

# Health Risks from Indoor Pollutants

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AGC Meeting, London, December 12-14, 2007

## Health Risks from Indoor Air Pollutants

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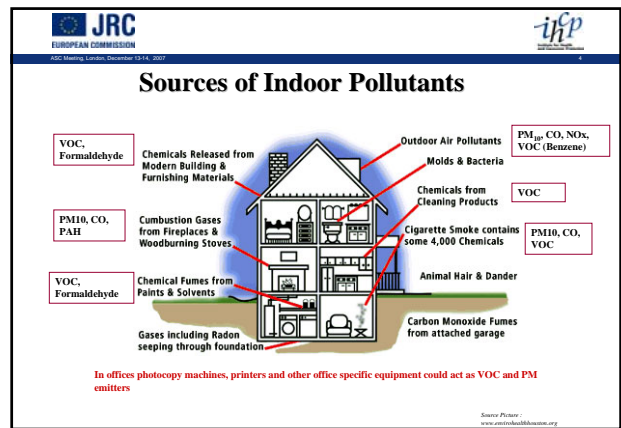
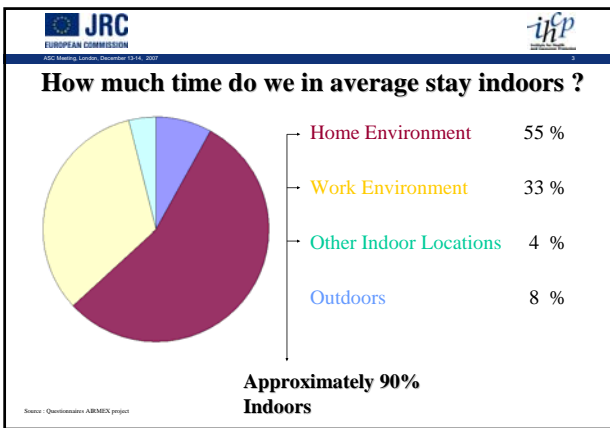
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## Outline

- The Indoor Environment
- Indoor Sources
- Indoor air contaminants
- Indoor air concentrations
- Health relevance/effects
- Concluding remarks



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## Which chemicals/biological materials are significant for Indoor Air Quality ?

**Gaseous inorganic Compounds**  
CO<sub>2</sub>, CO, Nitrogen Oxides, SO<sub>2</sub>, Ammonia

**Volatile Organic Compounds (VOC)**

**Particulate Matter and compounds bound to PM (SVOC)**  
Asbestos, PM<sub>10</sub>, PM<sub>2.5</sub>, PM<sub>1</sub>, Ultrafine Particles, PAH, Pesticides, Flame Retardants

**Radioactive Compounds**  
Radon

**Biological Contaminants**  
Substances produced by moulds, allergens, endotoxins

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## Questions to be answered

- Do we expect any health risks from exposure to these pollutants?
- Is there enough information justifying our concerns?
- What is the basis for the definition of risk?
  - Exposure to a single chemical?
  - Exposure to a mixture of chemicals?
  - At which concentration levels?
  - Duration of the exposure?



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**Benzene/AIRMEX**

28% of the outdoor concentrations,  
30% of the indoor concentrations,  
and 40.5% of the personal exposure  
concentrations measured exceeded the limit value of 5 µg/m<sup>3</sup>.

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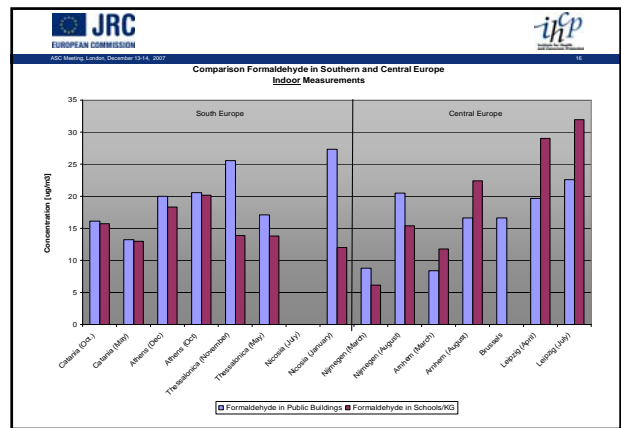
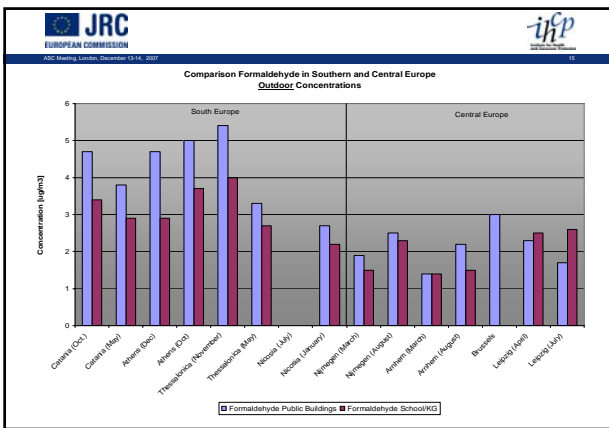
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**Typical indoor air levels/AIRMEX study**

Total Carbonyl Max. Expos. Conc. 126 µg/m<sup>3</sup>  
Total Carbonyl Max. Indoor Conc. 245 µg/m<sup>3</sup>  
Total Carbonyl Max. Outdoor Conc. 14 µg/m<sup>3</sup>

Formaldehyde max. personal exposure conc. 30 µg/m<sup>3</sup>  
(approx. 23% of total carbonyl personal exposure)

Carbonyl= Form, Acet, Prop, Hex.



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**Health Relevance/Effects for VOCs and Carbonyl Compounds (1)**

Eye, nose, and throat irritation; headaches, loss of coordination, nausea; damage to liver, kidney, and central nervous system.  
Some organic compounds are known to cause cancer in animals; some are suspected of causing, or are known to cause, cancer in humans.  
**Guidelines for VOCs: No harmonized, varying between 300 and 500 µg/m<sup>3</sup>**

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**Health relevance/effects (2)**

- Domestic exposure to VOCs at levels below currently accepted recommendations may increase the risk for childhood asthma (6 months-3 years)
- Children exposed to concentrations of VOCs of > 60 µg/m<sup>3</sup> (median level of exposure) had a fourfold increased risk of having asthma (Rumchev et al. (2007))


# Health Risks from Indoor Pollutants

**Formaldehyde (IARC Group 1)**

Formaldehyde is among the most important sensory irritants

At least 20% of the European population are exposed at levels exceeding the no-observed-effect-level (NOAEL:  $30 \mu\text{g}/\text{m}^3$ ). Within the concentration range measured, mild irritation of the eyes could be experienced by the general population as well as the odour perceived starting from about  $30 \mu\text{g}/\text{m}^3$ . HCHO could cause asthma like symptoms at a mean concentration of  $29 \mu\text{g}/\text{m}^3$ .

Reported formaldehyde concentrations were lower ( $99^{\text{th}} < 150 \mu\text{g}/\text{m}^3$ ) than a presumed threshold for cytotoxic damage to the nasal mucosa and hence considered low enough to avoid any significant risk of upper respiratory tract cancer in humans.

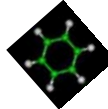


**Benzene identified as carcinogen for man (IARC Group 1)**

No safe level of exposure can be recommended

**Considering the WHO unit risk factor** People living in highly trafficked urban areas are expected, on average, to experience an estimated 6 to 30-fold increase in contracting benzene induced leukaemia during their life.

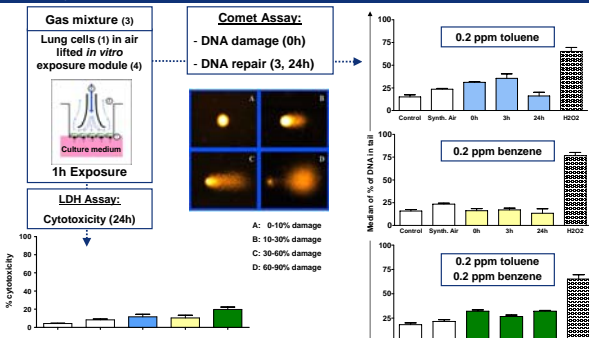
**LARS-Leipzig Allergy High Risk Study**-Styrene  $> 2 \mu\text{g}/\text{m}^3$  may lead to pulmonary infection/ benzene  $> 5.6 \mu\text{g}/\text{m}^3$  increased risk of airway infection in infants at 6 weeks age.



**Combined exposure to benzene/toluene**

Gas mixture (3)  
Lung cells (1) in air lifted in vitro exposure module (4)  
Culture medium  
1h Exposure  
LDH Assay: Cytotoxicity (24h)

**Comet Assay:**  
- DNA damage (0h)  
- DNA repair (3, 24h)



A: 0-10% damage  
B: 10-30% damage  
C: 30-60% damage  
D: 60-90% damage

% cytotoxicity

Control Synth. Air toluene benzene toluene/benzene

Median of % of DNA in tail

0.2 ppm toluene  
0.2 ppm benzene  
0.2 ppm toluene 0.2 ppm benzene

Control Synth. Air 0h 3h 24h H2O2

F. PARISELLI, M.G. SACCO, D. REMBGES – unpublished results -

**Chemical reactions:**

$\alpha$ -Pinene  $\xrightarrow{\text{O}_3}$  Pinonaldehyde

$\beta$ -Pinene  $\xrightarrow{\text{O}_3}$  Nopinone

Limonene  $\xrightarrow{\text{O}_3}$  Endolim

Linalool  $\xrightarrow{\text{O}_3}$  Lactol

Weschler et al., 2000; Wolkoff et al., 1997

**Concluding remarks**

- Environmental health effects: significant part of the total burden of disease- According to WHO 25-30% of this burden in developed countries can be attributed to environmental factors. *On the basis of the information available right now the contribution of bad indoor air quality to the total burden of disease cannot be quantified with a high degree of certainty.*
- Exposure to single compounds does not reflect real health risks. In future work the focus should be on *combined exposure to chemical mixtures (cocktail effect) and to chemicals and physical agents (e.g. noise).*
- Toxicological studies based on *chronic low dose exposure* would provide more in-depth information on possible long term effects of air contaminants at concentrations typical for indoor environments.
- European projects combining *epidemiological, chemical, biological studies* could provide the knowledge needed to assess the risk and evaluate the impact of indoor air pollutants on human health.