# 2nd EnVIE Workshop

# "Impact of Indoor Air Quality on Health"

**5-6 March 2008, Brussels**

## EUROPEAN COLLABORATIVE ACTION
## on
## "*Urban Air, Indoor Environment & Human Exposure*"

Overview of past, current and future activities

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# What ECA "*Urban Air, Indoor Environment and Human Exposure*" is?

**For more than 22 years, ECA is a widely accepted scientific network at EU level for:**

## BALANCING SENSES and CREATING CONSENSUS

**in the inter- and multidisciplinary research area of urban air, indoor environment and human exposure health in EU and worldwide covering practical and scientific aspects that range from technical (chemical, physical, biological) to medical research disciplines.**

# This is achieved by:

- preparing reports that summarize available knowledge of important issues in the research fields of urban air, indoor environment and human exposure and health
- identifying ongoing research within the participating countries and the major research needs to fill in gaps in existing knowledge
- establishing working groups for well defined tasks such as the development and/or validation of guidelines and reference methods for indoor human exposure related investigations and measurements or for measures to improve the quality of indoor environments and protecting human health.
- providing a forum to help the exchange centrally of information and collaboration with other national and international organizations and policy-making bodies active in the aforementioned field (e.g. EC DG Services, WHO, NATO/CCMS, U.S. EPA, EEA).

## Specific examples of the working areas of ECA are:

- the relative importance of outdoor and indoor sources of pollution
- the building-related interaction between outdoor urban air and indoor air
- exposure to pollutants from the different urban outdoor and indoor sources and its relation to health and comfort,
- validation and harmonisation of methodologies and models for assessing human exposure to, and health impact of, environmental stressors of high public concern.

**Integration** **Co-ordination** **Reference**

The overall scientific area of concern can be splitted into six areas of special focus:

(a) *exposure measurements*,
(b) *health effects*,
(c) *buildings science and design*,
(d) *exposure modelling*,
(e) *indoor air quality control and*
(f) *exposure risk assessment and management*

There is an increasing demand for better integrating these activities at European level to design and achieve effective urban air quality management and to minimise human exposure to harmful pollutants. Established 22 years ago, the ECA Network activities cover all the above topics, through its multidisciplinary character, offering a unique opportunity for further integrating these research activities mainly at European level.

**Integration** **Co-ordination** **Reference**

The ECA Steering Committee (coordinated and managed by the JRC/IHCP/PCE Unit) consists of 33 distinguished scientists from 15 EU countries States (plus Norway and Switzerland), WHO and the European Commission. During the 22 years of its operation more than 120 scientists of leading European Institutions have contributed to its activities through their participation in various WGs, prepared and delivered 26 state-of-the-art reports which have been distributed to more than 2000 addresses in Europe and worldwide.

Specific actions include preparation and contribution to the execution of joint scientific projects (e.g. VOCEM, INDEX, EnVIE), guideline documents, performance of Inter-laboratory comparison exercises, organisation of workshops and training courses.

The ECA has helped the activities in the field of indoor air pollution and human exposure and health to achieve a good level of coordination at EU level which is expected to be further enhanced through the DG RTD funded EnVIE co-ordination Network on "Indoor Air Quality and Health Effects" created under FP6 (DG RTD project no. SSPE-CT-2004-502671). The core group of this 3-years project is composed from ECA steering group members.

**Integration Co-ordination Reference**

Through its activities in the field of indoor human exposure and health, the ECA Network (coordinated and managed by the JRC/IHCP/PCE Unit):

(a) provides scientific and technical reference for policy making in the EC,
(b) contributes to the integration of research efforts in Europe,
(c) ensures capacity building, knowledge dissemination and sharing in EU Member States, the Accession Countries and beyond (for example: in 2001, China set up guidelines concerning formaldehyde emissions from wood based materials on the basis of the ECA Reports).

# Index of ECA reports published so far (1/2)

1. Radon in indoor air. EUR 11917 EN, 1988.*
2. Formaldehyde emission from wood-based materials: guideline for the determination of steady state concentrations in test chambers. EUR 12196 EN, 1989. *
3. Indoor pollution by NO2 in European countries. EUR 12219 EN, 1989.
4. Sick building syndrome - a practical guide. EUR 12294 EN, 1989.
6. Strategy for sampling chemical substances in indoor air. EUR 12617 EN, 1989.
7. Indoor air pollution by formaldehyde in European countries. EUR 13216 EN, 1990. *
8. Guideline for the characterization of volatile organic compounds emitted from indoor materials and products using small test chambers. EUR 13593 EN, 1991.
10. Effects of indoor air pollution on human health. EUR 14086 EN, 1991.
11. Guidelines for ventilation requirements in buildings. EUR 14449 EN, 1992.
12. Biological particles in indoor environments. EUR 14988 EN, 1993.
13. Determination of VOCs emitted from indoor materials and products. Interlaboratory comparison of small chamber measurements. EUR 15054 EN, 1993.
14. Sampling strategies for volatile organic compounds (VOCs) in indoor air. EUR 16051 EN, 1994.
15. Radon in indoor air. EUR 16123 EN, 1995.
16. Determination of VOCs emitted from indoor materials and products: Second inter-laboratory comparison of small chamber measurements. EUR 16284 EN, 1995.
17. Indoor air quality and the use of energy in buildings. EUR 16367 EN, 1996.

# Index of ECA reports published so far (2/2)

18. Evaluation of VOC emissions from building products – solid flooring materials. EUR 17334 EN, 1997
19. Total Volatile Organic Compounds (TVOC) in indoor air quality investigations. EUR 17675 EN, 1997
20. Sensory evaluation of indoor air quality. EUR 18676 EN, 1999.
21. European Interlaboratory Comparison on VOCs emitted from building materials and products. EUR 18698/EN, 1999.
22. Risk assessment in relation to indoor air quality. EUR 19529 EN, 2000.
23. Ventilation, good indoor air quality and rational use of energy. EUR 20741 EN, 2003
24. **Harmonisation of indoor material emissions labelling systems in the EU: Inventory of existing schemes. EUR 21891 EN, 2005.**
25. **Strategies to determine and control the contributions of indoor air pollution to total inhalation exposure (STRATEX). EUR 22503 EN, 2006.**
26. **Impact of Ozone-initiated Terpene Chemistry on Indoor Air Quality and Human Health. EUR 23052 EN, 2007. (*in print*)**

* out of print

http://web.jrc.ec.europa.eu/pce/pce-sa-expotools07-eca.html


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EUROPEAN COLLABORATIVE ACTION
on
"Urban Air, Indoor Environment and Human Exposure"

ECA REPORTS

All the reports that have been published are available here in pdf format. They can be opened from the menu on the left and also from the list below which provides the title and an abstract of each report. (each report opens in a new window)

Report Nr. 1 (799.9 KB) **Radon in indoor air (EUR 11917 EN 1988)**

Considering the likelihood of contributions of various indoor air pollutants to detrimental health effects, the Community-COST Concertation Committee of the Concerted Action "Indoor Air Quality and its Impact on Man" (COST Project 61 3) decided that indoor radon is a well studied indoor pollutant both in terms of occurring concentrations and expected adverse health effects. In July 1985 the Article 31 Euratom Treaty Group of Experts set up a Working Party to study and report on this matter. Their investigations were published in May 1987 as the report "Exposure to Natural Radiation in Dwellings of the European Communities". The following text is largely based on the above report but also includes other recent evaluations of this problem. The Community-COST Concertation Committee by publishing this text would like to provide further support to the work of the General Directorate XI (Environment, Consumer Protection and Nuclear Safety) in this matter and offer it to the Commission of the European Communities for its consideration.

Report Nr. 2 (993.9 KB) **Formaldehyde emission from wood-based materials: guideline for the determination of steady state concentrations in test chambers (EUR 12196 EN 1989)**

This guideline has been prepared by a working group of the concerted action "Indoor Air Quality and Its Impact on Man" (COST project 613) and describes a method for the determination of formaldehyde emissions from wood based materials using large scale, walk-in type environmental chambers. The guideline describes essential features of the chambers to be used, such as size, inner wall and sealing materials, tightness, air circulation and position of sensors for temperature and humidity. Moreover, values for temperature, relative humidity, air exchange rate, loading factor and air velocity in the chamber are recommended. The guideline also deals with sample preparation and positioning in the chamber, and with formaldehyde sampling and analysis In addition questions of quality control are discussed.

Report Nr. 3 (1.31 MB) **Indoor pollution by $NO_2$ in European countries (EUR 12219 EN 1989)**

The report summarizes information on indoor pollution by nitrogen dioxide (NO2) In European countries participating in the concerted action "Indoor Air Quality and Its Impact on Man" (COST project 61 3). Major scope of the report IS to give concise information to people involved In research planning, policy making and regulatory activities and to help to identify a European view of the issue. The summary includes a short review of health effects of NO2 and of existing

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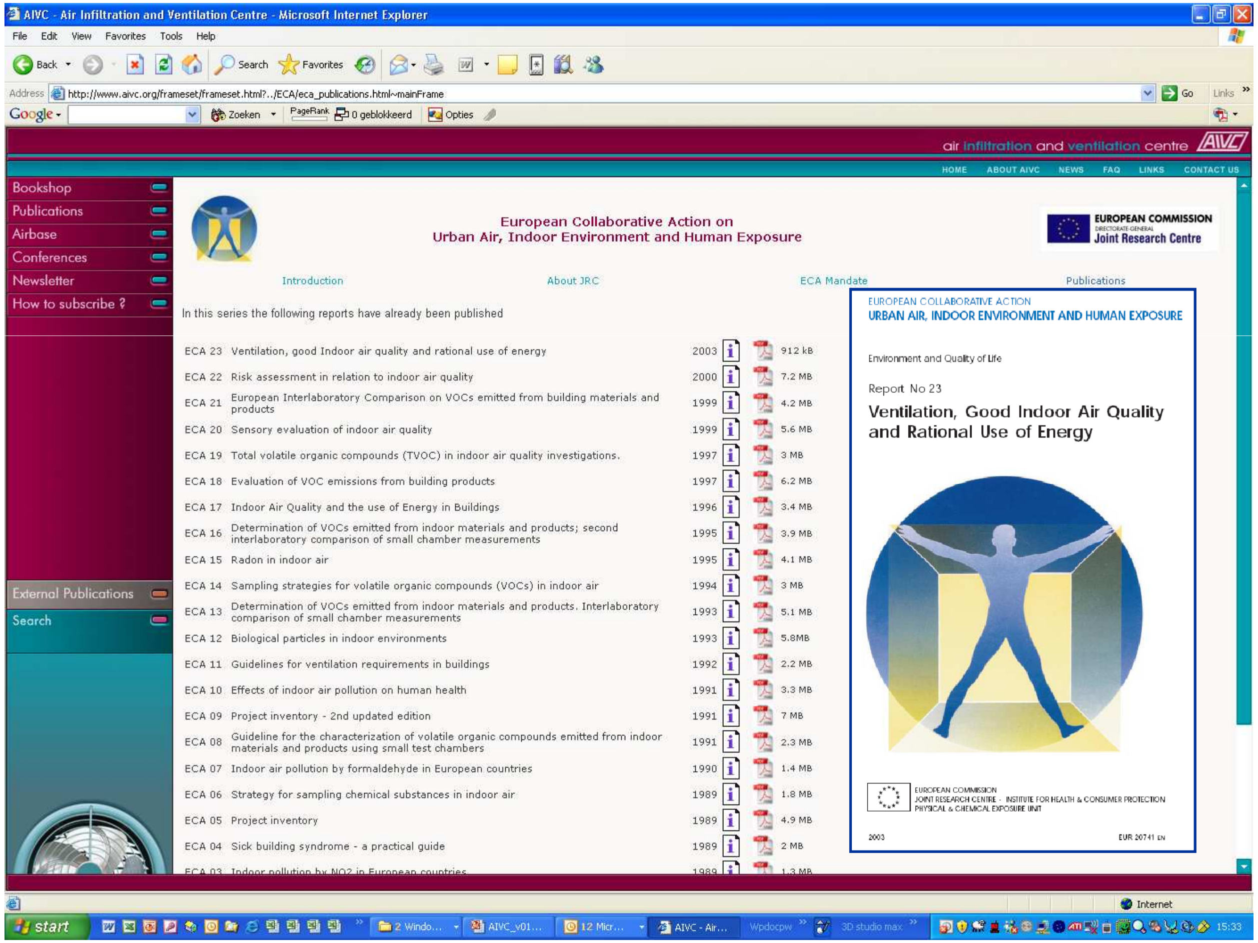

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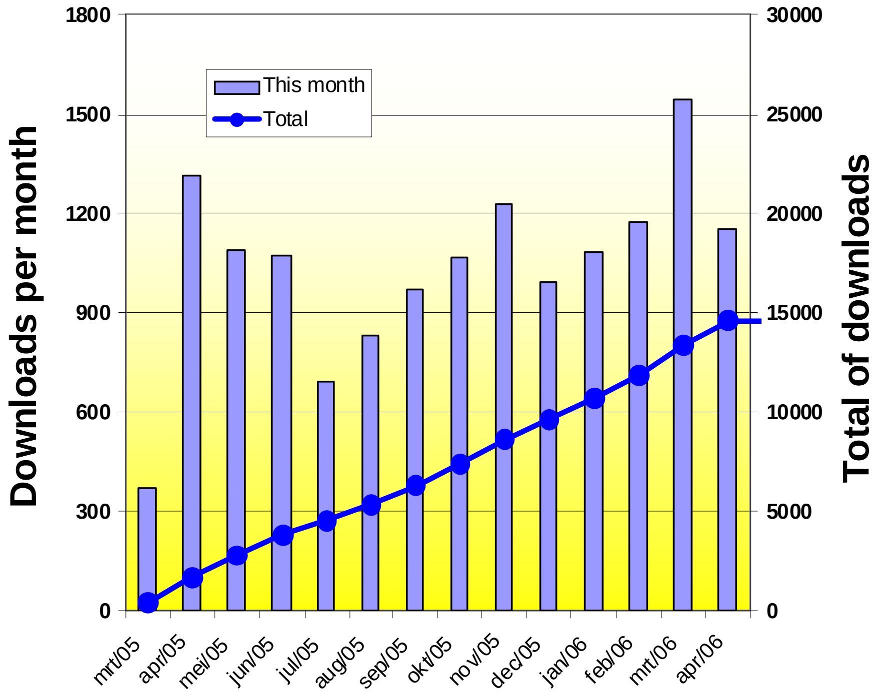


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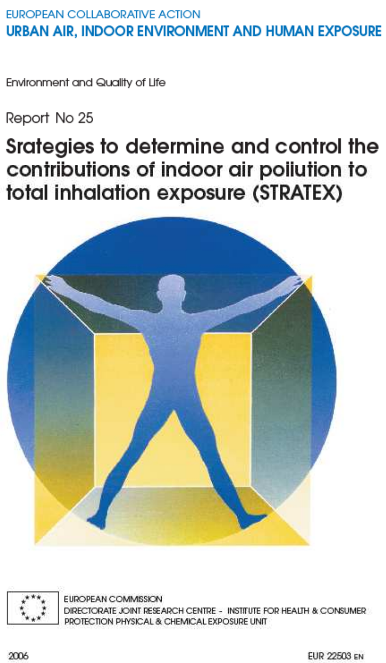
# ECA Report no. 25 (STRATEX)

ECA STRATEX offers a framework concerning strategies to determine and control the contributions of indoor air pollution to total inhalation exposure


EUROPEAN COLLABORATIVE ACTION
URBAN AIR, INDOOR ENVIRONMENT AND HUMAN EXPOSURE

Environment and Quality of Life

Report No 25

**Srategies to determine and control the contributions of indoor air pollution to total inhalation exposure (STRATEX)**

EUROPEAN COMMISSION
DIRECTORATE JOINT RESEARCH CENTRE - INSTITUTE FOR HEALTH & CONSUMER PROTECTION PHYSICAL & CHEMICAL EXPOSURE UNIT

2006 EUR 22503 EN

# ECA STRATEX structure

1. **Introduction**

2. **Determinants of Indoor Air Quality and Exposure**
   - 2.1 Indoor pollution sources
   - 2.2 The physical indoor climate and its interaction with IAQ
   - 2.3 Factors determining occupant exposure to indoor air pollutants (sources, sinks, dynamics of IAQ and ventilation)
   - 2.4 Time-microenvironment-activity, behaviour

3. **Determination of Exposure: Strategies and Techniques**
   - 3.1 General principles for exposure assessment
   - 3.2 Exposure to what
   - 3.3 Rapid assessment methods (Risk Management)
     - *3.3.1 Ambient air quality*
     - *3.3.2 Questionnaires*
     - *3.3.3 Source inventories*
     - *3.3.4 Intake fractions*
   - 3.4 Exposure microenvironment monitoring and modeling

# ECA STRATEX structure

## 3. Determination of Exposure: Strategies and Techniques

3.5 Source apportionment
3.6 Risk Management
3.7 Framework for exposure control strategies
*3.7.1 Whole population approach*
*3.7.2 Specific approaches*
3.8 Uncertainties

## 4. Conclusions

## 5. Recommendations

## 6. Annexes

Examples of exposure determination and control strategies

*Annex I. Fine Particulate Matter in Indoor Air*
*Annex II. Formaldehyde in Indoor Air*
*Annex III. Ozone in Indoor Air*

# Conclusions (1/3)

1. There are an enormous number and diversity of indoor air pollutants. There is a need to identify a short list of pollutants that could be taken as priority substances to be traced and quantified either for their own indoor related public health relevance or as indicators of other potential pollution.

2. For new building products VOC emissions tend to decrease. One reason is that VOC in many products have been substituted with SVOC. Consequently, there is an increasing trend of SVOC concentrations in indoor air. However, there is a need for more toxicity information for many such SVOCs.

3. In many cases the products of the chemical reactions occurring in indoor air are stronger irritants than their precursors. Interactions between other reactive air pollutants are expected to be frequently occurring but little general information is available.

# Conclusions (2/3)

4. At the commissioning phase of a building, adhesives, paints and solvents etc., present in many fittings, may not be adequately cured or stabilised and thus are likely to produce larger emissions of organic pollutants initially than at a later time.There are no generally accepted procedures for the commissioning or curing period.

5. Models have been developed that take into account factors such as emission from sources, subsequent diffusion, adsorption/desorption, dilution and removal by ventilation, transport and spreading of pollutants from the sources to the exposure of the occupants. Such models are essential for the development of indoor exposure and risk assessment. No comprehensive and general model, however, has yet emerged.

# Conclusions (3/3)

6. To efficiently reduce health risks from indoor air pollution, air quality management should be based on health concerns and exposure assessments for individual substances, accounting for indoor air quality, but also all other microenvironments and exposure relevant activities.

7. Exposure based and the current ambient-based air quality management strategies are built upon similar principles. For the exposure-based assessment, however, additional information needs to be incorporated, particularly concerning the indoor microenvironments and individual activities

8. The uncertainties, which are most relevant for exposure based indoor air quality assessment and management, relate to the pollutants of health concern, and the vulnerable target populations. The measurement (sampling and analysis) or modelling uncertainties are usually much smaller in comparison.

# Recommendations (1/3)

1. The common ventilation dilution model should be developed into a dynamic equilibrium model, which takes into account the effects of:

   - Transport of pollutants by air movements and removal of pollutants through dilution,
   - Removal of pollutants through filtration, absorption or deposition,
   - Adsorption into and re-emission of pollutants from sinks,
   - Chemical or biological transformations of pollutants in the air or in the sinks, including reactions.

2. The labelling schemes of construction products that are aimed at promoting the use of cleaner materials, should consider including SVOCs in addition to the VOCs, which may interfere with human health or well-being.

3. A labelling scheme for construction products should be implemented in all countries of EU. Such scheme should encompass all types of building materials.

# Recommendations (2/3)

4. **An overall policy strategy for indoor air quality management should be part of an integrated sustainable development strategy including public health; it should be combined with decision models and cost effectiveness analyses. It should be pro-active and include systematic preparation and dissemination of information and recommendations for the general public.**

5. An efficient exposure based air quality strategy focusing on the contribution of indoor air quality to the total inhalation exposure must be a balanced combination of sectorial strategies, so that it simultaneously requires the minimising of:

   - harmful exposures (from both outdoor and indoor sources),
   - health risks (exposures of the most vulnerable),
   - overall costs (of investment and operation, to individuals, organisations and the society),
   - loads on the environment (energy, materials, sustainability),
   - unhelpful restrictions to building materials, furnishings and technologies, and
   - non-productive restrictions to the activities of individuals and organisations.

Clearly, these six requirements are not commensurate, and not simple to fulfill.

# Recommendations (3/3)

6. An essential element of an appropriate risk management strategy is reduction of the uncertainties. It is recommended such reduction to be achieved by:

- targeted research concerning exposures to and health effects of harmful substances in indoor air,
- **improved study designs with emphasis on:**

  **(i) representativeness of the acquired samples,**
  **(ii) appropriateness of the analysed compounds,**
  **(iii) minimizing of the measurement errors (sampling and analysis), and**
  **(iv) statistical power analyses to ensure attribution of the health effects to substances at exposure as well as the exposures to their sources, and**

- correct identification and characterization of the vulnerable population groups through targeted meta-analyses of studies concerning these groups.

# STATEMENT

**The strategies to determine and control the contributions of indoor air pollution to total inhalation exposure as they described in the ECA STRATEX Report should be considered as a framework. This framework may have to be adapted to specific situations by policy makers, risk assessors and risk managers.**

# ECA Report no. 26 on "*Impact of Ozone-initiated Terpene Chemistry on Indoor Air Quality and Human Health*"

EUROPEAN COLLABORATIVE ACTION

URBAN AIR, INDOOR ENVIRONMENT AND HUMAN EXPOSURE

Environment and Quality of Life

Report No 26

**Impact of Ozone-initiated Terpene Chemistry on Indoor Air Quality and Human Health**

EUROPEAN COMMISSION
JOINT RESEARCH CENTRE
Institute for Health and Consumer Protection
Physical and Chemical Exposure Unit

2007 EUR 23052 EN

# Why?

DG SANCO SCHER opinion report on "Risk assessment on Indoor Air Quality" concludes:

- "*Consumer products, one source of chemicals in indoor environment, emit mostly volatile organic compounds. Lack of data on true exposure for emissions in consumer products has hampered evaluation of the associations with possible health effects most of which are also caused by other factors. The recent data suggest that some of the emitted products may react further in air and on surfaces producing secondary products, including fine and ultrafine particles. The health effects of those reaction products are poorly known*".

and recommends:

- ***Data requirements and gaps in knowledge related primarily to health effects of Indoor air pollutants:***

  *Need for more research:*

  - ✓ *"Effects and risks of products which emit indoor air pollutants that can react in indoor air (+). This is, for example, the case with terpenes that can react with ozone. The true role of such reaction products as indoor air pollutants is not clear"*

# Conclusions

- Certain use of of consumer products can result in abundant concentrations of terpenes.

- The chemistry of indoor air is dominated by ozone reactions with terpenes, reactions that can produce radicals, highly reactive intermediates (e.g., radicals), secondary ozonides, hydroperoxides, carbonyl compounds and also fine particles in the sub-micron range. An important product of such reactions is the OH radical, which can proceed to initiate further oxidation processes. Indeed, many of the reaction rates indoors have been predicted to be of a similar order of magnitude to outdoors and sometimes even larger.

- There is neither adequate knowledge of exposure patterns of ozone-terpene reaction products, nor dose/response relationships. There are toxicologically relevant compounds formed in ozone terpene reactions that are not identified. These compounds (e.g. radicals) are potentially responsible for observed health effects (e.g., sensory irritation, lung injuries, etc).

# Recommendations (1/2)

1. In this report our knowledge of ozone-terpene chemistry to date was summarised, although there are still significant gaps. In addition, many of the issues are exceedingly complex, both chemically and physically. It is increasingly recognised that secondary products are the cause of the ill-health effects observed indoors, however, the actual culprits have yet to be fully identified. Further, model predictions of OH and NO3 radical concentrations indoors have yet to be verified through experimental observation. Ideally, many of these gaps in our knowledge could be addressed by organising indoor air 'field campaigns' similar to those commonly performed outdoors. One would envisage that indoor measurements could be made *simultaneously* of the concentrations of radicals, ozone, NOX, VOCs (particularly the reactive compounds such as the terpenes), HONO, aldehydes including HCHO, as well as aerosol size, number and composition, photolysis rates, temperature and humidity *etc.*, in order to validate models and to identify compounds that may be deleterious to health.

2. Considering the long-term and integrated impact of material/product oxidation on exposure of indoor air, it is prudent to develop methodologies for emission testing of construction materials and consumer products (in particular spray products) under oxidative and realistic conditions for future standardization.

# Recommendations (2/2)

3. The ozone and formaldehyde concentrations should be measured in micro-environments suspected to have strong sources of terpenes due to product usage or personal activities.

4. Analytical methods to measure potentially toxicologically relevant compounds e.g. radicals should be further developed for practical use.

5. New metrics/proxies that are health relevant should be identified and developed, both with regard to acute/semi-acute effects and longer-term effects.

6. Risk characterization of the mixed terpene-ozone system calls for more toxicological knowledge:

   - Acute and longer-term exposure effects to eyes and upper and lower airways.
   - Evaluation and assessment of selected consumer products, in particular spray products, in presence of ozone by bioassays and full scale studies under realistic conditions.

# What's next?

- New ECA WG 27 on ***"Health Risks from Indoor PM"*** to be established in June 2008 aimed at summarising the current state-of-the-art concerning exposure to PM indoors and associated health effects and to prioritise research goals for the future.

  This activity is expected to provide with a direct input to the forthcoming "IAQ guidelines for PM" project of WHO to performed in collaboration with JRC and DG SANCO.

Why?

DG SANCO SCHER opinion report on "Risk assessment on Indoor Air Quality" concludes:

*"At the moment, there is an increasing concern about the smaller particles (PM2.5 and less) in outdoor air. However, as pointed out somewhere in the report, indoor particles are often larger. Although there is a shift of interest towards smaller particles in outdoor air, also $PM_5$ and $PM_{10}$ should be studied in indoor air. So far, there are too few studies but we know that the composition of indoor and outdoor PM differs within the different classes of size. Furthermore, the new technology of man-made nanoparticles should be followed very closely"*

VITO report on "Ranking of Indoor Air Health problems using health impact assessment" under 'Gaps and uncertainties':

"Particles – house dust !
–Excellent risk assessment in INDEX should continue"

- Candidate ECA WG 28 on "Sustainable Buildings and Indoor Air Quality" (2009?)

Why?

Recommendations of ECA STRATEX, VITO, Healthy Air………EnVIE discussions

- Continue working together with CEN WG TC351 and DG ENTR to validate standards and harmonize the indoor material emissions labelling schemes in EU in collaboration with major existing labelling schemes in EU (i.e., AgBB, ICL, M1).

Why?

Recommendations of DG SANCO SCHER and IAQ experts group, VITO, Healthy Air, LEnSE (A European Label for Sustainable Buildings)…………EnVIE discussions

- Continue the close collaboration with DG SANCO, DG ENV, DG ENTR, DG TREN, DG RTD, WHO, ENVIE, VITO and as many other relevant stakeholders and European projects are needed to create a robust framework for IAQ and setting up Indoor Air Health Priorities for EU!

Why?

Isn't this the reason why we are all together here under EnVIE?!!!