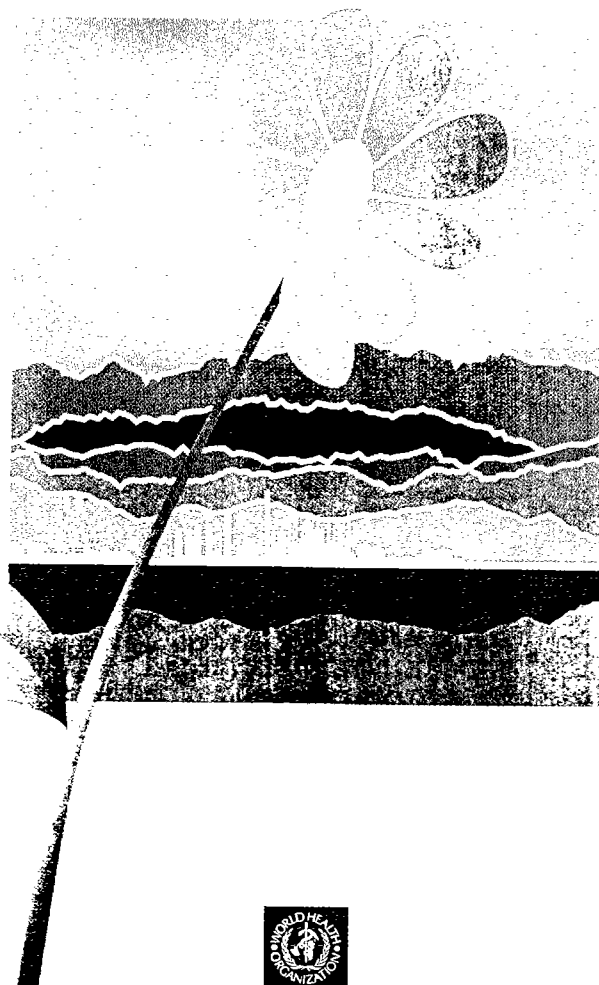


# Strategic approaches to indoor air policy-making



WHO European Centre for Environment and Health  
Bilthoven



## EUROPEAN HEALTH21 TARGET 10

### A HEALTHY AND SAFE PHYSICAL ENVIRONMENT

By the year 2015, people in the Region should live in a safer physical environment, with exposure to contaminants hazardous to health at levels not exceeding internationally agreed standards

*(Adopted by the WHO Regional Committee for Europe at its forty-eighth session, Copenhagen, September 1998)*

### Keywords

AIR POLLUTION, INDOOR  
AIR QUALITY  
ENVIRONMENTAL POLICY  
POLICY MAKING  
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## **Abstract**

Indoor air quality is an important determinant of public health and comfort. This document informs and advises governments, public health authorities and other policy-makers, and representatives of sectors relevant to indoor air quality (IAQ) management, on how to develop and strengthen IAQ policy in order to protect and promote health in the indoor environment. It specifically addresses strategies for the development of IAQ policies for non-industrial buildings such as homes, schools, offices, health care facilities and other public and commercial buildings. Development and implementation of a comprehensive, scientifically sound “action plan” is proposed as a key strategy tool. The document outlines the contents of such an action plan, addresses the roles of public and private sectors in policy implementation, and the roles of various levels of government, industry and research. Summaries of experience in various countries of Europe and in the USA illustrate the current situation and diversity of possible approaches to the improvement of IAQ.

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# Contents

	<i>Page</i>
Foreword.....	1
Executive summary.....	3
1. Goal and scope of the document.....	7
2. Importance of indoor air quality .....	8
3. General considerations.....	11
3.1 Need for a strategy.....	11
3.2 Responsibilities .....	13
3.3 Principles of action.....	14
3.4 Legal and political instruments .....	17
3.5 Assessment of indoor air quality .....	23
3.6 Cost–benefit analysis – foundation for decisions .....	26
4. Developing and writing a national strategy .....	28
4.1 Introduction .....	28
4.2 Assessment of the national situation .....	30
4.3 Legislation and other measures for managing the risks .....	34
4.4 Research .....	39
4.5 Information dissemination, education and training .....	42
4.6 Other incentives influencing the building sector.....	43
5. Evaluation of the strategy .....	45
5.1 Programme evaluation check-list .....	46
5.2 Methods of evaluation .....	48
6. Examples of national strategies .....	48
6.1 Indoor air quality in the Czech Republic (R. Kubinova)....	49
6.2 Indoor air quality in Denmark (O. Nielsen) .....	51
6.3 Indoor air programme in Estonia (O. Sadikova) .....	54
6.4 Indoor air quality in Germany (B. Seifert) .....	57
6.5 Indoor air quality in Lithuania (N. Jatulienė).....	61
6.6 Indoor air quality in the Netherlands (C. van de Bogaard). 66	
6.7 Indoor air quality in Poland (S. Maziarka).....	70
6.8 Approach to the solution of indoor air quality problems in the Russian Federation (A.I. Kucherenko) .....	75
6.9 Indoor air quality in the Slovak Republic (K. Slotová).....	78
6.10 Outline of national strategy on indoor air quality in Slovenia (M. Macarol-Hiti).....	82
6.11 Indoor air quality in Switzerland (J.E. De Payer).....	85
6.12 Indoor air quality in the United Kingdom: the Government’s strategy (L.Smith).....	89
6.13 Indoor air quality policy in the United States (John F. McCarthy) .....	93
7. Bibliography .....	98

## **Foreword**

Indoor air quality is an important determinant of human health and comfort. There is a large body of evidence on the hazardous nature of indoor air pollutants, on their sources or conditions leading to human exposure and on the significance of the related health effects. In addition, methods of pollution reduction are available in many cases. This knowledge gives a strong basis to comprehensive actions aimed at eliminating or reducing the risk to health and wellbeing caused by pollution in indoor spaces. The Declaration on Action for Environment and Health in Europe and the Environmental Health Action Plan for Europe, both endorsed by the Second European Conference on Environment and Health in Helsinki in June 1994, confirmed the need for such actions. However, the complexity of pollution sources and the multitude of parties responsible for creating indoor exposures make the development of an indoor air pollution reduction strategy difficult. As a result, few countries in Europe have introduced such strategies and there continues to be a risk of harmful exposures inside homes, offices and means of transport.

In view of this situation, a Consultation held in Bilthoven on 4–5 July 1994 at the WHO European Centre for Environment and Health (WHO-ECEH) recommended that WHO “... encourage each country to have a comprehensive and meaningful programme devoted to indoor air quality...”. Furthermore, “To assist countries in the development of their individual indoor air quality programmes, WHO-ECEH should develop and disseminate a guidance document on strategic approaches to indoor air policy-making”. That Consultation also recommended that WHO-ECEH prepare a report on exposure assessment in indoor environments. The latter document, providing the public health community with practical tools to assess indoor air pollution, was published in early 1998.

In response to the above recommendations, WHO-ECEH convened a working group to develop the guidance document. A preparatory group met in Bilthoven on 5–6 June 1997 to determine the scope and outline of the report and to propose authors for the first drafts of the individual sections of the document. The drafts were prepared and distributed for review by the working group, which met in Parabiago, Italy, on 20–21 November 1997. Based on the discussions at that meeting, the drafts were revised and modified to express the opinions agreed on by the working group. The revised drafts were edited by Dr Paul Harrison with the assistance of the WHO Secretariat and distributed for final approval in February 1998 by the members of the working group.

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## **Executive summary**

It is widely accepted that the indoor environment is important to public health and that a high level of protection against adverse effects resulting from inadequate quality of indoor air should be assured. Because of the complexity of factors determining indoor air quality, a comprehensive management strategy is required, involving governments and various economic sectors as well as individual occupants of indoor spaces.

The main purpose of this document is to inform and advise governments, public health authorities and other policy-makers and representatives of sectors relevant to the management of indoor air quality (IAQ), as to how to develop and strengthen IAQ policy in order to protect and promote health in the indoor environment. Specifically, it addresses strategies for the development of IAQ policies for non-industrial buildings such as homes, schools, offices, health care facilities and other public and commercial buildings. The principles developed also apply to other enclosed spaces frequented by the public, such as cars, buses and trains. Industrial environments and other working areas for which there are specific regulations concerning the handling of chemicals and dangerous substances are excluded.

A key strategy for the management of IAQ consists of developing a comprehensive, scientifically sound and thoroughly considered action plan. Such a plan should be targeted to new construction as well as existing buildings and other indoor spaces, and should entail action at both national and local levels.

To be successful, the action plan needs to consider the specific conditions of the country including, for example, outdoor climate and air quality, building design, operation and maintenance practices, types of building material used, knowledge and behaviour patterns of the occupants of the

buildings, incidence of certain diseases and complaints, energy policy and building system technology.

The quality of indoor air is determined by a large number of factors and, consequently, different professions are involved in dealing with and solving indoor air problems. This situation is reflected in the area of legislation. Countries do not generally have specific legislation on IAQ, so that there is often no single authority that has full responsibility for IAQ and climate. To avoid the consequence of problems not being addressed adequately because they are shifted from one authority to another, it is recommended that an interministerial task force be established comprising representatives of those ministries most involved. Generally, the task force will include representatives of the departments responsible for the environment, health, construction, labour, research, industry and transport. It is appropriate to designate one of these as the leading authority.

While central government may take the lead, industry and commerce also need to make appropriate contributions to the achievement of better IAQ. If product labelling procedures are in use, it is important that these include IAQ aspects. The role of the private sector in ensuring acceptable IAQ should be encouraged and supported through education and relevant incentives.

Policy-makers are urged to use the best available scientific evidence when devising actions and setting priorities. Several other basic principles should be applied in policy design and application, in particular:

- the precautionary principle
- the cooperation principle
- the polluter's responsibility ("polluter pays") principle
- the "right to know" principle.

The IAQ strategy should utilize a wide range of tools, instruments and processes, including:

- legal tools
- supervision
- monitoring of indoor environments
- monitoring of health effects related to indoor factors
- environmental health impact assessment
- environmental planning
- economic instruments
- information and advice
- participation by industry
- research.

Improving IAQ is one of the most profitable activities that society can undertake in the building sector. Even small improvements in IAQ will reduce labour costs through reducing morbidity and improving occupants' wellbeing. To generate the best possible foundation for decisions affecting IAQ and health, cost-benefit analysis should be applied to all matters that may have a bearing on indoor air.

The development of a national strategy will involve several stages and should consider all relevant indoor environments (homes, offices, transport media), the various pollutants and their sources, as well as the associated risk management strategies, with special emphasis on vulnerable groups. This development will begin with an assessment of the situation in the country through the collection of relevant information, evaluation of the health risks and determination of the most appropriate remedial measures. The material thus gathered should then be incorporated into the plan, which should specify the priorities for action, identify the available resources and describe the research and information needs. Depending on how much information is available, it may be possible to prepare the strategy all at once or there may need to be a pause while additional information is gathered on certain aspects. Finally, it is important that the plan is published and widely publicized.

The approach to the management of health risks related to IAQ will be different for new and existing buildings. For new buildings, appropriate design and selection of materials, confirmed during the commissioning of the building before occupation, will be the most effective way to assure adequate IAQ. In existing buildings used as offices or other non-industrial workplaces, remedial measures sometimes have to be taken based on occupational health and safety legislation and codes of practice. Remedial action in residential buildings may require a more diversified approach, using risk assessment techniques and identification of the main risk sources and perhaps focused on sensitive population groups.

The IAQ strategy also needs to include the assessment (and, where appropriate, the promotion or verification) of the safety of building materials and equipment, furniture, consumer products and other materials used inside enclosed spaces. In particular, the ability of such products to emit hazardous substances to indoor air or to increase damp or promote microbial growth, for example, should be assessed.

A substantial body of evidence pertaining to IAQ has been accumulated on the adverse effects and health risks of various conditions and products. Owing to the vast quantity and number of chemicals in use, however, and the combination of factors possibly affecting health in indoor spaces, there is a requirement for further intensive research focused on risk assessment and management. The necessary capabilities for such research must be assured by the national strategy. The mechanisms for international scientific information exchange and research collaboration must be developed to make best use of available resources.

The collection of examples of current national approaches shows that there is no unique strategy on IAQ throughout the Region. Clearly, individual national strategies are determined to some extent by the different local environmental and housing

conditions in the various Member States. However, appreciation of the problems also differs between various societies. A full understanding of the possible impacts on health of present conditions and of the gain in public health of the proposed comprehensive strategy, should be developed among the decision-makers in government and industry, and among the public to ensure effective reduction of risk from the health hazards present in indoor environments

## **1. Goal and scope of the document**

This document addresses strategies for the development of IAQ policies for non-industrial buildings such as homes, schools, offices, health care facilities and other public and commercial buildings. The principles developed also apply to other enclosed spaces frequented by the public, such as cars, buses and trains. Industrial environments and other working areas for which there are specific pollution sources and regulations with regard to the handling of chemicals and dangerous substances are excluded.

Indoor air quality is considered to be part of the broader concept of “healthy housing”. This document focuses on indoor climate and chemical and biological contaminants of indoor air. Other aspects, such as noise, lighting and electromagnetic radiation, are not included.

The main purpose of the document is to assist governments, policy-makers, public health authorities, and representatives of other sectors relevant to IAQ management (building industry, owners, facility managers, etc.), on how to develop and strengthen IAQ policy in order to achieve health protection and promotion in the indoor environment.

Information is provided on the strategies available to manage IAQ effectively at both national and local levels. Mechanisms are described for developing and applying health risk

assessment and risk management and evaluating the results of intervention with effectiveness indicators.

Finally, examples of national surveys or strategies are given to illustrate practical experience in countries with different economical and social contexts.

## **2. Importance of indoor air quality**

Indoor environments are where human beings spend most of their time in modern societies (up to 90% in some countries). The quality of the indoor air has become a matter of growing concern over the last twenty years. This concern was initially triggered by reports from occupants of various indoor environments who complained about a variety of unspecific symptoms, such as irritation or dryness of mucous membranes, burning eyes, headache or fatigue. Because in some cases these symptoms could be related to elevated concentrations of specific pollutants in indoor air, such as formaldehyde, increasing attention was devoted to assessing climate conditions and chemical compounds in the air of buildings.

It rapidly became clear, however, that acute reactions to specific pollutants were only one reason for being concerned about indoor air pollution. The other was more general and related to the fact that estimates of population exposure to air pollutants had been based exclusively on data derived from outside air monitoring; thus, the quality, duration and effects of human exposure to indoor air pollutants were likely to have been overlooked and under-evaluated.

In recent years, a large body of knowledge has accumulated concerning the effects on health caused by exposure to agents present in indoor air. For some of these effects, clear relationships with exposure to indoor air pollutants have been reported in the world literature. Among these are respiratory disease (particularly among children), allergy (for example, to

house dust mites, animal fur and dander) and mucous membrane irritation (due to formaldehyde, other irritant compounds and solvents). Large numbers of people have been and still are being affected. For example, in Nordic countries about 10% of schoolchildren have allergic asthma, and many of these cases are believed to be caused or exacerbated by indoor environmental exposure. Asthma is reported to be increasing in many countries.

Improperly vented, poorly ventilated or malfunctioning combustion appliances pose a real risk of acute poisoning by carbon monoxide. In France alone, CO poisoning causes some 400 deaths and 8000 hospital admissions every year. In the West Midlands region of England, the annual mortality rate of non-intentional poisonings was 1.1 per 100 000 in the early 1990s (Wilson et al., 1998).

An increased risk of developing lung cancer has been linked to exposure to environmental tobacco smoke (ETS) and to radon decay products. Lung cancer is a serious disease with a high fatality rate, although the number of people affected is much lower than the number of people contracting respiratory diseases or allergies, or experiencing irritative effects due to exposure to indoor pollution. However, in areas with high radon exposure, up to 10–15% of all lung cancers occurring in the population may be attributable to indoor radon exposure. With regard to ETS, it has been estimated that nonsmoking subjects living with smokers have about 30% increased risk of lung cancer when compared to the non-exposed population.

Many chemicals encountered in indoor air are known or suspected to cause sensory irritation or stimulation. These, in turn, may give rise to a sense of discomfort and other symptoms commonly reported in so-called “sick” buildings. Large surveys carried out in different countries have revealed a frequency of complaints among the occupants of some office buildings and other buildings for public use varying between 15% and 50%.

Perceived deterioration of IAQ has also been reported by a large proportion of occupants of houses, hospitals, kindergartens and other community buildings. Complex mixtures of organic chemicals in indoor air also have the potential to invoke subtle effects on the central and peripheral nervous systems, leading to changes in behaviour and performance.

The effects of indoor air pollution on reproduction, cardiovascular disease and on other systems and organs have not been well documented to date. However, some data indicate that indoor pollution may represent an important co-factor for cardiovascular and other systemic diseases. In view of the fact that such diseases affect a large proportion of the population, even a small increase in risk may result in thousands of cases at the population level.

An additional concern stems from the lack of knowledge on quality and quantity of substances emitted from materials used in the indoor environment and of their possible health impacts. In the building sector, for example, several thousands of chemicals are typically used in manufacture, some of them produced in high volume. Many of these chemicals enter indoor air as a pollutant and come into contact with all the individuals present in the buildings. Toxicological and health hazard assessments are available only for a small proportion of them. Similar considerations apply to the transport and consumer products sectors.

The social burden caused by indoor air pollution can be measured not only in terms of human suffering and diseases or lack of comfort, but also in terms of avoidable economic costs and loss to community productivity and wellbeing. For example, the annual direct medical costs of the principal illnesses related to indoor air were estimated to exceed US \$1 thousand million in the United States in 1986–1987 (Maroni et al., 1995). The estimated annual cost of additional emergency room visits for

asthmatic children in smoking households was estimated to amount to more than US \$200 million (Maroni et al., 1995).

As to the implications for losses in productivity, an average 3% productivity loss (corresponding to about 15 minutes per day in lost work time) was estimated from surveys in the United States (Maroni et al., 1995). The annual productivity costs of major illnesses related to indoor air in the United States were estimated to be in the order of US \$4–5 thousand million (Maroni et al., 1995).

These enormous figures give an indication of the importance of IAQ for our society from every respect. Questions intimately linked to the IAQ issue are human health and wellbeing, building technology, urban planning, energy efficiency and consumer goods markets. As each of these aspects is vital to the interest of the communities, a sound indoor air policy is a key priority for every national and local government, even in the face of other, perhaps more clear-cut or demanding health priorities.

### **3. General considerations**

#### **3.1 Need for a strategy**

Indoor air problems are mainly related to inadequate urban planning, design, operation and maintenance of buildings, materials and equipment in buildings, and inappropriate energy saving. IAQ problems affect all types of buildings including homes, schools, offices, health care facilities and other public and commercial buildings.

Many of the problems associated with poor IAQ can be prevented at low cost and without compromising energy efficiency if all the interested parties (including the national government, local authorities and industry) develop and implement an integrated strategy for the indoor environment in

concert with other social and economic partners. While the involvement of all these players is important, it is nevertheless clear that the national government has a crucial role to play in promoting and steering the overall development of a strategy.

Given the complexity of the economic, technical and social implications of interventions in the indoor environment sector, efficient and effective actions need accurate planning and full and careful consideration, to avoid inconsistencies, impracticalities or detrimental economic or social effects.

A key strategy for the management of IAQ consists of developing a comprehensive, scientifically sound and thoroughly considered action plan. Such a plan should be targeted to new construction as well as existing buildings and should entail actions at both national and local levels (see section 3.2).

To be successful, the action plan needs to consider the specific conditions of the country (as far as building problems are concerned) as well as all the other economic and social factors which may play a role, including for example, building design, operation and maintenance practices, types of building material used, the occupants' knowledge and behaviour patterns, the incidence of certain diseases and complaints, energy policy and building system technology.

The plan will establish goals that can be achieved through different actions entailing, as deemed appropriate, regulations and legislation, general public information, industrial and market interventions, technical developments, professional training and education, and cultural and behavioural modifications. In addition, since some of these matters are strongly influenced by political and economic international frameworks, international harmonization of policies in this area is likely to be invaluable.

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The above-mentioned elements account for the vastness of tasks in IAQ management, the necessity of adequate interrelation among the single components of the programme, and the need to adapt the programme to specific national situations priorities. Detailed guidance on producing a national strategy is given in Section 4.

### **3.2 Responsibilities**

Indoor air quality is determined by a large number of different factors including the quality of outdoor air, the type and condition of the building, the furnishings, and the occupants' lifestyles and habits. Consequently, different professions are involved in dealing with and solving indoor air problems. Thus, indoor air sciences represent a truly interdisciplinary field with no separate academic curriculum. This situation is also reflected in the area of legislation. Although time and again there have been calls for legislation that would address the indoor environment in particular, countries generally do not have such specific legislation. Rather, regulation initially intended mainly to serve other areas is also applied to indoor environments. Examples of such regulation are building codes, consumer product safety acts and chemicals acts (see section 3.4).

The result of this situation is that there is generally no single profession or authority that has full responsibility for IAQ and climate. The same applies at the government level, where a number of ministries are concerned in one way or another with questions related to the indoor environment. To avoid the consequence of problems not being addressed adequately because they are shifted from one authority to another, it is highly to be recommended that an interministerial task force be established, comprising representatives of those ministries which are most involved. Generally, the task force will then include representatives from the departments responsible for the environment, health, construction, labour, research, industry and transport. It is appropriate to designate one of these as the leading authority.

It is important that the responsibility for developing a strategic approach to indoor air policy in a particular country should lie with the national government. However, it is obvious that supranational regulations or recommendations must be taken into account in developing the strategy. Within the framework determined by the national strategic plan, additional action plans at regional or community levels are also possible, and should even be encouraged, depending on the subject.

Trade and industry need to make their contributions to achieve better IAQ. Industry should make as many efforts as possible to reduce hazards resulting from the use of products which have an impact on IAQ (including faulty use and application). Voluntary agreements play an important role, especially if they can contribute to reducing exposure more rapidly or effectively than legally enforceable national or international regulations. If product labelling procedures are in use, it is important that they include IAQ aspects.

The role of the private sector in ensuring acceptable IAQ should be encouraged and supported through education and incentives. Architects and the owners and managers of buildings can have an important and direct impact on IAQ if they show due concern for improved design, operation and maintenance of buildings. The private citizen can often improve IAQ if provided with appropriate incentives and information aimed at a better understanding of factors that influence exposure.

### **3.3 Principles of action**

According to target 21 of the health for all policy, air quality should achieve levels which protect people from adverse health effects. Governments and policy-makers are urged to use the best available scientific evidence when setting priorities for action aimed at this target. The actions should be based on the following principles.

*The precautionary principle*

Prevention is the best and, in the long run, the cheapest way of curing indoor air problems. A responsible indoor air policy should not be restricted to combating the danger or to removing the damage, but should be proactive in addressing emerging problems. The whole decision-making process in environmental policy should be imbued with the precautionary principle.

As the quality of indoor air substantially depends on the quality of the ambient air, the precautionary principle should manifest itself in every possible way to improve the quality of the ambient air, especially in areas heavily polluted due to intensive traffic or other sources of pollution. Indoor sources of pollution should also be eliminated as much as possible. Already at the design phase, good IAQ should be one of the planning objectives. Building materials and products used in the indoor environment should be free from harmful emissions. Guideline values for IAQ may assist both designers and users to select appropriate construction materials; in this way the producers would also be obliged to comply. Legally binding regulations by central and local authorities should also support the attainment of good IAQ.

*The principle of individual responsibility*

People should be informed about the danger that indoor air pollutants may pose to human health, and everyone should behave and act in such a way that he or she will not cause harm to other people's health. Smoking is the most prominent example for this, as environmental tobacco smoke is well known for its carcinogenic and other adverse effects. The designers and builders of buildings should also be aware of the possible danger that toxic emissions may create to the health of the users of the building and should choose materials and products accordingly.

*The cooperation principle*

Central and local governments should aim at cooperating with all community forces at the earliest possible phase in formulating political will and in the subsequent decision-making processes. This requires the involvement of the interested parties in both the planning and the authorization processes, in informing participating professional societies and experts about the preparatory work for new regulations, and in the undertaking of voluntary obligations by manufacturers during advanced negotiations with government organizations. The partners must develop mutual trust by free distribution of information, and openness and flexibility in methods and attitudes.

*The polluter's responsibility principle (the "polluter pays" principle)*

In the case of IAQ, the principle of the polluter's responsibility means that the costs of removing the sources of indoor air pollution, or compensation for the damage caused, should be borne by the polluter. This can be done either by prohibitive and directing regulations or, in the case of product-related pollution, by consistent application of liability regulations (see also section 3.4).

*The "right to know" principle*

People using indoor spaces should be entitled to know the possible harm to their health coming either from the construction materials and fittings used or from any kind of activity in or around the building which affects IAQ. Scientific evidence should be used and more widely distributed to relevant "stakeholders" (see also section 3.4).

*Limitations of action*

Application of these principles may conflict with other external principles, which may on occasion limit the action that can be taken. The right to personal freedom, for example, may have an impact on the scope for controlling indoor air, although this should not override other peoples' rights such as, for example, the right to breathe clean air. Smoking is one of the most

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disputed issues of this kind. Application of the principle of personal responsibility should help resolve such conflicts.

Another example is the freedom to trade between nations, which can make the regulations on product quality (e.g. emission standards) more difficult.

While application of the principle of the polluter's responsibility may not seem profitable in the short term, it will be advantageous to society in the longer term.

### **3.4 Legal and political instruments**

Effective environmental health programmes normally require broad political support and the use of a combination of instruments such as economic incentives, information, opinion formation and legislation. Internationally there is broad general agreement between countries on the need to work for good IAQ. The principal international declarations which have a bearing on indoor air policy-making include the Rio Declaration (1992) and Agenda 21 (1992) from the United Nations Earth Summit, and the Helsinki Declaration on Action for Environment and Health in Europe (1994). The Rio Declaration emphasizes the need to consider the effects of the environment on human health. Although not presently the case, Agenda 21 activities should also cover health and environment issues related to the indoor environment (ECA, 1996). In Europe, Member States are committed to meeting the air quality objectives set out in the WHO Environmental Health Action Plan for Europe (WHO, 1994), namely:

- to provide information on indoor and outdoor air pollution levels throughout Europe, especially in urban areas; and
- to adopt the measures required to bring, by a date to be specified nationally, air pollution levels below the health-related WHO air quality guidelines.

Nationally there is little specific legislation to regulate indoor air. The legislation is complex because it has usually been developed for other more general purposes, such as building regulations, but it has a bearing on IAQ.

### *Legal tools*

Governments should aim at the planned and well balanced development of legal tools to achieve better indoor air quality. Most regulatory actions, if they are deemed necessary, will probably concentrate on product-related measures and functional requirements for buildings, such as minimum ventilation requirements.

Different types of legislation may be necessary for particular circumstances, such as public places and domestic situations. Controls or guidelines on levels of pollutants in indoor air may be set for public places: applying such levels in domestic situations may be politically sensitive. These may also be different from occupational health and safety codes set for both industrial and non-industrial situations.

Most countries have legislation to control the design and construction of new buildings. Many include provisions for minimum ventilation and the proper installation of gas supplies, combustion appliances, mechanical ventilation and air conditioning, and measures to control the use of particular building products. Legislation to maintain or upgrade minimum standards in existing buildings may also be used to improve IAQ.

There are rafts of national and international legislation to regulate the marketing and quality of construction products, consumer products and chemicals. Examples include the European Union's Construction Products Directive and Marketing and Use Directive. There are also international quality standards for products. Such measures can be used to control both ingredients and emissions from products.

### *Supervision*

The supervision exercised by local and central authorities is the basis of all environmental health protection activities, including those directed towards the indoor environment. The best course is often to combine supervisory measures with information. An important instrument is the constitution of local, regional and national programmes for which concrete objectives, strategies and evaluation principles have been formulated, e.g. mandatory checks of ventilation systems.

### *Monitoring of indoor environments*

As with all environmental monitoring, the purpose of monitoring indoor environments is to describe the state of these environments, assess the threats, analyse the impact of various emission sources and provide data for decisions on appropriate measures. Monitoring may comprise relevant measurements of the physical environment, including the buildings' technical systems, exposure measurements, studies of the frequency of annoyance reactions or symptom reports due to indoor air pollution. It may also include the recording of accidents and technical failures, such as water leakage and air filter replacements.

### *Monitoring of health related to the indoor environment*

Attention should be given to analyses of the significance of the indoor environment in national public health reports. These may include details and analyses of trends in patterns of ill health that may be attributable to indoor environmental factors, and of health inequalities linked to such factors. The national environmental health reports should always include assessments of the health effects of the exposure to factors in the indoor air, and their comparison with exposures from outdoor environments, food, other environmental risk factors, lifestyles, and other living conditions.

### *Environmental impact assessments*

In many countries, environmental impact assessments (for the outdoor environment) are a requirement for all operations that are subject to government permission. Typically they contain assessments of the impact of the operation in question on the environment, on health and on the consumption of natural resources. Assessment of all high production chemicals and materials used in the building sector is also mandatory in many countries. However, assessments of the anticipated effects of the planned operations on indoor environments and health are not included in the environmental impact assessment procedures, or are inadequate, but should be strongly encouraged.

### *Planning*

In most countries, local authorities have overall responsibility for the planning of land use and new buildings. Land, water and the physical environment in general must be used in such a way as to promote sustainable management in ecological, social and national economic terms. This consideration includes also the built environment and indoor air.

### *Economic instruments*

Economic instruments have been used for a long time in many countries as a means of reducing outdoor environmental impact. The Rio Declaration reaffirms the “polluter pays” principle. Similar measures could be used for indoor environments: taxes and charges could be aimed at raising the cost of the loads on indoor environments and making it profitable to develop environmentally sound solutions. Grants of various kinds are being used as economic incentives to take remedial measures to improve the indoor environment, e.g. with respect to moulds and radon.

### *Information and advice*

The general public and professionals need to be informed about the available knowledge and the significance of risks associated

with poor IAQ. It is important to bear in mind that there are different levels of comprehension and that only an open dialogue at the various levels can contribute to understanding while avoiding unnecessary fears.

Occupants should be stimulated to seek a better environment for themselves and to behave more reasonably as consumers. However, only an adequate, consistent and broad level of information can lead to changes in behaviour. The consequent integration of the news media into the measures to be proposed and implemented should be envisaged.

Local public health centres can contribute significantly to solving questions regarding health complaints and indoor air pollution. These centres should collaborate closely with practitioners, scientific institutions and environmental authorities. They should be equipped with adequate staff and laboratory capacities to deal with the common questions related to indoor environments.

Although the behaviour of the public, which plays an important role in avoiding or reducing indoor air pollution, will mainly have to be influenced by appropriate information, regulation may play a role for specific public spaces, e.g. in the case of tobacco smoking.

#### *Contribution of industry*

The overall environmental impact of products, from manufacture to recycling or disposal, is being increasingly recognized. The use and disposal of building products sometimes have greater impacts on the environment than their manufacture.

Trade and industry must contribute to the achievement of better IAQ. Industry should make as much effort as possible to reduce hazards resulting from the use of products relevant to IAQ, including faulty or improper use and application. To assist in

this, environmental ISO and CEN<sup>1</sup> standards have been designed to help industry proceed from management by external rules to management by internal objectives and include, for example, life-cycle analysis and labelling.

Voluntary agreements may be even more effective than legally binding regulations. If labelling procedures are in use, care should be taken that they include IAQ aspects.

*The contribution of science*

Evaluating the health significance of individual factors in indoor environments and their combined impact on humans is the task of scientific research. This plays a leading role at all stages of risk assessment:

- identification of the factors with detrimental or positive influences on health and wellbeing of the occupants, and assessment of the safety of new materials introduced into the indoor environment;
- quantification of human responses to these factors;
- quantification of human exposure to the factors in various indoor environments, and
- characterization of risk.

Research is still needed to improve methodologies and approaches aimed at optimizing IAQ and reducing the risks related to possible hazardous exposures indoors. It also has a leading role in developing tools for the assessment of indoor environments and determining priorities for action.

A key determinant of progress in research is access to information and the exchange of expertise between scientists. Thus international contacts and research programmes contribute significantly to the IAQ programmes of individual countries.

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<sup>1</sup> ISO – International Standard Organization; CEN – Comité européen de normalisation.

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However, specific national capabilities will always be necessary to transmit and apply the international expertise to local conditions, and to identify problems which escape attention in other countries.

### **3.5 Assessment of indoor air quality**

#### *Indoor air quality assessment and its main problems*

Before any action aimed at improving IAQ is undertaken, the existing conditions should be assessed to determine the optimal course of action. The direct assessment of IAQ may sometimes be quite complicated, because the effects of poor IAQ on inhabitants are often delayed and cumulative and there exist many personal differences in sensitivity depending on sex, age, metabolism and other individual factors. Personal complaints may be useful early indicators of IAQ problems, and should not be too readily dismissed.

The assessment of IAQ in a room must normally be based on the measurement of different factors, including thermal and air quality conditions, in that room. The most simple thermal factor – room temperature – may be measured quite accurately in normal conditions and rooms with quite simple instruments, while measurement and assessment of the risk of draught in a room, for example, is much more complicated.

Reliable assessment of the different chemical and biological impurities in indoor air is complex, as highlighted by a recent WHO publication on the available methods of assessment of exposure to indoor air pollution (Jantunen et al., 1998). One of the main problems is availability of easily applicable analytical tools to measure low concentrations of pollutants found in normal room air. The concentrations of indoor pollutants may also vary considerably over time, depending on the sources and other factors, which poses another challenge to the assessment.

A distinction should be made between an assessment directed at an evaluation of IAQ as experienced by a certain population and the identification of a “problem building”. While the latter should be considered a necessary part of improving IAQ in a particular case, the former should provide background information for a general strategy and actions covering wide population groups. The assessment of IAQ problems in a population should be conducted within the framework of a well designed survey, based on a properly selected sample and using a range of available methods. Besides the direct measurement of chemical or physical properties of indoor air, buildings can be technically evaluated and members of the population surveyed by questionnaire (Jantunen et al., 1998).

#### *International guidelines*

In addition to problems with measurement, finding suitable and reliable criteria to be used as reference points for the assessment may be difficult. The WHO *Air quality guidelines* address the health significance of a number of pollutants relevant to indoor exposures. These guidelines provide a basis for setting national standards, which can subsequently be used directly in management decisions. Similar even more comprehensive guidelines have been published by different international organizations dealing with occupational health, but their usefulness is restricted to industrial situations. Such guidelines are not generally applicable to homes, schools or offices.

#### *National actions*

Based on the health risk evaluation presented, for example, in the WHO *Air quality guidelines*, some European countries have published their own IAQ guidelines. The form and status of these guidelines may be very different depending on national legislation and other circumstances. Section 6 presents examples of national approaches adopted by several countries, including the selection of indoor pollutants to be controlled and the methods for assessment. Often, several different agencies perform assessments relevant to IAQ, each using different reference criteria.

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*The assessment of buildings and other technical means for indoor air quality evaluation*

In many cases the construction of a building, and especially its in-built heating and ventilating equipment, is the key to achieving good IAQ. In almost all European countries requirements and guidelines exist for the design and construction of new buildings. Normally such activities need a building permit issued by local authorities. The main emphasis in these requirements is the stability and fire resistance of the building, but in many countries energy conservation, as well as prerequisites for good indoor climate, are also included. A practical and effective approach to ensure good IAQ is through setting limits for harmful emissions from building materials and/or standards for required ventilation airflow. The purpose of the building assessment is to verify that the design and construction standards have been followed. An assessment of different IAQ factors and compliance with the established air quality standards may serve to verify the effectiveness of the design and selection of the materials.

**Swedish experience**

In Sweden, a nation-wide check-up, measurement and assessment of the ventilation systems in existing buildings has been performed. This was done with an understanding that proper functioning of the ventilation systems is necessary for the maintenance of good indoor air quality, especially in a country with long and cold winters limiting the desire for ventilation and demanding the saving of energy. This obligatory survey of ventilation systems has shown clearly that there are many situations when the function of these systems is not at all satisfactory. (*T.Lindvall, personal communication*)

Many IAQ-related problems in buildings are seen only after construction is finished. Some of them occur only as a result of careless work during the construction phase, and subsequent

inappropriate exploitation or misuse of the building's technical systems. The reason may be the lack of appropriate education or training of the maintenance personnel, but hidden errors in construction may also lead to poor IAQ. Besides routine quality assurance procedures to avoid such errors, the only way to prevent the health consequences of such faults is through regular assessment of the building's condition. Such procedures may be facilitated by guidelines requesting regular check-ups and maintenance of the building systems, such as the German instruction on the hygienic aspects for the planning, design, operation and maintenance of air-conditioning systems (VDI 1997).

### **3.6 Cost–benefit analysis – foundation for decisions**

Improving IAQ is one of the most profitable activities society can undertake in the building sector. Even small improvements in IAQ will reduce labour costs. Since these are estimated to be 10–100 times greater per square meter of office space than energy and other operational costs of a building, the economic gain can be tremendous. To generate the best possible foundation for decisions affecting IAQ and health, cost–benefit analysis should be applied in all matters that may have a bearing on IAQ.

Treatment of diseases within the health, nursing and social sectors has a limited impact on the status of public health. Most decisions affecting health are taken outside these sectors, for example decisions regarding the social infrastructure including sanitation, transport policies and building regulations/codes as well as employment and financial policies. It is vital that knowledge about environment and health/productivity is used in all decisions made, regardless of in which sector they originate. This is in line with the common trend for cost–benefit analyses to be performed before new legislation or regulations are implemented.

The outputs from cost–benefit analyses serve as a basis for regulation by the relevant authorities, engineering standards as

part of quality assurance, and introduction of economic incentives and disincentives.

Cost-benefit models can be used in social as well as in business economics. However, considerations based on business economics are not necessarily adequate from the point of view of society. Therefore it is important to identify those parties who invest in the improvement of IAQ (as manufacturers and owners of buildings) and those that profit from it (such as employers, occupants, social insurance systems). Also the impacts are not spread equally: while employers may be damaged by loss of productivity and absenteeism caused by exposure to pollutants, the occupants or employees suffer from damage both in terms of health and expenses for medical care.

The economic models are general, but their application is critical. They can easily be misused. Caution is therefore required in the application of the models, and cost-benefit analysis should be based on input data from reliable sources and should display quantified uncertainty measures. Input data can include medical data (on exposure, disease and discomfort, dose-response relationships) and behavioural data (on subjective symptom reports, performance and behaviour, environmental perception, individual control of IAQ). Establishing costs both in terms of damage to health and costs of medical care is not easy but it is necessary to have at least an estimate of these items. Uncertainties in input data (and the subsequent output as well) must be accepted as inherent in all economic analyses and must be displayed. Sensitivity analyses may be applied in the model to estimate the effect on the results when the underlying assumptions are changed.

Another important aspect of societal economy is how the results of cost-benefit analyses are to be implemented. For example, how do economic incentives support or hamper the rational promotion of a healthy indoor environment? The value of the public building stock is not usually given adequate consideration

by its owners. No adverse result will be visible in the final balance of the community budget when a school building is not properly maintained. Such imbalances may explain some of the ongoing deterioration in many countries in the indoor climate in schools, kindergartens and other community-owned buildings.

Although there are uncertainties and limitations which make a precise cost–benefit analysis difficult, it is highly advisable that such analysis be attempted. The qualified use of input data in professionally designed economic models is currently the best available way of organizing the foundation for decisions on IAQ.

## **4. Developing and writing a national strategy**

### **4.1 Introduction**

The purpose of this section is to set general goals for a national strategy and illustrate how they might be achieved. The text highlights the issues which may need to be considered in developing and writing your strategy, including an initial various supportive actions. It gives examples of how you might set about the task. However this section is not intended to be prescriptive, since the diversity of local environmental, social and political conditions may require a selective and inventive approach, possibly different in each country.

The elements of a national plan include the following:

1. assessment of the present situation regarding IAQ in your country in order to establish appropriate goals for the reduction of health risks;
2. identification of existing programmes that have either beneficial or adverse effects on health and comfort in indoor environments in your country;
3. identification of appropriate building design, operation and maintenance practices that promote indoor environmental health as an integral part of energy efficiency;

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4. encouragement of the production and use of low-emitting materials through market and other appropriate incentives;
  5. mechanisms for the development and adoption of standards and codes, as appropriate, for ventilation, control of sources, and building maintenance requirements;
  6. development programmes to ensure the reliability and effectiveness of building products and services promoted for the control of IAQ;
  7. development of guidance and training for professionals who are:
    - involved in the design, operation and maintenance of buildings;
    - responsible for community health as well as individual patient care, or
    - providing diagnostic and mitigation services for buildings;
  8. recommendations on the appropriate levels of administration for any action needed to promote public and private initiatives to improve IAQ; and
  9. establishment of information programmes to raise public awareness and assist citizens to take reasonable measures to reduce their health risks from indoor air pollution.

Even in the absence of solid data, action should be undertaken as far as reasonable to reduce risks to health. Each of the different indoor environments and each type of pollutant should be addressed systematically, with respect to both new and existing buildings. It may be useful to construct a matrix considering:

- particular indoor environments (homes, offices, etc.)
- the sources of pollutants
- the pollutants
- possible risk management strategies.

The preparation of the strategy will involve a number of stages. These may include assessment of the situation in your country by the gathering of relevant information, assessment of the risks and their relevance to health, and determination of the most appropriate remedial measures. These should then be incorporated into the plan, bearing in mind the priorities for action and resources available and the research and information needs. You should also set out the steps needed to implement the plan and the arrangements for judging priorities. Depending on how much information is available, it may be possible to prepare the strategy all at once or there may need to be a pause while additional information is gathered on certain aspects. Finally, it is important that the plan is published and widely publicized.

#### **4.2 Assessment of the national situation**

Assessment of the existing building stock to identify and solve IAQ problems is a major task. The first step is to decide how to handle the assessment, by choosing the environments and considering the pollutants in turn or vice versa. In order to assess priorities for action you will need to decide where the greatest health risks lie in your country. It may be worth carrying out a preliminary qualitative assessment to identify where more detailed analysis or investigation should be concentrated.

##### *Stage 1: Collecting the necessary information*

As a first step you will need to review the current situation in your country. Assess all types of new and existing building stock, including:

- homes;
- offices and other commercial buildings;
- hospitals;
- schools;

- passenger compartments of vehicles and other means of transport;
- other public places.

Then assess the situation in each of these environments, including:

- all the likely pollutants and their sources, including human beings;
- the concentrations in air and the resulting exposure, taking into account the different population groups;
- evidence of the occurrence of health effects;
- gaps in information, whether it is necessary to fill these gaps and if so how and over what time-scale.

Examples of important sources of pollutants to be considered include:

- building materials and products
- furniture, furnishings and carpets
- consumer products and decorating materials
- gas cookers and other combustion appliances
- outdoor air
- pesticides and other chemicals used indoors
- ventilation systems
- the ground beneath the building producing or allowing ingress of gases such as methane and radon.

The main indoor pollutants of concern are well documented. It will be particularly appropriate to give consideration to those chemicals and materials producing high levels of pollutants that are used in the indoor environment. The priorities will depend on the circumstances in your country but the following are likely to be important:

- radon;
- combustion products, including carbon monoxide and oxides of nitrogen;
- volatile organic compounds;
- formaldehyde and other aldehydes;
- dusts and particles (e.g. PM10, PM2.5, or even smaller fractions);
- fibrous materials such as asbestos and man-made mineral fibres;
- pesticides or other less volatile organic compounds;
- carcinogens such as benzene and other constituents of tobacco smoke;
- allergens, including those from house dust mites and pets;
- bacteria and fungi;
- water vapour and damp.

The potential health effects related to the exposure to these pollutants are also documented in the literature. There is reasonable consensus for most pollutants on the level of acute exposure which will result in symptoms being experienced, but more uncertainty exists on the chronic exposures which may result in illness in the longer term. Depending on circumstances, reference can be made to published exposure limits or guideline levels; for example the relevant WHO guideline levels. Exposure to higher levels than these may pose a risk to health for some people and action may be needed.

You will need to carry out an assessment for each micro-environment and each pollutant to estimate:

- the likely range of concentrations in air;
- the duration of the exposures; and

- the resulting risk to health and wellbeing of children, adults and those at special risk.

Ideally this should be based on measurements of the levels of each pollutant in representative locations and an estimate of the time spent in each micro-environment. However, if such measurements have not been made in your country, the initial assessment can be based on work done in similar circumstances in other countries. Several in-depth studies have been carried out and published. Knowledge of the sources and potential sources (including building materials) is important in making the selection of pollutants for study; for example, there may be no need to address radon as a priority unless the underlying geology of the area indicates that the presence of radon is a possibility. Inventories of emissions from materials and products will be valuable in this process.

#### *Stage 2: Assessing the problem*

In the next stage you should assess the risks to health, with the main objectives of:

- identifying micro-environments where the levels of a particular pollutant are, or might be, higher than the relevant WHO or national guideline levels;
- estimating the number of people who might be exposed and the duration of their exposure;
- estimating the significance of this exposure in terms of effects on health and wellbeing, with particular reference to children and others who might be specially sensitive; and
- identifying possible remedial measures and their respective cost and difficulty if the health risks are significant.

The results of this procedure will form the basis for development of the risk management strategy and the setting of priorities for action.

### *Stage 3: Priorities for remedial action*

Development of remedial strategies will depend on knowledge of the following:

- the sources of the pollutants and their strength;
- options to control the sources, either by reducing their strength or by removing them or replacing them with something less hazardous;
- the ventilation arrangements and whether these have a bearing on the levels of pollutants encountered; and
- options for reducing exposure by reducing the time spent at the location.

The outline assessments for the various micro-environments and pollutants should then be collated and considered together to decide on priorities for action. In many instances the risks will not be directly comparable and may be difficult to rank. For example, it is difficult to judge the importance of the many extra cases of respiratory illness each year due to exposure to fumes from gas cooking or house dust mites against the relatively small number of fatalities from acute poisoning by carbon monoxide.

Having identified where the main risks to both individuals and populations may lie, further work may be necessary to refine the assessments to be confident that they reflect the situation as accurately as possible. In many cases survey work may be needed to confirm the typical and maximum likely levels of various pollutants in different micro-environments. Investigation of the relative strengths of various sources may also be needed.

### **4.3 Legislation and other measures for managing the risks**

The next stage is to consider the various strategies for reducing exposure to the pollutants and to assess the benefits in terms of improved health and wellbeing weighed against the cost and difficulty of the proposed action. This needs to be judged in a

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holistic way so that, where resources are limited, the cost and difficulty of action in one area is not disproportional compared with action in another area. It may be valuable to use the risk assessment matrix developed in Stage 1 to evaluate various possible options in order to make the decision on which option results in the greatest reduction in risk.

### *New buildings*

All new buildings, including dwellings, should be designed and constructed to ensure that good IAQ can be achieved from the start. As most buildings last several decades this is a very sound investment. National and local planning and building regulations and codes should explicitly address IAQ issues. The prevention of indoor air problems can only be successful if the starting point is thoughtful design, including selection of materials and products used to equip the building which have low emissions of pollutants. This must be complemented by appropriate source control and ventilation strategies for the intended use of the building and suiting the requirements of the occupants. Attention should also be paid to the commissioning of new buildings before occupation to ensure they are fit to assure good IAQ.

The design process should begin with an evaluation of the intended site with regard to general conditions such as outdoor air quality and climate, the uses of nearby sites, soil and groundwater quality. The design should aim to keep the level of technical sophistication appropriate to the intended use. Natural ventilation should be encouraged wherever possible, and energy efficiency and ventilation requirements should be carefully balanced without compromising the demand for good IAQ. Many guides and technical information on good practice for new buildings published by regulatory authorities and other bodies are available. The strategy should set out the current arrangements, the required improvements in procedures and the date by which they will be implemented. It should include arrangements for enforcing the rules and monitoring their success.

Once a building is completed and occupied it should be maintained to the appropriate standards, including cleaning and redecorating. Any changes of use or refurbishment should be accompanied by appropriate modifications or management to maintain the standard of air quality. Your strategy should address how this will be achieved.

#### *Existing buildings*

In contrast to new buildings, it is likely that different strategies will be needed for existing buildings depending on their use. In many countries the regulations applying to public and workplace buildings differ from those applying to dwellings.

#### *Remedial measures in workplaces*

In workplaces remedial measures can be taken using occupational health and safety legislation and codes of practice. You should consider the following options:

- applying new and more stringent standards together with a realistic programme for implementation which can be agreed with employers and the workforce;
- adopting recognized standards for building services such as mechanical ventilation and air conditioning;
- issuing guidance on difficult topics, such as the provision of adequate ventilation or solutions to building-related problems (such as the sick building syndrome), and arranging for the enforcing authorities to promote this guidance when they visit;
- ensuring that IAQ issues are addressed specifically during any renovation or extension of the premises or change of use; and
- securing improvements by offering financial incentives or government grants.

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### *Remedial measures for existing dwellings*

Action by governments to improve air quality in homes is a sensitive issue. Many people resent being told what to do, particularly when they own the homes they live in. Action is somewhat easier to implement where dwellings are owned by the state or private landlords.

In the risk assessment you should have identified the problem areas, and remedial action may fall within the following types:

- structural modifications, such as measures to prevent the build-up of radon or alleviate damp;
- provision of improved ventilation, generally or to remove combustion products from an appliance;
- correct installation and maintenance of gas supplies and appliances;
- influencing the behaviour and activities of the occupants; and
- special measures to protect babies and children and other vulnerable people such as the elderly.

The strategy will need to identify clearly:

- what the health risks are in homes
- which types of home are affected and how they are to be identified;
- what needs to be done;
- how it will be done and who will do it;
- who will pay (for example, owners, tenants, landlords or the state).

An example for a strategy focused on highly exposed groups is the programme to reduce the risk of radon exposure. In areas affected by radon, houses with high levels of radon must be identified individually by taking measurements. Priority for

action might be determined by tackling the worst affected areas first, focusing on homes with levels above a given threshold; lesser affected areas can be targeted later in a programme that might need to last several years. Financial help for remedial measures might be offered to poorer families.

An example of a strategy which considers the sensitivity of the target groups is a programme to reduce exposure to fumes from gas cookers and heaters. Since babies are considered particularly vulnerable, the programme will be most effective if it targets families with young children living in homes with gas supplies.

#### *Building materials, furniture and consumer products*

Building and construction materials, paints, furniture, furnishings and consumer products may be sources of indoor pollutants. The strategy will need to identify if and how these are to be controlled and emission levels reduced. The options include:

- legislation on products and their use imposing emission reduction;
- voluntary compliance with national or industry codes and standards in case they are not legally binding; and
- market forces and consumer preferences, stimulated by public information.

Although national action will be important to set appropriate controls on the use of products, international action and cooperation to set standards for products will be more effective. For example, the European Union Construction Products Directive provides a framework for setting quality and safety standards for materials and products used in buildings and marketed in member countries.

#### *Resources*

For the strategy to be a success it is essential that there are sufficient resources to implement it. This needs both finance and

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people. The strategy will need to address the provision of sufficient capacity, both nationally and locally, to carry out the necessary assessment work and put the required changes into practice, including introducing any necessary legislation. It must include provision of education and training.

#### *Implementation and tracking progress*

The strategy should set out the framework and programme by which the objectives are to be achieved. It must identify the participants and the actions each must take. Your decisions on the priorities for implementation will depend on the benefits of the proposed actions when balanced against the costs and difficulty. You will also need to decide who will bear the costs involved: government, industry, owners (landlords) of buildings, tenants or consumers. Progress will need to be monitored and reviewed, with changes made to the strategy if necessary to maintain the momentum.

#### **4.4 Research**

Earlier sections of this report and the bibliography provide a review of available knowledge on indoor air pollution and risk management related to indoor air pollution. They emphasize the importance of indoor air pollution and the need for an action plan. However, for some topics, sufficient information is not at present available. Therefore, you will need to set up a research programme, which will be an important part of the national IAQ plan.

The objectives of your research programme will be to provide:

- functional requirements on IAQ for obtaining good health, comfort and productivity;
- the scientific basis for policies aimed at identifying indoor air hazards, assessing risks and reducing and preventing indoor air pollution effects on health; and

- appropriate technology and other tools for the maintenance and development of indoor environments which are conducive to health and wellbeing.

The research section in your plan should contain:

- the description of the situation: key institutions, human resources, technical resources (test facilities), available knowledge, current activities;
- the strategy for research: ministries and other public bodies involved, organization (scientific committee, steering committee, evaluation, etc.), funding; and
- the goals to be achieved based on an assessment of the national situation (ranking of problems, priorities, etc.) and description of the situation in the research sector.

#### *Framework of the research programme*

You should establish a general framework for your research programme and then set out the measures which will be implemented and evaluated first in the national action plan. Your research programme can be organized in different ways, for example according to pollutants, sources, environments, health effects and by considering the main problems and the main partners.

You should consider whether the following topics need further research:

- assessment of the built environment with respect to both IAQ and energy use;
- characterization of sources of indoor air pollution: building materials, consumer products, equipment, activities;
- exposure assessment: personal exposure, activity patterns, a database of indoor pollutant exposures;
- identification and quantification of the health risks associated with indoor air pollutants: health effects

associated with exposure to low levels and mixtures of pollutants, role of indoor pollution in the development and exacerbation of allergic and hypersensitivity reactions and other diseases, transmission of infectious disease in indoor environments; and

- identification and evaluation of technologies and methods for reducing human exposure to the full range of indoor air pollutants, including appropriate building design, operation and maintenance practices that promote indoor environmental health simultaneously with energy efficiency, behavioural changes and the occupants' use of the building.

### *Key issues*

When you write your plan for your research programme, you should consider the following specific concerns.

- Interdisciplinary collaboration is a key issue for the indoor environment, and especially important in the field of research because researchers tend to be very specialized.
- Both the rational use of energy and the provision of good IAQ are important. There are potential conflicts between these two requirements, therefore the impact of possible energy-saving measures on IAQ should always be discussed before their eventual adoption; if unacceptable, they should be reconsidered.
- Priority should be given to controlling the sources.
- International collaboration provides a broader view and possibilities for cost-shared programmes.
- Information transfer is important. One of the main objectives of the research programme is to provide the scientific basis for policies. The results of research activities therefore have to be accessible.
- Indoor air quality is important enough to deserve a specific action plan. However, the national IAQ plan should not

overlook the importance of IAQ in other research programmes, such as the energy research programme or the environmental research programme.

#### **4.5 Information dissemination, education and training**

Many of the actions to improve IAQ are dependent on those designing, using and maintaining buildings. Therefore the strategy should address the training of professionals and other decision-makers, including health professionals. Your strategy should also include a programme for the dissemination of information to the public in order to satisfy people's "right to know" and stimulate changes in behaviour. Product information also has a vital role.

The objectives of the information programme should be:

- to raise public awareness and assist citizens to take reasonable measures to reduce the risks to their health from indoor air pollution;
- to ensure appropriate education and training for professionals, especially those involved in the building sector (design, construction, operation and maintenance) and the health sector (responsible for community health as well as individual patient care); and
- to promote the exchange of information between science and policy.

This part of your plan should start with a description of the situation, for example the general level of awareness among the general public, in specific population subgroups and among professionals. The plan should pinpoint the gaps that could be filled through information campaigns, education or training, as well as identify key institutions and current activities.

The specific goals to be achieved are to make professionals (from the building, health and education sectors) aware of the

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importance of IAQ and of their own responsibility in this field, and the necessity of education and training. In addition it should provide professionals and the public with the latest information through appropriate, comprehensible and useful means (e.g. guidelines, leaflets, seminars, media, specialized media).

You should decide on the measures to be adopted according to your particular priorities. They can either be specific, such as a campaign on the dangers of carbon monoxide from unflued combustion appliances, or comprise more general information campaigns (on allergy, air quality, etc.).

#### **4.6 Other incentives influencing the building sector**

Good IAQ can be promoted by other than obligatory and legislative means. In the building sector especially, there exist possibilities to improve IAQ by voluntary means through the use of different incentives. The house-owner and the builder should see the building more as a whole, where the building and maintenance costs (including energy costs) are only a small, often negligible, part of the total costs of the activities in the building. They should understand better that investments in good IAQ are also profitable from the private economic point of view since the occupants' health has a clear economic value. A number of incentives have been developed to promote such activities and understanding (see below).

##### *Environmental labelling*

Nowadays, public awareness of environmental issues is an important factor in the marketing of different goods. There is a real demand for ecologically sustainable solutions. To help the public make the right selections, various national, European or even worldwide labelling systems have been developed. The general idea is to select and label the best products/solutions from the environmental point of view. Some schemes cover the whole range of environmental factors, while some concentrate only on the energy conservation perspective.

It can be expected that the use of different environmental labels on products will become more and more widespread in the future. It is especially important that the characteristics for good IAQ (e.g. low emissions from building materials to the indoor air) should be made an essential factor in these environmental labelling procedures.

#### *Special indoor air quality labelling*

There have been many attempts to find a basis for the selection of clean, low-emission building products. A recent report of the European Collaborative Action (ECA, 1997) on IAQ presents ways to distinguish between acceptable and non-acceptable materials and to label these accordingly.

In two countries, Denmark and Finland, a special labelling scheme for construction products which takes account of impacts on IAQ has been introduced (IAQ labelling). It is based mainly on the measured emission rates from the materials.

#### **IAQ labelling in Finland**

In Finland, this IAQ labelling is an essential part of a larger national classification system of indoor climate, quality and cleanliness of construction works and emissions from finishing materials. The aim of the whole system is to enable the house owner, as well as the technical planners, to choose an appropriate level of IAQ and to find proper technical ways to achieve it.

#### *Subsidies*

Governments may also consider it necessary to improve the IAQ in buildings by financial incentives. Probably the most common way is to give higher subsidies for particular repairs, refurbishment and reconstruction activities, which have a positive effect on IAQ in practice. For example, in Finland during the years of economic depression in the mid-1990s, the Government

gave subsidies to private house-owners to undertake reconstruction work to activate the construction sector: measures to avoid mould problems or otherwise improve IAQ received a double subsidy.

Financial subsidies may also be directed to the inspection of buildings. Energy inspections, aimed at identifying possible ways to improve the energy economy of buildings, are today quite common and in many countries are subsidized by the government. Such inspection programmes should in the future also be directed to cover the possibilities for improving IAQ in these buildings.

#### *Taxation*

Positive improvements to IAQ may also be promoted by the use of selective taxation. The use of high taxes on tobacco products to reduce smoking has also produced positive side effects on IAQ. An example of successful “environmental taxation” is the increased duty imposed on leaded petrol (in favour of unleaded petrol) to help reduce lead in the environment.

### **5. Evaluation of the strategy**

Building and implementing an IAQ strategy may be a long-term task, and its elements may change with the progress in its implementation. Therefore, a periodic evaluation of the current status of the programme and of the direction and progress of its activities is necessary. Even partial completion of the strategy may have beneficial effects on public health. This should be recognized and used to support the full implementation of the programme. The critical assessment of partial achievements (or the lack of success) may increase the effectiveness of further activities by identifying necessary adjustment to them or verifying priority directions and methods.

To allow an evaluation of the effectiveness of the strategy, clearly defined goals or objectives must have been established. The goals may specify intended reduction of population exposure or the implementation of actions aiming at reducing exposure risk. For example, the goals may specify (a particular degree of) attainment of the WHO *Air quality guidelines* or of national guidelines with respect to specific compounds, or a reduction of the proportion of houses equipped with unvented appliances.

### **5.1 Programme evaluation check-list**

The previous sections of this document have presented and discussed individual elements of the strategy in detail. In this section, the main possible elements of the strategy are compiled and presented in the form of an evaluation check-list. Their review should facilitate evaluation of both the success and the completeness of the programme. The points below summarize the main elements only; more detailed and specific indicators may be necessary to evaluate a programme implemented in a well defined national or local situation.

#### *A Programme design*

1. Are the goals of the strategy clear and eligible for verification?
2. Have the main IAQ problems of the target population been identified (what are the problems; where; what is the extent of each problem)?
3. Are the necessary capacities and capabilities to construct the action plan available and have they been recruited?
4. Has the action plan been written up and published?
5. Does the action plan match the strategy?
6. Has the action plan been discussed with the stakeholders; has their support been assured?

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*B Preparation for programme implementation*

7. Is the public aware of the significance of good IAQ (health and economic aspects)?
8. Have the relevant legislative bodies accepted the action plan?
9. Have the agencies responsible for implementation been identified?
10. Are the (financial and professional) resources necessary for implementation available?

*C Definition and means of implementation of actions*

11. Are the remedial (or preventive) actions for each of the IAQ problems defined?
12. Is the expected effectiveness of each of the actions defined?
13. Are the proposed actions feasible in present conditions? Are the determinants of their success or failure defined?
14. Have the stakeholders been informed about the actions, their costs and benefits?
15. Has the collaboration of all stakeholders been assured (or at least sought)?

*D Programme monitoring and evaluation*

16. Have the indicators of programme implementation and its effects, together with the time schedule for achievement, been defined?
17. Are systems for monitoring and evaluating programme implementation installed (personal, financial, organizational capacities)?
18. Does the established monitoring show improvement in indicators relevant for IAQ?

19. Are the research capacities available to quantify IAQ problems, to identify new problems and to devise optimal preventive or remedial measures?
20. Is the information for the general public, national and local governments and each of the economic sectors relevant for IAQ available, up to date and supportive of effective actions?

## **5.2 Methods of evaluation**

Most of the criteria listed above are qualitative; some may depend on subjective assessment. For instance, the resources needed for action may be inadequate from the point of view of the institutions appointed as responsible for the actions, but excessive from the point of view of current budgetary possibilities. However, in each case, a reference scale should be defined allowing progress in the programme's implementation to be assessed. The assessment should be repeated periodically using the fixed evaluation criteria and this defined scale.

It should be recognized that an improved situation assessment, new research, or changes in determinants of IAQ may impose changes in the strategy. This may require periodic review and update of the strategy and of the evaluation criteria. Research programmes should provide a basis for such a strategy review.

## **6. Examples of national strategies**

The following sections, prepared by members of the Working Group, are intended to provide a general overview of the diverse approaches adopted for the management of IAQ in various countries. These presentations were available to all participants in the Working Group but were not discussed or reviewed by them. Therefore, in contrast to the previous sections, the texts below should not be considered as endorsed by the Working Group.

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## **6.1 Indoor air quality in the Czech Republic (R. Kubinova)**

### *Assessment of the national situation*

The pilot study Quality of Indoor Air is part of the system for monitoring the environmental impact on the health of the population (four big cities, 30 flats per city). The study has been carried out among young families with at least one pre-school-aged child. The result should be interpreted as descriptive of the particular population group and is expected to be different for other population samples. The study revealed that the population monitored is not at acute risk of health impairment. Nevertheless, the indoor environment of 10–15% of the flats studied harboured at least one factor at the risk limit. Nitrogen dioxide was found in concentrations above  $100 \text{ ug/m}^3$  in 9.2% of households and above  $50 \text{ ug/m}^3$  in 30.9%, formaldehyde above  $60 \text{ ug/m}^3$  in 20.1%, and airborne fungi above  $500 \text{ CFU/m}^3$  in 12.6%.

Radon emitted from the geological basement into indoor air constitutes the principal source of the overall exposure to radon of the population. Residents of buildings with a volume equivalent activity of radon in the indoor air above the intervention level of  $200 \text{ Bq/m}^3$  are systematically selected. The inquiry programme has so far found about 8300 buildings out of the estimated 65 000 buildings in the Czech Republic.

### *Legislation*

Ministry of Health directives on some aspects of the indoor environment mainly relate to the occupational environment. Special legislation on IAQ is not valid. Guidelines on IAQ limit values prepared by the National Institute of Public Health (NIPH) are used on a voluntary basis and are predominantly implemented by the Public Health Service and the professionals involved in the construction and reconstruction of buildings. A draft Directive on Building Materials and Health Protection has been prepared under the responsibility of the Ministry of Health. The following relevant legislation should also be taken into account: the Building Construction Act, the Directive on

Products, the Environment Act, the Act on the Environmental Impact Assessment, the Clean Air Act, the Directive on Green Labelling and a set of national technical standards on technical parameters of building and building facilities.

The new legislation aims at eliminating the sources of indoor pollution and limiting the use of polluting material. A system for controlling, testing and/or labelling building materials and appliances used in buildings has to be set up.

#### *Research*

A number of descriptive studies have been carried out of the IAQ in different indoor environments, especially homes, schools and hospitals, with a special emphasis on people who are sensitive to IAQ, i.e. those with asthma or hypersensitivity and children. There have been intervention studies on house dust mite elimination at home and the degree of asthma. Methods for laboratory testing of building material have been developed. A pilot study of the system of monitoring the environmental impact on public health is being carried out. The aim of the studies is to evaluate the health risk in buildings, set indicators for IAQ, screen the methods for assessment of health risk and limit the values, and to prepare guidelines for the elimination of sources of indoor pollution.

#### *Information, education, training*

The Council for Indoor Environment (advisory board of the NIPH) has made proposals for the education of graduate professionals in the Public Health Service. The subject of indoor environment has been added to the curriculum of medical students, nurses and public health nurses. There have been several seminars and workshop on IAQ health risk for public health professionals and for professionals involved in building construction. A brochure entitled *How to live with allergy*, a poster and a video have been made for parents. Articles on healthy housing have been published in newspaper and journals.

The Healthy Cities Network is being used to circulate the information.

Education and training aims to increase awareness of the importance of IAQ from a health and environmental protection point of view. The subject of indoor environment, especially IAQ, should be included in the curriculum of technical professionals involved in building construction and management. Consumers' awareness of ecological households should also be increased.

#### *Other incentives*

Building materials and products, including recycled materials, are controlled and tested from a technical, health and environment protection point of view. Green labelling for some products only (e.g. water-based paints and lacquers) has been introduced. This increases awareness of green products among manufacturers, producers and consumers. It is also planned to set up a system for the labelling of furniture, carpets, flooring and other materials used in the indoor environment, and to improve the criteria for testing and evaluating building materials and products.

### **6.2 Indoor air quality in Denmark (O. Nielsen)**

Legislation on the indoor climate in dwellings, family houses and non-industrial workplaces is the responsibility of the Ministry of Housing. One of the purposes of the Building Act is to ensure that buildings are constructed and furnished in a safe and healthy way. Such a general requirement does not result in satisfactory buildings.

Our two building regulations have contained for some time a number of specific requirements regarding home design, sanitary conditions, insulation, energy consumption, fire safety, recreational areas, facilities for the disabled, structural conditions, etc. Since 1995 the building regulations also contain a section on indoor climate with specific requirements regarding

ventilation, contamination from building materials, other contaminants and temperature.

In respect of legislation, indoor climate is a new topic where there is limited regulation. This is primarily due to the fact that, although there has been research in many areas of indoor climate, we simply do not know enough about it to be able to quantify requirements for regulations. This also reflects the fact that the relevant authorities have been unsure as to what kind of requirements could be made and how the issue could otherwise be tackled through regulation.

Another reason for the limited amount of regulation in this area is that the indoor climate researchers and the authorities have not been working together well enough. Researchers have been too reserved in their dealings with authorities with respect to providing information on new research findings and how these findings could be used.

In order to contribute to more and improved communication between the authorities and researchers and between technical and biological researchers, the Ministry of Housing has for many years had a collaboration committee on indoor climate. The activity of the committee has been very fruitful.

The task of the authorities with respect to indoor climate does not only concern new buildings and major rebuilding work; it also involves existing buildings and solving existing indoor climate problems. The task of a public authority is not simply to set out requirements for the building regulations but also to pass on the need for environmental and health quality requirements to producers of building materials, construction consultants, contractors and, especially, the end user.

In Denmark we have succeeded in pointing out that not only authorities can make demands on, for instance building material producers. Builders and their consultants are very important

groups in this respect. Thus, an important role for the authorities in this connection is to provide information, to take the initiative, to support relevant indoor climate research (among other things), and to take part in a wide range of efforts to inform both the experts and the general public.

Several years ago the Ministry of Housing also took the initiative and supported the development of a labelling scheme for building materials: Danish Indoor Climate Labelling. The scheme, which has been running for several years, is not based on legislation but on marketing forces. The use of the labelled building materials is recommended in the building regulations but is not a requirement.

Up to now the building regulations have included indoor climate legislation concerning such pollutants as: formaldehyde, asbestos, man-made mineral-wool fibres, fly ash and clinker from coal firing (gamma radiation), nitrogen oxides, radon and other contaminants from the subsoil. The ventilation requirements indirectly give levels for air humidity. On the basis of current knowledge and legislation and also on the practice, the Ministry of Housing is satisfied with the indoor climate regulation of the building regulations.

One of the greatest difficulties in improving indoor climate legislation is our limited knowledge of the effects of low doses of chemical pollutants on human organisms combined with the exceedingly large number of pollutants found in the indoor environment. This makes it necessary to look for possible synergistic effects as well. Although Denmark does not currently make use of actual indoor climate limit values in the indoor climate legislation, this form of regulation cannot be ruled out as a possibility. However, as far as pollutants from building materials are concerned, it is the Ministry's impression that using limit values for climatic chambers and corresponding mathematical models to calculate normal indoor climate

concentrations under standardized conditions will prove to be a more suitable method.

If we all want to speed up the process of making healthier buildings, players other than public authorities will also have to enter into the process and make demands on, among others, the producers. This has started to happen, but there is quite a long way to go.

### **6.3 Indoor air programme in Estonia (O. Sadikova)**

Estonia has adopted Air and Radiation Laws. Problems of IAQ are currently being dealt with by specialists in the Health Protection Department of the Ministry of Social Affairs, which was set up in June 1997.

Strategic approaches for indoor air policy are at the preparatory stage. The main tasks of the planned action is to prepare legislation on the following issues:

- physical parameters of indoor air
- chemical pollutants
- radon
- emissions from building materials and fittings/furnishing
- ventilation
- biological agents
- sick building syndrome.

*Physical parameters of indoor air, including temperature, humidity and air velocity*

Approximately 35% of the population live under conditions which do not meet the microclimate requirements. The microclimate regulations have been adopted.

The normal temperatures in non-industrial buildings are between 18 °C and 28 °C. Differences in the occupied zone in the same room are less than 2–3 °C per hour. Measurement points are to

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be placed 0.6 m above floor level for seated activities and 1.5 m above floor level for standing activities.

Air velocity is mainly measured to assess the risk of draughts. Together with air temperature and radiant temperature, air velocity is considered in the assessment of the thermal load. In the recommended temperature range, a mean air velocity below 0.15 m/s is considered satisfactory.

#### *Assessment of chemical pollutants in indoor air*

Since the 1980s IAQ has been estimated according to the classification of rooms. In rooms in buildings such as pre-school children's institutions, schools and colleges, boarding schools, hospitals, houses for invalids and elderly people, sanatoria, dwelling houses, theatres, cinemas and canteens the air quality is evaluated in accordance with atmospheric air daily allowed concentration limits. In order to evaluate the air quality in manufacturing establishments, the occupational exposure limits are used.

The main compounds monitored are:

- formaldehyde
- ammonia
- phenol
- carbon monoxide
- carbon dioxide
- nitrogen dioxide
- ozone
- hydrogen chloride.

These indexes were determined in accordance with patients' complaints, allergic tests and the building materials, adhesives, paints, etc, that had been used.

At present there is a lack of research which would enable decisions to be taken about the living conditions of the

population. The work is directed to controlling the emissions from building materials (fittings/furnishings).

#### *Radon level in dwellings*

In 1989 the Estonian Building Research Institute and the National Board for Health Protection started measuring radon levels in dwellings. As a result of radiation from uranium (100–200  $\mu\text{g/R/hour}$ ) in alum shale (argillite), which forms the bedrock in north and north-eastern Estonia, indoor radon concentrations are likely to be elevated where the sediments covering the alum shale are thin and highly permeable. The highest average concentrations have been found on the north-east coast: 256  $\text{Bq/m}^3$  in Silamäe, 451  $\text{Bq/m}^3$  in Tapa. Investigations are continuing in this direction.

#### *Toxicological research on the emission from building materials, fittings and furnishings*

Toxicological research has been carried out when products have not met their requirements (people's complaints). All materials for use in buildings, whether imported or manufactured in Estonia, receive certificates from the National Board for Health Protection, which enable them to be sold in the country. Quality certificates, health certificates and material data sheets are accepted. According to the results of such research, the use of the materials for the different types of building is determined.

#### *Ventilation*

Indoor climate problems often occur because the ventilation installation does not work properly, either because the rate of ventilation is too low or because of a lack of efficient ventilation. About 4.59% of the population are exposed to these conditions. Therefore, it is necessary to choose the right type of ventilation at the development stage of a project.

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### *Airborne micro-organisms*

Biological tests for airborne micro-organisms (fungal spores, bacterial cells) are being carried out.

### *Sick building syndrome*

At present the study of the sick building syndrome has encountered financial problems.

The substances classification (S- and R-phases) and Air Quality Guidelines are under preparation. The list of prohibited or strictly limited chemical substances will be finalized. All these documents are being prepared according to WHO and EU recommendations.

## **6.4 Indoor air quality in Germany (B. Seifert)**

### *General background*

Germany has been involved in problems relating to IAQ for a long time now. As early as 1858, Max von Pettenkofer published a figure of 0.1% for the volume concentration of carbon dioxide in indoor air, and about a century later, in 1977, the Federal Health Office recommended a figure of 0.1 ppm for formaldehyde in indoor air. Many other countries have followed these recommendations. Over the last two decades Germany has been active in various areas related to IAQ. Research in this field has been continuously promoted and supported, so as to react adequately to known and anticipated problems. Because of the restricted length of this document it is not possible to enter into details. The following text is limited to a report on the setting-up of a general strategic approach to achieve better IAQ, which was undertaken in the 1990s.

### *The German concept for better indoor air quality*

In view of the importance of IAQ for human health, consumer protection and environmental protection, the Federal German Government, in 1990, decided to set up a working group to

develop a national concept dealing with IAQ. As indoor air problems come under more than one ministry, an interministerial working group (IWG) was created comprising representatives from the Ministries for the Environment, Nature Conservation and Nuclear Safety (chair); Health; Economy; Construction; Labour and Social Affairs; and Research and Technology. Other ministries joined the IWG for the discussion of specific topics. The group was completed by a few experts from federal scientific institutions, such as the Institute for Water, Soil and Air Hygiene of the former Federal Health Office, the Federal Environmental Agency and the Federal Agency for Occupational Protection and Health.

In the Federal Republic of Germany a number of responsibilities and regulatory activities, such as the building codes, lie with the federal states (Länder). The Federal Government's concept for better IAQ was therefore also discussed with representatives of all German states before publication. The concept was published in 1992.

As a follow-up, in 1996, the Government responded to the German Parliament's request with a report on the results achieved so far. As could be anticipated (and continuously emerging new research results are only one reason for this), not all proposals could be transformed into activities and brought to a successful and complete end. However, by laying down the elements of a strategy, the concept has proved to be an excellent tool for sharpening the awareness of all parties concerned for the need for better IAQ.

#### *Contents of the concept*

The concept is divided into two parts, general and specific.

The general part starts with a description of the background, describing the importance attached to IAQ by the German Government and strongly emphasizing the need for an interministerial approach. It gives a short overview of the

history of IAQ activities in Germany and puts these activities into the context of international developments in this area. It also gives a definition of the indoor spaces considered in the report. These do not include workplaces, which are subject to special regulations concerning the handling of dangerous substances.

The importance of the problems posed by indoor air pollution is stressed, especially in view of the time spent indoors, the quality of the building stock, and the role of indoor climate. A special section discusses the principles which can be applied to control indoor air pollution, including the precautionary principle, the cooperation principle, and the polluter-pays principle.

The general part also emphasizes that changes in individual behaviour can help to decrease exposure to indoor air pollutants, and lists sources in categories regarding the possibilities for occupants to reduce pollutant levels. In fact, source control remains the most important tool for such reduction and may be achieved by either behavioural changes or by setting product-related requirements. If preventive measures have not been taken or have been unsuccessful, curative procedures need to be applied.

The general part ends with a discussion of the usefulness and applicability of indoor guideline values. It also addresses the problems encountered in the implementation and further development of regulatory tools. Such problems include the declaration of product components, the registration of substances and formulations in the field of pesticides accessible to the consumer and the implementation of tobacco smoke abatement. The full consideration of aspects of IAQ and health in the implementation of the European Directive on construction products or corresponding national legislation are also included. Finally, the importance of information and education at the various levels is stressed.

The specific part contains 13 sections which address the sources and classes of sources that have an impact on IAQ. These are, in the order given in the concept:

- building products;
- furnishings and equipment;
- open flames and fire places;
- heating, ventilation and air-conditioning systems;
- radon;
- the surrounding environment, with special emphasis on buildings in the vicinity of waste sites and highly trafficked areas, and on dwellings near trading and commercial activities;
- cleansing and maintenance products;
- products for pest control and disinfection for the protection of wood, textiles and indoor plants;
- consumer and do-it-yourself-products;
- tobacco smoke;
- house dust, micro-organisms and substances giving rise to allergic reactions;
- inappropriate use of chemical substances and products indoors;
- air pollution inside passenger cabins of transportation vehicles.

Each section of the specific part is structured according to the same principle. First, there is a summary of the currently available knowledge on the relevance of the respective source of the IAQ and of the current deficits in our knowledge. Second, all pertinent regulations that relate to indoor air are listed. These regulations extends over a wide range of areas, including building codes and acts concerning hazardous chemicals, fire safety, communicable diseases, consumer products and radiation protection, to name a

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few. Third, the general goals to be reached are laid down. At the end of each section, a number of measures to achieve better IAQ are proposed. The proposals refer to, inter alia, regulatory aspects, enhanced transfer of information and research projects.

### **6.5 Indoor air quality in Lithuania (N. Jatulienė)**

In 1990, after the restoration of independence in Lithuania, progress was made in the establishment of a foundation for State legislation based on the individual right of every citizen to be free and equal and to live in acceptable conditions. A system of ecological requirements and legislative norms, according to which the authorities should regulate activities, has been developed for the implementation of the environment protection policy. The national strategy for environment protection is based on the principle that large-scale environment protection should be assured through a system of public and national measures ensuring a harmonious interaction between people and environment. Legislation governing the collection of data on ecological tendencies should be improved, so that medical workers can participate as well as lawyers and environmental investigators.

In 1991 the Government passed a resolution on the privatization, sale and use of apartments. According to this resolution all the permanent residents of Lithuania who rent public apartments or apartments belonging to their employers have the right to buy them. By 1995, 77% of all publicly owned apartments had been privatized under this law. Subsequent laws lifted many earlier restrictions, such as limits on the choice of residence. This was a cardinal change for the inhabitants of Lithuania. An apartment or a house and land became their own property, of which they are free to dispose.

At present, there is a shortfall of 100 000 apartments in Lithuania: out of every 1000 residents, 329 have an apartment as against 473 in Denmark and 471 in Sweden. Considerable attention must be paid to the situation in Lithuanian villages,

where there is no shortage of apartments but the communal accommodation conditions are poor. Exact statistical data on the condition of rural residential houses are not available. On the basis of technical parameters new houses are better: new building materials are being used, designs are better, microclimates can be regulated and ventilation systems have been improved. According to 1996 data from the Ministry of Construction and Urban Planning, the situation in places of residence is not, however, satisfactory, although there are some improvements in the supply of apartments. Following the 1996 study on the development of towns, settlements and places of residence, the National Action Plan up to the year 2000 was developed. Furthermore, a Government-supported "Residential Space" programme has been carried out.

The main goal of indoor air hygienic supervision is the control of chemical, physical, biological and other pollutants in the environment and in residential and public buildings, as well as assessment of health risks from exposure to risk factors. In 1996 the National Board of Public Health Supervision in Controlling Environmental Air Pollution in Vast Territories evaluated the impact of pollution sources on the environment of sites destined for the construction of buildings. The regional institutions of public health care service monitor atmospheric air pollutants and carry out control studies in cities and residential areas in collaboration with the appropriate departments of the Ministry of Environmental Protection. Investigations are made at 20 stationary sites in Vilnius, Kaunas, Klaipėda, Siauliai, Panevėžys, Jonava and Kėdainiai. Over the period 1993–1996 there was hardly any change in urban air pollution. The air quality was also systematically controlled in the scope of investigations conducted in the Mazeikių Nafta and Jonavos Azotas factories, the Kėdainiai chemical plant and the Naujoji Akmenė building materials factory. Tests have been performed with about 20 harmful mixtures in these sites. There have also been occasional studies on the pollution of atmospheric air.

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The Ecological Medicine Centre of the Hygiene Institute carries out tests for polycyclic aromatic hydrocarbons (PAH) in the air in buildings and in residential environments. Since 1980 the Republican Centre of Allergology has, in cooperation with the Institute of Botany, been carrying out the Programme of Allergens in Household Environment. Every year about 14 000 samples of atmospheric air are tested by the hygiene service. Over the period 1989–1997, 14.35% of all atmospheric air samples did not conform to the hygiene norms established in Lithuania. From 1991 to 1997 no observations, follow-up or research work were carried out by any state institutions other than by the State Public Health Service and the Centre of Radiation Safety, which is carrying out the programme on Prevalence of Radon in the Residential Environment.

The principal measures for the regulation of IAQ are the official hygiene norms, which establish mandatory control limits so that environmental air pollutants do not have an impact on the health of the population.

Hygiene norm HN 35-1998 “maximum allowable concentration of chemicals polluting air of the residential environment” applies to indoor air in residential areas and residential and public buildings, except premises where industrial activity is carried out. This norm is observed by the institutions of design and technology development, by the enterprises involved in production or economic activity, by organizations, juridical and physical persons, and scientific and scientific research institutes, such as institutions performing follow-ups and control of air pollution. The norm was adopted on 1 October 1993 and is revised every three years. This norm includes the following official terms and definitions:

1. maximum allowable concentration for atmospheric air pollutants (MAC)
2. daily MAC
3. single MAC

4. tentative safe level (TSL)
5. residential environment – non-industrial environment of humans, where they are exposed to external (chemical, physical, biological) factors.

Annex A to HN 35-1998 contains an evaluation of the atmospheric air impact of a mixture of pollutants. Annex B contains indicated synonyms of indoor air pollutants, their names and codes. When HN 35-1998 does not specify MAC or TSL of the environmental air pollutant, a juridical person follows the appropriate documents of other countries. The Ministry of Health Public Health Centre has a database of international information at its disposition. Although other countries' regulations (not adopted by the established order) are not in force in Lithuania, they may be taken into consideration in the process of decision-making in a particular situation.

Territorial planning must follow obligatory hygiene conditions, which include rules for land use at national and local level, areas designated for construction, sanitary protection zones of objects contaminating the environment and of health resorts. When the hygiene of these designs is assessed, technological, technical and organizational measures are required not to exceed the values of pollutants given in hygiene norms. Since the object under design may contaminate the environment as a result of its economic activities, a separate section of the rules on environmental protection is being prepared. On 1 January 1994, the "Rules for Preparation" – RSN 153-93, a normative document approved by the Ministry of Construction and Urban Planning and by the Department of Environmental Protection, came into force. Every year the Ministry of Construction and Urban Planning issues revised lists of constructions, building and decoration materials, the order of their licensing, and the institutions allowed to perform these assessments and authorized to give licences.

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The following hygiene norms control the quality of the residential environment:

- HN 23-1993 “Harmful substances. Maximum allowable concentration in the workplace air”;
- HN 33-1993 “Acoustic noise. Allowable levels in the residential and working environment. General requirements for noise measurements”;
- HN 50-1994 “Vibration affecting the whole human body. The highest value allowed and requirements for measurements in residential and public buildings”.

Consideration was given to appropriate European Union documents when these hygiene norms were established (except HN 23-1993).

A new hygiene norm “Micro climate of residential and public buildings” was to be approved and adopted in 1998 (HN 42-1999).

The points mentioned only account for a small proportion of all the problems, but in the present economic and social situation in Lithuania it will be impossible to solve them in the near future. International collaboration and participation in different programmes, including the WHO programme, evaluating IAQ would help to solve problems more effectively.

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## **6.6 Indoor air quality in the Netherlands (C. van de Bogaard)**

In the Netherlands, the Ministry of Housing, Spatial Planning and the Environment (VROM) is responsible for the indoor environment. Together these three departments aim at improving the quality of the physical environment, the spatial quality and the quality of housing. The quality of the indoor environment is part of this policy. Specific targets for IAQ have not been set, partly because the actual quality of the indoor environment is mainly determined by the behaviour of the users of the buildings.

The Government has only limited possibilities of influencing this behaviour, and therefore standards for IAQ are not considered meaningful. For this reason more effort is made to improve the indoor environment as part of general policy.

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The quality of housing is determined by the availability of sufficient dwellings, technical qualities, design, costs, size of living space and physical and social environment. Continuous use of the available housing stock and a stable social structure are of primary importance. Attention has shifted from the quality of indoor air to that of living conditions in relation to, for instance, the availability of work, safety in the neighbourhood, troubles arising from drug use, environmental pollution, dirt in living quarters and conflicting lifestyles – problems that often accumulate in older neighbourhoods.

#### *Description of the situation*

Every four years the National Institute for Public Health and the Environment (RIVM) produces an overview of indoor environment problems as assessed in their national surveys. The five most important problems in the Dutch indoor environment are: concentration of nitrogen dioxide (in 90% of houses), noise pollution from neighbours (in 80%), radon concentration (70–80%), fine dust particles (in 62%) and allergens for house mites and moulds (in 15% of the houses).

Additional information is gathered through investigations of complaints regarding the indoor environment registered by the health section of the housing departments of the local government and housing cooperatives. An example of this type of investigation is the periodical qualitative dwelling survey. In 1996, according to this survey, 81% of the dwellings were classified as good, 13% lacked basic amenities, 4% were unfit and 2% were in serious disrepair.

#### *Legislation and policy on housing*

The basis of healthy housing is the building decree on housing. This decree contains technical regulations on requirements for the construction and designs of buildings. It covers only the essential aspects, as its aim is to give maximum freedom to both the owner and the user of the building. Safety, health, functionality and energy conservation are subject to regulation.

There are health requirements on noise reduction measures, the drinking-water system, on protection against radiation or hazardous or noxious substances as well as on ventilation. In this system minimum quality is defined for both existing and new houses. A similar decree is in preparation for commercial dwellings such as offices, schools and institutions for health care. At workplaces the law on working conditions is also applicable. This law includes a decree on safety for offices and schools and deals with noise, ventilation, lighting and landscape.

#### *Policy regarding spatial planning*

The intention of spatial planning is to separate housing geographically from industrial activities, so as to prevent environmental pollution of living conditions. By emissions into air, water and soil, industrial activities can cause pollution, noise or bad smells, and can even involve safety risks in case of accidents. Lack of space and traffic emissions provoked by an increase in traffic due to the need for mobility has led to changes. Nowadays, it is policy to integrate the functions of living, working and recreation. The idea of this “compact city” is realized in so-called “Vinex-locations”, regions appointed as growth centres.

#### *Environmental policy*

In the framework of the Dutch National Environmental Policy Plan the building trade is one of the target groups. In consultation with this group a special environmental policy has been developed including the setting of targets and specific goals. These goals are directed at reducing the use of rare raw materials, saving energy and improving quality. Policy concerning the indoor environment was formulated separately in the policy paper on buildings and the indoor environment, in which priority is given to humidity in relation to health problems of the airways, gases from burning fuel, nuisance caused by noise or noisy neighbours, radon emanation, fine dust particles, benzene, asbestos and formaldehyde.

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The general environmental policy also influences the indoor environment and especially air quality, by reducing the emissions of substances from industrial activities and traffic. Important in this respect is the reduction in the emissions of SO<sub>2</sub>, NO<sub>x</sub>, fine dust particles and VOCs and a decrease in the use of pesticides. A policy on radon is also being developed. The goals of this policy are translated into functional requirements for dwellings.

#### *Research*

There is no strategic research programme directed at IAQ, but a considerable amount of research, supported by the Government and on the initiative of other organizations, is being carried out. At this moment the research ranges from intervention studies into house-mite allergy, separation and storage of organic waste inside homes, energy-saving in relation to essential ventilation, to health classification for houses, health risks of asbestos in dwellings and emissions of construction products.

The effects of the increased use of (office) equipment in dwellings need to be examined further.

#### *Dissemination and implementation of available knowledge*

The Ministry of VROM is of the opinion that there is already an abundance of both knowledge and technology on healthy living conditions. Its policy is, therefore, aimed at collecting this knowledge and making it available to both the building trade and consumers. The basic principle is to test solutions on pilot projects and when the outcome is positive, to include them in regulations. It is vital to do this in cooperation with building professionals. At national level this is done by a consultative body (National Housing Board), where developments in sustainable building are discussed and implemented, in close cooperation with the Government, the building trade and the unions. The Board has developed a national package for sustainable building to be used by local and regional builders or other customers. This contains some

160 voluntary measures which not only elucidate aspects such as energy- and water-saving, but also of the indoor environment and the use of building materials. It includes measures that lead to better air quality, a higher degree of thermal comfort and a lower degree of nuisance from noise.

There is also a national consultative body for healthy living conditions in the indoor environment with working parties, such as houses, schools and office buildings. A national information office (DuBo Centre) has recently been established. Anybody working in the building trade can contact it to get information on sustainable building, especially information on local rules and regulations, as the local policies on environment, housing, spatial planning and health have to be integrated. Ideas and initiatives from Agenda 21 and the Healthy Cities Project have been included. Local authorities organize information campaigns directed at intermediaries and the public. On this level complaints regarding the indoor environment are dealt with by housing authorities and the departments of preventive health and pest control.

#### **6.7 Indoor air quality in Poland (S. Maziarka)**

During the past few years, wood impregnates based on pentachlorophenol have frequently been used in buildings, as a remedial measure against biological corrosion. As a consequence, the indoor air of many flats and houses has been heavily polluted with chlorophenols, dioxins, aromatic hydrocarbons and so on. On many occasions, the State Sanitary Inspection has been obliged to disqualify indoor air. So far more than 10 000 flats and houses (including new ones) have been reconditioned with elimination-impregnated materials, but about the same number of flats need to be renovated (1). An epidemiological study in the town of Gdansk revealed the harmful effects of these pollutants (2). In the light of different expertise and examination of air, the main sources of indoor air pollution are as follows:

- wood impregnants;
- formaldehyde resins present in many different building materials (insulation foam, chipboard, mineral wool, etc.);
- coal tar substances;
- organic solvents present in glues, paints and other building materials;
- asbestos fibres.

The health risk related to asbestos fibres is rather theoretical. Research into air pollution by asbestos fibres has not revealed a substantial growth of that risk. In Poland, asbestos has been used as asbestos-cement plates on roofs and external surfaces of walls (3).

Evaluations of and research into IAQ indicate that very important health risk results from gas installations in kitchens and bathrooms. Faulty facilities of gas fire devices in combination with insufficient ventilation generates great concentrations of toxic substances in living spaces (4).

In view of multiple examples of heavy indoor air pollution, the Government has decided to organize a systematic control of IAQ and of sources of pollutants in the indoor environment. The following measures have been undertaken.

- The National Institute of Hygiene has been appointed to attest health aspects of all building materials. Each year about 2000 building materials and products are evaluated from a health point of view. The tests are performed by the Institute of Tropical and Marine Medicine. The evaluation is based on legal regulations issued by the Minister of Building and Building Materials (5).
- Sanitary epidemiological stations, such as the State Sanitary Inspection, have to control the indoor environment and determine health risk. If concentrations of harmful

substances exceed the allowable limits the sources of pollution must be traced and eliminated or reduced.

- Special national funds have been set up for the elimination of health risks related to harmful building materials. They are used to eliminate defects in buildings caused by incorrect building, legal regulations or officially accepted building recommendations.
- The National Institute of Hygiene organizes training courses in the field of indoor environment protection, elaborates basic principles of testing building materials, and evaluates health risks and methods of indoor air examination. It recently drew up detailed guidelines on these subjects (6).
- A special Standard Committee has been funded in the framework of the Polish National Standard Organization with the main task of issuing standard methods of indoor air examination, for example for testing for: acrylonitrile, benzene, butanol, chlorobenzenes, chlorophenols, chloronaphthalenes, cyclohexane, ethylbenzene, phenol, formaldehyde, dibutylphthalate, cresols, p-cumenophenol, naphthalene, styrene, carbon monoxide, toluene and vinylchloride.
- On the basis of the building law the Minister of Health and Social Welfare has issued a decree determining the maximum allowable concentrations of harmful substances in indoor air (Table 1) and the maximum intensity of different physical factors (7). It also enumerates some very dangerous substances or mixtures thereof and determines their restrictions in buildings (a negative list) (Table 2).
- Three national research institutes are engaged in scientific work in the field of the indoor environment.

Table 1. Maximum allowable concentration of harmful substances in indoor air

	Substance	Allowable concentrations [ $\mu\text{g}/\text{m}^3$ ]	
		Category A	Category B
1	Acrylamide	1	3
2	Acrylonitrile	2	3
3	Ammonia	300	300
4	Benzene	10	20
5	Butadiene	100	300
6	Buthanol	300	300
7	Chlorobenzene	15	40
8	Chlorophenols (without pentachlorophenol)	15	20
9	Chloronaphthalenes	15	30
10	Cyclohexane	250	250
11	Cyclohexanone	40	100
12	Dichlorobenzene	30	50
13	Ethylbenzene	100	150
14	Phenol	20	50
15	Formaldehyde	50	100
16	Dibutylphthalate	100	150
17	Phthalate anhidrine	40	80
18	Ethylene glycol	15	50
19	Cresols	25	50
20	Xylene	100	150
21	p-cumene phenol	40	80
22	Maleinic anhidride	50	100
23	Napthalene	100	150
24	Butyl acetate	100	150
25	Ethyl acetate	100	150
26	Vinyl acetate	50	100
27	Ozone	100	150
28	Pentachlorophenol	5	10
29	Mercury	1	3
30	Styrene	20	30
31	Carbon monoxide	3000	6000
32	Toluene	200	250
33	Trichloroethane	75	150
34	Trichloroethylene	150	200
35	Vinyl chloride	5	10

Note: Category A – exposure up to 24 h per day.  
Category B – exposure limited to 8–10 h per day.

Table 2. Restrictions related to chemical substances or their mixture in building materials

	Name of substance	Limitation
1	Acrylamide and acrylonitrile	To be absent
2	Asbestos fibres	Ought to be absent as admixture
3	Benzene	Not more than 0.1% in materials
4	Benzine and another organic solvent in products for injections into walls	To be absent
5	Chlorophenols	Ought to be absent in materials applied inside buildings
6	Chromate ( CrVI )	Ought to be absent
7	Carbon tetrachloride	Ought to be absent
8	Mixture of aromatic hydrocarbons	Ought to be absent in materials applied inside buildings
9	Ethylene glycol	Ought to be absent in materials applied inside buildings
10	Cadmium as a pigment	Not to be used
11	Lindan	Ought to be absent as admixture
12	Methanol	Not more than 2% in materials
13	Lead as a pigment	Ought to be absent
14	Lead as a anticorrosive factor	May be used only in industry buildings excluding food industry
15	Tar substances ( from coal )	Only external application
16	Aromatic hydrocarbons as a solvent	Not more than 20% in materials used inside of buildings
17	Chlorohydrocarbons	Not more than 5% in materials

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### **6.8 Approach to the solution of indoor air quality problems in the Russian Federation (A.I. Kucherenko)**

Indoor air quality has a serious influence on strengthening and protecting human health in different age and social groups. It also determines the quality levels of recreational conditions.

These problems are determined by the circumstances in which most people spend their time in the indoor environment. It can last from 10 to 23 hours a day or they can remain for 14–16 hours inside their houses. People spend their time in different types of building, including residential buildings, offices, schools, or health care, public or commercial premises.

The low quality of the indoor air environment may cause discomfort in the human organism and could have serious negative consequences for human health, such as an increased rate of lung cancer and other cancer diseases, impairments of the nervous system and intoxication by dangerous chemicals.

One of the basic indicators characterizing the quality of the indoor environment in houses and public buildings is the level of air pollution by chemicals. Due to very small indoor air volumes, the rather small pollution sources are given the potential to produce relatively high chemical concentrations combined with rather long periods of exposure.

The quality of indoor air, in respect to chemical composition, depends in most cases on the quality of atmospheric air around buildings. It has been discovered that the indoor air in residential and public buildings could simultaneously contain more than one hundred chemicals of different classes of chemical compounds.

A common level of indoor air chemical pollution could exceed the level of atmospheric air pollution by 1.5–4 times, depending on the quality and location of atmospheric air and the intensity of the internal sources of pollution. The basic sources of indoor air pollution are:

- construction materials, polymeric materials and furnishing, forming 30–50% of total indoor air pollution by chemicals;
- products of human living activities: 10–30%;
- polluted atmospheric air: 20–40%.

Several legal instruments in the Russian Federation aim to provide safe living conditions for the population, protect their environment and guarantee the safe use and control of chemicals. These include:

- bases of the legislation of the Russian Federation on the protection of human health;
- the Law on Sanitary and Epidemiological Wellbeing of the Population;
- the Law on Protection of the Atmospheric Air;
- the Law on the Protection of Consumers' Rights;
- the Law on Purchases and Delivery of Products, Raw Materials and Food Products for Public Needs;
- the Law on Certification of Products and Services.

Article 17 of the Law on Sanitary and Epidemiological Wellbeing of the Population stipulates that the ambient air in populated areas, and indoor air in permanent and temporary residences of the population, must be in accordance with sanitary rules and requirements.

At present, there is no special programme or any special regulatory document dealing separately with IAQ problems in the Russian Federation.

All the hygienic requirements and norms or standards that deal with IAQ are included in different sanitary and epidemiological rules and norms: the hygienic normatives (standards), the construction norms and rules, and the state standards (GOSTs) on the design and construction of living areas, residential and public buildings, construction products and materials, furnishing, house facilities, etc.

The prevention of living area pollution from the ambient air is also conducted by limiting harmful emissions from industry and transport, by establishing maximum allowable concentrations

(MAC values) of harmful chemicals in the ambient air, and by establishing minimal sanitary protection areas, depending on the sanitary classification of enterprises, the construction and other criteria. This measure gives the possibility of reducing the level of chemical pollution in the ambient air to the established MAC values.

All building and construction materials in the Russian Federation should be checked for dangerous chemical content and should only be used after permission of the Ministry of Health.

The IAQ of residential and public buildings should comply with the established MAC values of chemicals in the ambient air. Laboratory control of the IAQ takes place in order to check whether the levels comply with the MAC values.

There are several research and scientific institutions dealing with the evaluation of the living conditions of the population, including indoor air problems and the interrelation between the IAQ and the health of the population. There are several scientific publications on the results of these studies. One of the basic institutions is the Sytin Scientific and Research Institute of Human Ecology and Environmental Hygiene of the Russian Academy of Medical Sciences. All the activities in this field are coordinated and organized under the Department of the State Sanitary and Epidemiological Surveillance, which is part of the Ministry of Health, as well as by the regional and local centres of the sanitary and epidemiological service.

## **6.9 Indoor air quality in the Slovak Republic (K. Slotová)**

### *Assessment of the national situation*

Although systematic attention is paid to the problem of public health protection in the Slovak Republic, no comprehensive policy and action has been developed in the area of IAQ of non-industrial environments. Various services are actually or

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potentially involved in selected issues related to IAQ, but their actions are based more on circumstantial than scientific evidence. The Ministry of Health has been designated as the leading authority responsible for intersectoral cooperation involving the Ministry of Construction and Public Works, the Ministry of the Environment, the Technical Ministry, the State Service and local government bodies.

In 1997 a project for the investigation of IAQ in non-industrial indoor environments was prepared. The aims of the study were to assess priorities for action and to identify where more detailed analysis or investigation should be concentrated.

The Indoor Air Programme is included in the Action Plan for Environment and Health of the Population of the Slovak Republic under the section "Health promoting living environment in urban and rural residential areas". The document specifies objectives and actions.

#### *Legislative regulations and documents*

Present legislation is subject to re-evaluation in correlation with changing sociopolitical conditions, with the aim of harmonizing legal norms with the laws of the European Union. Several legislative regulations and important documents have been adopted which unanimously proclaim the principles of health protection of the population and environmental protection, delimited by the following:

- Act of the National Council of the Slovak Republic No.272/1994 Coll. on Health Protection of Man;
- Act No.17/1992 Coll. on the Living Environment;
- a prepared set of legal regulations (including regulations of the indoor air) for the execution/ implementation of the Act of National Council of the Slovak Republic No. 272/1994 Coll., which will substitute legal regulations for lower legal forces issued on the basis of Act No. 20/1996 Coll. on the Care of People's Health;

- the National Programme of Health Promotion of the Slovak Republic;
- the principles of the Government's Policy on Health Protection of the Slovak Republic;
- the concept State Policy on the Protection of the Health of Man of the Slovak Republic;
- State Environmental Policy of the Slovak Republic;
- the Action Plan for Environment and Health of the Population of the Slovak Republic.

### *Goals*

The following are the goals to be achieved:

- stopping the deteriorating trend of the health status of the population;
- improving the health status of the population and the environment in compliance with the WHO health for all strategy;
- decreasing the incidence of common risk factors for the most frequent diseases with the aim of achieving a decrease in their occurrence;
- creating efficient approaches to and methods of disease prevention, as well as methods of control.

### *International framework*

The international framework for these activities consists of:

- the WHO European strategy and targets of health for all, healthy policy for Europe;
- target 21 of the European Regional Strategy, requesting that by 1995 everyone in the Region should be effectively protected against recognized health risks from air pollution;
- the NATO/CCMS Pilot Study on IAQ;
- the Environmental Health Action Plan.

### *Research*

Indoor air quality and its impact on humans is the main task of the Section of the Health Protection of the Population and of the Chief Hygienist of the Ministry of Health. The Action Plan for Environment and Health of the Population of the Slovak Republic includes a part on health-promoting living environments in urban and rural residential areas with specific aims and actions.

The National Reference Centre for Health Effect Assessment of the Ambient Air and Non-Industrial Indoor Environments has been established at the Specialized State Health Institute in Banska Bystrica. This Centre has developed a project for investigation of the IAQ in non-industrial environments, addressing all the factors affecting air quality in indoor environments, as part of the national programme of health promotion.

The project is now awaiting approval. Its general objectives will be:

- to decrease the negative influence of the indoor living environment on the health of the population, including maximum elimination of possible limitations and barriers; and
- to promote international cooperation in science and technology related to indoor air.

The specific aims are to:

- identify and characterize indoor air pollutants and sources;
- assess exposure;
- identify the health effects associated with exposure to low levels and mixtures of pollutants;
- develop and validate methodologies for the development of passive samplers;
- develop an information system and database of the gain data.

The policy document will contain studies and analyses to characterize the nature and extent of IAQ problems and levels of integration of information into clear policy options.

The building programme will cover the development of building-related and implementation programmes to encourage prevention, diagnosis and mitigation of IAQ problems.

The pollutant/source programme will include activities to identify and characterize specific indoor air pollution sources and pollutants, and to devise strategies for their control.

The programme will be implemented through the creation of a working group, organization of meetings and workshops and utilization of the literature and experiences of international organizations (WHO, NATO/CCMS, EPA) and other countries.

Other research activities have included:

1. CESAR PROJECT – concentrations of NO<sub>2</sub> and SO<sub>2</sub> were measured with passive samplers in indoor air and compared with the information in the questionnaire;
2. a survey on indoor environment and personal exposure to PM<sub>10</sub>, PM<sub>2.5</sub>, NO, NO<sub>2</sub>, NO<sub>x</sub>, sulfates and nicotine in the framework of the Slovak-American Joint Fund.

#### *Information dissemination, education and training*

A public information and education programme is being developed. Public awareness of the need to reduce health risks from indoor air pollution is poor. The authorities' supervisory responsibilities with respect to inadequate indoor environments need to be extended.

#### **6.10 Outline of national strategy on indoor air quality in Slovenia (M. Macarol-Hiti)**

The problem of indoor air pollution is a growing concern in Slovenia. Unfortunately, most of the legislation concerning IAQ

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still needs to be prepared. The exception is the legislation on occupational environment and smoking in public places.

In the mean time the following topics regarding IAQ are being tackled.

#### *Tobacco smoke*

Tobacco smoke contains over 3800 different chemical constituents and is the most important cause of lung cancer. Some 30–40% of the Slovenian population are smokers. A number of deaths from cardiovascular disease are caused by environmental tobacco smoke. Some 20–30% of all asthma and lower respiratory tract illnesses in small children can be attributed to exposure to tobacco smoke.

The first preventive measure against the effects of tobacco smoke is to remove the source. Consequently, a basic strategic approach of the smoke-free charter was adopted in 1997. The charter sets a number of limitations in order to protect people from tobacco smoke, including the designation of certain areas where smoking is allowed.

#### *Allergens*

Dust mites are widely spread allergens and are responsible for many incidences of asthma and other allergic reactions. Data are very scarce. Guidelines on cleaning were published as part of the national strategy. Most of the recommended measures are based on normal and special cleaning, the use of barriers and elimination of unnecessary furniture. As mites do not survive in low humidity the use of mechanical dehumidifiers, which can reduce the number of mites, is recommended.

Fungi grow in wet, cold and poorly ventilated houses. Inspection of houses and appropriate action to improve them so that they become warm, dry and well ventilated prevents the problem of fungi growth.

### *Radon*

Several areas in Slovenia have above average natural radiation levels, and a proportion of the population is also exposed to higher levels of radon in air. Radon concentrations and gamma dose rates have systematically been measured in kindergartens, schools and some residential areas. The results of the measurements conducted in all schools and in all kindergartens show that in the majority of buildings the concentration was below 100 Bq/m<sup>3</sup>. The results indicate that relatively many houses might have a higher radon concentration.

The key element in future activities is the reduction of radon levels to as low a level as possible. Future surveys of the country will lead, in all likelihood, to the identification of endangered areas. The Government will fund measurements in houses.

The national task is to take preventive measures so as to secure the foundations of new houses in radon-prone areas, and to undertake necessary preventive construction measures against radon inflow and its accumulation in order to reduce the exposure of the population to radon.

### *Combustion products*

Preventive measures regarding indoor air pollution with CO, NO<sub>x</sub> and SO<sub>2</sub> are important. Legislation and guidelines require good ventilation where gas is used. To prevent high exposure we recommend local exhausts with hoods and flues rather than increasing the general ventilation. In the long term the priority is to reduce the sources of emissions.

### *Volatile organic compounds*

Volatile organic compounds are becoming important indoor air pollutants. The policy requires that all material should be carefully selected and adequate ventilation provided. Only materials that have been tested and for which toxicological profiles have been issued can be used. IAQ standards should

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also be used in addition to emission standards of building materials and linings to account for the possible impacts of interaction between the various materials.

*Topics to tackle*

Education and training for key groups such as architects, local authorities and owner occupiers should be improved. The authorities' supervisory responsibility with respect to inadequate indoor environments needs to be extended.

**6.11 Indoor air quality in Switzerland (J.E. De Payer)**

*Description of the situation*

No national centralized regulatory organization has taken the lead in regulating and controlling IAQ in Switzerland. The major activities take place at the level of the cantons, municipalities and private institutions. Apart from the domain of occupational hazard, national legislation related to IAQ is very poor and there is no overall national strategy with respect to this problem. No programmes have been started at national level, except in the field of radon and passive smoking where the Swiss Federal Office of Public Health is monitoring activities.

The following activities are taking place in the field of IAQ.

*Building products*

The Swiss Association of Engineers and Architects (Schweizerischer Ingenieur- und Architekten-Verein, SIA) (1) has developed guidelines on ecological and toxicological aspects of construction materials in use. The aim of these guidelines is to provide the building-master with a clarification of these materials, allowing him to make a better choice with respect to the ecological properties of the materials. Other papers dealing with this problem have been published by private (2) or official (3) sources.

### *Radon*

In October 1994, the new Radiological Protection Act and the Radiological Protection Ordinance (4) came into force. A limit value of 1000 Bq/m<sup>3</sup> and a reference value of 400 Bq/m<sup>3</sup> for radon gas for residential and recreational premises were adopted. The following priorities have been set for the coming years:

- determination of areas with high radon concentrations;
- elaboration of building regulations in areas with high radon concentrations;
- public information with leaflets, booklets, CD-ROMs, etc.;
- collaboration with educational establishments and professional associations in the building sector.

All these activities are coordinated by the Radon and Waste Unit.

### *Tobacco smoke*

In August 1995 the authorities adopted a global programme for the reduction of health problems connected to tobacco smoke (5). The programme includes three priorities:

- strengthening primary prevention: reversing the increasing tendency of young people to smoke;
- developing the protection of nonsmokers at the workplace and in open places;
- promoting the abandoning of the smoking habit.

As part of this programme, smoking has been forbidden since 1 June 1997 everywhere in the Swiss administration, except for a few places reserved for smokers.

An information campaign will be held to point out the problem of environmental tobacco smoke to restaurant owners.

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Leaflets in various languages are being prepared and will be distributed to inform the general public of the effects of passive smoking on the health of children and pregnant women.

*Chemicals, including biocides, house dust, micro-organisms*

There are many activities at the level of cantons, municipalities and private institutions, which are mainly based on complaints from individuals about IAQ. The strategies to investigate them vary considerably from place to place and are in some cases inadequate.

*Legislation*

Most of these activities are isolated. There is no coordination between the different partners involved. In some places local authorities have implemented their own policies, but due to the lack of strong national legislation it is difficult to prescribe local rules. In order to deal with this situation, the authorities foresee the introduction of a section devoted to indoor pollution in a new law on chemicals, which is in preparation. Moreover, discussions are in progress with the aim of adopting the EU guidelines on building materials 89/106/EEC into Swiss legislation. Both laws will give the legislators the possibility of introducing binding clauses with respect to both prevention and control of indoor air pollution.

*Research*

In July 1997 the Federal Office of Public Health started a programme to gather information on who was doing what in the country. The main objectives of the programme are to:

- identify key health problems, including (but not limited to) chemical hypersensitivity;
- collect data on the methods used to investigate complaints from the population;
- create a network of information led by a coordination centre;

- coordinate research;
- develop national policies regarding the impact of indoor air pollutants on the general public by carrying out risk management studies of available data on exposure and health risks associated with indoor air pollution;
- implement a plan to reduce present levels of exposure;
- work with other programmes from other agencies to minimize risks associated with exposure to indoor contaminants.

### *Information*

Educating the public about indoor air pollution and its associated health risks will be another very important objective of the programme. Meanwhile, the Federal Office of Public Health is supporting a campaign by a private institute (the Institut für Baubiologie, SIB) to inform the population about the different aspects of IAQ and how to avoid indoor air pollution.

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### **6.12 Indoor air quality in the United Kingdom: the Government's strategy (L.Smith)**

Through the United Kingdom's National Environmental Health Action Plan (NEHAP), published in 1996, the Government has pledged actions which will lead to a reduction in the mean levels of key air pollutants in homes and ensure that everyone can have good air quality in their home. People spend such a large proportion of their time at home that exposure even to low levels of pollutants may have important repercussions for health and wellbeing.

The United Kingdom is committed to the WHO Environmental Health Action Plan for Europe (EHAPE), which sets the following air quality objectives:

- to provide information on indoor and outdoor air pollution levels throughout Europe, especially in urban areas;
- to adopt the measures required to bring, by a date to be specified nationally, air pollution levels below the health-related WHO *Air quality guidelines*.

In the United Kingdom indoor and outdoor air quality are dealt with separately, because the basis for action and the actions themselves differ greatly. Indoors the air quality is under the control of those in charge of the building. Outdoors the air quality depends on the combined effects of all sources of pollution.

On average in Britain people spend 90% of their time indoors and three quarters of that in the home. A typical adult in work will spend 60% of the time at home, while old people, young children and their mothers are at home much more of the time. A study by the Institute of Child Health at Bristol University found that mothers with young babies spent over 90% of the day indoors in their own homes. Thus exposure to indoor pollutants may play a major role in the health and wellbeing of the population. Respiratory disease and the incidence of allergic

responses such as asthma, have increased in the United Kingdom in recent years, and there is concern that some of this increase can be associated with changes in the indoor environment.

To tackle IAQ problems the Government's strategy has to be firmly based on knowledge of the sources and levels of pollutants likely to be experienced indoors and an assessment of the resulting risks to health and wellbeing. For several years now the Department of the Environment has been funding a programme of research to:

1. develop the necessary methodology to sample and examine indoor air;
2. apply that methodology to monitoring representative samples of homes in order to:
  - establish the levels of pollutants that exist;
  - assess the likely consequences for health and wellbeing of exposure to both peak and typical levels of pollutants found in homes, paying particular attention to their significance for susceptible groups such as babies or the elderly;
  - measure the rates of pollutant emissions from particular sources such as construction materials, carpets, furnishings and do-it-yourself products;
  - develop and investigate strategies for reducing the concentrations of particular indoor air pollutants where necessary and improving IAQ overall.

The action plan then provides a framework for action by central government, local authorities, local health authorities, consumer groups, manufacturers and suppliers of products and of course people themselves. The Government is already committed to stimulating effective action to bring about a long-term downward trend in the mean levels of key pollutants in homes. Further research and monitoring will be undertaken to check on progress.

The Government's objective is to reduce the mean levels of key air pollutants in homes and ensure that everyone can have good air quality in their homes. Proposed targets are to:

- ensure that advice on the health effects of key indoor pollutants and means of avoiding or minimizing exposure is made available to everyone by 1999 through general practitioners, environmental health officers and other health professionals;
- achieve a downward trend in mean levels of key indoor air pollutants such as nitrogen dioxide, formaldehyde and volatile organic compounds in homes by 2003.

To achieve these goals the Government is working in partnership, utilizing both legislation, voluntary action by manufacturers and suppliers and consumer pressure. There is a framework of legislation to ensure that buildings are of safe and sound construction. In respect of new buildings, building regulations require that certain standards of construction are met and that the buildings are provided with adequate levels of ventilation. Existing homes must meet minimum criteria for fitness, which includes provision of adequate ventilation. The marketing and use of particularly hazardous materials, such as asbestos, are controlled. However, this legislation has a restricted range and, to a great extent, the environment within a home is determined by the occupants.

Thus, information is the key and the Government will be instigating a programme of consumer information and media attention to give the public greater awareness of the problems. Everyone should be able to make informed choices about taking simple but effective measures to control the levels of pollutants in their own homes. It will also be important to encourage manufacturers and suppliers of materials and furnishings generally to reduce the levels of emissions from, and to provide relevant information about, their products so that people can choose to buy or specify the materials which they want.

Health professionals, including general practitioners and environmental health officers, can play a key role in helping those suffering from illnesses, such as respiratory diseases or asthma, to reduce their exposure at home to agents which may exacerbate their symptoms. Guidance will be distributed containing practical advice for use when advising the public on specific problems. This will complement the leaflets on house dust mites, good air quality in the home and gas cooking which have already been produced.

Health effects assessments to date indicate that, for the particular pollutants considered, there is a large variation in the amount of available information on levels in the home, in the degree of confidence in measuring and monitoring techniques and in the evaluation of likely health effects. Factors such as age, social class, ethnic group, geographical area and type of dwelling may also influence the likelihood and type of health effects brought about by exposure to these pollutants. While some of the pollutants are hazardous, levels in United Kingdom homes tend to be low. As a result, the individual risks of significant health effects resulting from exposure to these pollutants in indoor air is small, although the consequences to society may be more significant. It is, therefore, important to identify and reduce potential indoor sources and take appropriate measures to minimize exposure.

The Government is also concerned about smoking in public places and is committed to creating a nonsmoking environment with facilities, where appropriate, for those who wish to smoke. The Department of the Environment's code of practice on smoking in public places, first issued in 1992, is still the basis for policy. Over the last few years there has been a big change in public tolerance of smoking and the majority of public places now have smoking policies.

The workplace environment is also important, of course, since many people spend much of their day indoors at work. The Health and Safety Executive and environmental health officers have the responsibility for ensuring a healthy working environment and good air quality at work. Assessments of the risks from working with chemicals are of course required. With regard to the office environment, the Executive has already issued guidance on the sick building syndrome and smoking at work.

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### **6.13 Indoor air quality policy in the United States**

(John F. McCarthy)

Regulation of IAQ in the United States is not centralized in a single governmental or nongovernmental organization. Rather, various federal and state agencies and nongovernmental organizations have set their own standards and are pursuing their own research and educational agendas. At the federal level, coordination has been attempted through formation of the Interagency Committee on Indoor Air Quality, but this Committee has been far less active than the individual member

agencies such as the U.S. Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA). The development of an overarching set of federal statutes on IAQ has been hampered somewhat by the lobbying of special interest groups.

To circumvent these obstacles, government agencies are employing non-regulatory strategies such as the following.

- *Leading by example.* The General Services Administration, which operates thousands of buildings owned or rented by the Government, is in the process of classifying those buildings according to three categories: new, currently occupied, and recently remodelled. The Administration then establishes codes specifically for each group including ventilation standards, inspection schedules, restrictions on the use of certain construction and furnishing materials, and specifications for maintenance performance. Perhaps more importantly, they are establishing mechanisms for employees to report IAQ symptoms/illnesses without risking retribution.
- *Conducting research.* Several government agencies (federal and state) are in the process of assessing the status of buildings and their populations through a number of research projects intended to identify populations not currently covered by health and safety regulations and to classify buildings based on IAQ. Other research is currently identifying specific contaminants and their health effects in hopes of supporting future risk management.
- *Providing education.* Many government programmes are providing IAQ information to the public in the hope of educating consumers. This strategy will hopefully induce manufacturers, building developers, and building managers to use environmentally safe materials and to operate properties in a manner that satisfies knowledgeable consumers.

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- *Fostering private sector responsibility.* Other government programmes seek to show support for environmentally safe commercial products by offering government approved labels. For example, the Green Lights programme, sponsored by the EPA, promotes energy-efficient products by allowing those environmentally safe products to be labelled with an easily recognized “Green Lights” symbol. The Building Air Quality Alliance (BAQA), where private building owners demonstrate compliance with preferred practice and can be certified as a partner, was originally developed by EPA. The BAQA has been privatized due to Congressional concerns and is slowly gaining acceptance.

Furthermore, in the light of the lack of federal regulatory authority or unified guidance, several states have implemented their own laws, guidelines, research or educational programmes. The regulations or guidelines promulgated by the states are, for the most part, limited in scope and target specific issues such as smoking or mechanical ventilation codes. As with the federal activities, legislative pressure from special interests has hampered development of comprehensive and legally binding state regulations. The state of California has the most comprehensive programme, with three state agencies participating and numerous publications available for the general reader.

Even in the absence of a strong body of law defining the standards and practices associated with acceptable IAQ, litigation is already occurring based on injury or illness putatively associated with poor IAQ. In such actions, standards developed and promoted by nongovernmental agencies are often cited as the benchmark of good practice (professional standard of care). An example of a fairly comprehensive treatment of IAQ issues is that developed and compiled by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Because professional organizations such as ASHRAE develop their standards through committee

consensus, the standards they develop tend to be more comprehensive than those developed by governmental bodies. However, the way the standards are written also tends to limit their rapid adoption into regional building codes, which would give them the force of law. (Currently, the revisions to ASHRAE Standard 62-1989 are not being fully adopted due to certain controversial issues, which include the decision as to whether the standard is an appropriate code document and legally enforceable or is a design document that simply represents preferred practice.) Unless federal and state authorities are soon able to enact legislation that covers most important aspects of IAQ, such nongovernmental guidelines will, *de facto*, become the context for setting legal precedents regarding what constitutes acceptable IAQ. The actions of litigants and the courts, along with continuing refinement of IAQ standards by nongovernmental agencies, may in fact serve as the most significant general driving force for improving IAQ in the United States.

Current research on IAQ has begun to identify issues beyond what have traditionally been considered the most important IAQ parameters, such as high levels of particles or volatile organic compounds. Airborne microbiological contamination, especially by fungi, appears to be of much greater importance indoors than was thought a few years ago, and may be responsible for many of the respiratory symptoms reported in poor IAQ situations. Fungal growths are often associated with indoor building materials that have become wet. Recent studies have suggested that complex mixtures of low levels of organic compounds, such as those emitted by new building or finishing materials, may act cumulatively or synergistically to produce IAQ-related health effects beyond what any one of the compounds would cause. Other chemicals, such as pesticides, are sometimes used indoors, and may enter indoor environments after nearby outdoor applications. Evidence is mounting that such compounds at low levels may function as neurotoxins or disrupters of the endocrine system, producing subclinical or long-latency health effects that

may not be readily associated with indoor environmental factors. Additional emission issues surrounding product testing are treated as data gathering, since acceptable levels are not yet established.

For governmental involvement in IAQ to have a worthwhile impact on public health, the impasse between regulatory agencies and the regulated communities must be overcome. To this end, it will be necessary for corporate and other business interests to work cooperatively with EPA, OSHA and other governmental authorities to develop IAQ standards and practices. Such cooperation is unprecedented, but the increasing profile of IAQ as a litigation issue may serve as a catalyst to move forward on these issues in this way.

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