

# Air Infiltration Review

a quarterly newsletter from the IEA Air Infiltration and Ventilation Centre

International Energy Agency - AIVC

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## A Wind Pressure Database from Hungary for Ventilation and Infiltration Calculations

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### Introduction

Wind pressure coefficients ( $C_p$  values) are among the basic data required for ventilation and air infiltration calculations and modelling. More than two years of systematic wind tunnel testing in ETI of some of the most frequent building shapes has resulted in a database that has been provided with a handling program. This package is available from ETI, for IBM XT/AT and compatible PC's.

### The CPBANK Concept

Sources of  $C_p$  values are almost exclusively, wind tunnel tests. These tests are, however, usually much too expensive to be incorporated into the budget of design of small or medium scale building projects, though some of these may require the knowledge of  $C_p$  values. Computer simulations of ventilation and air infiltration processes also use

such data. There are three main approaches to provide  $C_p$  sets for these calculations:

- (1) Wind tunnel testing is always workable but seldom economic.
- (2) Use of existing databases - this requires quality and easy access to data.
- (3) Generating parametric functions from measurement databases and using these to reproduce  $C_p$ 's. Except for some rather simple cases this method is not generally workable. CPBANK follows the second approach.

CPBANK is a software package comprising a set of wind pressure coefficient ( $C_p$ ) data files for a range of building shapes, fixed degrees of shielding and three types of upwind terrain. It also includes a handling program that supports easy selection of parameters, definition of distribution of points over the building envelope and a simple management of user files. CPBANK is built around a nested menu concept in which Main Menu items activate submenus.

The primary application of the produced  $C_p$  data is to supply input for air infiltration and ventilation calculations. Without any deeper knowledge of building aerodynamics

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CPBANK should only be used for building geometries included (see Figs 1,2). In most cases about 25% deviation from predefined geometric ratios may be accepted without causing substantial error. The same tolerance may be applied for the absolute dimensions of the buildings.

The  $C_p$ 's in this package are all time-mean values and to calculate wind pressures the wind speed at the reference height, conventionally taken equal to the building height, has to be known.

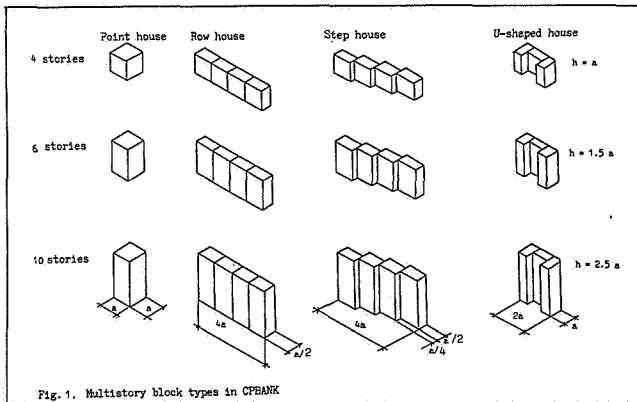


Fig. 1 Multi-story block types in CPBANK

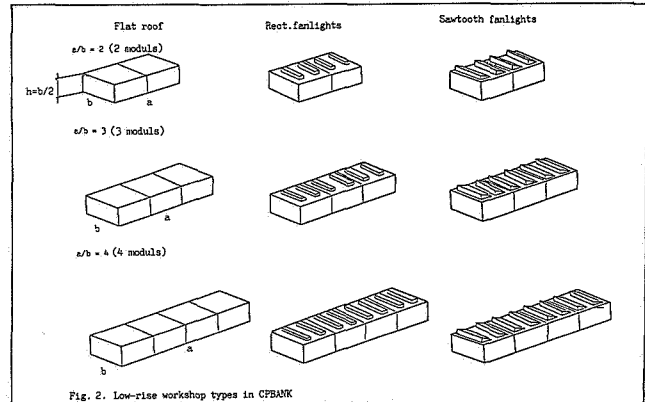


Fig. 2 Low-rise workshop types in CPBANK

# Air Infiltration Review

Editor: Janet Blacknell

Air Infiltration Review has a quarterly circulation of 3,500 copies and is currently distributed to organisations in 40 countries. Short articles or correspondence of a general technical nature related to the subject of air infiltration and ventilation are welcome for possible inclusion in AIR. Articles intended for publication must be written in English and should not exceed 1,000 words in length. If you wish to contribute to AIR, please contact Janet Blacknell at the Air Infiltration and Ventilation Centre.

Conclusions and opinions expressed in contributions to Air Infiltration Review represent the author(s)' own views and not necessarily those of the Air Infiltration and Ventilation Centre.

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\*Participating countries

## Wind Tunnel Tests

The Wind Tunnel Laboratory of the ETI carried out hundreds of test runs to develop the  $C_p$  database. After multiple checking the measured pressure data were transformed into  $C_p$  values.

Fig. 3 shows shielding degrees used during wind tunnel testing. CPBANK offers three categories for the aerodynamic roughness of the upwind terrain. Rural terrain applies for flat, smooth, rural land with low vegetation, scattered trees, bushes or cultivated agricultural area. Suburb terrain means single family housing areas, villages and suburbs of low-rise housing. Urban terrain refers to densely built up urban area of multi-story housing.

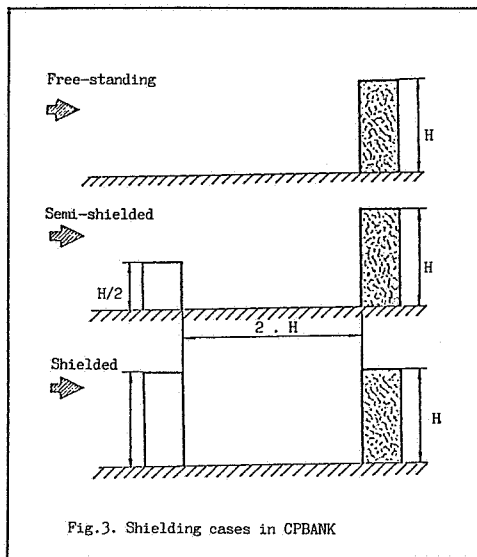


Fig. 3 Shielding classes in CPBANK

The above exposure parameters may be, and usually are, dependent on the wind direction, which may be selected in 22.5 degrees increments. Zero degree wind direction coincides with the +y axis of the building coordinate system.

## Data for Input

Two groups of data are required for input. The first comprises building data, and the second exposure data. The input of these data through the keyboard is supported by help screens, simple graphics and other tools that facilitate easy amendments and modifications. The simple file management tool and the fixed format of the user files makes it possible to create house data files by other means and pass them to CPBANK.

## How CPBANK works

One group of the supplied CPBANK files contains the x,y,z coordinates of the surface points for which  $C_p$  values have been measured. These coordinates are stored in non-dimensional form, i.e.,  $x/X_{max}$ ,  $y/Y_{max}$ ,  $z/Z_{max}$ , where the

subscript 'max' refers to the total building dimension. In order to enable the location of the surface points of the given building, its coordinates must be scaled accordingly. Thus CPBANK starts with calculating scaled surface point coordinates of the defined building. Then it performs a search in the database for retrieving all data files necessary for the given task.  $C_p$  values are assigned to any defined surface point from the CPBANK files by interpolation (see Fig. 4).

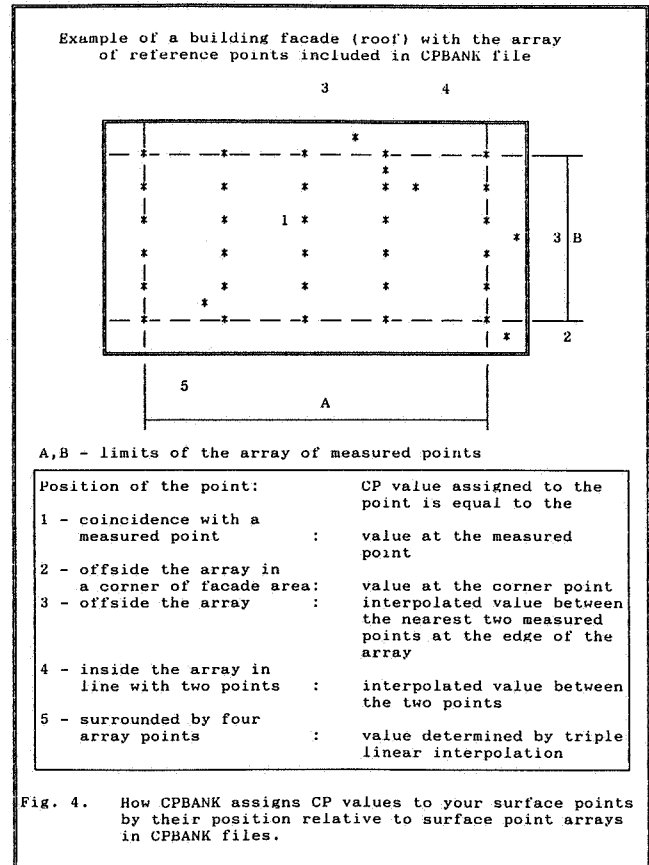


Fig. 4 How CPBANK assigns  $C_p$  values to your surface points by their position relative to surface point arrays in CPBANK files

## Structure of CPBANK Database Files

There are two types of CPBANK data files. These are: XYZ files - these contain the serial numbers and non-dimensional XYZ coordinates of the surface points where measurements were made, and  $C_p$  files - these contain 3x2 arrays of  $C_p$  data corresponding to the three roughness categories of the upwind terrain.  $C_p$  values are tabulated according to the serial number of surface points (rows) and actually measured wind directions (columns). The second array of  $C_p$  averages are tabulated according to the serial number of surfaces (rows) and measured wind directions (columns).

$C_p$  values for wind directions other than those tabulated are derived from the measured values by making use of symmetry to one or two axis or the center point of the actual building type.

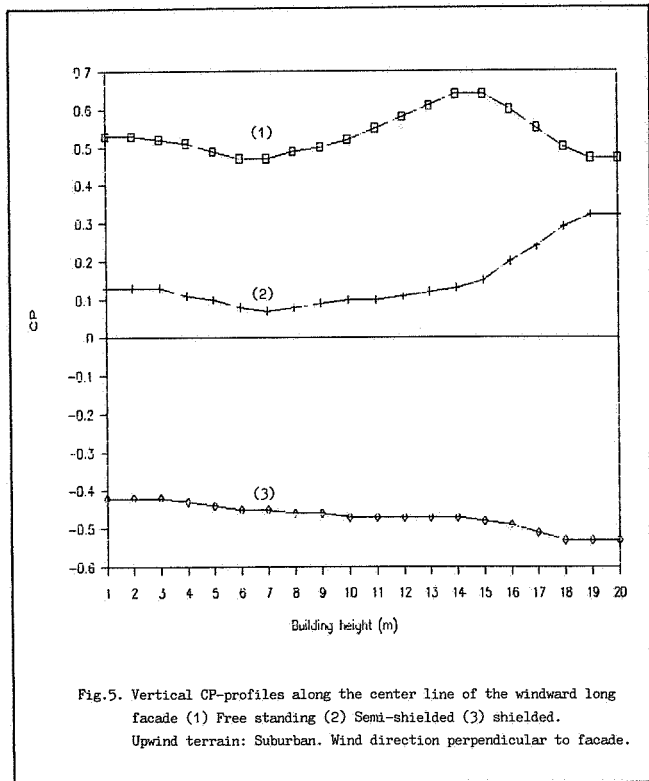


Fig. 5 Vertical Cp profiles along the center line of the windward long facade (1) Free standing (2) Semi-shielded (3) shielded. Upwind terrain: Suburban. Wind direction perpendicular to facade

Table 1 Example file of house data

Project:  
Example of looking up CP values for a rowhouse  
1st December 1988  
Building Wizard consultants Ltd, Fabuland County, Nowhereland  
File name:  
a:\EXAMPLE2.hus

House data:  
House type : 1 Rowhouse  
Nominal size : 4  
Length (m) L 40.2 Width (m) L20.0 Height (m) 12.0  
Your choice of Averages/Distribution : 2  
Surface distribution of CP values  
Number of faces of the defined building : 5  
Total number of defined points : 33  
Serial number of the first and last points on building faces:

Face no.	First point	Last point
1	1	3
2	4	8
3	9	14
4	15	23
5	24	33

X Y Z coordinates of points selected on the building envelop:

Point number	X (m)	Y (m)	Z (m)
1	20.0	0.0	10.0
2	1.0	0.0	1.0
3	2.0	0.0	2.0
4	0.0	1.0	1.0
.	.	.	.
.	.	.	.
.	.	.	.
30	2.0	3.0	12.0
31	4.0	7.0	12.0
32	8.0	9.8	12.0
33	2.0	8.0	12.0

Table 2 Example file of exposure data

Project:  
Example of looking up CP values for a rowhouse  
1st December 1988  
Building Wizard Consultants Ltd, Fabuland County, Nowhereland  
File name:  
a:\EXAMPLE2.env

Defined environmental data  
Defined wind directions : 2

Number	Wind direction	Shielding	Terrain type
1	1 0.0	2 semi shielded	1 Flat rural
2	5 90.0	1 exposed	2 Suburban

Table 3 Example of Cp values

Project:  
Example of looking up CP values for a rowhouse  
1st December 1988  
Building Wizard Consultants Ltd, Fabuland County, Nowhereland  
File name:  
a:\EXAMPLE.cpv

Your choice of Averages/Distribution : 2  
No. of points : 33 Wind dirs : 2  
Surface distribution of CP values

Point no.	Wind direction	
	00.0	90.00
1	00.13	00.08
2	-0.21	-0.46
3	-0.20	-0.42
4	-0.52	00.66
.	.	.
.	.	.
.	.	.
30	-0.44	-0.04
31	-0.43	-0.23
32	-0.41	-0.60
33	-0.44	-0.04

### Output and User Files

All data files created by the user are stored as text files which are easy to handle by means of common word processing and spread sheet programs.

Tables 1- 3 show printouts of user files from an example run. Fig. 5 shows vertical  $C_p$  profiles along the center line of one long facade of a rowhouse type building for three cases of shielding. The upwind terrain is suburban type and the wind direction is perpendicular to the facade.  $C_p$  values in the figure were retrieved from CPBANK.

The CPBANK package is available at \$1,000 U.S. from:

ETI, the Hungarian Institute for Building Science,  
H-1113, Budapest, David F.u.6.

Telex: 22-4285 eti h. Fax: 36-1-663-766.

For further information or inquiries please contact the author.

# ASHRAE Annual Meeting

Vancouver, Canada, 24-28 June 1989

Report by Martin Liddament, AIVC

The Annual Meeting of the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) takes the form of technical sessions, symposia, seminars and forums. In addition, afternoons and evenings are reserved for ASHRAE Technical Committee sessions which all participants are invited to attend.

## Technical Sessions

Infiltration and ventilation topics were well represented at several of the Technical Sessions and Symposia as well as being covered by a number of technical committee sessions and a forum. Technical papers included a contribution by Damin Zhang from China and Katsuhiko Tsuji from Japan which covered the solution of the Navier Stokes flow equations for two dimensional, isothermal laminar and/or turbulent flow. Turbulence was solved using a one equation model. Shinsuke Kato from the University of Tokyo, Japan introduced a 3-dimensional finite difference approach to solving turbulent air flow in and around buildings. An approach using curvilinear coordinates was introduced in which the boundary of a space could be better represented than when using a classical Cartesian coordinate system. Simulated results compared favorably with measurement. Shuzo Murakami also from the University of Tokyo described how computational fluid dynamics modelling could be used to study the effect on air distribution of supply and exhaust opening configurations in clean rooms. Air distribution in offices resulting from the use of supply plenums located under raised floors was covered in a technical paper by Robert Genter, USA. He considered the design aspect and provided examples based on variable air volume systems.

## Symposia

Infiltration related symposia included:

- Residential duct leakage and infiltration
- Calculation of interzonal heat and mass transfer in buildings.
- Calculating air flow around buildings
- Scandinavian symposium on displacement ventilation

The symposium on residential duct leakage followed concern in the United States over air leakage from warm air heating ducts located in the roof space or in other unheated zones. Five papers were presented, the first paper by D Parker of the Florida Solar Energy Center and the second by Les Lambert of Lambert Engineering reported

on comparisons between the energy consumption and airtightness of dwellings with ducted and unducted heating systems. It was noted that 13-40% more heating energy was found to be required in the ducted homes. The third and fourth papers by David Robison of Lambert Engineering and James Cummings of the Florida Solar Energy Center reported on more detailed testing while the final paper by Mark Modera of the Lawrence Berkeley Laboratory analysed the impact of the problem from a national perspective. His paper also covered methods to reduce duct losses.

Interzonal air flow can play an important role in determining the energy performance, air quality and comfort in buildings. The objective of the interzonal heat and mass transfer symposium was to review calculation methods to predict such flow. J van der Maas from the École Polytechnique Fédérale de Lausanne, Switzerland reviewed gravity driven flow through large openings, while the combined effect of door opening and gravity driven flow was discussed in a paper by Darwin Kiel and David Wilson from the University of Alberta, Canada. The effect of turbulent natural convection in driving interzonal flow was described by F Haghghat of Concordia University, Canada. George Walton of the National Institute for Science and Technology in the United States described recent developments in multizone flow modelling and James Axley of the Massachusetts Institute of Technology described the coupled solution of air flow and thermal analysis.

The symposium on air flow around buildings introduced Chapter 14 of the new ASHRAE 1989 Handbook of Fundamentals. This has been extensively revised in order to provide assistance for the designer in the calculation of wind induced pressures and exhaust gas dilution. This symposium focused on these areas to show how design methods from Chapter 14 can be applied in practical situations. Specific numerical examples were used to illustrate the ASHRAE methods for wind pressure and ventilation rates. For exhaust gas dilution, the ASHRAE design procedures were compared with the results of independent wind tunnel studies on real building configurations. Presentations included the estimation of wind pressures at ventilation inlets and outlets by Richard Aynsley of the Georgia Institute of Technology, USA, wind induced ventilation by Francis Allard of the Institute of Applied Sciences, France, analytical versus wind tunnel determined concentrations due to laboratory exhaust by R Petersen of Cernak, Peterka Petersen Inc, USA and Comparisons of wind tunnel test results with empirical exhaust dilution factors by F Schuyler of Turner, Rowan Williams Davies & Irwin Inc, Canada.

The final symposium on displacement ventilation was well attended, reflecting the considerable interest in this ap-

proach. In recent years many displacement ventilation systems have been installed in Scandinavia. Speakers from Denmark, Finland, Norway and Sweden reported their experience with these systems. The theory behind the displacement principle was presented and results of new laboratory research were given. Practical experience was presented by numerous case studies on systems in operation. Ventilation efficiency, the risk of draft as well as the energy economy of displacement systems compared to traditional ventilation was discussed.

The papers presented included:

- "Nordic experiences of displacement ventilation systems" by Anders Svensson of Stifab AB, Sweden,
- "Case studies of displacement ventilation in public halls" by Hans Martin Mathisen of the Norwegian Institute of Technology, Norway,
- "A comparison of conventional mixing and displacement air conditioning and ventilation systems in US commercial buildings" by Olli Seppanen of the Helsinki University of Technology Finland and Bill Fisk (presenter) of the University of California,
- "Displacement ventilation systems in office rooms" by Mats Sandberg of the National Swedish Institute of Building Research, Sweden
- "Local thermal discomfort due to draft and vertical temperature difference in room with displacement ventilation systems" by Arsen K Melikov of the Technical University of Denmark.

Much of the discussion in this symposium was concerned with comfort aspects which were claimed not always to be a success due to the need for relatively high air flow rates. It was stated by the first speaker that the predominance of displacement systems (50%) was in industrial installations or similar applications where comfort was not the main priority.

#### Forum

ASHRAE forums are intended to provide a focal point for discussion. One such forum was entitled "Should ASHRAE prepare a manual of standard practice for ventilation?" This meeting arose from the impending approval

of ASHRAE Standard 62 on ventilation for acceptable indoor air quality. Once introduced, this standard will impose more rigorous ventilation requirements on building operators, especially in relation to smoking areas. It is argued that if these new requirements are met, experience and research results predict generally acceptable indoor air quality. However, throughout the review period of this standard concern was expressed on how contaminant levels, ventilation effectiveness and other system factors should be measured. The purpose of this forum was to explore the need for guidance in complying with the standard. It was concluded that there was a need for such a manual specifically aimed at designers, standards or coding authorities, building operators and independent testers.

#### Technical Committees

Two related Technical Committees are TC 2.5 on air flow around buildings and TC 4.3 on infiltration and ventilation requirements. Both of these groups met with the view of promoting new programmes of research. Proposed future work within TC 2.5 included an analysis of the shielding conditions surrounding buildings and the translation of wind data from remote sites to conditions at the locations of buildings. Under the auspices of TC 4.3 a standards Project Committee has been established to develop a standard technique of measuring the adequacy of ventilation rates in dwellings which rely on infiltration to satisfy ventilation needs. A draft standard has now been prepared and is aimed at specifying the effective air change rate for given climatic conditions and leakage area. Allowance is made for mechanically supplied air.

#### Ordering Papers

Preprints of papers presented at ASHRAE meetings are available at \$4.00 each from:

ASHRAE Publications Sales,  
1791 Tullie Circle, NE,  
Atlanta, GA 30329,  
USA.

In addition the transactions of this meeting will be published by ASHRAE in January 1990 price \$170.00 (\$115.00 members).

## Contacting the AIVC

New Fax Number direct to the Centre

Please Fax your requests for immediate attention to the following number:

**(0203) 416306**

# AIVC Library - Book Review

## Indoor Airflow, Air Quality and Energy Consumption of Buildings

by Chen Qingyan

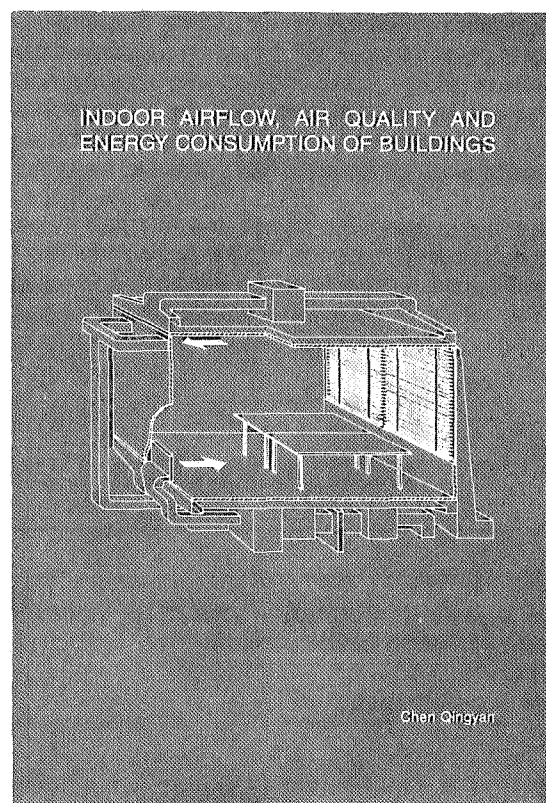
PhD Thesis from the Technical University of Delft, Netherlands

Main contents are as follows:

- Introduction
- Indoor air movement modelling
- Experimental setup
- Computations and validations of indoor airflow heat transfer and air quality
- Air conditioning load modelling
- Computations and validations of air-conditioning load and room air temperature
- Predictions of building energy consumption

Research was carried out in order to study the influence of different kinds of air supply systems in an air-conditioned room on comfort and energy consumption. The research was performed by numerical simulation as well as experiments. Until some years ago, it was not possible to compute the airflow and temperature distribution in a room. Therefore, the comfort in the room in relation to the air supply systems could not be calculated and uniform temperature distributions were assumed in air-conditioning load calculations. Due to the development in computational studies of fluid flow, it is now possible to deal with these problems by using a suitable airflow program and combining it with an air-conditioning load program. However, experiments are required to validate the calculated results.

The experiments were carried out in a full-scale climate room with different air supply systems, heat gains from heated venetian blinds and ventilation rates. The measurements concerned room airflow patterns, air temperature-, air velocity-, and contamination concentration-fields, air-conditioning load, enclosure surface temperatures, and convective heat transfer on walls. With respect to the influence of different kinds of air supply systems on comfort, the airflow computer programs, CHAMPION SGE and PHOENICS, have been used for the numerical simulation of airflows in the room. The computational method involves the solution, in finite-domain form, of two-dimensional (CHAMPION SGE) and three-dimensional (PHOENICS) equations for the conservation



of mass, momentum, energy, concentration, turbulence energy and the dissipation rate of turbulence energy, with wall function expressions for solid boundary conditions. The ventilation efficiency and temperature efficiency, which are used for the evaluation of indoor air quality and energy consumption, are also calculated.

The airflow programs calculate the airflow distributions in the room under heating and cooling conditions with the following two types of systems: (1) systems with a vertical stratification of air temperature within the room, where air inlets are located near the floor and air outlets near the ceiling; (2) well-mixed systems without a vertical stratification of air temperature with the room where the inlets and outlets are situated near the ceiling and floor of the room respectively.

*(From summary)*

*The publication may be obtained on loan from AIVC Information Services. For details of how to purchase a copy, please contact the AIVC.*

# The AIVC's New Survey of Research into Air Infiltration Ventilation and Indoor Air Quality

The Air Infiltration and Ventilation Centre has embarked on its fifth worldwide survey of research into air infiltration, ventilation and related indoor air quality. The information obtained from this survey will provide many organisations with updated information about ongoing research in this field. The survey also encourages an international exchange of research ideas and promotes co-operation between research organisations in different countries.

Since the first survey was conducted in 1980, there has been an increasing response, so it is hoped that this year replies will be even greater. While the analysed results of this survey will only be available to organisations in the AIVC participating countries (See list at back of this news-

letter.), contributors from other countries will receive a complete listing of survey replies.

A brief instruction guide is shown below, to help you with your response to this survey. I would be most grateful if those that are currently involved in a related research project, and who have not already replied, could either complete this form, or ring Mark Limb at the AIVC for a copy.

The revised deadline for all survey forms is now 31st August 1989, at the latest.

## Instructions for Describing Research Projects

<p><b>The following information should be included in the description of the project.</b></p> <p><b>Specific objectives</b></p> <p>Include the primary aims of the project and its relationship (if any) with previous or other current studies.</p> <p><b>Project details</b></p> <p>(a) Measurements in buildings:</p> <p>(i) size and construction type, e.g. brick, wood, concrete, etc</p> <p>(ii) natural or mechanical ventilation system and type of heating system (gas, oil, etc.)</p> <p>(iii) measurements being taken, e.g. pressurization, type of tracer gas, surface pressures, pollutant type, etc.</p> <p>(iv) brief instrumentation details</p>	<p>(b) Theoretical/model calculations:</p> <p>Please indicate conceptual approach, estimation technique and validation trials.</p> <p><b>Building and/or Component Type</b></p> <p>Type of building, e.g. house, apartment, commercial, factory, office etc.</p> <p><b>Parameters with which infiltration and indoor air quality will be related</b></p> <p>Please include the following where appropriate:</p> <p>(a) weather (temperature, wind, humidity, etc.)</p> <p>(b) performance of building components (windows, doors, etc.)</p> <p>(c) behaviour of occupants (real or simulated)</p> <p>(d) sources of pollution</p> <p>(e) other</p>
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# Numerical Database for the AIVC

Martin Liddament, AIVC

## Background

As part of its new operating programme, the Air Infiltration and Ventilation Centre is establishing a numerical database to be used both in support of design studies and for the verification of numerical models. (Fig. 1) In addition to being available as a computer database, it is intended to present selected source data and simple algorithms in loose leaf form as a new volume in the AIVC's series of Application Guides.

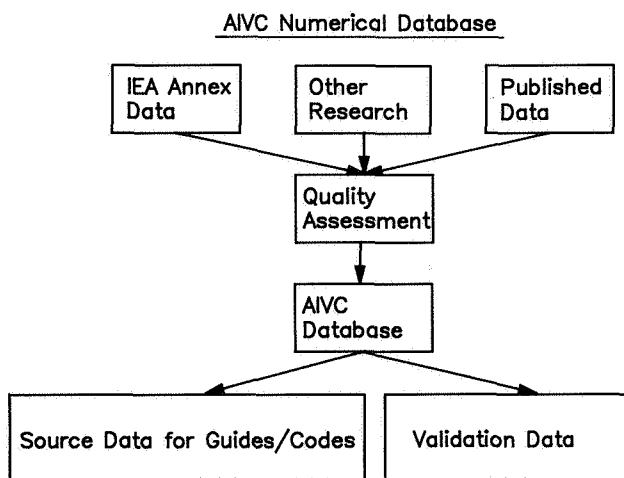


Fig. 1 Database Structure

Design data will include:

- component leakage values
- whole building leakage values for representative building types
- wind pressure coefficients and wind pressure algorithms
- basic climatic data
- key standards relating to ventilation and indoor air quality requirements
- impacts of occupant interaction on air change rates and energy use
- cost effectiveness data
- ventilation effectiveness and air flow patterns data

Validation data will include:

- air change rate measurements
- interzonal air flow
- air movement patterns

- ventilation heat loss
- pollutant transport

In each case validation data will be drawn from selected studies in which careful measurement control has been introduced and in which the key parameters needed for data input to models have also been recorded (e.g. driving forces, leakage distribution, fan, duct and diffuser characteristics, pollutant sources, etc).

## Data Sources

Although the selection of data is intended to be very rigorous, it is planned to represent in the database all building types and conditions for which suitable measurements are available. By combining data from many sources throughout the world it will be possible for designers and numerical modellers to consider a far wider range of operating conditions than would be possible using the results of a single set of measurements. In many instances data from several sources covering similar areas of measurement will provide further cross checks on quality.

A key source of data will be the related air flow annexes of the International Energy Agency's Implementing Agreement on Energy Conservation in Building and Community Systems. Thus this approach will further ensure the maximum dissemination of knowledge resulting from IEA activities. Associated Annexes include:

- Annex 8: Inhabitant Behaviour with Regard to Ventilation
- Annex 9: Minimum Ventilation Rates
- Annex 14: Condensation
- Annex 18: Demand Controlled Ventilation Systems
- Annex 20: Air Flow Patterns within Buildings

The COMIS project taking place at the Lawrence Berkeley Laboratories in the United States (See AIR, June, 1989) is undertaking comprehensive multizone air flow measurements as part of the development of a building air infiltration and ventilation simulation code. It is hoped that these data will also provide further input to the database. Other data sources include a new compilation by ASHRAE on air leakage characteristics of component openings and data located during the AIVC's present world wide survey of current research.

## Management system

In selecting a database management system, consideration had to be given to several requirements. For example, it is essential to ensure widespread availability of the database. Equally, it is important that the system should offer maximum flexibility in relation to establishing

and linking data fields. Another fundamental requirement is that it must be possible to introduce new parameters at a later date should it prove desirable to increase the scope of the database. The initial database will be PC based using DBASE IV software. Provision has also been made to introduce ORACLE software on workstation based systems if necessary. Access to the database will be by arrangement with nominated organisations within each country.

This development programme will span the full three year current operating period of the Centre with data entry commencing early in 1990 (See Fig. 2).

### Other Activities

In addition to its numerical database, further technical activities are planned by the AIVC. These include a review of air flow simulation techniques and a study of combined thermal and ventilation heat loss models. The objective of the air flow review is to outline recent developments in building air flow analysis and to focus on some of the difficulties associated with air flow simulation. Rather than dealing with the considerable developments taking place in respect to refinements to computational methods the intention is to show how these algorithms can be applied to building orientated problems. Bibliographic references will be restricted to specific examples and case studies. Similar objectives are planned for the combined heat loss/ventilation modelling review. A number of numerical models are now available which are able to handle the simultaneous solution of conduction, convection and ventilation heat transfer in both single zone and multizone structures. The intention of the Centre is to investigate this area of activity since there is a need to develop the theory of infiltration and ventilation in context with the entire building energy field. As with the AIVC's air flow analysis

this study has significant interactions with other IEA annexes. The intention is to prepare a technical note on combined models and to investigate potential data for a validation exercise. The study will also reappraise the significance of ventilation as a heat loss mechanism in relation to conductive heat losses for different building types.

### Technical Dissemination

As part of its dissemination and technical transfer role, further conferences and specialist workshops are planned for the new operating period beginning with a workshop at the AIVC on the Centre's numerical database in March of next year. Also planned for the very near future is a new PC version of AIRBASE the Centre's bibliographic database which offers full search capabilities yet will be available at only a fraction of its current cost. Pre-release versions have already been distributed and are operating successfully. For the first time regularly updated versions of AIRBASE will be available in every country and to individual organisations. Combined with improved fax and communication facilities, it should therefore be possible to expand substantially the library services of the AIVC. To coincide with this expansion an increase in the subject coverage of AIRBASE is also planned to include air flow related and air quality topics covered by other IEA annexes and to include improved coverage from non participating countries. Summaries of key documents from France and Japan will be translated into English. In future the AIVC library will also carry IEA reports from other activities within the Energy Conservation in Buildings and Community Systems Implementing Agreement, thus, to some extent, coverage will be broadened to beyond the scope of air infiltration and ventilation.

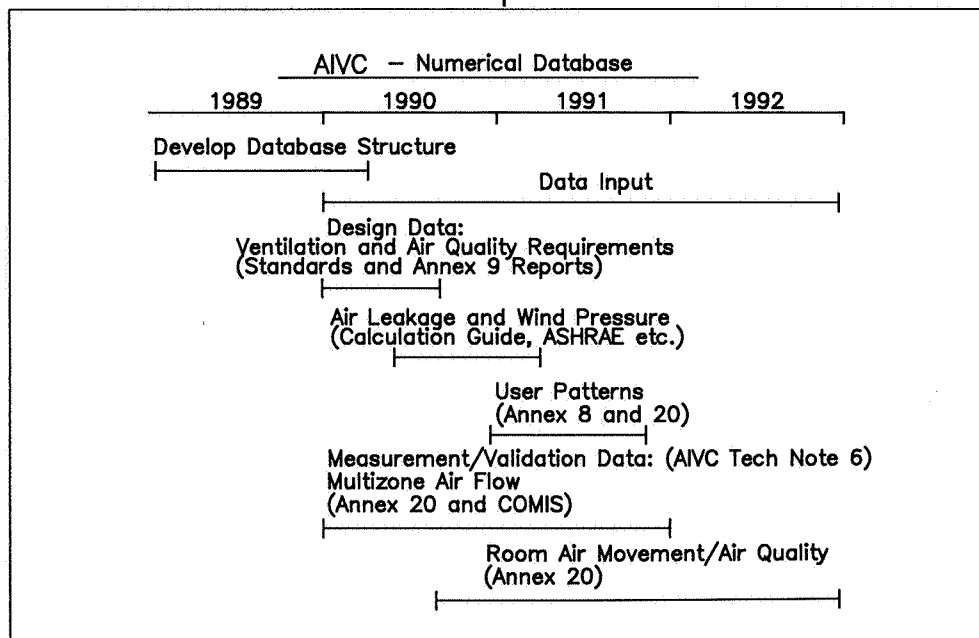


Fig. 2 Development Programme

## Forthcoming Conferences

**Blueprint for a Healthy House Conference**  
11-13 October 1989  
Cleveland, Ohio, 44102  
USA

*Further details from:*

*Housing Resource Centre*  
1820 W 49 Street  
Cleveland, Ohio 44102  
USA

Tel: (216) 281 4663

**The Sick Building Syndrome**  
16-20 October 1989  
Schafergarden, Copenhagen  
Denmark

*Further details from:*

*Nordic Institute of Advanced Occupational Environment Studies,*  
*c/o Institute of Occupational Health,*  
*Tope liuksenkatu 41a,*  
*SF-00250 Helsinki, Finland*  
Tel: 358 0 47471

**Urban Climate, Planning and Building,**  
IFHP/CIB/WMO International Conference,  
6-11 November 1989,  
Kyoto, Japan

*Further details from:*

*IFHP/CIB/WMO International Conference on Urban Climate, Planning and Building,*  
*c/o Assoc Prof Yasuto Nakamura,*  
*Department of Architecture,*  
*Sakyo-Ku, Kyoto 606, Japan*

Tel: 075 753 5739

**Thermal Performance of the Exterior Envelopes of Buildings IV,**  
4-7 December 1989,  
Crowne Plaza Hotel, Orlando, Florida, USA

*Further details from:*

*George E Courville,*  
*Building Thermal Envelope Systems and Materials,*  
*Oak Ridge National Laboratory,*  
*PO Box 2008, Oak Ridge, TN 37831, USA*

**Science and Technology at the Service of Architecture,**  
4-8 December 1989,  
Unesco Centre, Paris, France

*Further details from:*

*WIP, Sylvesterstrasse 2,*  
*D-8000 Munchen 70,*  
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**Roomvent '90,**  
Engineering Aero-and Thermodynamics of Ventilated Rooms,  
Second International Conference,  
13-15 June 1990,  
Oslo, Norway

*Further details from:*

*Room Vent,*  
*c/o Norway VVS Teknisk Forening,*  
*PO Box 5042 Maj., N-0301 Oslo 3, Norway*

**Indoor Air Quality and Climate,**  
5th International Conference,  
29 July - 3 August 1990,  
Toronto, Ontario, Canada

*Further details from:*

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**Energy, Moisture, Climate in Building International Symposium,**  
3-6 September 1990,  
Rotterdam, Netherlands

*Further details from:*

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*3rd fold (insert in Flap A)*

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*2nd fold (Flap A)*

*1st fold*

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