The WHO work on indoor environments

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http://www.euro.who.int/air - http://www.euro.who.int/housing
This presentation:

• Plan for development of WHO IAQ Guidelines
• Guidelines on IAQ – Dampness and Mould
• Developing IAQ guidelines on selected substances
• Other WHO work on indoor contaminants
Development of WHO Guidelines for Indoor Air Quality
Working Group Meeting, Bonn, 23-24 October 2006

38 participants
(14 countries, EC, WHO, IARC)


Co-chairs: M. Jantunen, HR Anderson
Rapporteur: Kwok Wai Tham
Three small groups

- Air pollutant specific guidelines
- Biological agents
- Combustion and other developing world issues

Tasks of the small groups

- Confirm the health relevance of the group of agents
- Recommend format of the guidelines
- Recommend actions to develop the guidelines (systematic review etc)
# Group A – Air pollutant specific guidelines

## Table 1. Specific compounds recommended for development of guidelines.

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Formaldehyde</td>
<td>2.1 Toluene</td>
</tr>
<tr>
<td>1.2 Benzene</td>
<td>2.2 Styrene</td>
</tr>
<tr>
<td>1.3 Naphthalene</td>
<td>2.3 Xylenes</td>
</tr>
<tr>
<td>1.4 Nitrogen dioxide (NO₂ )</td>
<td>2.4 Acetaldehyde</td>
</tr>
<tr>
<td>1.5 Carbon monoxide (CO)</td>
<td>2.6 Hexane</td>
</tr>
<tr>
<td>1.6 Radon</td>
<td>2.7 Nitric oxide (NO)</td>
</tr>
<tr>
<td>1.7 Fine particles (PM₂.₅)</td>
<td>2.8 Ozone (O₃)</td>
</tr>
<tr>
<td>1.8 Halogenated compounds (tetrachloroethylene, trichloroethylene)</td>
<td>2.9 Phthalates</td>
</tr>
<tr>
<td>1.9 PAH (BaP)</td>
<td>2.10 Biocides, Pesticides</td>
</tr>
<tr>
<td></td>
<td>2.11 Flame retardants</td>
</tr>
<tr>
<td></td>
<td>2.12 Glycol ethers</td>
</tr>
<tr>
<td></td>
<td>2.13 Asbestos</td>
</tr>
<tr>
<td></td>
<td>2.14 Carbon dioxide (CO₂)</td>
</tr>
<tr>
<td></td>
<td>2.15 Limonene and pinene</td>
</tr>
</tbody>
</table>

### Criteria of classification to group 1:
- ✔ Indoor sources
- ✔ Toxi / epi data available
- ✔ Indoor levels of health concern
Group B – Biological Agents

Identification and prioritization of factors

- Dampness and mould
- Ventilation
- Allergens
  - From house dust mites (HDM)
  - From pets

Guidance

- Qualitative identification of sources / exposure
- Technological solutions
Group C – Combustion of solid fuels

- **Stove Venting**
  - Flues; Hoods

- **Household ventilation**
  - Natural / Forced

- **Combustion quality**
  - Stove types
  - Burning temperature
  - Air / fuel ratio
  - Fuel consumption

- **Cleaner fuels**
  - Solid
  - Processed biomass
  - Liquid fuels
  - Gas fuels
  - Electricity

**Guidance / Technology - based guidelines**

Each option to include:
- Purpose
- Possible technical solutions
- Evidence on impacts on IAQ (PM, CO, ..)
- Evidence of total exposure reduction
- Practical limitations (costs, feasibility)
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Background material:

1. Introduction

2. Building dampness and its impact on indoor exposures to biological and non-biological pollutants (J. Douwes - NZ)

3. Moisture control and ventilation (O. Seppänen, J. Kurnitski - FIN)


5. Evaluation of human health effects

Development of WHO Guidelines on IAQ: Dampness and mould: WG meeting, 17-18 Oct 07

**Working Group members:** 32 experts (16 countries)
- authors, reviewers, SG members, EC, WHO (+ CEFIC)

Co-chairs: A. Nevalainen, B. Seifert
Rapporteur: L. Morawska

**RECOMMENDED GUIDELINES:** formulated at the meeting


**GUIDELINES** – to be launched by the end of 2008
Summary of the health risk evaluation (selected items)

- Sufficient epidemiologic evidence … showing that occupants of damp or mouldy buildings, … are at increased risk of experiencing respiratory symptoms, respiratory infections, and exacerbations of asthma.

- Some evidence suggests an increased risk of developing allergic rhinitis and asthma.

- Remediation of dampness problems leads to reduction in adverse health outcomes.

- Clinical evidence: exposures to moulds and other dampness-related microbial agents increase the risk of rare conditions, such as hypersensitivity pneumonitis/allergic alveolitis, chronic rhinosinusitis and the allergic fungal sinusitis.
**WG Recommendations (selected) (1 of 2)**

- Persistent dampness and microbial growth on interior surfaces and in building structures should be avoided (or minimized) as they may lead to adverse health effects.

- Indicators of dampness and microbial growth include:
  - presence of condensation on surfaces or in structures,
  - visible mould,
  - perceived mould odour,
  - history of water damage, leakage or water penetration.

- No quantitative health based guideline values or thresholds can be recommended for acceptable levels of specific micro-organism contamination (no quantitative exposure-effect relationships available at present).
WG Recommendations (selected) (2 of 2)

• **Dampness and mould-related problems should be prevented.** When they do occur, they should be remediated because of the increased risk of adverse microbial and chemical exposures.

• **Well-designed, constructed, and maintained building envelopes are critical to the prevention and control of excess moisture and microbial growth** by avoiding thermal bridges and preventing intrusion by liquid or vapour phase water.

• **Management of moisture requires proper control of temperatures and ventilation** to avoid high humidity, condensation on surfaces, and excess moisture in materials. Ventilation should be distributed effectively in spaces and stagnant air zones should be avoided.
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## Air pollutants-specific guidelines – 2008/9

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Authors of background material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formaldehyde</td>
<td>C. Mandin (FRA), DA. Kaden (USA), P. Wolkoff, G.D. Nielsen (DEN)</td>
</tr>
<tr>
<td>Benzene</td>
<td>R. Harrison, J.D. Saborit (UK), F. Dor (FRA)</td>
</tr>
<tr>
<td>Naphtalene</td>
<td>D. Kotzias, S. Kephalopoulos (JRC), A. Buckpitt (USA)</td>
</tr>
<tr>
<td>NO2</td>
<td>V. Ezratty, G. Guillossou (FRA), F. Kelly, D. Jarvis (UK)</td>
</tr>
<tr>
<td>CO</td>
<td>D. Penney (US), D. Kotzias, S. Kephalopoulos (JRC), A. Verrier (FRA)</td>
</tr>
<tr>
<td>Radon</td>
<td>M. Kreuzer (GER), J. McLaughlin (IRE)</td>
</tr>
<tr>
<td>Trichloroethylene</td>
<td>M. Loh (FIN), N. Bonvallot (FRA)</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>M. Loh (FIN), N. Nijhuis (NET)</td>
</tr>
<tr>
<td>PAH (BaP)</td>
<td>R. Harrison, J.D. Saborit (UK), H. Komulainen (FIN), H. Choi (USA)</td>
</tr>
</tbody>
</table>
Structure of the assessment for each pollutant:

1. General description of the compound
2. Indoor sources and pathways of exposure
3. Current indoor levels and relationship with outdoor levels
4. Kinetics and metabolism
5. Health effects (non-cancer and carcinogenic effects)
6. Evaluation of human health risk
7. Guidelines and guidance (WG)
8. References
Air pollutants-specific guidelines – 2008/9

Time schedule:

1 Sept 2008   Selection of background material authors completed
1 Nov 08      Background material drafted
15 Nov 08     Background material distributed for external review
               (reviewers needed!)
1 Jan 2009    Comments returned
Feb/Mar 09    Working Group meeting – recommendation of guidelines
July 09      Background material finalized / edited
Nov 09       IAQG cleared and published

Funding available from France, Netherlands, UK
2008-9

Development of guidelines on:
- combustion products (Group C)
- ventilation
- allergens

Funding needed
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• Other WHO work on indoor contaminants
WHO review of actions related to dampness and mould

Collection of case studies aiming at:

• Reduction of relative humidity in indoor air
• Reduction of damp / condensation in/on building structures
• Removal / prevention of mould growth
• Improvement of ventilation / air exchange rates

with the overall objective of exposure reduction and health benefits

Indoor spaces covered:

• Residential buildings / dwellings
• Schools
• Child and elderly centres with focus on non-care elements
• (typical medical care settings are excluded)
30 case studies collected from 11 countries => 17 case studies collected for discussion at WHO expert meeting

- 13 studies used questionnaires, six of them conducted medical examinations
- Effect sizes for improvement of health were greater if the authors used self reported data
- Possibility of a placebo effect, because blinding is not possible
- Possibility of publication bias
A: Prevention
- Moisture control is the key
- Building standards, building maintenance, ventilation systems and behavioral campaigns can be effective
- Solutions depend on climate and building use

B: Remediation
- Proper remediation is effective (good exposure evidence, some health evidence)
- Needs to go with moisture control measures
- May include building, equipment and design adaptations
- Has to be done promptly
- Depends on building use and occupants
Key elements of successful actions identified from case studies

- examination of buildings by experts with proper tools
- resolution of moisture problem causes
- removal of mould as well as damaged material (mechanical or chemical cleaning)
- drying remaining structures
- improvement of ventilation and thermal insulation
- use of proper materials that do not promote mould growth
- protection of workers
- prevention of cross-contamination by separating clean-up areas from non-infected areas initiating remediation work as soon as possible
- minimizing the remediation period to prevent occupant discomfort
- relocation of occupants to reduce exposure and health complaints
- follow-up of remediation and quality control.
<table>
<thead>
<tr>
<th>Hygrothermal problems</th>
<th>Remedial action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Increased relative humidity indoors</td>
<td>1) Addressing indoor moisture sources, control of ventilation and HVAC systems, increasing temperature as necessary</td>
</tr>
<tr>
<td>2) Surface condensation without increased indoor humidity</td>
<td>2) Addressing thermal insulation, including local thermal bridges and defects</td>
</tr>
<tr>
<td>3) Combined problem</td>
<td>3) Measures starting with relative humidity indoors</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outdoor sources</th>
<th>Remedial action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Outdoor sources and rising damp</td>
<td>1) Diagnosis of moisture path, necessary actions addressing drainage, sealants, water-membranes, flashings, water stops, capillary layers etc. Consultation with an expert may be recommended.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indoor sources</th>
<th>Remedial action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Plumbing</td>
<td>1) Inspection, repairs and replacements</td>
</tr>
<tr>
<td>2) Occupants</td>
<td>2) Addressing exact moisture source, educating occupants to change occupant behaviour</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Catastrophic events</th>
<th>Remedial action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Flooding, storm water intrusion, fire fighting efforts, major waterline breaks, etc.)</td>
<td>1) Temporary relocation occupants, immediate remedial actions</td>
</tr>
</tbody>
</table>
Results - process perspective

Good practice process

- Awareness of the problem
- Identification of stakeholders
- Assessment
- Agreement on measures
- Awarding of contracts
- Follow-up assessment

Responsibilities

- Description / Actors
- Description / Actors
- Description / Actors
- Description / Actors
- Description / Actors
### Example

<table>
<thead>
<tr>
<th><strong>Stage 3: Assessment</strong></th>
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<tbody>
<tr>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>Mould/dampness problems should be fully investigated to determine their causes. The assessment can be carried out on medical grounds, building physics investigation and tenant/occupant interview. Guidance can be given to the tenant/owner as to the level of intervention that may be required.</td>
</tr>
<tr>
<td><strong>Actors or stakeholder involved</strong></td>
</tr>
</tbody>
</table>
| **Occupants** should be encouraged to clean small areas of mould as an initial step.  
**Building owners** should assess the extent of affected areas and determine the need to appoint a dedicated professional.  
**Inspectors** should be qualified and trained to a suitable level, as determined by a third-party organization where possible. Guidelines should be provided on how to carry out an investigation in a structured and effective manner. A directory of approved inspectors could be provided to ensure quality.  
**Medical professionals** should carry out examinations where a patient referral has been requested. Any diagnosis provided should be presented by specialized professionals.  
**Tenant organizations or local authorities** could carry out interviews.  
**Funding agencies** relevant to the situation should be involved in these discussions. |
Overall conclusion

Need for

- inter(national) guidance and tools
- targeted education (construction professionals, craftsmen / potential remediators, occupants)
- (national) guidance values on risk parameters (e.g. relative humidity)
- quality control mechanisms for remediation work
- adequate measures for risk identification (inspections, public information, etc.)
- mechanisms to address private residences
- STRENGTHEN PREVENTIVE ACTION
## 2. Exposures

### 1. Effects

<table>
<thead>
<tr>
<th></th>
<th>Tobacco</th>
<th>Combustion Particles</th>
<th>CO</th>
<th>Radon</th>
<th>Dampness, mold, dust mites, bio-aerosols</th>
<th>(S)VOCs Indoor chemistry products</th>
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<tbody>
<tr>
<td>Allergic and Asthma symptoms</td>
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<td>Lung Cancer</td>
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<tr>
<td>Chronic obstructive pulmonary disease</td>
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<tr>
<td>Airborne respiratory infections</td>
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<tr>
<td>Cardiovascular morbidity and mortality</td>
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<tr>
<td>Odour and irritation</td>
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</table>

### 3. Causes & Sources

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Outdoor Air</td>
<td></td>
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<tr>
<td>Building / Equipment / Ventilation</td>
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<tr>
<td>Consumer Products</td>
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<tr>
<td>Occupant behaviour &amp; maintenance</td>
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</tbody>
</table>

Different colours degrees ● mean different levels of impact.
Out of ENVIE scope.
Support to

- Housing / buildings as a health setting to be considered in a multidisciplinary way
  - „fail-safe“ buildings and equipment
  - Ventilation versus insulation / energy efficiency
  - Home safety; fire safety, product safety
  - Tolerance to user behaviour
- Building manual / operating book and responsible building manager
- Regular inspections of HVAC systems
- Smoking ban
- Ban unflued combustion devices
EnVIE comments on priorities

Priority action on

- Inter(national) guidance and tools
- Targeted education and official certification for craftsmen / service companies
- Evaluation and control mechanisms for indoor work and rehabilitation
- Filling the black box of responsibility for private homes (especially in rental sector)
- Policies suitable for the existing housing stock
- Minimum ventilation standards **being realized**
- Smoking ban in indoor settings
- Regulation on smoke and CO detectors
- Incentives and financial support on building renewal and removal of harmful substances
- Product labelling (voluntary and mandatory)
- Harmful materials and home products, toys etc.
EnVIE comments

General comments
• Need to address and find solutions for „other“ health-related effects of IAQ policies
  => E.g water heating above 55°C to protect from Legionella versus risk for child accidents
• Introduction mentioned „conflicts“ which arise between various policies and objectives
  => Give priority list to indicate which policy may rule over others
• Consider extending the HVAC inspections into a more solid health risk inspection approach
• Comment on dwelling layout in relation to natural ventilation (cross-ventilation!)
• Remove introductory note on accessibility as it is not discussed throughout the report
• Inform in more detail on the tolerance of policies and building conditions to various user behaviours
• Consider adding a note on relevance of outdoor exposure penetrating indoors (PM etc.)
Nota bene I

Sophisticated systems are energy-dependent.

„Fail-safe“ and energy dependency may be a contradiction.

Effectiveness of basic approaches and manually operated systems to be explored / weighed against benefits of powered systems.
EnVIE comments

Nota bene II

Many proposals are possibly increasing housing costs and rent levels.

This will mostly affect low-income households and potentially increase the expression of inequities.

Incentives and financial support campaigns needed.
Further information:

Indoor Air Quality Guidelines:  
[www.euro.who.int/air](http://www.euro.who.int/air) (=>Indoor Air Quality Guidelines)

Damp and mould case studies:  
[www.euro.who.int/housing](http://www.euro.who.int/housing) (=>Policy support; Damp and mould)