

# AIR INFORMATION REVIEW

Vol 25, No. 2, March 2004

A quarterly newsletter from the IEA Air Infiltration and Ventilation Centre



Development of demand controlled hybrid ventilation systems - RESHYVENT - 1

Indoor air quality in Hong-Kong - 2

The European Commission Website on Non-Nuclear Energy Research - 2

Natural ventilation in urban areas, Potential assessment and optimal façade design - Urbvent - 3

European project HOPE - 4

The Performance Approach and the Indoor Environment - 5

RESSET - 6

INTERSET - 6

European Energy Performance Directive and standardisation - 7

A contribution in energy labelling of small residential buildings - 7

International workshop on Assessment of Innovative Technologies in the Framework of the New Energy Performance in Buildings Directive - 9

Online purchase of Standards - 9

Natural Ventilation in Urban Areas 10

Night Ventilation Strategies - 10

Air exchange rate and airtightness measurement techniques - An application guide - 10

Ventilation and productivity: some interesting publication "The Benefits of Daylight through Windows" - 11

New strategy of information dissemination at BBRI - 12

Mediterranean Congress of Climatization - Climamed - 12

Call for proposals "Intelligent Energy for Europe programme": SAVE and ALTENER - 12

AIVC Conference - 13

## Development of demand controlled hybrid ventilation systems - RESHYVENT -

*P.J.M. Op 't Veld - Cauberg Huygen*

In January 2002 the EU RESHYVENT project started, a three-year project within the EU Fifth Framework Programme on the investigation and development of demand controlled hybrid ventilation systems in residential buildings. The project is a clustering of four industrial consortia from Sweden, Norway, the Netherlands and Belgium/France, with a scientific group. Each of these industrial consortia will develop a working prototype of a hybrid ventilation system for a specific climate and specific application.

Hybrid ventilation is defined as a two-mode system that is controlled to minimise the energy consumption while maintaining acceptable indoor air quality and thermal comfort. The two modes refer to natural and mechanical driving forces. Hybrid ventilation systems must provide air for indoor air quality, thermal conditioning and thermal comfort. The heart of a hybrid ventilation concept is a control system to establish the desired air flow rate and pattern at the lowest energy consumption possible. This means:

- air flows will be exactly controlled to the actual needs, based on thermal comfort and IAQ
- using natural driving forces as long as possible, using mechanical forces when necessary

Within the RESHYVENT project there is specific emphasis on the application of renewables. Despite the hybrid character of the system, auxiliary energy is needed for running the fans, the sensors and the control system. This energy will be, as far as possible, generated by sustainable technologies, such as PV and wind energy. The scope of the project is residential buildings, single family houses as well as multifamily houses in the new build sector and the existing sector. The hybrid ventilation systems will be developed for different climates, ranging from (severe) cold, moderate, mild to warm. Specific attention will be paid to the thermal comfort conditions during winter (draught) for the cold and moderate climates and for the thermal conditions during summer (overheating) for the mild and warm climates.

In general the RESHYVENT project has two outputs:

- a generic output: guidelines and terms of references mainly dedicated to industries to develop demand controlled hybrid ventilation systems
- a specific output, i.e. the four systems developed by the four industrial consortia

By the end of 2003 the Dutch and Norwegian consortia had their prototypes ready for testing in demonstration houses. The Swedish and Belgium/French consortium expect to complete their prototypes this spring.

A number of RESHYVENT participants will contribute to a seminary on hybrid ventilation during the Polish Ventilation Forum in Warsaw, March 2 and 3. Presentations are foreseen on:

- Design constraints for hybrid ventilation
- The European energy Performance Directive: overall status and relevance for ventilation community
- Classification of hybrid ventilation
- Commissioning and Quality Control for ventilation systems
- Hybrid ventilation in urban environments and presentations of the Dutch and French/Belgian systems

During the 25th AIVC conference in Prague (15-17/09/2004) a session will be dedicated to the RESHYVENT project. As RESHYVENT is in the completion phase, then a total overview of the results will be presented.

*Read the full article on the AIVC-CD .*

# AIR

## AIR INFORMATION REVIEW

The newsletter of the AIVC, the Air Infiltration and Ventilation Centre. This newsletter reports on air infiltration and ventilation related aspects of buildings, paying particular attention to energy issues. An important role of the AIVC and of this newsletter and CD is to encourage and increase information exchange among ventilation researchers and practitioners worldwide.

### Published by:

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**Contributions to AIR:** Suggestions for contributions are welcomed.

**Subscriptions: (See also the subscription form on page 15 or on the CD )**

The subscription is for 4 issues of the newsletter, with accompanying CD, per year (starting in September) Issues are published in September, December, March and June.

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200 EUR/year (renewals at 100 EUR)

#### 2) Non-AIVC Member Countries

400 EUR/year (renewals at 200 EUR)

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## GUIDE TO THE NEWSLETTER

### Guide to the newsletter and AIVC-CD

The Air Information Review is available in electronic format (PDF file) on the AIVC-CD. This electronic version is provided with hyperlinks to other documents located on the CD and to external web sites or e-mail addresses.

In the document, links are represented by small red icons or by red text.

To follow a link: Position the pointer over the linked area on the page until the pointer changes to a hand with a pointing finger, then click the link.

### Content of the AIVC-CD

The AIVC-CD contains various AIVC products, such as the Air Information Review newsletter, Technical Notes, "Airbase" (the AIVC's bibliographical database) and recent conference proceedings. It also contains a lot of third party publications.

The content of the CD is summarised in a document called "What's on the AIVC-CD?" . This document is also available on the CD and is provided with hyperlinks.

In order to have an overview of the content of all the AIVC-CD's, a compilation of their tables of content is also available on the CD .

### How to find information on the AIVC-CD

Once you have introduced the AIVC-CD in the CD-Rom driver of your computer, the index.html file should open automatically . (If this is not the case, you can locate the file on the main root of the AIVC-CD and open it yourself). This file is provided with hyperlinks to other documents located on the CD.

Within Acrobat Reader, you can use the Search command (Edit > Search) for finding a word or phrase in the current PDF document or in other PDF documents.

## WEBSITES

### Indoor air quality in Hong-Kong

<http://www>

The Indoor Air Quality Information Centre was set up in 1998 by the Hong-Kong Productivity Council and Environmental Protection Department, in order to allow public access to information on IAQ and to improve indoor air quality in buildings and public places, especially through an "IAQ management programme".

This programme includes a voluntary IAQ certification scheme for offices and public places the requirements are described in detail (in English) on the Indoor Air Quality Information Centre website. 24 buildings in Hong-Kong have now got an IAQ certificate.

The IAQ Information Centre website also offers free publications in English, such as booklets about IAQ, biological air contaminants, tobacco smoke, formaldehyde, radon, VOC, or notes such as "Guidances notes for the management of IAQ in offices and public places".

### The European Commission Website on Non-Nuclear Energy Research

An overview of the EU non-nuclear energy research can be found on <http://>

Under the heading of "Publications", a whole range of interesting reports can be downloaded, eg.:

- Renewable energies newsletter (free inscription is possible)
- European Photovoltaics Projects report
- Clean, safe and efficient energy for Europe
- Renewable energy technologies and Kyoto Protocol mechanisms

## INFO FROM PROJECTS

### Natural ventilation in urban areas, Potential assessment and optimal façade design - URBVENT -

#### Why the URBVENT project?

##### *Energy savings*

One of the biggest challenges the World is facing in this early stage of the 21st Century is to reduce its energy consumption, especially fossil and nuclear energy consumption. There are several reasons for doing so: to save money, to reduce CO<sub>2</sub> production - which is responsible for global warming (Kyoto Protocol) -, to preserve fossil energy reserves for future generations and to reduce sources of potential international conflicts.

Everyone should clearly be aware that industries and transport are far from being the only energy consumers. Indeed, 40 % of the energy consumption in Europe is to be found in residential and services buildings (against 32 % for transport and 28 % for industry). Therefore, it is not surprising that according to the Green Paper of the European Commission, energy savings in buildings has to be one of the priorities for future actions. The new Directive on the Energy Performance of Buildings (EPBD), published on January 4, 2003, is in line with this objective.

##### *Natural ventilation...*

Natural ventilation is a technique to provide good Indoor Air Quality, and that can help to save energy. The main savings are not necessarily related to the absence of fans (required for mechanical ventilation), but to the decreased need for air-conditioning (thanks to e.g. free night cooling). In this context, the European Commission has financed several projects that aimed to develop and promote the use of natural ventilation in buildings (PASCOOL, AIOLOS, NATVENT, URBVENT...).

##### *...in urban areas*

Urban areas are more challenging for natural ventilation, as driving forces are reduced and potential barriers are increased. As the level of urbanization in Europe is very high (75 %), it was therefore necessary to specifically analyse natural ventilation in the urban environment; this was the task of the URBVENT project.

#### Work program of the URBVENT project

The URBVENT project (2000 – 2003) was organised in four work packages.

- **WP1: Natural Ventilation Potential Assessment.** The type of ventilation strategy to implement in a new building is a decision that must be taken at the early stages of the design process, as it has a deep impact on the building design. It seems therefore necessary to provide to designers a tool to quickly assess the Natural Ventilation Potential (NVP) of a site. This was the task of WP1.
- **WP2: Optimal openings design.** When a site with a good NVP is selected, it is necessary to size the natural ventilation system, especially the operable windows. Key factors are the wind and noise conditions of that particular site. These aspects were analysed in WP2. A tool was produced to optimise the window sizing.
- **WP3: Validation.** The tools developed by WP1 and WP2 were validated by WP3.
- **WP4: Synthesis.** The aim of WP4 was to disseminate the results of the project to a large audience of designers.

#### Main results of the URBVENT project

- An important part of URBVENT was dedicated to so-called canyon streets, at it is a very important pattern in urban areas. The wind was measured in 5 canyons and a methodology was developed to relate the wind field in a canyon to the wind conditions outside the canyon. The noise attenuation of a canyon in function of its characteristics was evaluated to measurements carried out in 9 canyons.
- URBVENT has produced two pre-design tools. The first one is to assess the NVP of a site, and to evaluate the energy savings that natural ventilation can provide. The second one is to optimise the window sizing and estimate the airflow inside a room.
- A "Handbook on Natural Ventilation in Urban Areas" has been written. This Handbook includes the URBVENT tools. It will be published by the international environmental science publisher James & James (London), in 2004. Its table of contents is given below:

1. Introduction
2. Role of natural ventilation
3. Physics of natural ventilation
4. Urban environment
5. Strategies for natural ventilation
6. Devices
7. Optimal openings design
8. Natural ventilation potential
9. Financial implications
10. Conclusion

- In order to disseminate them to a large number interested in natural ventilation, the main results of the project were summarised in a 16 page brochure. This brochure will be published in the next AIVC CD (June 2004).

#### *Participants to the URBVENT project*

The participants included 9 organisations from 6 countries:

- University of La Rochelle, France (URBVENT coordinator, WP1 coordinator)
- National and Kapodistrian University of Athens, Greece (WP2 coordinator)
- Axima, Switzerland (WP3 coordinator)
- Belgian Building Research Institute, Belgium (WP4 coordinator)
- EPFL, Swiss Federal Institute of Technology of Lausanne, Switzerland
- London Metropolitan University, United Kingdom
- Instituto de Engenharia Mecânica, Portugal
- National Scientific Research Center, Rhône-Alpes Division (Ecole Nationale des Travaux Public de l'Etat, Lyon), France
- Building Research Establishment, United Kingdom

The participants would like to gratefully thank the European Commission, which financed the URBVENT project (Fifth Framework Programme).

**European project HOPE  
(Health Optimisation Protocol  
for Energy-efficient buildings)**

Ch. Cox - TNO  
M. Maroni - University of Milan  
C. Aizlewood - BRE Environment  
C.-A. Roulet - EPFL  
<http://>

The potential for improving the indoor environment is high as well as the potential for reducing energy use in buildings. However, there appears to be a conflict between strategies to reduce energy use in buildings and strategies to create healthy buildings. In January 2002, a European project named HOPE (Health Optimisation Protocol for Energy-efficient Buildings) started with 14 participants from nine European countries.

The following scientific objectives have been defined:

- Solve the conflict between strategies to reduce energy use and strategies to create healthy buildings
- Identify European agreed parameters to describe the health status of occupants and energy efficiency status of buildings
- Develop European agreed techniques to assess the health status of occupants and the energy efficiency of buildings
- Develop methods to relate the health status of occupants and energy efficiency status of buildings.

The final goal of the project is to provide the means to increase the number of energy-efficient buildings, i.e. buildings that are at the same time healthy and low energy users.

In the HOPE project, based on available knowledge and bearing in mind the research scope, the following definition of a "Healthy and Energy Efficient Building" has been adopted:

- Doesn't cause or aggravate illnesses in the building occupants
- Assures a high level of comfort for the building's occupants with respect to the designated activities for which the building has been intended and designed
- Minimizes the use of non-renewable energy taking into account available technology including life cycle energy costs.

Stakes, criteria and factors for energy efficient, healthy and comfortable building

Stake	Criteria		Factors
Low energy use	Energy use per heated floor area		Heating and hot water energy index
			Electric energy index
Does not cause or aggravate illness	Health	Risks of illnesses	E. g. presence of radon, asbestos, heavy metals, microbes, allergens, etc.
		Building related symptoms	Dry or irritated skin; blocked or stuffy nose; runny nose, dry throat; chest tightness; wheezing, dryness of the eyes; itchy or watery eyes, lethargy or tiredness; headaches
High level of comfort for the building's occupants	Indoor environment quality	Indoor air quality	IAQ dissatisfaction Air stuffiness or dryness; odour
		Thermal comfort	Thermal discomfort in general Too cold or too hot; draughts
		Acoustical comfort	Noise dissatisfaction Noise from outdoors or building systems
		Visual comfort	Lighting dissatisfaction Glare and light flickering

Based on this definition, a (preliminary) set of performance criteria for healthy and energy-efficient buildings for Europe has been developed. A comprehensive table of health parameters and related target values and associated factors/building objects has been drafted. Target values are based on generally-accepted guidelines (WHO, EU), standards or best available data.

The set of performance criteria is checked in existing buildings by:

- a multi-disciplinary study in 180 office and multi-apartment buildings of which 75 % are designed to be energy-efficient
- a detailed investigation on at least 32 (all energy-efficient) of the above buildings

The multidisciplinary studies have been performed using a common protocol. The protocol combines occupant questionnaires and checklists to collect data on building and systems and use of the building. Measurements have, intentionally, not been included in this protocol.

The results of the multidisciplinary study are introduced in a database called HODA (Hope Database). Using the database, the metrics for ranking the buildings according to health and energy efficiency can be determined.

The energy use of the building is evaluated by the yearly total energy use, the yearly total energy use for heating, and the total electricity use. These data are either derived from data about the fuels and electricity actually used, or by calculation (e.g. energy for heating).

To be able to compare buildings of different sizes, the energy use is expressed per m<sup>2</sup> heated floor area, including walls (i.e. measured with the external dimensions of the building) but excluding unheated zones such as garages, cellars or unoccupied attics. This value is straightforward to assess from blueprints or on site. The energy indexes are then defined as:

$$I_t = \frac{E_t}{A_r} \quad I_h = \frac{E_h}{A_r} \quad I_e = \frac{E_e}{A_r}$$

I<sub>t</sub> = total energy index (MJ/m<sup>2</sup>)  
I<sub>h</sub> = heating energy index (MJ/m<sup>2</sup>)  
I<sub>e</sub> = electricity index

The health requirements are evaluated using three types of metrics:

- Acute building-related (perceived) symptoms (from the questionnaires)
- (Perceived) environmental comfort (from the questionnaires)
- Building health risk factors (mainly from the checklists but some data also from questionnaires)

Building health risk factors are those characteristics of the building or the environment that may, directly or indirectly, have an impact on the health of the occupants. These will be used to identify the presence (or likelihood of presence) of specific hazards. The health risk metric is based on qualitative relations between checklist items and hazards. From these relations, evaluation rules have been drafted, mainly focussing on the presence of sources and ventilation (as a mitigating factor).

The hazards are grouped in 3 classes, based on the level of health outcome:

- Class 1: hazards causing death or an illness with a high probability of being fatal (e.g. lung cancer): asbestos, radon, carcinogenic volatile organic compounds (VOCs), Environmental Tobacco Smoke (ETS) and a high carbon monoxide concentration
- Class 2: hazards causing illness (principally respiratory illness): ozone; heavy metals, infection from occupants, infection from building, fungi, house dust mites, oxides of nitrogen, particulate matter, sulphur dioxide

and finally

- Class 3: hazards causing discomfort: lighting, noise, VOCs non-carcinogenic, low carbon monoxide concentration, too hot, too cold

For a global evaluation of overall quality, for sorting or labelling of a building, a multicriteria analysis tool is being developed. In this tool, the different stakes at issue (energy efficiency, health and comfort) in the HOPE project are represented by one criterion. Each criterion itself is evaluated by a family of factors (table?).

In the next phase of the project, in the detailed field investigation 32 buildings that have a low energy use are now being studied to characterise the differences between those that are healthy and those that are not (based on the WP 3 findings).

A building-specific approach has been agreed upon. The starting point for the investigation in each building will be the results of the multidisciplinary study: symptoms and comfort scores and hazard analysis. Relevant problems and hazards for each building will be investigated. Where necessary, a more detailed analysis of the energy use in the selected buildings will be made.

The combined data and information of WP2, WP3 and WP4 will be used to develop:

- a final set of performance criteria for energy-efficient and healthy buildings
- a final methodology for assessing the performance of buildings with regard to energy use and health
- a set of health-energy integrated guidelines to improve unhealthy or low energy-efficient buildings a protocol for improving a unhealthy and low energy-efficient building

The database containing building's data will be incorporated into the web site of the project, allowing the possibility for non-participants of the project to submit their own data and make their own multi-criteria analysis of how healthy and energy-efficient their building is, as compared to the investigated buildings.

#### References:

Bluyssen, P.M., Cox, C., Maroni, M., Boschi, N., Raw, G.J. Roulet C.A., Foradini, F. Bluyssen, Cox European project HOPE (Health Optimisation Protocol for Energy-efficient buildings), Proceedings Healthy Building 2003, Singapore.

Maroni et al., 2003, Performance criteria for healthy buildings, Healthy Buildings 2003, Singapore

Roulet, C.-A., Johner, N., Flourentzou, F., Greuter, G., 2003, Multi-criteria Analysis Methodology of Health, IEQ and Energy Use for Sustainable Buildings, Healthy Buildings 2003, Singapore

#### Acknowledgments:

HOPE is partly sponsored by the European Union in the JOULE programme (DGXII) under the management of Dr. G. Deschamps.

## The Performance Approach and the Indoor Environment

*M. Loomans, Ph. Bluyssen - TNO*  
<http://www.>

Performance Based Building (PBB) is the topic that is dealt with within the EU 5<sup>th</sup> Framework Thematic Network PeBBu (Competitive and Sustainable Growth Programme). This concept can be described in one sentence: 'Thinking and working in terms of ends rather than means'. However, the practical implications and the application of the concept are less straightforward. As advantages of the PBB approach are obvious and have been proven to some extent, the Thematic Network PeBBu wants to increase the momentum.

PeBBu has been initiated by CIB. The overall objective is to stimulate and proactively facilitate the international dissemination and implementation of Performance-based Building (PBB) in the building and construction industry. It is not intended to present the ultimate solution for PBB, but to allow for a more fundamentally motivated and integrated continuation of the further development of PBB.

The PeBBu Network is divided into a number of so-called domains. These domains deal with specific topics that are affected by or influence the PBB approach. One of the domains is Domain 2 'Indoor Environment'. TNO is leader of this domain. The focus of this domain is on performance criteria for healthy buildings and the physical parameters that relate to the context of health (i.e. visual comfort, noise, **air quality** and **thermal comfort and humidity**). This domain wants to gather available guidelines, standards, methods and tools to evaluate the health status of buildings or designs for buildings based upon such performance criteria. We start from the assumption that the achievement of healthy buildings can be pursued by designers, constructors, building owners and building occupants, through the application of qualitative and quantitative health-based criteria. From the occupant point of view, the ideal situation is an indoor environment that satisfies all occupants (i.e. they have no complaints) and does not unnecessarily increase the risk or severity of illness or injury.

Domain 2 gathers more than 40 members, observers and guests from over 20 countries, in and outside Europe. The participants are experts in the field of building physics and indoor environment. Several already have long-time experience with the application of the performance approach with respect to, e.g., building physical aspects.

Activities in PeBBu concentrate around workshops in which status and developments are discussed. Furthermore, a state-of-the-art report for each domain is prepared. The contents of this report is prepared by the domain leader and then discussed with the members. A first overall state of the art report from PeBBu has recently become available. This report includes synthesis reports from the separate domains that are part of PeBBu.

Please visit <http://www.> to learn more about these reports.

In this news article an overview is given of the results of the work of Domain 2 "Indoor Environment". It will discuss the "language", i.e. the definition of PBB, the "harmony", i.e. a framework, and it will present a state of the art. Finally, future work is indicated. For more information on this topic and on PeBBu a reference is provided to the internet. The PeBBu Network will continue until September 2005.

**Design guidelines for the efficient integration of renewable energy sources in new built settlements**  
- RESSET -

RESSET aims to deliver a global and integrated plan for the implementation of Renewable Energy Systems and techniques in new developed settlements. It is a joint effort, set to provide design tools and support to a wide range of professionals, consumers and public authorities. The project has been running since January 2002 and is now finalised.



The final outcomes of the project are:

- a. A reference manual – Design Guidelines Handbook, presenting globally design guidelines, performance criteria and methodologies for best practice implementation of renewable energy systems and techniques in new built settlements,
- b. A complete technical, financial and environmental assessment of the potential for energy conservation when the proposed interventions are applied to new settlements,
- c. A series of extended brochures presenting results from the performed case studies
- d. The conclusions and results of the organised workshops on the global integration of RES in new built settlements

All final documents will be available when approved by the Commission through the AIVC CD.

**Development of an Integrated Scheme for the Energy Efficient Refurbishment of Existing Settlements**  
- INTERSET -

INTERSET aims to study and propose global strategies, tools and guidelines that promote the efficient and cost effective global implementation of advanced systems and techniques in the refurbishment of existing settlements in Europe.

The specific objectives of the project include:

- the combination and adaptation of scientific and technological knowledge with best engineering and architectural practice in order to study, develop, propose and disseminate global actions on the integration of energy efficient systems and techniques in existing settlements requiring refurbishment,
- the development of tools for best practice and economic efficient management and retrofitting of existing settlements,
- the study of the existing legislative framework on the implementation of advanced energy efficient systems and techniques in settlements,
- the assessment of five case studies on the energy efficient retrofitting of specific settlements in Europe,
- the integration of the results and conclusions into a set of design guidelines for managers and designers of settlements, urban sites and utilities.

The final deliverable of the present project are a global and integrated plan for the energy, environmental and financial efficient refurbishment of existing settlements, aiming to provide design tools and support to a wide range of professionals, to consumers and to public authorities.



It includes:

- A Reference Manual - Design Guidelines Handbook, presenting globally design guidelines, performance criteria and methodologies for best practice for the efficient retrofitting of existing settlements, and in particular a) of techniques to improve local microclimate, b) of techniques to improve the building performance, c) of RES based district heating/cooling techniques and DSM methods, d) of advanced low energy consumption heating/cooling
- A complete technical, financial and environmental assessment of the potential for energy conservation of the above mentioned groups of energy efficient interventions when applied to refurbished settlements. The assessment considers different climatic, operational, energy and environmental criteria and characteristics
- A series of extended brochures presenting results from the performed case studies, where global scenarios to integrate energy saving systems and techniques during all phases of the retrofitting of an existing settlement will be developed and applied theoretically. The scenarios assess the potential for energy conservation and financial and environmental benefits due to the extensive use of active and passive energy efficient techniques
- The conclusions and results of the organized workshops on the efficient refurbishment of settlements
- All final documents will be available when approved by the Commission through the AIVC CD.

## ENERGY PERFORMANCE OF BUILDINGS

## European Energy Performance Directive and standardisation

*P. Wouters - BBRI*

The European Directive 2002/91/EC on the energy performance of buildings (EPBD) requires several different measures by the member states in order to improve the energy efficiency of buildings and to reduce the environmental impact of the energy use for buildings.

One tool for this will be the application by Member States of minimum requirements on the energy performance of new buildings and for large existing buildings that are subject to major renovation (Articles 4, 5 and 6). Other tools will be energy certification of buildings (Article 7) and inspection of boilers and air-conditioning systems (Articles 8 and 9).

A basic requirement for measures in Articles 4, 5 and 6 is the existence of a general framework for a methodology of calculation of the integrated energy performance of buildings, as set forth in Article 3 and in the Annex to the Directive.

Access to such a calculation methodology in the form of European standards will facilitate and make a harmonisation of the various measures for improving energy efficiency in buildings possible between the Member States. It will increase the accessibility, transparency and objectivity of the energy performance assessment in the Member States, as mentioned in recital (10) of EPBD.

The use of European standards for calculating energy performance, as well as for energy performance certification and the inspection of boilers and air-conditioning systems will also reduce costs compared to developing standards at national level. Enough flexibility can be left for necessary national and regional differentiation.

To a certain extent parts of such a methodology already exist in the form of a number of European standards for calculation and testing. To fulfil the objectives of the EPBD, further standards need to be developed and integrated and some of the existing standards need to be modified and/or extended.

Within this context, it is anticipated that the European Commission will give a mandate to CEN, (<http://www.cen.eu>) CENELEC (<http://www.cenelec.eu>) and ETSI (<http://www.etsi.org>) for the elaboration and adoption of a whole range of standards.

As far as the ventilation related aspects are concerned, it is expected that the following work items will be included in this mandate (N= new):

- Energy performance of buildings - Energy certification of buildings (N)
- Energy performance of buildings - Overall energy use, primary energy and CO<sub>2</sub> emissions (N)
- Energy performance of buildings - Ways of expressing energy performance of buildings (N)
- Energy performance of buildings - Additional applications of calculations for the inclusion of the positive influences of daylighting, solar shading, passive cooling, position and orientation, renewables, district heating and cooling, CHP (including on-site) and for modular inclusion of future technologies (N)
- Energy performance of buildings - Certification systems (N)
- Energy performance of buildings - Systems and methods for the inspection of air-conditioning systems (N)
- Dynamic calculation of room temperatures and of load and energy for buildings with room conditioning systems (including solar shading, passive cooling, and position and orientation)
- Thermal performance of buildings - Calculation of energy use for space heating and cooling - Simplified method (N)
- Thermal performance of buildings - Calculation of energy use for space heating - Simplified method
- Thermal performance of buildings - Sensible room cooling load calculation - General criteria and validation procedures
- Energy performance of buildings - Calculation of energy use for space heating and cooling - General criteria and validation procedures
- Ventilation for buildings - Calculation methods for the determination of air flow rates in dwellings
- Ventilation for buildings - Calculation methods for energy requirements due to ventilation and infiltration in buildings
- Calculation methods for energy efficiency improvements by the application of integrated building automation products and systems
- Ventilation for non residential buildings - Performance requirements for ventilation and room conditioning systems.
- Performance requirements for temperature calculation procedure without mechanical cooling

## A contribution in energy labelling of small residential buildings

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The European directive 2002/91/EC on Building Energy Performance aims at improving and harmonizing assessment, certification and labelling practices in the member states. The work presented here has been performed in the framework of the European project PREDAC (European Actions for Renewable Energies, Further information and documents are available on: <http://www.predac.eu>, particularly a guide for a building energy label can be downloaded). This work is concerned with small residential buildings and includes:

- a review of existing approaches in 7 countries (Germany, Austria, Belgium, France, United Kingdom, The Netherlands and Switzerland)
- identification of good practice
- realisation of a guide to building energy labelling
- improvement and dissemination of this guide, after consultation of concerned organisations and professionals during workshops

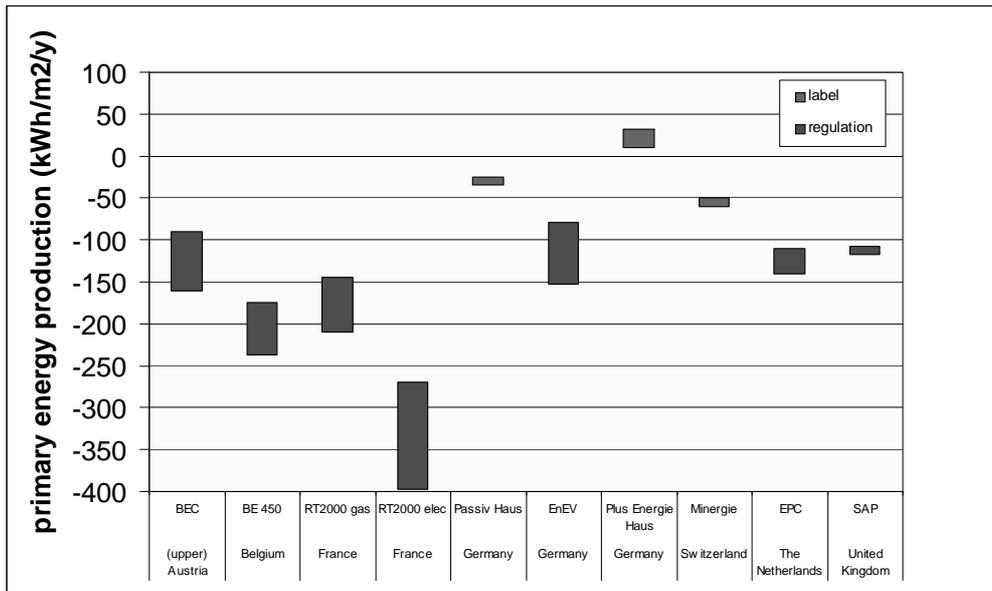
## Comparison of different European approaches

European consumers have presently little information about the performance of their dwelling. The thermal regulations are very different: in similar climatic conditions, the energy consumption for space heating can vary by a factor of 3.

The following graph shows the primary energy consumption for space heating, domestic hot water, ventilation and lighting, corresponding to different labels and regulation thresholds. If lighting is not included in a national assessment method, a 10 kWh primary energy consumption per m<sup>2</sup> has been considered. A conversion factor of 2.58 is used to transform 1 kWh electricity into primary energy. The German label "Plus Energy House" corresponds to a net energy production, the other thresholds are expressed as negative values (energy consumption).

In most cases, the regulation threshold varies in terms of the compactness of a building.

A performance interval is then given for two buildings: a detached single family house (minimal compactness) and a small apartment building. In France, a higher primary energy consumption is allowed for electric heating.



Not advisable	Good practice
Limit performance to specific aspects, for instance heat losses	Integrate space heating, domestic hot water, ventilation and lighting, envelope and equipment
Express performance as end energy	Express performance as primary energy, integrating efficiency along the whole process : from extraction of natural resources, energy transformation (e.g. electricity production, uranium enrichment), distribution, until the end use
Express performance as consumption per dwelling unit or per m <sup>2</sup>	Express performance both per dwelling unit and per m <sup>2</sup> , so that architectural design is integrated (because a ratio per m <sup>2</sup> depends on compactness) and in order to show that the consumption is higher in large dwellings
Vary the thresholds in terms of the building shape (compactness)	Adopt fixed thresholds in kWh/m <sup>2</sup> /an, in order to promote energy efficient architectural practice
Vary the thresholds in terms of the climate (*)	Adopt a single threshold : a higher insulation level will be required in colder climates to achieve the same performance (*)
Choose a national format for the label	Adopt the European energy label, which is already well known by the general public because it is used for domestic appliances
Impose the use of a simplified calculation method	Allow the use of dynamic simulation tools
Allow the assessment to be performed by non qualified persons (e.g. estate agents)	Develop training activities so that precise assessment can be performed, e.g. by quantity surveyors or local energy agencies

\*) this statement is not agreed by all partners

	<p>A : more than 21 points, C &lt; 31 kWh/m<sup>2</sup>/y                      B : from 19 to 21 points, C between 31 and 60 kWh/m<sup>2</sup>/y                      C : from 16 to 18 points, C between 61 and 90 kWh/m<sup>2</sup>/y                      D : from 13 to 15 points, C between 91 and 130 kWh/m<sup>2</sup>/y                      E : from 9 to 12 points, C between 131 and 170 kWh/m<sup>2</sup>/y                      F : from 5 to 8 points, C between 171 and 210 kWh/m<sup>2</sup>/y                      G : less than 4 points, C &gt; 210 kWh/m<sup>2</sup>/y</p> <p>In complement to the letter, the dwelling energy consumption should be indicated, for instance : <b>12,000 kWh/year</b>                      This value could be complemented by environmental indicators, e.g. 4,000 kg CO<sub>2</sub>/year, 0.23 dm<sup>3</sup> radioactive waste/year, 20% renewable energy</p>
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**Good practice in certification**

The different approaches were compared, which allowed good practice to be identified concerning assessment, certification and labelling of building energy performance.

**Implement Building Energy Labelling**

A method for building energy labelling is proposed in the guide developed during this project, for new constructions and existing buildings. A list of dynamic simulation tools is given, the European standard EN 13790 also requires a computer for the assessment. For small size buildings, the use of such tools might be expensive and complex. A points based method is then proposed.

The first step has been to identify the key parameters : compactness, insulation and thermal bridges, area, orientation and quality of glazing, efficiency of equipment (space heating, domestic hot water, lighting), ventilation (air flow rate and preheating efficiency if any), use of renewable energies (solar domestic hot water, photovoltaics, wood fuel...).

A sensitivity study has been performed to evaluate the influence of these parameters, using different methods : RT 2000 (France), SAP (United Kingdom), EnEV (Germany), TRNSYS (Belgium). This sensitivity study allowed points to be allocated to various techniques : if one point corresponds e.g. to a 10 kWh/m<sup>2</sup>/year reduction of the primary energy consumption, a certain number of points can be obtained by technical measures (thermal insulation, advanced glazing etc.) or architectural design (compactness, solar aperture). Concerning ventilation, points can be obtained if the ventilation air is preheated, and the number of points depends on the efficiency of the heat recovery from exhaust air and the air tightness of the building.

Points based methods are not very precise, but some calculation methods neglect important parameters (e.g. solar aperture, thermal bridges) and can be misleading. A points based method can be helpful to identify relevant measures to improve the performance of an existing construction.

It is proposed that the A class correspond to the best practice, i.e. to the "passive house" and "plus energy house" labels (primary energy consumption lower than 30 kWh/ m<sup>2</sup>/an). The G class could correspond for instance to a consumption higher than 210 kWh/m<sup>2</sup>/an.

**International workshop on Assessment of Innovative Technologies in the Framework of the New Energy Performance in Buildings Directive**

All present and future member states of the EU have to apply the Energy Performance of Building Directive (EPBD) before the 4<sup>th</sup> of January, 2006.

Several states have already developed calculation procedures to evaluate the integral Energy Performance of Buildings. Most of these procedures only deal with standard products and systems. Procedures have still to be developed for the assessment of innovative systems.

Even if this workshop is organised in the framework of RESHYVENT (dealing with hybrid ventilation in residential buildings), the workshop will consider innovative technologies in general, and not only technologies related to ventilation.

*Innovative technologies* are defined as technologies:

- which in most cases give better performances in terms of the Energy Performance of Buildings than the common technologies and,
- whose performances cannot be assessed by the procedures in the Energy Performance calculation methods.

**The aims of the workshop are:**

- to inform interested parties (industry, regulators,...) of the specific challenges regarding the assessment in a national EPBD context of so-called innovative technologies
- to present and discuss INNOVET, a SAVE project proposal aiming to solve a substantial part of the existing problems
- to present the objectives and envisaged approach for a permanent European based platform for the market implementation of innovative systems
- to identify relevant stakeholders for such a project

The International workshop on Assessment of Innovative Technologies in the Framework of the New Energy Performance in Buildings Directive will be held in Brussels on 29-30 March 2004.

The flyer of this workshop can be found on the AIVC-CD .

**STANDARDS AND REGULATIONS****Online purchase of Standards**

*P. Wouters - BBRI*

The internet offers increased possibilities for online purchase of standards. An interesting website is

<http://www.>

Established in 1922, **Standards Australia** is recognised through a Memorandum of Understanding with the Commonwealth Government as the peak non-government standards development body in Australia. It is a company limited by guarantee, with 72 Members representing groups with an interest in the development and application of standards and related products and services. It is Australia's representative on the International Organization for Standardization [ISO], the International Electrotechnical Commission [IEC], and the Pacific Area Standards Congress [PASC].

Through its committee structure, Standards Australia develops and maintains more than 7000 Australian Standards® and related publications. Standards Australia was apparently one of the first organisations of its type in the world to develop on-line delivery of technical and business standards. Today, in partnership with SAI Global, it continues to deliver its standards and related products through: <http://www.> to industry.

On <http://www.>, there are over **40,000 international standards** available on line:

- 16.000 standards from ISO (The International organization for Standardization)
- 4.000 standards from the IEC (International Electrotechnical Commission)
- 4.000 standards from JIS (Japanese Standards Association)
- Over 9.000 standards from DIN (German Institute for Standardization)
- 11.000 standards from ETSI (European Telecommunications Standards Institute)
- 7.000 Australian standards

Standards can be obtained by one of the following methods:

**Individual purchase**

The standards are all available either as an immediate download or as printed copies for mail delivery. If downloaded, a 10 % reduction on the paper price is obtained, and there are no mailing costs.

BOOKSHOP

**Natural Ventilation in Urban Areas**

A new Ventilation Information Paper from the AIVC

*AIVC VIP 03, 2004, 10 pp, M. Santamouris*

Natural ventilation is one of the most effective passive cooling techniques. Because of the serious reduction of the wind speed in the urban environment and the corresponding reduction of the air flow rate, for both single and cross configurations, the cooling load on the buildings inside the canyons is much higher than the one of buildings where wind is not obstructed. Thus, it is very important to consider other techniques than windows to enhance air flow in urban buildings. Traditional techniques like solar chimneys or wind towers can be easily integrated in urban buildings and may contribute significantly to increase natural air flow through the building.

For more information read the new Ventilation Information Paper .



**Night Ventilation Strategies**

A new Ventilation Information Paper from the AIVC

*AIVC VIP 04, 2004, 12 pp, M. Santamouris*

Addressing successful solutions to counterbalance the energy and environmental effects of air conditioning is a strong requirement for the future. Possible solutions involve the use of passive cooling techniques and in particular of heat and solar protection techniques, heat amortisation and heat dissipation techniques.

Recent research has shown that night ventilation techniques may contribute highly to improve thermal comfort in free floating and decrease the cooling energy consumption of air conditioned buildings. The present document presents the principles of night ventilation, the main limitations of the technique, the expected performance, tools to size and analyse the energy potential of night cooling techniques, and finally some successful case studies.

For more information read the new Ventilation Information Paper .



**Air exchange rate and airtightness measurement techniques – An application guide**

*AIVC Guide AG, 1988, 228 pp, P S Charlesworth*

Now also available in pdf format! 

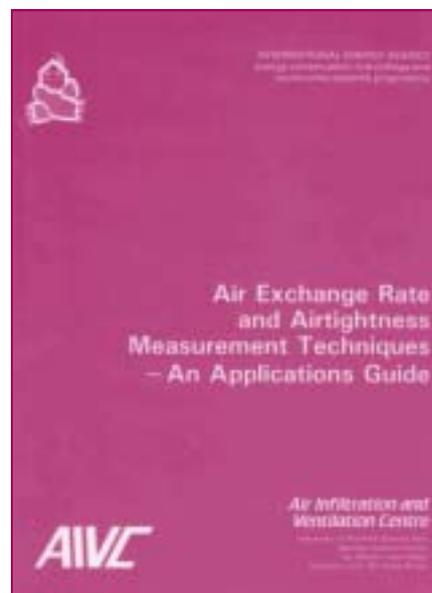
A loose-leaf handbook (228 pp) divided into seven chapters covering air change rate, interzonal airflow and building airtightness measurement techniques.

This guide is concerned with the measurement of those parameters which are important in gaining an understanding of air infiltration and ventilation.

The guide has been designed so that the material suited to your particular level of interest or current expertise is readily accessible.

The introduction provides a general overview of infiltration and ventilation in buildings. Ventilation studies are discussed and the aims of the guide outlined.

Chapter 1 defines the parameters which are important, presents the reasons why they should be measured,



and gives a guide to the selection of techniques for particular applications. Summaries of the main techniques available are presented, which are cross referenced with the main body of the guide.

Chapter 2 presents the fundamental theory and practice of measuring air exchange rates. Air exchange between a building and the external environment is examined, as is the air exchange between the various internal spaces of a building.

Chapter 3 presents the fundamental theory and practice of measuring the airtightness of the building envelope. The airtightness of whole buildings and building components is considered. Leakage location and leakage path distribution is also examined.

Chapter 4 discusses some of the specialist equipment and instrumentation required to make air infiltration and ventilation measurements.

Chapter 5 examines standards and regulatory documents which relate to air exchange rate and airtightness measurement techniques.

Chapter 6 contains detailed descriptions of selected measurement techniques. To aid comparison and selection, each technique is presented in a standard format.

Chapter 7 contains descriptions of selected instruments and instrument types. Information is presented in a standard format to aid the location of specific details.

Appendix 1 is a glossary of terms used in the guide relating to air exchange and airtightness measurement techniques.

The guide is presented in a loose leaf format to enable fresh developments in measurement technology to be readily accommodated.

**Ventilation and productivity: some interesting publication “The Benefits of Daylight through Windows”**

*A. Deneyer - BBRI*

The importance of a good ventilation and a good indoor air quality in relation to productivity (and economic value) has been receiving more interest in the last decade. Similar trends are observed in the area of visual comfort and productivity.

Just recently, LRC (Lighting Research Centre, Rensselaer Polytechnic Institute), on behalf of the Daylight Dividends program sponsors (U.S. Department of Energy, New York State Energy Research and Development Authority, California Energy Commission, Connecticut Light and Power Company, Iowa Energy Center, Northwest Energy Efficiency Alliance and the North Carolina Daylight Consortium), created a new website highlighting the benefits of daylighting:

<http://www.aivc.org>

Moreover, an interesting study has been realised by Peter Boyce, Claudia Hunter and Owen Howlett and entitled “The benefits of daylight through windows”. (The full report is available on the AIVC-CD).

The study presents the factors influencing productivity. On one hand, it considers the human factors of the individual (motivation, well-being, ability to perform, ...) and on the other hand, it considers system factors and the personal circumstances which influence the human factors (organisation, occupation, indoor environment,...). Precisely, it is on the indoor environment level that ventilation, temperature, humidity and lighting play a role.

One of the interests of this study is the link it makes between visual comfort and productivity, which is a function of the worker (age, visual acuity,...) but is also function of the environment (illuminance distribution, contrast,...).

The graphics below (extracted from the study) demonstrate, for different luminance levels, the relation between the work speed (time taken to perform a numerical verification task) and the luminance contrast between the task area and the background.

It shows that :

- At the same luminance contrast (i.e. 0.1), the performance (work speed) is better at higher luminance (0.031 for 169 cd/m<sup>2</sup> against 0.026 for 12 cd/m<sup>2</sup>)
- At lower luminance contrasts (i.e. 0.1), the performance tends to saturate for higher luminance (169 cd/m<sup>2</sup>)

This clearly means that productivity is linked to visual comfort and that rising the visual comfort inside offices rises the productivity of workers.

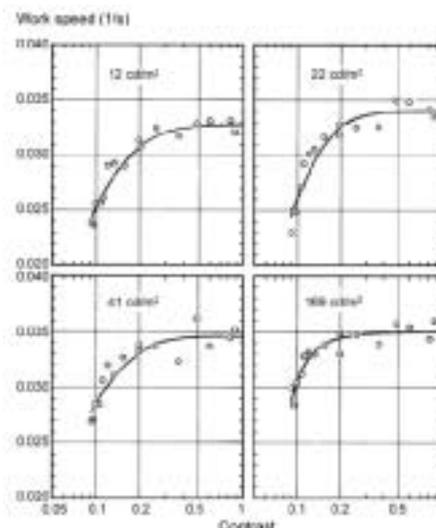
Such considerations may be done for ventilation regarding the installation (temperature, debit,...), the worker (age, sensibility,...) and productivity.

The study also focuses on other aspects of daylighting:

It demonstrates the importance of daylight and its benefits (daylight and health) due to its intrinsic properties like its spectrum and its variability, which are physiologically and psychologically very important for human well-being.

It also makes the relation between daylighting and finance (capital costs and rental value of daylighting).

The study demonstrates the value placed on the admission of daylight and the view out: if providing windows is more expensive than providing a blank wall, windows are still widely used !



**New strategy of information dissemination at BBRI**

*O. Vandooren - BBRI*  
<http://www.bbri.be>

The Belgian Building Research Institute has developed a new strategy of information dissemination the service of the entire construction sector. This future-oriented strategy makes use of the modern communication technologies and hinges upon an entirely new website (<http://www.bbri.be>).



This site has the potential to become an indispensable working tool and, thus, a reference for the sector. Its contents will be enhanced by means of different media, one being a magazine called CSTC-Contact (in French) or WTCB-Contact (in Dutch). This magazine is to be published quarterly and will be sent for free to all construction companies contributing to the BBRI – that is some 70,000 Belgian building contractors. As CSTC-Contact/WTCB-Contact constitutes a permanent connection to the BBRI-website – by integrating its essential principles – it can be considered to be one of the strongest links of the new information dissemination chain. This magazine contains short articles, summaries or selected extracts whereby more detailed articles are available on-line.



In order to ensure a large information dissemination, CSTC-Contact/WTCB-Contact can be downloaded for free on the Internet.

In the near future, BBRI intends to have in addition to the publication of the CSTC-Contact/WTCB-Contact a monthly e-mail-service, to which the readers can subscribe for free via the BBRI-website.

The new BBRI strategy of information dissemination will be implemented progressively in the course of the year 2004 and has one major goal : offering a better, larger and faster information dissemination to the national and international construction sector.

On the AIVC-CD: CSTC-Contact in French  and WTCB-Contact in Dutch  can be found.

For the AIR reader, the article about double ventilated façades on page 3 is probably of specific relevance.

E-mail: [info@bbri.be](mailto:info@bbri.be)

April 2004. The organising associations are pleased to invite for this first edition, not only the Portuguese hosts, but also all the technicians from Mediterranean border countries, specially those coming from Spain, France and Italy, and performing their professional activity within such an important area of work of nowadays, the Air Conditioning.

**Call for proposals “Intelligent Energy for Europe programme”: SAVE and ALTENER**

[http://](http://www.intelligent-energy.eu)

"Intelligent Energy - Europe" (EIE) is the Community's **support programme for non-technological actions** in the field of energy, precisely in the field of energy efficiency and renewable energy sources. The duration of the programme is from 2003-2006.

The programme was adopted by the European Parliament and the Council on 26 June 2003. It was published in the Official Journal of the European Union on 15 July 2003 (OJ, L 176, p 29-36) and entered into force on 4 August 2003.

Intelligent Energy - Europe (EIE) is intended to support the European Union's policies in the field of energy as laid down in the Green Paper on Security of Energy Supply, the White Paper on Transport and other related Community legislation (including the Directives on renewable electricity, energy performance of buildings and biofuels). Its aim is to support sustainable development in the energy context, making a balanced contribution to achieving the general objectives of security of energy supply, competitiveness, and environmental protection (Art. 1 of the programme Decision).

The programme is structured in four fields: SAVE, ALTENER, STEER and CO-OPENER. ALTENER and especially SAVE may be relevant for most readers : **SAVE** – improvement of energy efficiency and rational use of energy, in particular in the building and industry sectors, **ALTENER** - promotion of new and renewable energy sources for centralised and decentralised production of electricity and heat and their integration into the local environment and the energy systems.

The deadline for the call for proposals is April 30. More information can be found on the website [http://](http://www.intelligent-energy.eu)

**MEETINGS AND EVENTS**

**Mediterranean Congress of Climatization**

16th and 17th of April 2004 in Lisbon  
<http://www.climamed.com>



CLIMAMED was born from the need felt by the associations of air conditioning from several countries in the Mediterranean border to create, under the auspices of REHVA, a forum to analyse, discuss and present solutions to particular problems from this climate area, which wouldn't be discussed in the European association, although they are very important for the countries involved.

Therefore, last March, during the Air Conditioning exhibition fair in Madrid, representatives from four associations, such as ATECYR from Spain, AICARR from Italy, AICVF from France and APIRAC from Portugal, decided to carry out, in a joint organisation, an annual congress. The objectives would be to widen the forum to other Mediterranean, European or Arabic countries, thus creating a source of information and constituting both the guidelines to all these countries as well as an extra asset for the enhancement of REHVA's activity.

CLIMAMED will be organized in a rotating basis between the four countries (Portugal, Spain, Italy and France). The first Edition will take place in Lisbon during the next EXPOCLIMA – HVAC&R and Energy Control International Event, in

## AIVC Conference 2004: "Ventilation and Retrofitting" - 15-17 September 2004

Since 1980, the AIVC conferences have been the meeting point for presenting and discussing interesting developments and results regarding ventilation in buildings. For each conference a specific theme is selected and a substantial part of the presentations relate to this theme. **The 2004 conference is the 25th AIVC conference** and therefore the "**Silver Jubilee**" conference. The theme of this conference is "**Ventilation and Retrofitting**". There are several reasons for selecting this theme:

- air quality is below standards and/or the energy consumption for ventilation is high to very high in many existing buildings
- improvement of the air quality and ventilation performances in existing buildings can be quite challenging
- substantial improvement of the overall energy consumption of the building stock requires implementing large-scale measures in existing buildings, and often requires attention, even when it was not an issue before the retrofit
- the retrofitting of existing buildings is a major theme in the EU 6th framework programme as well as in the 5-year plan of the US Department of Energy

### Programme

The programme will cover the following topics:

- performances of ventilation systems in existing buildings (air flow rates, acoustical performances, energy consumption, system characteristics)
- airtightness of existing buildings and ventilation systems
- retrofitting of existing buildings (dwellings or non-domestic buildings)
- air quality in existing buildings before and after retrofitting
- economic aspects of retrofitting measures
- occupant productivity and health
- standards or regulations for existing buildings (air quality, energy,...)
- development and application of innovative systems for the retrofitting market
- systems integration and synergetic effects
- demand-controlled ventilation in existing buildings
- ventilation retrofitting and improved security (anti-terrorism)
- retrofit case studies

Moreover, the topic of **hybrid ventilation in new and existing buildings** will be given particular attention and at least 1 session will be organized in close collaboration with the EC RESHYVENT project.

The programme for this conference will consist of: Papers: 15 to 20 minute oral presentations followed by discussion; posters: 5 minute oral introduction followed by exhibit; summing-up at the end of the conference.

### Venue

AIVC Conference 2004 will be held at the Hotel Dorint • Don Giovanni • Prague  
Vinohradska 157a - 13020 Prague - Czech Republic

Tel.: +420 (0) 2.67.03.11.11- Fax: +420 (0) 2.67.03.67.17 - <http://www.dorint.com/prag>

### Hotel information

A contingent of rooms is being reserved for conference participants and accompanying persons at the Dorint Don Giovanni Prague and a special group rate will be offered (150 €/night, single or double room, breakfast and taxes included). To obtain the preferential price, please mention the reference code "AIVC Conference".

### Registration fees

	Before 1st July 2004	From July 1st 2004
Conference fee (without accomodation)	599 €	699 €
Conference fee for students (without accomodation)	349 €	399 €
Full Conference package (incl. 3 nights and breakfast)	999 €	Only available till 1st May

One full registration fee by participant is required for each technical paper included in the programme. Papers submitted without payment of the registration fee will not be inserted in the Conference proceedings nor included in the technical programme.

*The fees cover:* Attendance at all sessions; welcome coffee, lunches (except on Thursday noon) and breaks throughout the conference; the guided tour, food and drinks on Wednesday evening; the proceedings.

Only the full conference package covers 3 nights accommodation (from Tuesday 14 till Friday 17 September 2004) at the Dorint Don Giovanni.

### Conference secretariat

AIVC – c/o INIVE EEIG - Boulevard Poincaré 79, BE-1060 Brussels, Belgium

Tel.: +32.2.655.77.70 - Fax +32.2.653.07.29 - E-mail: [conferences.inive@bbri.be](mailto:conferences.inive@bbri.be) - Contact: Stéphane Degauquier

## AIR + AIVC CD

The Air Information Review (AIR) is a quarterly newsletter containing topical and informative articles on air infiltration and ventilation research and application. The newsletter is distributed with the AIVC-CD.

This set contains the printed version of the Air Information Review and a CD-Rom with:

- Current Air Information Review (with annex documents)
- Related newsletters;
- Airbase (AIVC bibliographical database);
- AIVC publications;
- AIVC conference proceedings.

The set is available through subscription. Subscriptions are for 4 consecutive issues of AIR (from September issue to June issue). See selling prices on the order form.

Enquirers in INIVE countries (Belgium, France, Greece, Norway) can obtain AIR and the AIVC-CD at preferential rates (even free of charge in some countries). Please contact INIVE for practical information ([inive@bbri.be](mailto:inive@bbri.be)).



## AIRBASE

The full version of AIRBASE, the bibliographical database of AIVC, is available on the AIVC CD Rom. It contains more than 15,000 references and abstracts of articles and publications related to energy efficient ventilation.

New additions to AIRBASE include references of numerous papers from the International Journal of Ventilation and from the recent Healthy Buildings conference (National University of Singapore – December 2003).

## Conference proceedings - CD

A CD-Rom with the proceedings of the last AIVC conferences is available. At present, the CD contains the proceedings of AIVC conferences 1998, 1999, 2000, 2001, 2002 and 2003. See selling prices on the order form.



## AIVC publications – CD

A CD-Rom with all the guides (6), annotated bibliographies (12), ventilation information papers (2) and technical notes (46 – only some old superseded ones are missing) published by the AIVC between 1979 and 2003 is available.

See selling prices on the order form.



## The free publication of the month

One of the AIVC publications is available for free on the Internet (<http://www.aivc.org>). The publication is available for 1 month and afterwards replaced by another one.

## Printed version of old technical notes

Since June 2001, the new publications of the AIVC are no longer produced in a printed version. However remaining printed copies of previous AIVC documents are still for sale at ECBCS Bookshop (£ 15 + postage).

An overview of the remaining stock is available at <http://www.aivc.org/Publications/clearance.html>

(mainly: Technical notes 39 to 51; Guide to energy efficiency ventilation; Improving ductwork: a time for tighter air distribution systems; Annotated Bibliographies 5 to 10, Conference proceedings 1995 to 2000). A brochure presenting these publications is available on the AIVC-CD.

Send orders by e-mail at [essu@ecbcs.org](mailto:essu@ecbcs.org) (for printed AIVC publications only), or by fax at +44(0)121.262.1994, marked for the attention of Malcolm Orme.

Mailing Address:  
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*\* Note: The CD Roms have been developed for use in a Microsoft Windows environment for PC. There is no guarantee that they will work with other operating systems.*

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March 2004



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No 11

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