CEC ACTIVITIES ON INDOOR AIR QUALITY #6231

P.Wouters
Belgian Building Research Institute
Aarlenstraat 53, 1040 Brussels, Belgium

Philomena. M. Bluyssen
TNO-Building and Construction Research
Department of Indoor Environment, Building Physics and Systems
P.O. Box 29 2600 AA Delft, The Netherlands

INTRODUCTION

Besides the circle of experts, the awareness of the enormous importance of comfort in buildings: be it visual, thermal or acoustic comfort or comfort related to Indoor Air Quality (IAQ) is expanding. This awareness has been intensified by registration of serious complaints in some buildings. A recent salient example is the Berlaymont building in Brussels, headquarters of the Commission of the European Communities, which will be demolished partly because comfort (IAQ) and safety (asbestos) requirements were not met.

During the past twenty years, Indoor Air Quality has received growing attention. Many complaints with respect to IAQ occur and the causes of these complaints are often not found, in spite of thorough measurements of indoor air. This phenomenon as well as the outcome is often called Sick Building Syndrome (SBS).

In Europe, the IAQ-issue had already emerged in the late 1960s, first in the Northern countries, in particular in Denmark and Sweden, whereas in most mediterranean countries it has been perceived only relatively recently.

This paper aims to highlight a number of important aspects of the European activities on Indoor Air Quality. The activities within the European Community and especially those set up by the Commission of the European Communities (CEC) receive special attention, but also work including other European Countries is described.

BRIEF SURVEY ON CEC ACTIVITIES RELATED TO INDOOR AIR QUALITY

The services of the Commission of the European Communities are organized in General Directorates and Special Services or Agencies in charge of specific policy and legislation areas in the Community . The overview in this paragraph is to a large extent based on information in the paper by Dr. H. Knöppel, CEC Joint Research Centre, Ispra (1).

The Directorate General (DG) III **'Internal Market and Industrial Affairs'** is in charge of the building products directive 89/106/CEE (2) on the "approximation of laws, regulations and administrative provisions of the Member States relating to construction products", approved by the council of Ministers in December 1988. In order to guarantee the free movement of goods, this directive sets out a framework for regulations on construction products. The directive indicates that such products "must be suitable for construction works which (as a whole and in their separate parts) ... satisfy the ... essential requirements".

In total, six essential requirements are defined :

1. Mechanical resistance and stability;
2. Safety in case of fire;
3. Hygiene, health and environment;
4. Safety in use;
5. Protection against noise;
6. Energy economy and heat retention.

The third requirement concerning 'Hygiene, health and environment' specifies : "The construction work must be designed and built in such a way that it will not be a threat to hygiene and health of occupants or neighbours, in particular as a result of any of the following :

+ the giving off of toxic gas;
+ the presence of dangerous particles or gases in the air,
+ the emission of dangerous radiation..".

Setting this basic rule, the directive 89/106/CEE commits to "interpretative documents (ID) the creation of necessary links between essential requirements " and standards, guidelines or other technical specifications.

An ID 'Hygiene, health and environment' has been drafted and asks for "harmonized standards" on calculation and measurement methods of a wide range of indoor air quality parameters and for technical specifications of some others.

In the future, the practical implications of this directive will be enormously. The harmonized standards will replace all national standards. Moreover, only specifications expressed according harmonized standards will be allowed in the future. As a result, nearly all efforts related to standardization are now focused on the preparation of CEN-standards. (CEN = European Committee for Standardization).

Besides the countries of the European Community (Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom), all EFTA (European Free Trade Association)-countries (Austria, Finland, Iceland, Norway, Sweden, Switzerland) are involved in these activities of standardization. Achieving free movement of goods within these 18 countries represents therefore an enormous potential and several advantages.

Presently, limitation of formaldehyde emissions from wood based materials is under consideration as a first case to safeguard the above mentioned essential requirement. CEN has been charged to validate a method for determination of formaldehyde emissions from wood based materials.

Since March 1987 directive 87/217/CEE regarding asbestos is in force. Although no explicit reference to indoor air pollution is made, measures to prevent and reduce air and other environmental pollution by asbestos are introduced. Rules to be observed during removal of materials from buildings containing asbestos are specified as well.

DG V 'Employment, Industrial relations and Social Affairs' is in charge of the programme 'Europe against Cancer'. In the framework of this programme the Council of Health Ministers adopted in 1989 a resolution to ban smoking in public spaces, except in clearly defined areas reserved for smokers. Such resolutions are not binding but are in principle a commitment to achieve a desirable goal.

Recently, the traditional interest of DG V in industrial medicine and hygiene issues has been expanded to non-industrial workplaces like offices. Expertise has been inventoried on potential future needs of regulation in this field focusing on IAQ. Also, the international conference 'Clean air at work - new trends in assessment and measurement for the 1990s' organized by DG V in collaboration with BCR (Common Reference Bureau) included a session on indoor air which was organized in collaboration with the concerted action 'Indoor Air Quality and its impact on Man' (see further).

DG XI 'Environment, Nuclear Safety and Civil Protection' prepared the 4th 'Policy and action programme on the environment (1987-1992)', approved by the Council of Ministers on 19 October 1987. One of the major objectives is the development of "an overall longer-term strategy to reduce air pollution". As part of this strategy is included: "to define and implement preventive measures against indoor air pollution from a growing number of substances". A "Recommendation of the Commission on the protection of the public against indoor exposure to radon(90/143/Euratom) has been issued. It introduces " a reference level for consideration of remedial actions" for existing houses (not intended for legal enforcement) and a "design level" for future housing. The two levels, in terms of effective dose equivalent, are respectively 20 and 10 mSv/year and, in terms of radon gas concentration, 400 and 200 Bq/m^3.

Table 1 gives an overview of the recommendations from different organizations and countries.

Authorities	Existing dwellings (Bq/m³)	New dwellings (Bq/m³)
ICRP(International Commission for Radiological protection)	400	200
CEC	400	200
WHO (World Health Organization)	200	200
Sweden	400	140
Germany	250	250
United Kingdom	200	200
United States	150	150

Table 1 : **Overview of recommendations concerning maximum values of radon (Bq/m³) for the average yearly concentrations inside dwellings (based on long term measurements) (3)**

Presently, the subject 'the impact of consumer products on indoor air quality' is considered to be included in a new action programme on consumer protection from the Consumer Policy Service.

DG XII 'Science, Research and Development' and the 'Joint Research Centre' are both involved in the promotion of research at Community level. Environmental and energy related research, including some research into indoor air quality, are important issues in the framework of COST (**CO**-opération européenne dans le domaine de la recherce **S**cientifique et **T**echnique). COST is the name of a co-operation agreement between all European OECD countries and the European Community. The concerted action 'Indoor air quality and its impact on man' of COST is till now the most important effort of the Commission in the field of IAQ, undertaken jointly by DG XII and the JRC.

In the Radiation Protection Programme, the radon Issue has been given attention . The research work included epidemiological studies, modelling and remedial actions. In the new Nuclear Fission Safety Programme (1991-1994), radon research is included in the 'Radiation Protection Action'.

One of the research tasks in the JOULE 2 programme (Joint Opportunities for Long term and Unconventional Energy Supply) is "Air management systems, in particular their environmental and health aspects".

During the preparation of JOULE 2, a workshop was organized by the CEC in Lausanne, May 27 and 28,1991 (4), to determine the state of the art of current knowledge on Indoor Air Quality management, missing know-how and possible research areas. 26 experts from CEC and EFTA countries attended.

Overview of some relevant research activities regarding IAQ.

COST Project 613 'Indoor Air Quality and its impact on man' (1)

In this project 10 working groups carried out the work:

WG 1	:	Preparation of a practical guide to 'Sick building Syndrome' investigations
WG 2	:	Preparation of a strategy for sampling substances in indoor air
WG 3	:	Preparation of a guideline for the determination of steady-state concentrations of formaldehyde in large test chambers due to the emissions from wood based materials.
WG 4	:	Preparation of a discussion document on health effects of indoor air pollution
WG 5	:	Preparation of a guideline or standard procedure for the determination of microbiological pollutants
WG 6	:	Preparation of a guideline on ventilation requirements based on perceived air quality
WG 7	:	Sick Building Syndrome research
WG 8	:	Preparation and validation of a method for the characterization of VOC emitted from indoor materials and products using small environmental test chambers
WG 9	:	Strategy/guideline for VOC measurements in indoor air (follow-up WG 2)
WG 10	:	Review of the state of knowledge of sensory stimulation by indoor air pollution and resulting sensory, neurological and psychological effects.

Epidemiological studies of workers in European Offices

Since the beginning of the eighties, several studies were done regarding IAQ in office buildings. These kind of studies are often closely linked to the so-called Sick Building Syndrome.

According to P.S. Burge (5), the first European study of a number of buildings unrelated to known building sickness was done by Finnegan et al in 1984. (6)

Since then, various studies have been carried out. An overview of some of the major European studies carried in office buildings is given in table 2.

Reference	Description
Finnegan et al. (6)	+ 9 office buildings (5 HVAC, 1 mechanically ventilated, 3 naturally ventilated); + Doctor administrated questionnaires.
Burge et al. (7)	+ 46 office buildings, wide range of ventilation systems; + 4,373 office workers; + Self-administered questionnaires, 92 % response.
Skov, Valbjorn (8)	+ 14 town halls (2 recirculation, 2 humidification, 6 naturally ventilated); + 4,369 office workers; + Self-administered questionnaires, 80 % response.
Preller et al. (9)	+ 61 office buildings (42 HVAC, 13 steam-humidification, 12 water-spray humidification, 19 naturally ventilated); + 10,500 office workers; + Self-administered questionnaires, 74 % response.
Stenberg et al. (10)	+ 6,000 office workers; + 4,943 questionnaires processed.
Kroeling (11)	+ Adults questionned outside the working place; + 1,019 replies (420 in HVAC buildings, 699 in naturally ventilated buildings).

Table 2 : **Overview of some of the major European epidemiological studies in office buildings**

Besides workrelated studies in office buildings, studies are/were also carried out in other buildings, like dwellings. Presently, probably the largest study is carried out in Sweden (12) in which 5000 randomly selected dwellings from some 60 villages/cities are investigated. This study includes questionnaires as well as complementary measurements.

New methods for air quality assessment

The evaluation of air quality by measurement of the aircontent with chemical/physical methods is often insufficient. Danish research by Fanger et al. (13) resulted in a new approach for evaluating IAQ. Besides the theoretical development of the method (including the introduction of two new units : olf and decipol), a number of buildings were investigated with respect to perceived indoor air quality. This methodology allows to indicate the origin of the perceived pollution.

Ventilation research in Europe

There is clearly evidence available that knowledge with respect to ventilation parameters of a building (flow rates, system characteristics, maintenance, ...), play a crucial role in the understanding and explanation of indoor air quality problems. Since the end of the seventies and the beginning of the eighties, ventilation research has

received an increased interest by various CEC and EFTA countries. Important R&D programmes are running in all Scandinavian countries, as well as in Switzerland as in several EC-countries. In more southern countries (Greece, Spain and Portugal) a significant increase is expected.

An important part of the research is conducted in close relation with projects set up by the International Energy Agency (IEA). At the moment, the following countries are actively participating in one or more ventilation related IEA-projects :

CEC countries : Belgium, Denmark, France, Germany, Italy, the Netherlands, United Kingdom

EFTA countries : Finland, Norway, Sweden, Switzerland

The Air Infiltration and Ventilation Centre (AIVC) is one of these projects. It is a so-called cost shared annex, operated by a small information and dissemination centre in the vicinity of Birmingham, UK. More information can be found in the paper, presented by M. Liddament at this conference .

Until now, the CEC itself has only supported a limited number of projects related to ventilation. Ventilation aspects receive specific attention in the following CEC projects :

PASSYS (1986-1992) (14):

+ Network of 36 outside test cells located in 13 test centres in 11 countries for the evaluation of the thermal and solar performances of building components;
+ Standardized equipment for performing pressurization measurements as well as tracer gas measurements.

PASCOOL (1992-1994):

+ Study on serious overheating problems in buildings during summer, including study on efficient strategies for reducing comfort problems;
+ Ventilation strategies will receive special attention.

EUROPEAN AUDIT PROJECT TO OPTIMIZE INDOOR AIR QUALITY AND ENERGY CONSUMPTION IN OFFICE BUILDINGS (1992-1994):

+ Development of a common agreed European-wide method to investigate indoor air quality in office buildings;
+ In each participating country (8 in total), 10 office buildings will be investigated. The investigation includes a.o. questionnaires, walk-through surveys, assessment of IAQ by a trained panel, indoor climate and ventilation measurements;
+ Guidance on ventilation and source control to optimize IAQ and energy use in office buildings.

CONCLUSIONS FROM THE CEC-IAQ MEETING IN LAUSANNE

As mentioned before, one of the major aims of the CEC-IAQ meeting in Lausanne, May 1991, was to determine an overview of missing know-how and possible research areas in the IAQ field. All authors were asked to give conclusions of the state-of-the

art as well as an indication of future research needs. At the request of the CEC, Dr. P.N. Bluyssen (15),(16) made an executive summary of this workshop, including a list of conclusions. These conclusions listed below are very useful for future planning of research.

Sick Building Syndrome

1. SBS is a multifactorial cause-effect problem. A key-issue is knowledge of the mechanisms behind it and the strength of the effects. Mechanisms for the symptoms have not yet been defined.
2. A question still exists over which of the two groups of factors, psychological or physical, is the determining element or whether they at all interfere.
3. The relation between hypersensitivity and air quality is one of the major contemporary problems encountered in buildings. However, biological mechanisms of non-allergic hypersensitivity reactions are largely unknown.
4. Few chemicals have been evaluated adequately for neurotoxicity.

IAQ measurement

5. No absolute test for lethargy, headache and dry throat are available.
6. No statistically significant information on ventilation performance in buildings is available.
7. Reproducibility and credibility of indoor air pollutant identification, quantification and sampling are often questionable.
8. Limits of exposure for all pollutants causing health effects have not been determined. All pollutants causing health effects may not even have been identified yet.
9. More information can be gained from measurement of pollutant concentrations in biological tissue and fluids.
10. Quantification and identification of each of the hundreds of compounds present in indoor air is impossible with the instruments developed so far. On the effects of mixed pollutants, little or no knowledge is available.
11. A standard method is lacking to obtain the strength of a pollution source in olf.
12. A method to train persons to evaluate perceived air quality in decipol has been developed, but needs further development and standardisation.
13. The olf-load of complete buildings (olf/m^2) have been determined in Denmark.
14. There is a lack of information concerning comfort under transient conditions.
15. Biological indicators for environmental health monitoring are needed.
16. Research is required to develop measurement methods of neurotoxicity, and to clarify the size of the problems in different populations and the responsible mechanisms in the nervous system.

IAQ and Energy

17. The IAQ-issue and energy use are closely linked.
18. The challenge in the near future is simultaneously to aim at a low energy consumption and a comfortable and healthy indoor environment.
19. Definition of limits and prospects of energy efficient yet healthy buildings is needed.

Sources and Source Control

20. Effects of prolonged pollution exposure are not completely known.
21. Identification of pollution sources is difficult due to dynamic processes like adsorption and desorption.

22. Most organic chemicals with high boiling points, e.g. SVOC, which are generally bound to dust particles, have until now not been sufficiently studied.
23. There is little information on product composition since manufacturers are generally not obliged to provide such information. Evaluation of this information is the next step to be taken.
24. The olf-load of a building can help to determine the source control strategy.
25. Deposition of pollutants, absorption, adsorption, desorption, condensation, etc. are factors which strongly influence indoor pollutant levels.

Ventilation

26. The present ventilation guidance is insufficient.
27. Knowledge of air change rates is required to recommend ventilation rates which improve building air quality.
28. There is a lack of knowledge on flows through large openings. Information on airflow and contaminant transport from floors and leakage from crawlspaces to the wall cavities, is almost completely lacking.
29. Very little can be found on the effect of the use of doors on the ventilation rates of buildings.
30. Experience with Demand Controlled Ventilation (DCV) systems is still very limited. IAQ-sensors are a key-point for the good performance of DCV.
31. Study in areas of Europe were air conditioning is used in a necessity. Most studies have taken place in temperate areas of Europe.

Ventilation Systems

32. Little has been done to analyze the IAQ problems stemming from ventilation systems, to identify potential sources, and to eliminate them. Guidelines of hygiene requirements are almost totally lacking.
33. Our knowledge of the sanitation of ventilation systems is very limited.

European Activities

34. The concerted action "Indoor Air Quality and its impact on man" is so far the most important activity in the field of IAQ in the European Community.
35. In Sweden a large epidemiological study has started and one hopes will contribute to the IAQ database.

Regulations

36. It is of utmost importance to pinpoint all relevant building factors before specifying requirements.
37. Recommendations for outdoor air, used as intake air, are lacking.
38. Development of guidelines and/or standards is recommended as an essential tool to promote the achievement of high IAQ, e.g. international standards on emission testing; guidelines on indoor pollutant concentrations, ventilation, material emission and methods for IAQ assessment and control; guidelines on the commissioning process of building and installations; and guidelines on quality assurance and product responsibility.
39. Criteria for source control, outdoor air rates and air treatment are needed.
40. Requirements for maximum, permissible emission levels of selected types of pollutants must be specified. Standard test methods should be developed.

Besides these conclusions, a number of "General Research Needs" were determined.

CONCLUSIONS

At the present, indoor air quality aspects receive an increased attention in Europe through research programmes as well as in standardization activities . Mainly due to climatic factors and applied construction methods, IAQ was first studied in Scandinavia. At the moment, nearly all European countries have research projects in which indoor air quality problems are examined. A major part of these projects are part of CEC-research or IEA-projects.

ACKNOWLEDGMENTS

The authors wishes to thank the participants of the CEC workshop Indoor Air Quality Management, held at Lausanne on May 27 and 28 1991.

REFERENCES

(1) Knöppel, H., The Concerted Action "Indoor Air Quality and its Impact on Man', Proceedings workshop 'Indoor Air Quality management', Lausanne, 27-28 May 1991, Publication No EUR 137766 EN, pp.1-10.

(2) Council Directive of 21 December 1988 on the Approximation of Laws, Regulations and Administrative Provisions of the Member States relating to the Construction Products (89/106/EEC).

(3) W.T.C.B./C.S.T.C., Le Radon dan les Habitations, W.T.C.B./C.S.T.C., Brussels, 1991.

(4) Proceedings workshop 'Indoor Air Quality management', Lausanne, 27-28 May 1991, Publication No EUR 137766 EN.

(5) Burge, P.S.,Sick Building Syndrome, Epidemiological Studies and Medical Aspects, Proceedings workshop 'Indoor Air Quality management', Lausanne, 27-28 May 1991, Publication No EUR 137766 EN, pp.25-36.

(6) Finnegan,M.J., Pickering, C.A.C., Burge, P.S., Sick Building Syndrome; prevalence studies, Brit. Med J, 1984, 289, pp. 1573-1575.

(7) Burge, P.S., Hedge, A., Wilson, S., Harris Bass, J., Robertson, A.S., Sick Building Syndrome : a study of 4373 office workers. Ann. Occup Hyg, 1987,pp. 493-504.

(8) Skov, P., Valbjorn, O., The Sick Building Syndrome in the Office Environment; the Danish Town Hall Study. Environ Int, 1987,13,pp. 339-349.

(9) Preller, L., Zweers, T., Brunekreef, B., Boleij, J.S.M., Sick leave due to work-related health complaints among office workers in the Netherlands, Indoor Air '90, Proceedings of the 5th international Conference on Indoor Air Quality and Climate, Vol. 1, pp. 227-230.

(10) Stenberg,B., Mild, K.H., Sandstrom, M., Lonnberg, G., Wall, S., Sundell, J., Zingmark, P.A., The Office Illness project in northern Sweden. Part 1: a prevalence study of sick building syndrome related to demographic data, work characteristics and building factors, Indoor Air '90, Proceedings of the 5th international Conference on Indoor Air Quality and Climate, Vol. 4, pp. 627-632.

(11) Kroling, P., Gesundheit Haustechniek Bauphysik Umwelttechnik, 1987, 108, pp. 121-131.

(12) Norlen, A.T.U., Assessing Indoor Air Quality in Existing Buildings, Proceedings workshop 'Indoor Air Quality management', Lausanne, 27-28 May 1991,

Publication No EUR 137766, pp. 191-200.
(13) Fanger, P.O., Decreased ventilation requirement through Control of Indoor Air Pollution Sources, Proceedings workshop 'Indoor Air Quality management', Lausanne, 27-28 May 1991, Publication No EUR 13776, pp. 161-168.
(14) Wouters. P., Vandaele, L. (eds), The PASSYS Test Cells, CEC DG XII, 1990, EUR 12882 EN.
(15) Bluyssen, P.M., Indoor Air Quality Management, A state of the Art and Research Needs, Executive summary of the workshop on Indoor Air Quality Management, Lausanne, 2728 May, 1991.
(16) Bluyssen, P.M., Indoor Air Quality Management, A state of the Art Review and Identification of Research Needs, Indoor Environment, accepted for publication (28-05-92).