDT Europe GmbH,** Dresden, Germany, [2] **IDT Inc.,** San Jose, USA

### TVOC and Indoor Air Quality

The awareness of indoor air quality is increasing worldwide especially in terms of our well-being and living comfort. Indoor air quality (IAQ) can be determined with a Total Volatile Organic Compound (TVOC) measurement. Typical sources of TVOCs include bio effluents (breathing, transpiration, digestion etc.), outgassing (furniture, wall paint etc.) and home products (deodorants, cleaners, solvents etc.).

### Standards for Indoor Air Quality

Since TVOC exposure can lead to fatigue, headache and other negative impacts to our well-being and health it should be considered to observe the IAQ as a common used indicator for the TVOC level and to react to polluted air. However, there is no global standard at present that defines good air in the context of indoor air quality. Some countries, including Germany and the German Environmental Agency (UBA), have local approaches and have published studies that give indicators of clean ambient air and its implications.

### Measurement of Indoor Air Quality

There are various technologies on how to measure air contamination; one of them are semiconducting Metal-Oxide (MOx) sensors, which are well known and have been used in industry for many years. The effect of a changing MOx conductivity during TVOC gas exposure is used for the IDT gas sensor technology to determine a reliable indicator for the indoor air quality. With the input of lots of long-term measurements at different countries (North America, Europe and Asia) at various locations (bathroom, kitchen, bed room, meeting room) and under different environmental conditions (air pressure, humidity) we empirically determined algorithms to get a match between the measured MOx resistance, the CO2 concentration and the IAQ standard of the UBA. This sensor has been included into an IoT hub with webserver application and is in use for air monitoring and to control actuators, for example a smart HCAV or smart windows.

---

## P10 - Quality Improvement of VOC chamber emission tests observed for 10 years with round robin tests

**Wolfgang Horn [1], Olaf Wilke [1], Matthias Richter [1]**

[1] **Bundesanstalt für Materialforschung und -prüfung (BAM),** Berlin, Germany

In Europe, the Construction Products Regulation (CPR, 2011/305/EU) sets basic requirements (BR) on how construction works must be designed and built. BR 3 "hygiene, health and the environment" states low emissions of toxic gases, Volatile Organic Compounds (VOCVOCs), particles, etc. from building materials. Meanwhile, a worldwide network of professional commercial and non-commercial laboratories performing emission tests for the evaluation of products for interior use has been established. Therefore, comparability of test results must be ensured. The participation in Round Robin Tests (RRTRRTs) is a means to prove a laboratory's proficiency. Since 2006 BAM offers such proficiency test for emission chamber test every two years.

Any commercially available product on the market can be used as reference material, provided it is thoroughly characterised. However, these materials often emit only a few and material specific VOCs and appropriate homogeneity is not given. Therefore, alternative materials should be found. BAM used different materials over the years. Currently, the best suited reference material is a cured lacquer surface which contained several VOCs added to the liquid lacquer system. The round robin tests 2014, 2016 and 2018 were conducted with such a system.

Compounds like Styrene or n-Alkanes like Decane or Tridecane were tested in many of the proficiency test operated by BAM. Up to now the relative standard deviation of these compounds decrease continuously. Starting with values about 30 % in 2008 we reached values for the mentioned compounds 15 to 20 % now. But even for more polar compounds improved results were received.
Over the years the results of a large group of laboratories detected many compounds with much higher accuracy than at the beginning. So, the comparability between results of different laboratories becomes much better.

## P11 - Development of indoor air sampling and analytical methods for detection and classification of material emissions

**Salvatore della Vecchia [1], Samy Clinchard [1], Rick Aller [1], Ulla Haverinen-Shaughnessy [1]**

[1]**720 Degrees,** Helsinki, Finland

Air quality sensors can be used to monitor various indoor air quality parameters including temperature, relative humidity, carbon dioxide ($CO_2$), particulate matter and volatile organic compounds (VOCs). Cloud technology enables real time monitoring and continuous data provide opportunities to detect temporal, recurrent and/or long-term trends. Previously, we have presented analytical processes used to estimate ventilation rates based on $CO_2$ data, thermal comfort based on T and RH, as well as predicted performance and health outcomes in a number of Finnish office buildings. Hereby we describe a procedure developed to detect Material Emission (ME) events and classify them.
Continuous data on VOCs have been collected from over one hundred buildings with E4000 Air Quality Probe with accuracy of + / - 0.1 ppm & 15% (formaldehyde equivalent). Data from unoccupied hours are extracted and classified using Machine Learning. The first extraction consists of the night time series (weekdays between 4 pm and 8 am). In this case the query selects all the measurements with a 15 minute interval from each node (68 observations). The second extraction consists of the series over the weekend (between Friday 4 pm and Monday 4 am). The query selects all the measurements with 30 minute interval (122 observations).
Initially, the shape of the time series was used to classify them series into 0 (normal) or 1 (ME), based on which a training set (806 series for weekdays and 1557 for weekends) was created. A machine learning technique called Dynamic Time Warping and KNN is used, where each time series is compared with the training set and classified (0 or 1) based on the closest match. ME observations are further classified into High, Low and Medium ME based on the VOC concentration detected. An automatized application of the ME detection is scheduled to run hourly on workdays. The application is monitored in AWS CloudWatch and an alert is sent to the administrator if there is a CRITICAL event in the log. In addition, suggestions are generated to the end user. In general, low or medium ME would not require immediate attention, whereas high ME would result in suggestion to increase ventilation.

# P12 - VOC concentrations in hospital settings: definition of a protocol for monitoring activities ininpatient wards, its application and the first results

**Gaetano Settimo [1], Marco Gola [2], Marco De Felice [1], Veruscka Mannoni [1], Giorgio Padula [1], Stefano Capolongo [2]**

[1] **Istituto Superiore di Sanità, Environment and Health dept.,** Rome, Italy, [2] **Politecnico di Milano, ABC dept.,** Milan, Italy

**Introduction:** Indoor Air Quality is one the main issue in which governments are focusing. In healing spaces, several researches are reporting a growing number of data analysis and research works in order to improve users' health. Currently the main investigations are related to biological and physical risks, otherwise chemical ones are less investigated. Several countries are carried out air quality monitoring in those professional workplaces in which chemicals are used, but also in some typically indoor spaces for building hygiene assessment. Therefore, it determinated the definition of guideline values for hospitals because the current scenario lacks of specific norms. **Method:** A research group has started a monitoring activity of air quality in inpatient rooms, giving rise to a protocol supported by ISO 16000 and guidelines by international institutions. The analysis examines VOCs -referring to WHO (2010) and ISO 16000- considered dangerous, and the influence of thermo-hygrometric, ventilation and concentration of pollutants' conditions. The methodology with passive samplers requires the use of an activity log for registering all the activities during the day. **Results:** The application of the protocol on some inpatient rooms permitted to verify the feasibility of the monitoring. Each investigation (one week per month, per a year) considered all the activities, users and processes that influence the indoor air, as well as room configuration, furniture and finishing materials. Although data analysis reports quite adequate values, several inadequate design and management activities cause inadequate values, especially related to formaldehyde (values between 8 and 10,2/ 10 μg/m$^3$), benzene (0,7 and 3,4/ 2 μg/m$^3$) and carbon dioxide (914 and 1154/ 1000 ppm). **Conclusion:** The analysis is work in progress on some case studies for controlling the indoor air values even during the year, and it is expanding to several hospitals. Although the main goal is to reduce the concentration levels, the aim is to define limit values for VOCs, for guaranteeing healthy healing spaces. These data will support the definition of design and management guidelines for healthy inpatient wards.

---

# P13 - Active indoor air sampling of organochlorinated persistent pollutants and polycyclic aromatic hydrocarbons

**Schramm K.-W. [1, 2], Henkelmann B. [1], Dreyer A. [3],**

[1] **Helmholtz Zentrum München-German Research Center for Environmental Health, Molecular EXposomics,** [2] **Department für Biowissenschaftliche Grundlagen,** Technische Universität München, **Wissenschaftszentrum Weihenstephan für Ernährung, Landnutzung und Umwelt,** Freising, Germany, [3] **Eurofins GfA GmbH,** Hamburg, Germany

**Introduction:** The German guideline VDI 2464 Part 41 targets the sampling and measurement of organochlorinated persistent pollutants (OCPP) and polycyclic aromatic hydrocarbons (PAH) in outdoor and indoor air. Repetitive trials of indoor air sampling on the basis of VDI 2464 Part 4 were executed to gain information about the quality of determination of OCPP and PAH. **Method:** The sampling campaign was performed in the period from July 7th to 10th 2015 in a building of about 600 m$^3$ volume, employing two low volume samplers (LVS) in parallel as described in VDI 2464 Part 4. In addition, a second backup cartridge filled with XAD -2 was connected behind the master cartridge. Field blanks for filter and XAD-2 were utilized. For quality control the master cartridge was spiked with 16 13C-labelled EPA-PAH as sampling standards. **Results and Discussion:** Recoveries are sufficient for all compounds. Both LVS perform very similarly. Recovery values lower than 70 % only occur for benzo(a) pyrene (BaP). Backup values are often 10% or less, which confirms a quantitative sampling. On filters, concentrations above the LOQ are only detectable for compounds with lower vapor pressure and high affinity to filter trapped aerosols (eg. DDTs).

However, the filter values indicate that aerosol bound compounds are not abundant in the indoor air sampled. Concentrations of less volatile PAH and OCPP are mainly in the range of the field blank values. The field blank situation allows to determine benzo(a)pyrene at the limit of 1000 pg/Nm3. **Conclusions:** Low volume sampling of OCPP and PAH in indoor environments can be successfully executed at sampling volumes of about 55 Nm3. The LOQ and LOD values are compliant with tentative limit values. Recoveries of sampling standards indicate an adequate quantitative performance of the sampling and were confirmed by the acceptable breakthrough percentages in the backup-cartridges.The trials were executed during a few quite hot summer days with outdoor temperature ⇢30 oC, but neither the recoveries nor the concentrations indicate a substantial influence of temperature and the method can be considered also reliable at such conditions.

**Reference:**

1. VDI 2464 Part 4 (2018)

## P14 - Investigations on emissions of VOCs from consumer products made of polymers

**Morgane Even [1], Mathilde Girard [1], Christoph Hutzler [1], Bärbel Vieth [1], Andreas Luch [1]**

[1] **German Federal Institute for Risk Assessment (BfR), Department for Chemical and Product Safety,** Berlin, Germany

**Introduction:** The influence of emissions from building materials on indoor air quality has been studied in detail for some time and has induced the development of standardized analytical methods and limits for health-related indoor air concentrations (EU-LCI or NIK values). However, consumer products, for example toys, may also release harmful substances into indoor air: those compounds can be inhaled and may influence the occupant's health. So far, the knowledge on the inhalative exposure to consumer products has been insufficient. Contents of volatile organic compounds (VOCs) in products or their headspace have been acutely studied. But these values do not allow a realistic evaluation of the inhalative exposure of consumers for risk assessment. **Objective:** The goal of this work was to identify polymer samples with a significant release of VOCs and to subsequently study their emission properties to provide useful results for inhalative exposure assessment from consumer products. **Materials and methods:** An analysis of 46 real samples (toys, decorations) was performed. First, the polymer was identified by pyrolysis coupled online to a gas chromatograph with mass spectrometric detection (py-GC/MS). In parallel, the headspace analysis from pieces of the same samples was performed using the dynamic headspace technique at 40°C and 14.2 mL/min. Subsequently, emission tests were carried out on relevant samples at 23°C and 50 % r.h. for 28 days: different real samples (e.g. a water wing, two plopper figurines and a playing mat) were examined in a 203 L chamber. For comparison VOC profiles of pieces with 12 mm diameter from six samples (plopper figurines) were also studied in 44 mL micro-chambers. The emitted VOCs from dynamic headspace or chamber experiments were sampled on TENAX® TA tubes and analysed after thermal desorption by GC/MS. **Results:** It has been observed that soft plastics emit more volatile substances than hard plastics: samples characterized as polyvinyl chloride (PVC) or polyethylene (PE) emitted broader profiles of VOCs compared to other polymers like polystyrene or polypropylene. For example, phenol from the PVC water wing, cyclohexanone from the PVC plopper figurines and acetophenone from the PE playmat were detected at high levels. However, the corresponding calculated room concentrations of the target analytes (30 $m^3$ room) over the first hours were smaller than the European or German lowest concentration levels (EU-LCI or NIK). The highest emission value was found for acetophenone from a PE playmat; but it was lower by a factor of 34 in the first 9 hours than the EU-LCI values. **Conclusion:** First evaluations on real toy samples led to acceptable calculated room concentrations. However, consumer products only represent one indoor pollution source out of many others and there is an urgent need for more data to have a clearer overview on the current market.

# P15 - Emission of ultrafine particles and volatile organic compounds (VOC) from ABS filaments by two different low-cost 3D-printers

**Duangkamol Yenying Dietrich [1], Stefan Seeger [1], Doris Brödner [1], Olaf Wilke [1]**

[1] **Bundesanstalt für Materialforschung und -prüfung,** Berlin, Germany

Nowadays, the use of 3D-printer increases dramatically. There are many types of filament available on the market for 3D-printing. However, ABS-filament is the most popular used for 3D-printer. In this study, the emission of ultrafine particles from 14 ABS-filaments (three different manufactures and seven colours) was characterized. The printing of filament was performed by two different printers: (1) printer with housing and top cover; (2) printer with housing, top cover with HEPA filter. The measurements were carried out under controlled conditions (RH 50±5%, Temp. 23±2°C, air velocity range 0.1 and 0.3 $ms^{-1}$ as well as air exchange rate 1 $h^{-1}$) in a 1 $m^3$ test chamber. Particulate emissions were investigated by engine exhaust particle sizer (EEPS) with the rage from 5.6 to 560 nm. The printer (1) and (2) emitted total particle numbers in the range of $5.3 \times 10^{11}$ to $2.1 \times 10^{12}$and 2.8 $\times 10^{11}$ to $5.3 \times 10^{12}$, respectively. The particle size distribution from printer (1) and (2) emitted mainly in the range of 6 nm to 107 nm. The maximum particle concentration from printer (1) was found $1.5 * 10^5$ [1/$cm^3$] in the particle size range between 29 nm to 34 nm. The maximum particle concentration from printer (2) was found $2.5*10^5$ [1/$cm^3$] in the particle size range of 11 nm and between 22 nm to 29 nm. The testing object weights from printer (1) and (2) were between 1.9 g to 2.2 g and 1.8 g to 2.1 g respectively. VOC emission from both printers were determined. Chamber air was sampled on Tenax and analysed by GC-MS. The main VOC generated from printer (1) and (2) was styrene with concentrations of 147 and 167 µg/m3, respectively.

---

# P16 - Contribution of indoor activities to fine and ultrafine particles: A study of 20 private dwellings in Germany

**Jiangyue Zhao [1], Birgit Wehner [1], Thomas Tuch[1], Kay Weinhold [1], Maik Merkel [1], Ulrich Franck [2], Anja Lüdecke [3], Wolfram Birmili [3], Tareq Hussein [4], Alfred Wiedensohler [1]**

[1] **Leibniz Institute for Tropospheric Research,** Leipzig, Germany, [2] **Helmholtz Centre for Environmental Research,** Leipzig, Germany, [3] **German Environment Agency (UBA)**, Berlin, Germany, [4] **University of Jordan,** Amman, Jordan

**Introduction:** People spend around 65% of their time in residences (Brasche and Bischof 2005), being exposed to a mixture of particles from outdoor and indoor origin (Morawska, Ayoko et al. 2017). At present, there is considerable lack of representative information on size resolved indoor particle characteristics, particularly their dependency of the individual life-style and activities of residents in their homes. **Methods:** Measurements were performed in 2017 in 20 private homes in Leipzig, Germany. Measurements included total particle number concentration (PNC), particle number size distributions (PNSD, 10-800 nm) for two 1-week periods in livingroom (warm and cold season). Simultaneous outdoor measurements took place in the vicinity of the building, i.e. on a balcony, or a terrace. The original time resolution of the data is 5 minutes, which allows to detect and classify short-lived and intermittent phenomena. **Results and discussion:** Figure 1 shows the statistical median of PNSD at the peak-time of different indoor activities in 20 households for the entire observation time. The peak-time here is defined as the time when the PNC reaches maximum during the single event. Compare to the PNSD during steady state (the periods which have no influence from indoor activities), indoor concentrations notably increased by all activities. By opening windows, outdoor particles entered into the indoor space, caused the increase of indoor concentration. The highest contribution of toasting, baking, frying were to 20 nm, 20-50 nm and 50 nm particles, respectively. Candle burning emits high levels of 10 - 20 nm particles.

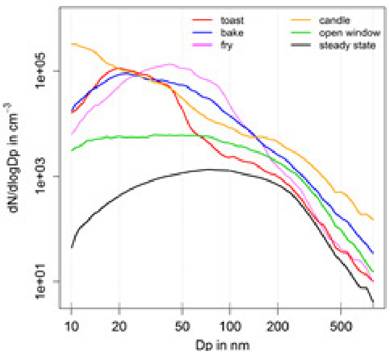


Figure 1. Median PNSD at the peak-time of different indoor activities.

**Conclusions:** Current measurements captured the size resolved particle characteristics of representative indoor activities. During the time when windows are opened, indoor PNC increases due to the contribution of outdoor particles. Indoor combustion sources provide the highest contribution to the concentration of ultrafine particles.

## P17 - Occurrence of benzothiazole in indoor air of public buildings in cases of complaint and its association with rubber floor

**Heike Papavlassopoulos [1], Guido Ostendorp [1], Diana Riemer [1], Katja Ehring [1], Claudia Röhl [1]**

[1] **Department of Environmental Health Protection, State Agency for Social Services Schleswig-Holstein,** Kiel, Germany

Benzothiazole (BZT, CAS no. 95-16-9) is a degradation product of compounds used i.a. as vulcanization accelerators in rubber production. Data on the toxicity of BZT are rare. It is described as skin /eye irritative and maybe organ toxic, but it is not classified according to CLP. BZT is rarely found in indoor air and concentrations are typically low. Nevertheless, cases with higher concentrations of BZT in indoor air might occur under certain circumstances. To analyze these cases, 815 indoor air samples of 255 public buildings, taken between 2015 and 2018 mainly due to health problems or odour complaints, were evaluated for the occurrence and the possible source of BZT. Only those samples with BZT concentrations ≥ 1µg/m³ were considered. Sampling was performed actively by adsorption of BZT to synthetic carbon (ANASORB®) for 5 h or to porous polymer (TENAX®) for 0.3 h with an air volume of 600 or 2 l (0°C, 101.3 kPa). Samples were analyzed by means of gas chromatography with flame ionization detector (GC-FID) or GC mass-spectrometry (MS). BZT occurred in 45 out of the 815 samples (5.5 %) in concentrations of 1 | 12 | 16 | 52 | 61 µg/m³ (= min. | median | mean | P95 | max.). As BZT is a degradation product in rubber production we analyzed the data for their association with rubber floor and found that 50 % of the 18 BZT positive buildings were furnished with rubber floor. Vice versa, in all buildings with rubber floors (n=9) BZT was found in indoor air. To compare the concentrations arising under conditions with rubber and non-rubber floors we took the mean concentrations of samples from the same building taken under unaired conditions. Mean BZT concentrations in cases with rubber floors were 8 | 12 | 17 | 33 | 37 µg/m³ and in cases with non-rubber floors accordingly 1 | 3 | 3 | 7 | 8 µg/m³ (= min. | median | mean | P95 | max.). These results indicate that rubber floor is probably an important source of BZT in indoor air. It is also a good example for a substance for which an exposure indoors might occur but health risk assessment is rarely possible due to the lack of toxicological data and, thus, indoor air guide values.

# P18 - Effects of energy retrofits on indoor air quality in multifamily buildings

**Liuliu Du [1], Virpi Leivo [2], Tadas Prasauskas [3], Martin Täubel [1], Dainius Martuzevicius [3], Ulla Haverinen-Shaughnessy [1, 2]**

[1] **National Institute for Health and Welfare, Department of Health Security,** Kuopio, Finland, [2] **Tampere University of Technology, Department of Civil Engineering,** Finland, [3] **Kaunas University of Technology, Department of Environmental Technology,** Lithuania

We studied selected indoor air quality (IAQ) parameters in 45 multifamily buildings (240 apartments) from Finland and 20 from (96 apartments) Lithuania, out of which 37 buildings in Finland and 15 buildings in Lithuania underwent energy retrofits. Building characteristics, retrofit activities, and energy consumption data were collected, and indoor environmental quality parameters, including carbon monoxide (CO), nitrogen dioxide ($NO_2$), formaldehyde ($CH_2O$), selected volatile organic compounds (benzene, toluene, ethyl benzene and xylenes (BTEX)), radon, and microbial content in settled dust were measured before and after the retrofits. After the retrofits, heating energy consumption decreased compared to the before situation by an average of 24% and 49% in Finnish and Lithuanian buildings, respectively. After the retrofits of Finnish buildings, there was a significant increase in BTEX concentrations (estimated mean increase 2.5 μg $m^{-3}$), whereas significant reductions were seen in fungal (0.6-log reduction in cells/$m^2$/d) and bacterial (0.6-log reduction in gram-positive and 0.9-log reduction in gram-negative bacterial cells/$m^2$/d) concentrations. In Lithuanian buildings, radon concentrations were significantly increased (estimated mean increase 13.8 Bq $m^{-3}$) after the retrofits. Mechanical ventilation was associated with significantly lower $CH_2O$ concentrations in Finnish buildings. The results and recommendations presented in this paper can inform building retrofit studies and other programs and policies aimed to improve indoor environment and health.

---

# P19 - Impact of outdoor air quality on indoor exposures

**Antti Korhonen [1], Heli Lehtomäki [1], Arja Asikainen [1], Otto Hänninen [1]**

[1] **National Institute for Health and Welfare, Department of Public Health Solutions,** Kuopio, Finland

**Introduction:** Indoor air quality is affected by outdoor air, indoor emission sources, and ventilation rates. It has been estimated that outdoor air fine particles ($PM_{2.5}$) caused about 50 % of the environmental burden of disease attributable to indoor exposures in Finland in 2010. Outdoor air can be brought in by natural or mechanical ventilation. Exposures can be reduced by filtration of outdoor air. World Health Organization guideline for ambient $PM_{2.5}$ annual average is 10 μg/$m^3$. In the HealthVent work 6 μg/$m^3$ was chosen as the reference value for indoor air to determine the filtration efficiency. Here we estimate size of the Finnish population living in areas where there is need to apply filtration of building air intake according to the HealthVent ventilation guidelines. Public health relevance of population exposures to indoor sources is investigated by Asikainen et al. in their parallel work and health-based optimal ventilation principles summarized by Carrer et al. **Methods:** Annual $PM_{2.5}$ concentrations calculated with chemical transport model SILAM and Statistic Finland population data were used to estimate distribution of ambient $PM_{2.5}$ levels at population level in Finland in 2015. We quantified the share of the Finnish population living in areas where ambient air concentrations are above 6 μg/$m^3$. **Results:** About 1.3 million persons (20% of the population) in Finland live in areas where ambient $PM_{2.5}$ concentrations exceed the HealthVent ventilation guidelines. In their residences implementation of the health-based ventilation guidelines would require considerations for filtration of intake air. **Conclusions:** The Finnish building codes do require application of category G3 filters in all mechanical ventilation systems, and F7 filters in urban areas already since 2002 (section D). In addition, energy efficiency requirements are mostly reached by using mechanical ventilation systems with heat recovery units. In practice the necessary technical elements are in place to apply the HealthVent guidelines and subsequently reduce the health impacts of indoor air.

---

# P20 - The activities of the Italian National Study Group (GdS) on Indoor Air Pollution by National Institute of Health – ISS

**G.Settimo [1], E. Beccaloni [1], L. Bonadonna [1], M. Chirico [1], S. Fuselli M. Mosetti [1], A. Pilozzi [1], A. Santarsiero [1], V. Marisi [2], K. Maiella [2], S. Giovannoli [2], L. Mangiamele [3], G. D'Amato [4], A. Ganzi [5], D. Cimini [6], G. Scaloni [6], M. Colitti [7], C. Pettazzi [8], D. Pulvirenti [9],F. Di Gregorio [9], S. Bongiorno [10], A. Cipriani [10], A. Sanna [11], M. Schintu [12], M. Vazzoler [13], A. De Martino [14], G. Pironti [14], M.G. Dirodi [15], C. Mancuso [16], A. Milieni [16], M. Gherardi [17], R. Uccelli [18], S. Brini [19], M. Baldini [20], A. Cecinato [21]**

[1] **Istituto Superiore di Sanità, Environment and Health Dept.,** Rome, Italy, [2] **ASL** Pescara, Italy, [3] **ARPA Basilicata,** Potenza, Italy, [4] **Università di Napoli**, [5] **Azienda USL Reggio Emilia,** Italy, [6] **ASUR Marche,** Italy, [7] **ASL Molise, Campobasso,** Italy, [8] **ASL Asti,** Italy, [9] **ASL Sicilia,** Italy, [10] **Azienda USL Valle D'Aosta,** Italy, [11] **Region Sardinia,** Italy, [12] **University di Cagliari,** Italy, [13] **Region Veneto,** Venezia, Italy, [14] **Ministry of Health,** Rome, Italy, [15] **Ministry for the Environment and Protection of the Territory and the Sea,** Rome, Italy, [16] **Ministry of Labor and Social Policies,** Rome, Italy, [17] **INAIL,** Rome, Italy, [18] **ENEA Laboratory Biosafety and Risk Assessment,** Rome, Italy, [19] **ISPRA,** Rome, Italy, [20] **SNPA,** Rome, Italy, [21] **CNR, Institute for Atmospheric Pollution IIA,** Rome, Italy

**Introduction:** In Italy, in 2010, the National Study Group (GdS) on Indoor Air Pollution was established by the National Health Institute (Istituto Superiore di Sanità – ISS). The Group is composed by the representatives of the ministerial bodies (Ministry of Health, Ministry for the Environment and Protection of the Territory and the Sea, Ministry of Labor and Social Policies), regions, local authorities and research institutes (ISS, CNR, ENEA, ISPRA, SNPA, INAIL). **Method:** The GdS is working to provide shared technical-scientific documents and reports in order to allow harmonized actions at national level. There are several initiatives by the GdS with the primary aim of filling the knowledge gaps on indoor air pollution. The main findings of these works have been reported in ISS reports series, available online on the official website of ISS dedicated to indoor air pollution (www.iss.it/indo). **Results:** The GdS has elaborated eight reference documents for the air monitoring strategies of the main indoor chemical and biological pollutants, the role of different sources, the specific features of indoor working environments, the energy efficiency activities and different internal combustion. Technical indications are given as references at national level and they can be useful for the definition of national legislation because they consider WHO indications. The GdS also prepared a booklet entitled "The air in residential facilities: how to improve it?" which illustrates sources of indoor air pollution, impacts of individual behavior and a series of actions to reduce pollution, providing specific recommendations for those most at risk, and vulnerable populations (for example children, population suffering from asthma, respiratory and cardiovascular diseases, etc.). **Conclusion:** Currently, the GdS is engaged in the preparation of two technical-scientific reports (Rapporti ISTISAN) that address the problem of indoor air quality in schools (classrooms, laboratories, information technology and, arts rooms, gyms, libraries, offices, etc.) and various Healthcare Centres (healthcare facilities hospitals, clinics, ambulatory surgery, doctor's offices, administration officies, etc.) with the identification of specific monitoring methods and possible hygienic-sanitary implications.

---

# P21 - Odours at indoor workplaces: challenges for research

**Simone Peters [1], Yvonne Giesen [1], Kirsten Sucker [2]**

[1] **Institute for Occupational Safety of the German Social Accident Insurance (IFA),** Sankt Augustin, Germany, [2] **Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Institute of the Ruhr University Bochum (IPA),** Bochum, Germany

**Objectives:** Following increased building tightness and energy conservation measures, reducing the amount of outside air supply, complaints about bad indoor air quality increased in recent years. Modern office equipment, a growing use of synthetic materials, cleaning products, and outdoor air pollution can also increase the level of indoor air contamination. Perception of an

odour is often seen as an indicator of indoor air contamination and associated with concerns about harmful effects on health. The causes of complaints are multi-factorial and often elusive. They can involve chemical, microbiological, physical and psychological mechanisms. However, analysis of air samples often fail to reveal significant concentrations of any contaminant, so the problem may be attributed to the combined effects of different pollutants at low-level concentrations, probably complicated by other influence factors. Environmental stressors or psychosocial problems (such as job stress) can also reduce tolerance for substandard air. **Methods:** In order to investigate indoor air quality complaints, standardized survey instruments are available. These include, on the one hand, questionnaire methods in order to record the situation from the point of view of those concerned with special emphasis on the perception of odours. On the other hand, type and extent of the odour load itself can be measured additionally to indoor air measurements. Current challenges for research are to

- differentiate between odour nuisance and health effects,
- investigate dose-response relationships between low-level indoor exposures and well-being, health, and performance while odours are perceivable and/or odour complaints are present
- taking into account important psychosocial influencing factors, such as individual sensitivity, personality traits and other

Therefore, the research institutes of the German Social Accident Insurance (DGUV) - the Institute for Prevention and Occupational Medicine (IPA) and the Institute for Occupational Safety and Health (IFA) have launched a joint project to assess and evaluate odours at indoor workplaces as an approach to objectify complaints about annoying odours.

**Results:** A preliminary study was conducted in offices in 2016. In addition to employee surveys, indoor air measurements of volatile organic compounds (VOC), aldehydes and carbon dioxide ($CO_2$) concentration as well as measurements of air temperature and humidity were carried out. The first results show that the questionnaire is suitable for capturing user satisfaction with indoor air quality. The aim of the main study is a survey in office rooms in Germany without known indoor air problems. Reference values are derived from the frequency of complaints about the indoor environment, health problems and data on odour perception and odour annoyance. In order to ensure that no contamination is present in the indoor air, accompanying indoor air and climatic measurements are carried out.

**Conclusions:** The questionnaire developed within the framework of the project can be used to answer the following specific questions: examination of complaints, consideration of the necessity and / or effectiveness of measures, e.g. before and after a renovation (reorganization control) and, where appropriate, assessment of (new) buildings (certification).

## P22 - Register studies related to indoor exposures

**Isabell Katharina Rumrich [1, 2], Antti Korhonen [1], Kirsi Vähäkangas [3], Matti Viluksela [1, 2, 3], Mika Gissler [4, 5], Jukka Jokinen [6], Heli Lehtomäki [1], Arja Asikainen [1], Otto Hänninen [1]**

[1] **National Institute for Health and Welfare, Department of Public Health Solutions,** Kuopio, Finland, [2] **University of Eastern Finland (UEF), Department of Environmental and Biological Sciences,** Kuopio, Finland, [3] **University of Eastern Finland (UEF), School of Pharmacy/Toxicology,** Kuopio Finland, [4] **National Institute for Health and Welfare, Department of Information Services,** Helsinki, Finland, [5] **Karolinska Institute, Department of Neurobiology, Care Sciences and Society,** Huddinge, Sweden, [6] **National Institute for Health and Welfare, Department of Public Health Solutions,** Helsinki, Finland

**Introduction:** Indoor air contaminants are derived from many sources, such as building materials, heating sources, lifestyle (such as smoking) and ventilation systems, challenging exposure assessment. Here we elaborate and discuss the usability of register data for exposure assessment using maternal smoking as an example of a source of chemicals in indoor air.

**Method:** Qualitative information on maternal smoking from the Finnish Medical Birth Register (MBR) were analysed from 1991 to 2016. Information availability from other relevant registers was recorded.

**Results:** The overall smoking rate during early pregnancy was relatively constant from 1991-2016 with small decline from 16% to 14% between 2012 and 2016. The fraction of women who continued smoking after the 1st trimester decreased from 15% (1991) to 7% (2016). MBR does currently not contain information on maternal (or paternal) smoking behaviour at home after birth or e.g. use of other nicotine containing products. We are working on developing research plans to collect such data. Other registers relevant for estimating indoor exposures and health effects include the Finnish Building and Dwelling Register (BDR). Information can be used to estimate need and actual ventilation rate and associated air quality (cf. parallel work by Korhonen et al.). The Population register provides the address history. Several Finnish health registers are available for additional diagnoses, treatments and medicine use. **Conclusion:** Legislative efforts to end tobacco smoking in Finland had so far limited success. The exposure of the unborn child to maternal smoking and the high likelihood of exposure after birth will contribute to morbidity during childhood and later in adulthood. Register-based epidemiological analyses of indoor air quality are feasible. Registers and other private and routinely collected data sources may prove to be valuable, for example, for designing indoor air quality monitoring programmes, public guidance, and surveillance.

## P23 - German brick industry in the current field of European Construction Products Regulation EU 2011/305 (CPR)

**Dr Petra Augustin** [1]

[1] **Mein Ziegelhaus GmbH & Co. KG,** Königswinter, Germany

In January 2018 the German version of European testing standard DIN EN 16516 was published. It defines the horizontal reference method of assessment of emission into indoor air in terms of CE marking and the connected evaluation of conformity. The European standard is valid for construction products being regulated by harmonized standards or by European technical assessments (ETA). That means that from February 1, 2019 producers of masonry are also legally bound to declare VOC emissions of their products in the context of CE marking. Products with zero or generally low Volatile Organic Compounds (VOC) release into indoor air can be treated under a "without testing" (WT) option or a "without further testing" (WFT) option. Second option is valid if an initial type testing can prove that all volatile emissions always will be in the best available VOC emissions class. Several types of filled clay bricks have been analyzed in conditioned testing chambers at eco-INSTITUT in Cologne which is listed as European notified testing body following EN 16516. All analytical results show a minimum order of magnitude of TVOC, VVOC and SVOC emissions and no relevant amounts of cancerogenic components after 28 days. Quantitative amounts and LCI limit values for all detectable chemical components are listed. Comparisons were made with the test values on the filler material provided by the suppliers. After extended assessment the tested brick products can be classified as “very low emitting composites”. Recent VOC emission testing results support the argumentation to classify normal clay bricks under a WT option and filled clay bricks under a WFT option.

## P24 - Environmental health risk assessment needs improvement cooperation between science and doctors' offices specialized in Clinical Environmental Medicine

**Peter Ohnsorge** [1]

[1] **European Academy for Environmental Medicine,** Hermeskeil, Germany

For an advanced scientific understanding of the environmental health risk assessment we urgently need a complex approach, involving mixtures / combination of multiple chemical, physical, biological and psycho-social stressors. The current environmental health risk assessment fails, usually still following a linear- and monocausal scientific approach and a dose-effect relationship of toxins. This is far off any complex strategy.

Complex environmental health risk assessment must regard

- Interactions of chemicals, bioavailability, multiple burdening
- long-time low dose burdening as well as cumulation and storage of toxins
- not solely toxically, but also immunologically effects

⇢ relevant vulnerability and individual susceptibility.
⇢ among others, the Neuro-Endocrine-Immune-System (NEIS) as a main target of chemical, physical, biological and psycho-social stressors
Clinical Environmental Medicine
⇢ deals with complexity, following multi-factorial burdening, multi-functional effects of different organs and functions and multi-dimensional burdening over the stages of the entire life.
⇢ regards a complex awareness, diagnosis and treatment of diseases associated to the environment
⇢ is aware of ⇢ patients suffering from diseases associated to the environment in a very early stage of complex symptomatology and pathology,
⇢ detecting multiple common and individual stressors
⇢ regarding regional cluster of burdening very early

A cooperation between scientific institutes and doctors' offices specialized in Clinical Environmental Medicine introduces an ideal early warning system for detecting health burdening stressors associated to the environment. The increased knowledge and expertise in diagnose and therapy of chronic complex diseases associated to the environment as well as the consequently developed strategies for primary prevention, make those physicians a worthful partner in the discussion of an environmental health risk assessment.

## P25 - Framework for health-based ventilation guidelines

**Paolo Carrer [1], Eduardo de Oliveira Fernandes [2], Hugo Santos [3], Otto Hänninen [4], Stylianos Kephalopoulos [5] and Pawel Wargocki [6]**

[1] **Occupational and Environmental Health, Department of Biomedical and Clinical Sciences "L. Sacco" University of Milan,** IT-20157 Milan, Italy, [2] **University of Porto,** Porto, Portugal, [3] **INEGI-Institute of Science and Innovation in Mechanical and Industrial Engineering,** Porto, Portugal, [4] **National Institute for Health and Welfare,** Kuopio, Finland, [5] **European Commission, Joint Research Centre, Directorate for Health, Consumers and Reference Materials,** Ispra, Italy, [6] **International Centre for Indoor Environment and Energy, Department of Civil Engineering, Technical University of Denmark,** Kongens Lyngby, Denmark

Ventilation is one of the strategies that are used for controlling indoor air quality (IAQ) in buildings. It supplies outdoor air that is generally assumed to be clean or cleaned and fresh, to reduce exposure by diluting and ultimately removing the air pollutants indoors. This process is undertaken with the aim of reducing exposures to hazardous pollutants indoors and consequently the associated risks for health, comfort and wellbeing, as well as work performance and learning.
EU DG Sanco commissioned the HealthVent project to define health-based guidelines for ventilation. As a result a framework based on three principles was developed [1]: 1. Criteria for permissible concentrations of specific air pollutants set by health authorities have to be respected; 2. Ventilation must be preceded by source control strategies that have been duly adopted to improve IAQ; 3. Base ventilation must always be secured to remove occupant emissions (bio-effluents). The air quality guidelines defined by the World Health Organization (WHO) are used as the reference for determining permissible levels of the indoor air pollutants.
Implementation of the framework requires technical guidelines, directives and other legislation. Studies are also needed to examine the effectiveness of the approach and to validate its use. It is estimated that implementing the framework would bring considerable reduction in the burden of disease associated with inadequate IAQ.
As a follow-up on the HealthVent ventilation guideline framework presented in this abstract three parallel abstracts are included. Public health relevance of population exposures indoor sources in Finland is investigated by Asikainen et al. Korhonen et al. demonstrate the role of outdoor air quality in Finland. Rumrich et al. discuss the benefits and potential of health registers and other routinely collected data in analyzing and managing indoor exposures.
[1] Carrer P, de Oliveira Fernandes E, Santos H, Hänninen O, Kephalopoulos S, Wargocki P, 2018. On the development of health-based ventilation guidelines: principles, approach and proposed framework. International Journal of Environmental Research and Public Health 15:1360. http://www.mdpi.com/1660-4601/15/7/1360

# P26 - Prioritization of indoor originating exposures by public health relevance

**Arja Asikainen [1], Heli Lehtomäki [1], Jenna Reinikainen [1], Otto Hänninen [1]**

[1] **National Institute for Health and Welfare, Department of Public Health Solutions,** Kuopio, Finland

**Introduction:** Many chemicals and other exposures present in indoor spaces have harmful effects on the health of the occupants. It is important to consider the relative role of each risk factor when developing effective and balanced risk management strategies. The aim of this work is to present a tentative analysis of public health significance of six indoor originating harmful exposures in the Finnish population. **Methods:** International studies and reviews were used to identify health endpoints relevant to selected indoor risk factors: radon, second hand smoking, fine particles (PM2.5), dampness and mould, carbon monoxide and formaldehyde. Health impacts were quantified using disease burden methods. WHO Global Health Estimates for Finland for the relevant health endpoints were used together with exposure-based population attributable fractions to estimate the attributable burden of disease, expressed in disability adjusted life years (DALY). **Results:** The burden of disease attributable to indoor exposures was largest for radon (6800 DALY) followed by second hand smoke (6100), PM2.5 from indoor sources (5500), dampness and mould (1800), carbon monoxide poisonings (280) and formaldehyde (120). Internationally high radon levels in Finnish buildings thus seem to dominate the public health effects. Second hand smoke exposures are estimated using survey data from 2008, and those are expected to be now slightly lower. Included health endpoints for dampness and mould do not include all symptoms, such as skin effects and eye irritation or hypersensitivity syndrome. Inclusion of these symptoms might significantly increase environmental burden of dampness and mould. **Conclusions:** Environmental burden of disease estimates allow for quantifying the magnitude of public health losses due to well known risk factors. Exposure and effect estimates are missing for large number of chemicals found in indoor spaces.

---

# P27 - Estimation of indoor fungi contamination level based on ratio of termotolerant aspergillus

**Novikova TP [1], Dotsenko EA [1], Arashkova AA [2], Goncharova IA [2], Malahova IV [3]**

[1] **Byelorussian State Medical University,** Minsk, Belarus, [2] **Institute of microbiology of National Academy of Sciences of Belarus,** Minsk, Belarus, [3] **Republican Scientific and Practical Center for Medical Technologies,** Minsk, Belarus

**Introduction:** One of the problems of modern medicine is the treatment and prevention of fungal allergy, which number continues to grow. The study of the mycobiota spectrum of the upper respiratory tract conducted in Belarus in 2005-2010 showed that mycotic rhinosinusitis is dominated by microscopic (mold) fungi (83%). About 20% of asthma patients have Ig E mediated allergy to indoor fungi allergens. The purpose of this study was to evaluate the level of contamination with thermotolerant Aspergillus fumigatus, flavus et niger, as a criterion for assessing ecological safety of residential and public premises.
**Method:** Fungi of Aspergillus were isolated from mycological examinations of premises taken from the surfaces with signs of mold damage on Chapec's medium in Petri dishes, which were placed at 28 ° C. Determination of biomass density in cultures giving continuous growth at 37 ° C made it possible to introduce the concept of thermotolerance comparative index. The ratio of the yield biomass of the lawn culture at 37° C to this index at 28° C (B37 / B28) was taken as the coefficient of thermotolerance. The level of total serum IgE and specific serum IgE antibodies to fungi allergens were investigated in 104 adults from mold affected premises. **Results:** At 28 ° C, in all the isolates continuous mycelial growth was observed. Significant number of isolates gave single colonies at 37 ° C and the level of thermotolerance increased. Aspergillus, which was isolated from various materials (natural and synthetic), actively accumulated biomass on Saburo's medium, which may to some extent indicate the potential for provoking various mycoses and allergic reactions. The growth activity of the isolates at 37° C varied depending on the strain

belonging, and was usually higher on the Saburo plates. Among examined adults, 23 patients had increased level of total serum IgE and spesific serum IgE antibodies to Aspergillus fumigatu et niger, including threshold. **Conclusion:** Identification of the indoor presence of mold fungi with a high ratio of thermotolerant Aspergillus should become one of the criteria for assessing the microbiological safety of premises.

---

## P28 - Support to developing the Exposome in Horizon 2020

**Laia Quirós Pesudo [1], Tuomo Karjalainen [1]**

**[1] DG Research and Innovation. Unit E5 Innovative tools, technologies and concepts in health research, European Commission,** Brussels. Belgium

This poster introduces the concept of the Human Exposome, briefly reviews previous research efforts funded under the European Union's 7th Framework Programme for Research and Innovation (FP7) and presents the Horizon 2020 (current FP) funding opportunities available to support research and innovation on this topic.

The aim of the 'Human Exposome' is to allow the assessment of the different life-long environmental exposures of individuals and the resulting health impacts. The Human Exposome represents a fundamental shift in looking at health, by moving research away from 'one exposure, one disease', to a more multifactorial, complex picture. It brings new knowledge upon which to build solid, cost-effective actions and policies in the future for improved prevention of non-communicable diseases. This concept is increasingly being taken up by the environment and health research community and has been applied to a variety of exposure settings such as the 'urban exposome' (Robinson et al, Environmental HealthPerspectives, 2018), the 'waste exposome' (Sarigiannis, Environmental Research, 2017), and the 'saliva exposome' (Bessonneau and Rappaport, 2016). It could be applied to indoor air exposure situations.

Under FP7 three pilot projects (EXPOSOMICS, HELIX, and HEALS) forming the EU Exposome Cluster were funded. These projects have advanced our knowledge on how to measure the external and internal exposome and have applied the concept to specific exposures (e.g., air and water pollution; chemicals in pregnancy, etc.).

Based on the advances accomplished, the European Commission has opened a new call for research and innovation proposals under Horizon 2020, Societal Challenge 1 'Health, Demographic Change and Wellbeing' on 'The Human Exposome Project: a toolbox for assessing and addressing the impact of environment on health'. The submitted proposals are expected to respond to a persistent or long-standing policy/regulatory need where the exposome approach would be useful to solve a scientific issue to underpin better regulation now or in the future (examples: indoor and outdoor air quality, waste, occupational health, noise). The deadline for proposal submission is 16 April 2019. The selected projects for funding will be required to coordinate their activities for a maximum impact.

---

# Index of chairs, speakers and panelists

**Erwin Annys,** European Chemical Industry Council (CEFIC)
**Josje Arts,** Akzo Nobel Chemicals B. V., Arnhem, The Netherlands
**Kenichi Azuma,** Kindai University Faculty of Medicine, Japan
**Vanessa Beaulac,** Health Canada, Canada
**Wolfram Birmili,** Germany Environment Agency (UBA), Germany
**Marilyn Black,** Underwriters Laboratories Inc., Founder GREENGUARD, USA
**Carl-Gustaf Bornehag,** Karlstad University, Sweden and Icahn School of Medicine at Mount Sinai, New York, USA, Sweden
**Lilian Busse,** German Environment Agency (UBA), Germany
**Katleen De Brouwere,** Flemish Institute for Technological Research VITO, Belgium
**Eduardo de Oliveira Fernandes,** Emeritus Professor University of Porto, Portugal
**Sani Dimitroulopoulou,** Public Health England, UK
**Ruth A. Etzel,** Office of Children's Health Protection, U.S. Environmental Protection Agency (EPA), USA
**Saul García Dos Santos-Alves,** Institute of Health Carlos III, Spain
**Colin Ehnes,** BASF Germany
**Lars Gunnarsen,** Danish Building Research Institute, Denmark
**Birger Heinzow,** German Committee on Indoor Guide Values (AIR), Germany
**Dorota Jarosinska,** WHO European Centre for Environment and Health
**Gunnar Johanson,** Karolinska Institutet, Sweden
**Marion Keirsbulck,** French Agency for Food, Environmental and Occupational Health & Safety (ANSES), France
**Carsten Kneuer,** German Federal Institute for Risk Assessment, Germany
**Marike Kolossa-Gehring,** German Environment Agency (UBA), Germany
**Martin Kraft,** North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection, Germany
**Maria Krautzberger,** German Environment Agency (UBA), Germany
**Stylianos Kephalopoulos,** European Commission, DG JRC
**Frank Kuebart,** eco-INSTITUT Germany GmbH, Germany
**Heli Lehtomäki,** National Institute for Health and Welfare, Finland
**Steven Nordin,** Umea University, Sweden
**Michael Riediker,** The Swiss Centre for Occupational and Environmental Health (SCOEH), Switzerland
**Pawel Rostkowski,** Norwegian Institute for Air Research, Norway
**Helmut Sagunski,** German Committee on Indoor Guide Values (AIR), Germany
**Tunga Salthammer,** Fraunhofer Institute for Wood Research, Wilhelm-Klauditz-Institut (WKI), Germany
**Jorma Säteri,** Finnish Society of Indoor Air Quality and Climate and, Helsinki Metropolia University of Applied Sciences, Finland
**Ana Maria Scutaru,** German Environment Agency (UBA), Germany
**Anne Stauffer,** Health and Environment Alliance (HEAL), Belgium
**Wolfgang Straff,** German Environment Agency (UBA), Germany
**Maria Uhl,** Environment Agency Austria, Austria
**Axel Vorwerk,** Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU), Germany
**Pawel Wargocki,** Technical University of Denmark, Denmark
**Wenjuan Wei,** Scientific and Technical Centre for Building (CSTB), France
**Gerhard Wiesmüller,** Public Health Department Cologne, Germany
**Thomas Witterseh,** Danish Technological Institute, Denmark
**Peder Wolkoff,** The National Research Centre for the Working Environment, Denmark
**Birgit Wolz,** Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU), Germany

# Index of participants

**George Afrifa,** Africa Center for Government Policies and Projects, Ghana
**Doris Ahnen,** Ministerium für Bildung, Wissenschaft, Jugend und Kultur, Germany
**Mervi Ahola,** Finnish Society of Indoor Air Quality and Climate, Finland
**Azwani Alias,** The National University of Malaysia, Malaysia
**Petra Augustin,** Mein Ziegelhaus GmbH & Co. KG, Germany
**Regine Baeker,** MASGF Brandenburg, Germany
**Herbert Bender,** BDI e.V., Germany
**Julia Borowka,** SWISS KRONO Tec AG, Switzerland
**Katrin Bossmann,** German Environment Agency (UBA), Germany
**Farouk Boujemaa,** Washing International company, Tunisia
**Gregor Brasse,** German Environment Agency (UBA), Germany
**Corinna Brieske,** Drägerwerk AG & Co. KGaA, Germany
**Rolf Buschmann,** BUND für Umwelt und Naturschutz Deutschland (FoE Germany), Germany
**Allison Busgang,** LDD Advanced Technologies, Israel
**Paolo Carrer,** University of Milan, Italy
**Ibrahim Chahoud,** Charité Berlin, Germany
**Maria Christofidou,** State Genaral Laboratory, Cyprus
**André Conrad,** German Environment Agency (UBA), Germany
**Anja Daniels,** German Environment Agency (UBA), Germany
**Christine Däumling,** Formerly German Environment Agency (UBA), Germany
**Dieter De Lathauwer,** Ministry of Health and Environment, Belgium
**Jan Jaap de Roo,** Eastman Chemical, Netherlands
**Silke De Smet,** Flemish Government, Belgien
**Malgorzata Debiak,** German Environment Agency (UBA)
**Katharina Deering,** Institute and Outpatient Clinic for Occupational, Social and Environmental Medicine, Clinical Centre of the Ludwig Maximilian University Munich, Germany
**Steven Dörr,** Verband der Deutschen Holzwerkstoffindustrie e.V. (VHI), Germany
**Ulrike Doyle,** German Environment Agency (UBA), Germany
**Kerstin Etzenbach-Effers,** Verbraucherzentrale Nordrhein-Westfalen, Germany
**Morgane Even,** German Federal Institute for Risk Assessment (BfR), Germany
**Jim Fanning,** Health & Safety Authority, Ireland
**Thomas Göen,** University of Erlangen-Nuremberg, Germany
**Marco Gola,** Politecnico di Milano, Italy
**Katrin Groth,** German Environment Agency (UBA), Germany
**Elisabeth Habla,** Holzforschung Austria - Austrian Forest Products Research Society, Austria
**Jörn Hameister,** Landesamt für Gesundheit und Soziales M-V, Germany
**Joachim Hasch,** SWISS KRONO Tec AG, Switzerland
**Wolfgang Heger,** Germany
**Astrid Heiland,** German Federal Institute for Risk Assessment (BfR), Germany
**José Alberto Herrera-Melián,** University of Las Palmas de Gran Canaria, Spain
**Hans-Ulrich Hill,** Germany
**Olaf Holtkötter,** Henkel AG & Co KGaA, Germany
**Wolfgang Horn,** BAM Bundesanstalt für Materialforschung und -prüfung, Germany
**Julia Hurraß,** Gesundheitsamt Köln, Germany
**Outi Ilvonen,** German Environment Agency (UBA), Germany
**Helena Järnström,** VTT Expert Services, Finland
**Wolfgang Kahlen,** Berger-Seidle, Germany
**Jörg Kaschubowski,** Bundesamt für Strahlenschutz (BfS), Germany
**Eva Kaspar,** Scientific free lancer, Germany
**Violeta Kauneliene,** Kaunas University of Technology, Lithuania
**Anika Krause,** University of Cambridge, United Kingdom

**Carmen Kroczek,** anbus analytik GmbH, Germany
**Jens Küllmer,** Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), Germany
**Annelise Larsen,** IKEA of Sweden AB, Sweden
**Anja Leetz,** Be Well International, Germany
**Paul Lloyd,** S C Johnson, United Kingdom
**Astrid Lusch,** Deutsches Institut für Bautechnik (DIBt), Germany
**Joana Madureira,** Institute of Public Health, University of Porto, Portugal
**Brendan Mahon,** Department for Environment Food & Rural Affairs, United Kingdom
**Elida Mataj,** Institute of Public Health, Albania
**Judith Meierrose,** German Environment Agency (UBA), Germany
**Christian Meyer,** IDT Europe GmbH, Germany
**Georg Meyers,** Umweltanalytischer Dienst - Meyers, Germany
**Wolfgang Misch,** Private expert indoor air hygiene and building chemistry (former DIBt), Germany
**Iukova Nataliya,** Republican Scientific and Practical Center for Medical Technologies, Information, Administration and Management of Health (RSPC MT), Belarus
**Ralf Nehring,** Ministerium für Umwelt, Energie, Ernährung und Forsten, Rheinland-Pfalz, Germany
**Friederike Neisel,** German Federal Institute for Risk Assessment (BfR), Germany
**Thomas Neuhaus,** Eurofins, Denmark
**Anne Nicolas,** TOXILABO, France
**Niss Skov Nielsen,** Aalborg University, Copenhagen, Denmark
**Tatiana Novikova,** Belarusian State Medical University, Belarus
**Martin Ohlmeyer,** Johann Heinrich von Thünen Institute Federal Research Institute for Rural Areas, Forestry and Fisheries, Germany
**Peter Ohnsorge,** European Academy for Environmental Medicine, Germany
**Salko Olga,** Republican Center for Medical Rehabilitation and Balneotherapy, Belarus
**Murnira Othman,** Universiti Kebangsaan Malaysia, Malaysia
**Heike Papavlassopoulos,** Department of Environmental Health Protection, State Agency for Social Services Schleswig-Holstein, Germany
**Antonio Maria Pasciuto,** Assimas, Italy
**Santiago Perandones Marrero,** Canarian goverment, Portugal
**Dulce Perez Ferrandez,** Procter & Gamble, Belgium
**Simone Peters,** Institut für Arbeitsschutz der DGUV (IFA), Germany
**Hans-Georg Pirkl,** Covestro Deutschland AG, Germany
**Dietrich Plaß,** German Environment Agency (UBA), Germany
**Volker Plegge,** Tauw GmbH, Germany
**Tippawan Prapamontol,** Research Institute for Health Sciences (RIHES), Chiang Mai University, Thailand
**Katja Pulkkinen,** Homepakolaiset ry (Finnish Indoor-Air Patients' Association), Finland
**Laia Quiros Pesudo,** European Commission, Belgium
**Tanja Rademann,** Drägerwerk AG & Co. KGaA, Germany
**Fabian Rasch,** Bundesanstalt für Materialforschung und -prüfung (BAM), Germany
**Julia Rehling,** German Environment Agency (UBA), Germany
**Rolf Rheinschmidt,** Rhine-Waal University of Applied Sciences, Germany
**Matthias Richter,** Bundesanstalt für Materialforschung und -prüfung (BAM), Germany
**Sylva Rödlová,** Third Faculty of Medicine, Charles University, Prague, Czech Republic
**Claudia Röhl,** State Agency for Social Services Schleswig-Holstein, Germany
**Dieter Rosen,** Bundesverband der Deutschen Ziegelindustrie e.V., Germany
**Evelyn Roßkamp,** Verband der Chemischen Industrie e. V., Germany
**Anniina Salmela,** The National Institute for Health and Welfare (THL), Finland
**Irene Scheler,** Ministry for Environment North Rhine-Westfalia, Germany
**Renate Scheunemann,** Gesundheitsamt der Stadt Nürnberg, Germany

**Jan Henrik Schlattjan,** Hessisches Landesprüfungs- und Untersuchungsamt im Gesundheitswesen, Germany
**Maria Schmied-Tobies,** German Environment Agency (UBA), Germany
**Anne Christine Schoon,** Freie Universität Berlin, Germany
**Karl-Werner Schramm,** Helmholtz Zentrum München, Germany
**Katrin Schröder,** Behörde für Gesundheit und Verbraucherschutz, Germany
**Michael Schümann,** HBM-Kommission, Germany
**Gaetano Settimo,** Istituto Superiore di Sanità, Italy
**Ashok Shrestha,** Children's Shade, Nepal
**Madhuri Singal,** Reckitt Benckiser, LLC, United States of America
**Martin Spleiß,** PCI Augsburg GmbH, Germany
**Thomas Stingl,** Covestro Deutschland AG, Germany
**Anemon Strohmeyer,** VHI e.V., Germany
**Holger Struwe,** TÜV SÜD Industrie Service GmbH, Germany
**Kirsten Sucker,** Institute for Prevention and Occupational Medicine of the German Social Accident Insurance, Institute of the Ruhr-Universität Bochum (IPA), Germany
**Katrin Süring,** German Environment Agency (UBA), Germany
**Tamás Szigeti,** National Public Health Institute, Hungary
**Gunnar Thielecke,** SWISS KRONO Tec AG, Switzerland
**Cornelia Tietz,** European Solvents Industry Group - a Cefic Sector Group, Belgium
**Verena Tykiel,** Deutsches Institut für Bautechnik (DIBt), Germany
**Erik Uhde,** Fraunhofer Wilhelm-Klauditz-Institut (WKI), Germany
**Kulinkina Valiantsina,** Republican Scientific and Practical Center for Medical Technologies, Information, Administration and Management of Health (RSPC MT), Belarus
**Brigitte van Eymeren,** Verlagsgesellschaft Rudolf Müller GmbH & Co. KG, Germany
**Roger Waeber,** Federal Office of Public Health FOPH, Switzerland
**Norbert Weis,** Bremer Umweltinstitut GmbH, Germany
**Michael Wensing,** Fraunhofer Wilhelm-Klauditz-Institut (WKI), Germany
**Barbara Werschkun,** Wissenschaftsbüro Berlin, Germany
**Karin Wichterey,** Federal Office for Radiation Protection, Germany
**Martin Wieske,** WirtschaftsVereinigung Metalle, Germany
**Klaus Winkels,** GEV, Germany
**Jutta Witten,** Hessisches Ministerium für Soziales und Gesundheit, Germany
**Duangkamol Yenying Dietrich,** Bundesanstalt für Materialforschung und -prüfung (BAM), Germany
**Irina Zastenskaya,** World Health Organization, Regional Office for Europe, Germany
**Jiangyue Zhao,** Leibniz Institute for Tropospheric Research (TROPOS), Germany

# Organizing committee/

# Scientific Committee for poster exhibition

**Organizing committee:**

**Ana Maria Scutaru,** German Environment Agency (UBA), Germany
**Malgorzata Debiak,** German Environment Agency (UBA)
**Marike Kolossa-Gehring,** German Environment Agency (UBA), Germany
**Wolfram Birmili,** Germany Environment Agency (UBA), Germany

**Scientific Committee for poster exhibition:**
**Ana Maria Scutaru,** German Environment Agency (UBA), Germany
**Malgorzata Debiak,** German Environment Agency (UBA)
**Otto Hänninen,** National Institute for Health and Welfare, Finland
**Peder Wolkoff,** The National Research Centre for the Working Environment, Denmark
**Thomas Witterseh,** Danish Technological Institute, Denmark

as of August 31, 2018

**Organizers and publisher:**
Federal Ministry of the Environment,
Nature Conservation, Building and Nuclear Safety
Robert-Schumann-Platz 3, 53175 Bonn, Germany
**www.bmu.de**

German Environment Agency
Wörlitzer Platz 1, 06813 Dessau-Roßlau, Germany
**www.umweltbundesamt.de**

**Design:**
Media Company – Agentur für Kommunikation GmbH
Wilhelmine-Gemberg-Weg 6
10179 Berlin

**Venue:**
Umweltforum
Pufendorfstraße 11
10249 Berlin, Germany

www.umweltbundesamt.de/en/indoor-air-toxicology-start