Technical Note AIVC 31

1990 Survey of Current Research into Air Infiltration and Related Air Quality Problems in Buildings

October 1990

Air Infiltration and Ventilation Centre
University of Warwick Science Park
Barclays Venture Centre
Sir William Lyons Road
Coventry CV4 7EZ
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1990 Survey of Current Research into Air Infiltration and Related Air Quality Problems in Buildings

Mark Limb
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International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an International Energy Programme. A basic aim of the IEA is to foster co-operation among the twenty-one IEA Participating Countries to increase energy security through energy conservation, development of alternative energy sources and energy research development and demonstration (RD&D). This is achieved in part through a programme of collaborative RD&D consisting of forty-two Implementing Agreements, containing a total of over eighty separate energy RD&D projects. This publication forms one element of this programme.

Energy Conservation in Buildings and Community Systems

The IEA sponsors research and development in a number of areas related to energy. In one of these areas, energy conservation in buildings, the IEA is sponsoring various exercises to predict more accurately the energy use of buildings, including comparison of existing computer programs, building monitoring, comparison of calculation methods, as well as air quality and studies of occupancy. Seventeen countries have elected to participate in this area and have designated contracting parties to the Implementing Agreement covering collaborative research in this area. The designation by governments of a number of private organisations, as well as universities and government laboratories, as contracting parties, has provided a broader range of expertise to tackle the projects in the different technology areas than would have been the case if participation was restricted to governments. The importance of associating industry with government sponsored energy research and development is recognized in the IEA, and every effort is made to encourage this trend.

The Executive Committee

Overall control of the programme is maintained by an Executive Committee, which not only monitors existing projects but identifies new areas where collaborative effort may be beneficial. The Executive Committee ensures that all projects fit into a pre-determined strategy, without unnecessary overlap or duplication but with effective liaison and communication. The Executive Committee has initiated the following projects to date (completed projects are identified by *):

I Load Energy Determination of Buildings *
II Ekistics and Advanced Community Energy Systems *
III Energy Conservation in Residential Buildings *
IV Glasgow Commercial Building Monitoring *
V Air Infiltration and Ventilation Centre
VI Energy Systems and Design of Communities *
VII Local Government Energy Planning *
VIII Inhabitant Behaviour with Regard to Ventilation *
IX Minimum Ventilation Rates *
X Building HVAC Systems Simulation*
Annex V Air Infiltration and Ventilation Centre

The IEA Executive Committee (Building and Community Systems) has highlighted areas where the level of knowledge is unsatisfactory and there was unanimous agreement that infiltration was the area about which least was known. An infiltration group was formed drawing experts from most progressive countries, their long term aim to encourage joint international research and increase the world pool of knowledge on infiltration and ventilation. Much valuable but sporadic and uncoordinated research was already taking place and after some initial groundwork the experts group recommended to their executive the formation of an Air Infiltration and Ventilation Centre. This recommendation was accepted and proposals for its establishment were invited internationally.

The aims of the Centre are the standardisation of techniques, the validation of models, the catalogue and transfer of information, and the encouragement of research. It is intended to be a review body for current world research, to ensure full dissemination of this research and based on a knowledge of work already done to give direction and firm basis for future research in the Participating Countries.

The Participants in this task are Belgium, Canada, Denmark, Federal Republic of Germany, Finland, Italy, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom and the United States of America.
INTRODUCTION

The Air Infiltration and Ventilation Centre’s worldwide survey of current research into air infiltration and related topics provides organisations in participating countries with regularly updated information about ongoing research in this field. In particular the major objectives of this survey are to encourage the international cross fertilization of research ideas and to promote cooperation between research organisations in different countries. The results of the first survey were published in October 1980, and contained an analysis of 65 research summaries received from researchers in 14 different countries. The second edition followed in December 1981, with the number of entries almost doubling to 126. In November 1983, the third survey was published. This edition extended its scope to cover research into indoor air quality and the response was again increased, with 187 summaries being received from organisations in 22 countries. In addition to the increased scope of the survey, researchers were also asked to provide an indication of project size in terms of allocation of staff time. The fourth survey followed in December 1986; 219 project summaries from 19 countries were received and analysed.

This, the fifth survey, is based on summaries received from researchers following the distribution of a survey form (Appendix A) to organisations thought likely to be involved in air infiltration and indoor air quality research. Essentially similar to the form used in the 1986 survey, additional space was provided in order that more detailed information regarding objectives and project details could be obtained. Additional space was also allowed so that important reports or publications could also be listed. Once again there has been an increase in the number of projects reported; Figure 1 shows the trends over the last ten years in the number of replies received from the first survey of 1980 to the results of the fifth survey in 1990. A total of 233 summaries have been received from organisations in 23 different countries. The origin and distribution of survey replies are shown in Figures 2 and 3 and have been tabulated in Table 1.

The analysis of the survey is provided in two sections. In the first the results are analysed in terms of the various headings on the survey form, i.e., specific objectives, project details, building or component type, parameters with which infiltration and indoor air quality will be related, and allocation of staff time. This information is presented in such a way that the reader may use the analysis to ascertain which research summaries lie within the bounds of any subject area. In order to facilitate this type of analysis, and to enable easy access to the data the research summaries are stored in a database, which can be rapidly searched using the Air Infiltration and Ventilation Centre’s free text retrieval system. This facility is also available as a supplementary database, alongside our extensive bibliographic database known as "AIRBASE". Both are available for purchase in a
personal computer version; details are given in Appendix D. The task of analysing the research replies was also eased by the allocation of a set of keywords to each summary. These keywords are presented in alphabetical order, in Appendix B.

Air Infiltration Ventilation and Indoor Air
Quality - Trends in Research

![Bar chart showing number of survey replies by year.](image)

Figure 1

All the research summaries are presented in Section two. They are divided into two sub sections; AIVC Participating and Non-Participating countries. Each project is identified by a reference number comprising a country identification code, (Table 1) followed by a number indicating the order in which it appears under the relevant country heading, (Countries are listed in alphabetical order in each subsection). A list of principal researchers and organisation addresses is contained in Appendix C.

The preparation of this report was only possible as the result of the cooperation of the researchers in forwarding details of their studies. The assistance of all who contributed to this study is acknowledged with gratitude.
Origin and Distribution of Survey Replies

AIVC Participating Countries

<table>
<thead>
<tr>
<th>Countries</th>
<th>Number of Replies</th>
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<tbody>
<tr>
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<tr>
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<tr>
<td>Denmark</td>
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</tr>
<tr>
<td>Finland</td>
<td></td>
</tr>
<tr>
<td>Fed. Rep. Germany</td>
<td></td>
</tr>
<tr>
<td>Italy</td>
<td></td>
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<tr>
<td>Netherlands</td>
<td></td>
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<tr>
<td>New Zealand</td>
<td></td>
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<tr>
<td>Norway</td>
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<tr>
<td>Sweden</td>
<td></td>
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<tr>
<td>Switzerland</td>
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<tr>
<td>United Kingdom</td>
<td></td>
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<td>USA</td>
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Non-AIVC Participating Countries

<table>
<thead>
<tr>
<th>Countries</th>
<th>Number of Replies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td></td>
</tr>
<tr>
<td>Austria</td>
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</tr>
<tr>
<td>Brazil</td>
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<tr>
<td>Czech.</td>
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<tr>
<td>France</td>
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<tr>
<td>Hungary</td>
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<tr>
<td>Japan</td>
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<tr>
<td>Kuwait</td>
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<tr>
<td>Turkey</td>
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<tr>
<td>USSR</td>
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Figure 2

Figure 3
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<th>Participating countries</th>
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<tr>
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<tr>
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<td>11</td>
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<tr>
<td>Norway</td>
<td>N</td>
<td>5</td>
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<tr>
<td>Switzerland</td>
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<td>17</td>
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<tr>
<td>United Kingdom</td>
<td>UK</td>
<td>39</td>
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<tr>
<td>United States of America</td>
<td>USA</td>
<td>35</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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<td>203</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Non participating countries</th>
<th>Code</th>
<th>Replies</th>
</tr>
</thead>
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</tr>
<tr>
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<td>AU</td>
<td>1</td>
</tr>
<tr>
<td>Brazil</td>
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<td>1</td>
</tr>
<tr>
<td>Czechoslovakia</td>
<td>CS</td>
<td>1</td>
</tr>
<tr>
<td>France</td>
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</tr>
<tr>
<td>Hungary</td>
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<td>4</td>
</tr>
<tr>
<td>Japan</td>
<td>J</td>
<td>7</td>
</tr>
<tr>
<td>Kuwait</td>
<td>K</td>
<td>1</td>
</tr>
<tr>
<td>Turkey</td>
<td>TR</td>
<td>1</td>
</tr>
<tr>
<td>USSR</td>
<td>SU</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>

**Grand Total** 233

Table 1 - Origin and distribution of survey replies
Section 1
Analysis of Results
SECTION 1 - ANALYSIS OF RESULTS

1.1 Specific objectives

The specific objectives of the research summaries have been divided into 27 categories. The range of subjects are outlined below. In many cases a single project has several different objectives, and therefore may appear under more than one heading. The 27 categories have been divided into 3 principal groups; Group A relates to studies and measurements, Group B to simulations and modelling, and Group C to other aspects.

A) Projects related to studies and measurements

This is the largest group and has been further subdivided into four broad subject areas and 13 specific categories, (Table 2). The replies include those projects currently involved in the study or measurement of air movement and indoor air quality, the major theme being the study and measurement of indoor air and contaminant movement (83 replies). Compared with the previous survey there is increased interest in relation to indoor air quality/occupant comfort and health (65 replies), and studies involving heating, ventilating systems and strategies (47 replies). The final category within this division concerns the projects that are involved in energy conservation and the use of energy (19 replies).

B) Projects related to simulation and modelling of indoor air and contaminant movement

Group B has been further subdivided into 2 broad subject areas and 6 specific categories, (Table 3). Replies cover projects involved with indoor air movement and air quality simulations. Much work is being undertaken to simulate air and contaminant movement within the indoor environment (31 replies). The simulation of infiltration and ventilation, and the investigations of internal and external pressures and air movement around buildings form the second division within this group (15 replies).
Table 2 - Projects related to studies and measurements

<table>
<thead>
<tr>
<th>Air movement</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Indoor air movement. (24 replies)</td>
<td></td>
</tr>
<tr>
<td>2) Indoor air/heat movement. (9 replies)</td>
<td></td>
</tr>
<tr>
<td>3) Indoor air/heat/moisture movement. (4 replies)</td>
<td></td>
</tr>
<tr>
<td>4) Air infiltration, ventilation and air change rates within buildings. (23 replies)</td>
<td></td>
</tr>
<tr>
<td>5) Airtightness/air leakage of buildings. (22 replies)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Indoor air quality</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6) Indoor air quality/climate. (41 replies)</td>
<td></td>
</tr>
<tr>
<td>7) Indoor air pollution sources. (8 replies)</td>
<td></td>
</tr>
<tr>
<td>8) Moisture/mould generation and prevalence in buildings. (6 replies)</td>
<td></td>
</tr>
<tr>
<td>9) Occupant behaviour/perceptions. (7 replies)</td>
<td></td>
</tr>
<tr>
<td>10) Thermal comfort. (3 replies)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heating and ventilation systems and strategies</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11) Heating and ventilation systems and/or strategies. (43 replies)</td>
<td></td>
</tr>
<tr>
<td>12) Vented appliances. (4 replies)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy conservation and use</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13) Energy conservation/efficiency/use within buildings. (19 replies)</td>
<td></td>
</tr>
</tbody>
</table>

C) Miscellaneous

This sub division contains 8 categories, representing projects related to work in air infiltration, ventilation and indoor air quality, but which do not fall into the above two sections. This section (Table 4) includes market reviews, the formulation of expert systems and databases, model validation and work to improve codes and standards. This miscellaneous section also includes projects monitoring radon, and investigating tracer gas methods, both new and old.
Table 3 - Projects related to simulations and models

<table>
<thead>
<tr>
<th>Projects related to simulations and models</th>
</tr>
</thead>
<tbody>
<tr>
<td>14) Indoor air movement. (10 replies)</td>
</tr>
<tr>
<td>15) Indoor air/heat movement. (10 replies)</td>
</tr>
<tr>
<td>16) Indoor air/heat and contaminant movement. (8 replies)</td>
</tr>
<tr>
<td>17) Indoor air quality. (3 replies)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Air infiltration and ventilation simulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>18) Air infiltration and ventilation in buildings. (7 replies)</td>
</tr>
<tr>
<td>19) Outside pressure distribution/air movement around buildings. (5 replies)</td>
</tr>
</tbody>
</table>

Table 4 - Projects related to all other activities

<table>
<thead>
<tr>
<th>Projects related to all other activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>20) To compare and validate airflow models. (2 replies)</td>
</tr>
<tr>
<td>21) Relating air movement/ventilation and infiltration to construction practices. (4 replies)</td>
</tr>
<tr>
<td>22) To investigate new or existing tracer gas methods. (7 replies)</td>
</tr>
<tr>
<td>23) To monitor radon entry/harmfulness as a pollutant. (11 replies)</td>
</tr>
<tr>
<td>24) To produce/contribute to new ventilation and indoor air quality guidelines and standards. (7 replies)</td>
</tr>
<tr>
<td>25) To compile a database of information. (5 replies)</td>
</tr>
<tr>
<td>26) To develop expert systems. (2 replies)</td>
</tr>
<tr>
<td>27) To undertake a market review. (2 replies)</td>
</tr>
</tbody>
</table>

Table 5 examines in greater detail the categories and divisions discussed above.
### Table 5 - Specific Objectives

#### A) Projects related to studies and measurements

<table>
<thead>
<tr>
<th>Air movement</th>
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<tbody>
<tr>
<td>1) Indoor air movement (24 replies)</td>
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<tr>
<td>B6,B7</td>
<td>SF9,SF10</td>
</tr>
<tr>
<td>CA6,CA9</td>
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<td>CH2,CH5</td>
<td>USA13,USA14,USA15</td>
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</tr>
<tr>
<td>DK1,DK3</td>
<td></td>
</tr>
<tr>
<td>F10</td>
<td></td>
</tr>
<tr>
<td>I3</td>
<td></td>
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<tr>
<td>NL2</td>
<td></td>
</tr>
<tr>
<td>S4</td>
<td></td>
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<td>SF9</td>
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<tr>
<td>USA2,USA7,USA24</td>
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<td>2) Indoor air/heat movement (9 replies)</td>
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<td>CA20</td>
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<td>UK3,UK5</td>
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<td>USA8</td>
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<tr>
<td>4) Air infiltration, ventilation and air change rates within buildings (23 replies)</td>
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<tr>
<td>5) Airtightness/air leakage of buildings (22 replies)</td>
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<td>8) Moisture/mould generation and prevalence in buildings</td>
<td>6 replies</td>
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<tr>
<td>9) Occupant behaviour/perceptions</td>
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<td>10) Thermal comfort</td>
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<td>Heating and ventilating systems and strategies</td>
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</tr>
<tr>
<td>11) Heating and ventilation systems and/or strategies</td>
<td>43 replies</td>
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<tr>
<td>AU1, B8, BZL1, CA7, CA13, CA18, CA25, CA30, D6, D7, DK7, DK10, F1, F4, F7, J5, N2, NL6, NL7, S1, S2, S5, S14, S15, S16, SF1, SF2, SF3, SF4, UK6, UK7, UK22, UK29, UK31, UK33, UK35, UK36, UK38, UK39, USA15, USA20, USA23, USA34</td>
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</tr>
<tr>
<td>12) Vented appliances</td>
<td>4 replies</td>
</tr>
<tr>
<td>F6, J1, NL1, USA27</td>
<td></td>
</tr>
<tr>
<td>Energy conservation and use</td>
<td></td>
</tr>
<tr>
<td>13) Energy conservation/efficiency/use within buildings</td>
<td>19 replies</td>
</tr>
<tr>
<td>CA3, CA4, D5, D11, H4, NL9, S2, S6, S9, S15, SF2, UK5, UK9, UK18, UK27, UK29, UK39, USA11, USA12, USA26</td>
<td></td>
</tr>
<tr>
<td>B) Projects related to the simulation and modelling of indoor air and contaminant movement</td>
<td></td>
</tr>
<tr>
<td>Air movement and quality simulation</td>
<td></td>
</tr>
<tr>
<td>14) Indoor air movement</td>
<td>10 replies</td>
</tr>
<tr>
<td>CH8, D13, DK2, J3, J7, NL3, UK1, UK17, UK28, USA31</td>
<td></td>
</tr>
</tbody>
</table>
15) Indoor air/heat movement (10 replies)

B4  
CH3  
D3  
F3  
SF6  
SU1  
UK20,UK24  
USA6,USA17

16) Indoor air/heat/contaminant movement (8 replies)

CH9,CH17  
J2  
S7  
SF7,SF11  
NL1,NL9

17) Indoor air quality (3 replies)

NL9  
USA5,USA32

Air infiltration and ventilation simulations

18) Air infiltration and ventilation in buildings (7 replies)

B5  
CA17  
CH11  
NL9  
H2  
SF6  
UK34

19) Outside pressure distribution/air movement around buildings (5 replies)

CH16  
F2,F12  
I2  
USA2

C) Miscellaneous

20) To compare/validate airflow models (2 replies)

TR1  
UK25

21) Relating air movement/ventilation and infiltration to construction practices (4 replies)

AU1  
CS1  
K1  
S10

22) To investigate new or existing tracer gas methods (7 replies)

CH4  
DK8  
S4  
I5  
UK21  
USA7,USA30

23) To monitor radon entry/harmfulness as a pollutant (11 replies)

B9  
CA2,CA10,CA30  
CH1  
DK11  
J1  
USA1,USA25,USA26,USA33

24) To produce/contribute to new ventilation and indoor air quality guidelines and standards (7 replies)

AU1  
CA5  
CH10  
D6  
I4  
S14  
UK16
25) To compile a database of information (5 replies)

CH12
NL8
H1,H3
UK32

26) To develop expert systems (2 replies)

J6
UK1

27) To undertake a market review (2 replies)

CH6
S14
1.2 Project details

Project details have been divided into the following subjects:

- Measurement analysis. *(Table 6)*
- Analysis of tracer gas tests. *(Table 7)*
- Analysis of indoor climate. *(Table 8)*
- Theoretical analysis. *(Table 9)*
- Building occupancy. *(Table 10)*
- Heating and ventilation systems. *(Table 11)*

As with the specific objectives *(1.1 above)*, often the details of individual projects span several categories.

Details of measurement analysis are summarized in Table 6. Tracer gas studies account for 33% of the replies, while pressurisation and airtightness studies account for a further 20% of the total. Of growing importance are projects related to the measurement of energy consumption (29% of the total). The remaining 16% of replies encompass measurement techniques such as pressure differences, flow visualisation, thermography and wind tunnel models.

Tracer gas investigations are still the most popular type of measurement technique. Table 7 identifies the methods and the tracer gases currently being used. The most common tracer techniques reported are the passive methods, based on passive perfluorocarbon techniques (PFT’s) and grab bag sampling. Constant concentration and constant injection are also popular methods. Sulphur hexafluoride (SF6) is still the most common tracer gas used, but since the last survey in 1986, nitrous oxide (N2O) shows increasing use.

The increased number of survey replies covering indoor air quality and related work has led to a greater number of pollutants being investigated than in the 1986 survey. Table 8 gives a breakdown of these pollutants.

It is interesting to note that the most measured pollutant is carbon dioxide (CO2). Pollutants which are being increasingly measured include bacteria and mycoflora, suspended particles and organic compounds. Other pollutants reported at a similar level to the previous survey include combustion products, formaldehyde, moisture, odour and radon. Pollutants not previously covered in recent surveys include polychlorinated biphenyls (PCB’s), ozone and noise.
Items relating to theoretical analysis are covered in Table 9; modelling is referred to in 146 replies, a large proportion of these replies concerning airflow models, including multizone and room air movement simulation. Other modelling activities include air quality modelling, occupant behaviour simulation, thermal analysis and the development of scale models. A substantial number of studies in this section include surveys, questionnaires and reviews (42 replies). Other replies include the development of expert systems, databases and the contribution to standards and guidelines.

A large number of replies made reference to either real or simulated occupancy, (80 replies). The greater amount of work concerned studies of occupied buildings (69 replies). The results of building occupancy studies appear in Table 10.

Since 1986 projects involving ventilation and heating systems have increased from 51 to 132 replies; Table 11 identifies the main systems, although studies involving mechanical ventilation systems account for the majority of the work in this area (76 replies). Natural ventilation is also significant, (49 replies) and still accounts for a good deal of research work. Demand controlled ventilation (DCV) research has also increased, with carbon dioxide (CO₂) being the most popular pollutant used to govern demand controlled ventilating systems.

1.3 Building type and components

Information relating to this section is outlined in Table 12. The majority of this work is centred on residential type buildings, such as single family dwellings and apartments. Commercial/office and industrial type buildings are also well represented in the survey. The remaining studies cover a variety of other building types, including test chambers, attic spaces, theatres, auditoriums and schools.

Studies on building components include facade openings (for example windows, doors and cracks) and flow through internal components, such as walls, ceilings and floors.
1.4 Parameters to which air infiltration, ventilation and indoor air quality are related

In almost all instances air infiltration data is being related to weather parameters, specifically wind speed and direction, temperature and humidity.

Table 13 details those parameters which are related specifically to air infiltration and ventilation studies. Such parameters as building characteristics and performance are included. These cover building design/type, airtightness and internal airflow paths. Other parameters include heating and ventilation systems, occupant behaviour and energy consumption.

Table 14 details those parameters to which indoor air quality is being related. Parameters include pollutant concentrations and sources in general. A total of eighteen specific pollutants are referred to including carbon oxides, radon, and moisture. Physical variables encompass areas such as indoor air movement, type of building and heating and ventilation systems.

1.5 Allocation of staff time and origin of replies

Information about the staff time allocated to each project was stated in 70% of the survey replies. These results are summarized in Figure 4. As in the 1986 survey, the time being expended on individual projects is in the region of 1 to 3 person years. There are some notable exceptions, with 15 long term projects of between 10 000 - 20 000 hours, and 6 projects over 20 000 person hours. These projects tend to involve research into more than one subject, and include NZ1, D9, and B5. The overall picture again is similar to the 1986 survey with an estimated one million hours of research effort being documented by this survey.

The distribution of replies is given in Table 1 (see above). From this table it can be seen that nearly half the replies received were from three countries i.e., the United Kingdom, the United States of America and Canada. All AIVC participating countries are represented in the survey. Response from the non participating countries was greater than in the 1986 survey, with France and Japan providing the majority of the replies. The number of replies should be looked upon as an overview, since response to the survey is entirely voluntary, and therefore does not necessarily provide a complete picture.
### 1.6 Concluding remarks

In terms of the total number of replies received and the subjects covered, this survey represents the most comprehensive review of current research yet published by the AIVC. The project summaries from 23 countries essentially cover all aspects of air infiltration and indoor air quality research. It is interesting to note that research into indoor air quality has increased, as too has research into simulating airflow movement.

Research on ventilation and heating systems and strategies, which was deficient in the 1983 survey, has continued to increase into the 1990's as alternative energy sources and a renewed drive towards energy conservation and efficiency have provided a greater impetus to improve the way we use energy.

Simulation work on multizone indoor airflows has continued to increase since the 1986 survey, but so too have airflow models in general, air quality models and models attempting to predict occupant behaviour.

The use of passive tracer gas techniques initially identified in the last survey, has also increased. These passive techniques allow air change rates to be unobtrusively monitored in occupied buildings.
Indoor air quality research has also increased. Of specific interest have been the causes and sources of indoor air pollution, the effect of indoor climate on occupant health and comfort, and the effect of airtightness measures and minimum ventilation rates on indoor air quality. The overall aim of such projects is the development of energy efficient buildings, which also have low levels of indoor air pollution.

An analysis of the research effort being devoted to each project reveals that the reported research studies are generally of fairly short duration, typically between one and three person years. There are exceptions to this, with a total of 15 long term projects having between 6 and 12 person years of effort devoted to them and 6 projects requiring over 12 person years of effort.

It is intended that the survey of current research will be an ongoing venture, as it now appears alongside our bibliographic database "AIRBASE". Thus the database will be continually updated, as projects are completed, and new projects begun.
<table>
<thead>
<tr>
<th>1) Tracer gas studies (See also Table 7)</th>
<th>3) Energy consumption/Heat loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUS1, B5,B6,B7,B9, CA1,CA17,CA18,CA30</td>
<td>CA2,CA4,CA9,CA11,CA20,CA25,CA26</td>
</tr>
<tr>
<td>CH1,CH4,CH14, D8,D13, DK6, F2, I5, J1, H4, NZ1</td>
<td>CH6,CH8,CH11, D11,D12</td>
</tr>
<tr>
<td>S2,S3,S4,S5,S6,S8,S9,S10, SF7,SF9, UK4,UK11,UK14,UK19,UK21,UK22,UK23, UK25,UK27,UK33, USA7,USA8,USA10,USA11,USA12,USA13, USA15,USA24,USA28,USA29,USA30,USA33, USA34,USA35</td>
<td>DK7,DK8,DK10, F1, H2,H4, I1, I4, N4</td>
</tr>
<tr>
<td>2) Pressurisation/depressurisation</td>
<td>4) Internal/external pressure</td>
</tr>
<tr>
<td>B6,B7,B8,B9, CA17,CH13,CH14, D8, F8,F10,F11, J1, NZ1, S2,S3,S5,S6,S9,S10, UK8,UK15,UK22,UK23,UK33,UK37, USA10,USA11,USA12,USA13,USA16,USA20, USA21,USA29,USA33,USA34</td>
<td>CA10,CA12,CA14,CA21,CA22, DK7, F12, H1, SF3, SF4, SF6, TR1, UK19,UK24, USA27</td>
</tr>
<tr>
<td>5) Flow visualization</td>
<td></td>
</tr>
<tr>
<td>B10, SF11, UK1, USA2</td>
<td></td>
</tr>
<tr>
<td>6) Thermography</td>
<td></td>
</tr>
<tr>
<td>USA21</td>
<td></td>
</tr>
<tr>
<td>7) Wind tunnel models</td>
<td></td>
</tr>
<tr>
<td>CA14, CH16, CS1, F2,F12</td>
<td></td>
</tr>
</tbody>
</table>
### Table 7 - Analysis of Tracer Gas Studies

#### A) Techniques

<table>
<thead>
<tr>
<th>Technique</th>
<th>Countries/Regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Constant concentration</td>
<td>B7, CA17, CH4, S2,S3,S6,S9,S10, UK33, USA24</td>
</tr>
<tr>
<td>2) Constant injection</td>
<td>B7, D8, UK19,UK33</td>
</tr>
<tr>
<td>3) Decay</td>
<td>CH14, D8, S6, UK14,UK19,UK33, USA10,USA33,USA34</td>
</tr>
<tr>
<td>4) Pulse injection</td>
<td>UK19, USA7</td>
</tr>
<tr>
<td>5) Passive techniques (PFT/Grab-bag)</td>
<td>AUS1, CA1,CA30, CH4, DK6, NZ1, S8,S10, SF9, UK23, USA13,USA24,USA29,USA35</td>
</tr>
</tbody>
</table>

#### B) Tracer gas

<table>
<thead>
<tr>
<th>Gas</th>
<th>Countries/Regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Carbon dioxide (CO₂)</td>
<td>B6, CA1, USA7</td>
</tr>
<tr>
<td>2) Freons</td>
<td>UK11, USA24</td>
</tr>
<tr>
<td>3) Nitrous oxide (N₂O)</td>
<td>B6,B7, CH1, D8,D13, N₂S₂,S₃,S₄,S₅,S₆,S₉ UK33</td>
</tr>
<tr>
<td>4) Perfluoro monomethyl/ dimethyl cyclohexane</td>
<td>USA35</td>
</tr>
<tr>
<td>5) R-12</td>
<td>UK14</td>
</tr>
<tr>
<td>6) Sulphur hexafluoride (SF₆)</td>
<td>US1, CA1,CA17, D8, DK6, UK4,UK23,UK33, USA12,USA24,USA33,USA34</td>
</tr>
</tbody>
</table>
Table 8 - Analysis of Indoor Climate

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Location Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Bacteria/mycoflora/fungi etc</td>
<td>CA6, CA7, CA8, CA13, CA15, CA24, CA26</td>
</tr>
<tr>
<td></td>
<td>USA9, USA14</td>
</tr>
<tr>
<td>2) Carbon dioxide (CO₂)</td>
<td>B6, B8, CA1, CA6, CA15, CA24, CA26, CA26, CA27, CA28, CA29</td>
</tr>
<tr>
<td></td>
<td>CH6, D5, D11, DK10, F4, J1, N1, N2, NL5, S5, S13, S14, S15, S16, UK36, UK39, USA14</td>
</tr>
<tr>
<td>3) Carbon monoxide (Combustion/CO)</td>
<td>CA1, CA4, CA6, CA12, CA15, CA16, CA25, CA26</td>
</tr>
<tr>
<td></td>
<td>F6, I1, UK36, USA14, USA15, USA27, USA32</td>
</tr>
<tr>
<td>4) Chlorine (Cl)</td>
<td>N1</td>
</tr>
<tr>
<td>5) Formaldehyde (HCHO/UFII)</td>
<td>CA6, CA9, CA11, CA15, CA26</td>
</tr>
<tr>
<td></td>
<td>D10, N1, S13, S15, UK36, USA11, USA14, USA22</td>
</tr>
<tr>
<td>6) Landfill gas/soil gas</td>
<td>CA10, UK16</td>
</tr>
<tr>
<td>7) Moisture/condensation</td>
<td>B2, B3, CA3, CA4, CA7, CA13, CA21, CA22, D5, D11, F1, NL9, NZ1, H3, H4, S14, UK36, UK9, USA3, USA4, USA8, USA13, USA26</td>
</tr>
<tr>
<td>8) Noise</td>
<td>CA1, CA24, UK26, UK36</td>
</tr>
<tr>
<td>9) Nitrogen oxides (NOₓ)</td>
<td>CA6, CA9, CA11, CA26, N1, N2, USA11, USA35</td>
</tr>
<tr>
<td>10) Odour</td>
<td>B8, CH17, DK8, DK9, S14, USA13</td>
</tr>
<tr>
<td>11) Organic compounds</td>
<td>CA6, CA15, CA16, CA19, CA29, D6, F1, S13, S14, S15, S16, UK2, USA14, USA15</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>12) Ozone (O₃)</strong></td>
<td><strong>15) Tobacco smoke</strong></td>
</tr>
<tr>
<td>CA1,CA3,CA6,CA15</td>
<td>CA16</td>
</tr>
<tr>
<td>USA14</td>
<td>D5,D7</td>
</tr>
<tr>
<td></td>
<td>USA14</td>
</tr>
<tr>
<td><strong>13) Radon</strong></td>
<td><strong>16) Suspended particles</strong></td>
</tr>
<tr>
<td>B9</td>
<td>CA6,CA15,CA16,CA29</td>
</tr>
<tr>
<td>CA2,CA3,CA9,CA10,CA26,CA30</td>
<td>B2,B3</td>
</tr>
<tr>
<td>CH1</td>
<td>F1</td>
</tr>
<tr>
<td>DK11</td>
<td>N1,N2</td>
</tr>
<tr>
<td>J1</td>
<td>UK10,UK36</td>
</tr>
<tr>
<td>UK16</td>
<td>USA14,USA15</td>
</tr>
<tr>
<td>USA1,USA11,USA15,USA25,USA26</td>
<td></td>
</tr>
<tr>
<td><strong>14) Sulphates (SO₄)</strong></td>
<td><strong>17) Polychlorinated biphenyls (PCB'S)</strong></td>
</tr>
<tr>
<td>N1</td>
<td>D2</td>
</tr>
</tbody>
</table>
Table 9 - Theoretical Analysis

1) Modelling

<table>
<thead>
<tr>
<th>a) Airflow models (General)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B5, B10</td>
</tr>
<tr>
<td>BZL1</td>
</tr>
<tr>
<td>CA4, CA17, CA19, CA20</td>
</tr>
<tr>
<td>CH3, CH5, CH14, CH17</td>
</tr>
<tr>
<td>D3</td>
</tr>
<tr>
<td>DK1, DK2</td>
</tr>
<tr>
<td>F1, F2, F3, F7, F10</td>
</tr>
<tr>
<td>I2</td>
</tr>
<tr>
<td>H1, H2</td>
</tr>
<tr>
<td>J3, J4, J5</td>
</tr>
<tr>
<td>N2, N5</td>
</tr>
<tr>
<td>NL1</td>
</tr>
<tr>
<td>S10</td>
</tr>
<tr>
<td>SF4, SF5, SF9</td>
</tr>
<tr>
<td>TR1</td>
</tr>
<tr>
<td>UK1, UK16, UK17, UK20, UK25, UK28,</td>
</tr>
<tr>
<td>UK33, UK35</td>
</tr>
<tr>
<td>USA2, USA7, USA12, USA15, USA17, USA23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) Airflow models (Multizone)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B6, B8</td>
</tr>
<tr>
<td>CA19</td>
</tr>
<tr>
<td>CH2, CH3, CH5, CH8, CH9, CH11, CH12</td>
</tr>
<tr>
<td>F3</td>
</tr>
<tr>
<td>H2</td>
</tr>
<tr>
<td>I2, I4, I5</td>
</tr>
<tr>
<td>J7</td>
</tr>
<tr>
<td>NL4, NL7</td>
</tr>
<tr>
<td>S6</td>
</tr>
<tr>
<td>SF7, SF9</td>
</tr>
<tr>
<td>UK21, UK23, UK24, UK25, UK28, UK31, UK33, UK34</td>
</tr>
<tr>
<td>USA5, USA7, USA24, USA30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>c) Airflow models (Single zone/rooms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA17</td>
</tr>
<tr>
<td>CH8, CH9</td>
</tr>
<tr>
<td>NL3</td>
</tr>
<tr>
<td>UK23, UK25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>d) Air quality/pollution models</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA19</td>
</tr>
<tr>
<td>D6</td>
</tr>
<tr>
<td>F2</td>
</tr>
<tr>
<td>I3, I4</td>
</tr>
<tr>
<td>J5</td>
</tr>
<tr>
<td>NL7, NL9</td>
</tr>
<tr>
<td>S10</td>
</tr>
<tr>
<td>USA5, USA32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>e) Model vented appliances</th>
</tr>
</thead>
<tbody>
<tr>
<td>F6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>f) Model validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>B5</td>
</tr>
<tr>
<td>CA20</td>
</tr>
<tr>
<td>CH5, CH7</td>
</tr>
<tr>
<td>DK4</td>
</tr>
<tr>
<td>NL1</td>
</tr>
<tr>
<td>TR1</td>
</tr>
<tr>
<td>UK11, UK17, UK23, UK25, UK33</td>
</tr>
<tr>
<td>USA15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>g) Occupant behaviour models</th>
</tr>
</thead>
<tbody>
<tr>
<td>BZL1</td>
</tr>
<tr>
<td>CH9, CH7, CH11</td>
</tr>
<tr>
<td>D5, D13</td>
</tr>
<tr>
<td>DK7, DK9</td>
</tr>
<tr>
<td>F3</td>
</tr>
<tr>
<td>UK27, UK34</td>
</tr>
<tr>
<td>USA15</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>h) Scale modelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>B10</td>
</tr>
<tr>
<td>NL2, NL3</td>
</tr>
<tr>
<td>UK1, UK7, UK21</td>
</tr>
<tr>
<td>USA2</td>
</tr>
<tr>
<td>1) Thermal modelling</td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>B1,B4,B5, BZ1, CS1, DK4, H2, I, SF5, SF6, SU1, UK7, UK20, UK28, UK30, USA6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2) The development of an expert system</th>
<th>6) To conduct a survey (General)</th>
</tr>
</thead>
<tbody>
<tr>
<td>J6, UK1</td>
<td>CA21, CA12, F7, K1, UK29, UK31, USA1, USA26</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3) The development/use of a database</th>
<th>7) To conduct a market review</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH2, CH11, CH12, CH17, DK2, H1, H2, H3, NL8, UK23, UK32, UK37, USA26</td>
<td>CH6, D5, S14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4) To conduct a literature survey/study</th>
<th>8) To contribute towards the preparation of guidelines/standards or reference manuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA19, CH12, DK2, F6, F12, H1, J6, NL2, NL3, NL8, NL9, UK11, UK31</td>
<td>AU1, B6, CA5, CA29, CH2, CH4, CH9, CH10, CH17, D4, D6, I4, N4, NL7, NL10, S1, S14, UK16, USA4, USA30</td>
</tr>
</tbody>
</table>
## Table 10 - Building Occupancy

### 1) Occupied

- B6, B7, B10
- CA1, CA4, CA5, CA6, CA9, CA10, CA11, CA12, CA13, CA15, CA16, CA23, CA24, CA26, CA30
- CH1, CH7, CH9, CH11, CH14, CH17
- D5, D11, D12, D13
- DK4, DK6, DK7, DK9, DK10
- F4, F9
- H4
- I1
- J1
- N1, N3, N5, NL5, NL7, NL10
- S1, S3, S4, S9, S13, S14
- SF8, SF10
- UK1, UK15, UK27, UK33, UK34, UK35, UK36, UK39
- USA11, USA13, USA14, USA15, USA22, USA25, USA26, USA29, USA35

### 2) Unoccupied

- AUS1
- CA1, CA4, CA17
- CH14
- D13
- F3
- J1
- S4, S14
- UK7, UK14, UK27, UK33
- USA11, USA12

### 3) Simulated occupancy

- BZL1
- CH9, CH11
- D5, D13
- DK7, DK9
- F3
- UK27, UK34
- USA15
Table 11 - Heating and Ventilating Systems

A) Ventilation Systems

1) Mechanical ventilation

<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>CA1, CA2, CA3, CA5, CA7, CA8, CA9, CA11, CA12, CA13, CA17, CA20, CA23, CA25, CA26, CA29</td>
<td>CH6, CH8, CH10, CH13, CH14, CH15</td>
<td>D6, D7, D12, D13</td>
<td>DK5, DK7</td>
<td>F1, F3, F4</td>
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2) Natural ventilation

<table>
<thead>
<tr>
<th>System Code</th>
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<tbody>
<tr>
<td>B7, BZL1, CA1, CA2, CA5, CA7, CA8, CA12, CA13, CA17, CA20, CA24, CA30</td>
<td>CH13, CH14</td>
<td>CS1, D1, DK7, F7, H2, I3, J1, N1, N5, S1, S6, S7, S14, SF2, SF4, SF5, SF10, UK5, UK6, UK7, UK9, UK15, UK16, UK18, UK20, UK23, UK31, UK36, USA5, USA15, USA16, USA23, USA31, USA33</td>
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3) Demand controlled ventilation

<table>
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<th>System Code</th>
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</thead>
<tbody>
<tr>
<td>B7</td>
<td>CA23, CA27</td>
<td>D5, DK10, N2, I1, S14, S15, S16, SF3, SF4, UK39</td>
</tr>
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4) Heat recovery systems

<table>
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<tr>
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<th>System Code</th>
<th>System Code</th>
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</thead>
<tbody>
<tr>
<td>CA13, D7, DK7, SF2, UK18, UK33</td>
<td>USA5, USA15, USA16, USA23, USA31, USA33</td>
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</table>

5) Variable air volume systems

<table>
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<th>System Code</th>
<th>System Code</th>
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<tbody>
<tr>
<td>S14, S15</td>
<td>USA34</td>
<td>USA20</td>
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</table>

6) Air conditioning systems

<table>
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<tr>
<th>System Code</th>
<th>System Code</th>
<th>System Code</th>
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</thead>
<tbody>
<tr>
<td>AUS1, CA8, CA29, CH10, N4, S8, SU1, UK3, UK36, UK38, USA14, USA15, USA20, USA34</td>
<td>USA14, USA15, USA20, USA34</td>
<td></td>
</tr>
</tbody>
</table>
B) Heating Systems

1) Heating Systems (General)

AU1, CA4, CA8, CA9, CA12, CA18, CA24, CA25, CA26, CA29, CH6, CH14, D3, D12, F3, F5, I1, I4, N5, NL10, S1, S2, S3, S5, S6, S9, S11, SF1, SF2, SF4, UK1, UK15, UK22, UK29, UK33, UK37, USA1, USA2, USA11, USA12, USA13, USA26, USA35

2) Electric Heating Systems

CA1, F3, S2, S5, S6, S9, UK37, USA11, USA12, USA13, USA15, USA29

3) Domestic Hotwater Heating Systems

CA1, S1, S2, S9, UK15, UK27, USA35

4) Oil Fired Heating Systems

S1, UK15

5) Gas Fired Heating Systems

CA25, UK15, UK33, USA11, USA15, USA35
Table 12 - Building/Building Components

A) Buildings

<table>
<thead>
<tr>
<th>1) Buildings general/all</th>
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<tbody>
<tr>
<td>AU1</td>
</tr>
<tr>
<td>CA5</td>
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<tr>
<td>CH11</td>
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<tr>
<td>DK8</td>
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<tr>
<td>H2,H3</td>
</tr>
<tr>
<td>I5</td>
</tr>
<tr>
<td>J6</td>
</tr>
<tr>
<td>NL9</td>
</tr>
<tr>
<td>S10,S14</td>
</tr>
<tr>
<td>SF6</td>
</tr>
<tr>
<td>UK8, UK9, UK20, UK24, UK26, UK31, UK32, UK33</td>
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<tr>
<td>USA6, USA30, USA31</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>2) Dwellings (General)</th>
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<tbody>
<tr>
<td>B2, B8, B9</td>
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<tr>
<td>CA3, CA4, CA9, CA10, CA11, CA12, CA13, CA14, CA17, CA18, CA19, CA22, CA26, CA30</td>
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<tr>
<td>CH6, CH8, CH9, CH12, CH13, CH14</td>
</tr>
<tr>
<td>CS1</td>
</tr>
<tr>
<td>D5, D9</td>
</tr>
<tr>
<td>DK4, DK6</td>
</tr>
<tr>
<td>F1, F2, F3, F4, F6, F7, F8, F10</td>
</tr>
<tr>
<td>H1</td>
</tr>
<tr>
<td>I1, I3, I4</td>
</tr>
<tr>
<td>J2, J6</td>
</tr>
<tr>
<td>K1</td>
</tr>
<tr>
<td>NL7, NL8, NL10</td>
</tr>
<tr>
<td>NZ1</td>
</tr>
<tr>
<td>N1</td>
</tr>
<tr>
<td>S2, S3, S5, S6, S7, S9, S12, S14</td>
</tr>
<tr>
<td>SF2, SF4, SF7, SF9, SF10</td>
</tr>
<tr>
<td>TR1</td>
</tr>
<tr>
<td>UK1, UK2, UK4, UK5, UK11, UK13, UK16, U21, UK22, UK33, UK34, UK35</td>
</tr>
<tr>
<td>USA1, USA4, USA8, USA9, USA12, USA15, USA18, USA21, USA22, USA24, USA25, USA27, USA32, USA34, USA35</td>
</tr>
</tbody>
</table>

3) Dwelling (Detached)

| CA2                     |
| F10                     |
| J1, J3                  |
| S6                      |
| SF1                     |
| USA11, USA13, USA24, USA26, USA27, USA29, USA33 |

4) Dwelling (Semi detached)

| SF10                   |
| USA24, USA27           |

5) Apartments/flats

| B6, B7, B8             |
| CH13, CH14             |
| CS1                    |
| F7, F9                 |
| D5                     |
| I1                     |
| J1, J3                 |
| H4                     |
| N1                     |
| NL10                   |
| S1, S3, S14            |
| SP9, SF10              |
| TR1                    |
| UK2, UK22              |

6) Single-storey buildings

| UK6                     |
7) Commercial/office buildings

AUS1
B8
CA1,CA6,CA7,CA16,CA23,CA27,CA28,CA29
CH15,CH16,CH17,CH18,CH19,CH17
CS1
D2,D5,D6,D11,D13
DK4,DK11
F5
K1
N4
NL5
NZ1
S12,S14,S15
SF1,SF5,SF8,FS11
UK1,UK2,UK15,UK20,UK23,UK28,UK35,
UK36,UK38
USA1,USA2,USA9,USA14

8) Public buildings

CA21
NL5
NZ1
UK23

9) Industrial/factory buildings

B10
BZL1
CA14
CH6
F5
D13
NL6
SU1
UK14,UK25,UK29,UK35,UK37

10) Test chambers/test house

B5
CA1,CA17,CA20,CA22
CH7,CH15
D7,D12,D13
DK4,DK5,DK7,DK11
F11
J1
S5,S11

11) Mobile homes

USA10

12) Agricultural buildings

B10
USA23
UK10

13) Hospitals

CA8
D6
UK18

14) Schools

B8
CH6
N3
S14
UK2,UK27

15) Day nurseries

CA24
S14

16) Retail outlets

UK39

17) Clean rooms

J5
S4,S11

18) Single Rooms

B3,B4
D8
NL3
<table>
<thead>
<tr>
<th>19) Churches</th>
<th>B) Building Components</th>
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</thead>
<tbody>
<tr>
<td>NZ1</td>
<td>1) Openings (General)</td>
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<tr>
<td>N5</td>
<td>B6,B8</td>
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<td>CA17</td>
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<td>CH2,CH3,CH7</td>
</tr>
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<td>H2</td>
</tr>
<tr>
<td></td>
<td>J5</td>
</tr>
<tr>
<td></td>
<td>NL3,NL4,NL6</td>
</tr>
<tr>
<td></td>
<td>UK9,UK11,UK16,UK21</td>
</tr>
<tr>
<td></td>
<td>USA3,USA8,USA16,USA31</td>
</tr>
<tr>
<td>20) Museums</td>
<td>2) Windows</td>
</tr>
<tr>
<td>S8</td>
<td>B4</td>
</tr>
<tr>
<td></td>
<td>CA3,CA4,CA17</td>
</tr>
<tr>
<td></td>
<td>CH7,CH17</td>
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<tr>
<td></td>
<td>F9,F10</td>
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<td>H1</td>
</tr>
<tr>
<td></td>
<td>J1,J3</td>
</tr>
<tr>
<td></td>
<td>K1</td>
</tr>
<tr>
<td></td>
<td>NL2,NL10</td>
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<td>S1,S4,S11</td>
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<td></td>
<td>USA2</td>
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<tr>
<td>21) Libraries</td>
<td>3) Walls</td>
</tr>
<tr>
<td>S13</td>
<td>B5</td>
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<tr>
<td></td>
<td>CA3,CA4,CA10,CA22</td>
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<tr>
<td></td>
<td>CH8,CH17</td>
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<tr>
<td></td>
<td>CS1</td>
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<td>D9</td>
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<td></td>
<td>J2,J3</td>
</tr>
<tr>
<td></td>
<td>S1,S10,S11</td>
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<td>UK5,UK6,UK7,UK11,UK12,UK15,UK20,UK22</td>
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<tr>
<td></td>
<td>USA2,USA10</td>
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<tr>
<td>22) Theatres/auditoriums</td>
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<tr>
<td>N2</td>
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<tr>
<td>NL2,NL4</td>
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<tr>
<td>UK30,UK39</td>
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<tr>
<td>23) Attics/roofs</td>
<td></td>
</tr>
<tr>
<td>B6,B10</td>
<td></td>
</tr>
<tr>
<td>CA3,CA10</td>
<td></td>
</tr>
<tr>
<td>I2</td>
<td></td>
</tr>
<tr>
<td>S1,S11</td>
<td></td>
</tr>
<tr>
<td>UK3,UK11,UK22</td>
<td></td>
</tr>
<tr>
<td>USA8</td>
<td></td>
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<tr>
<td>24) Crawlspace/basements</td>
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<td>B9</td>
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</tr>
<tr>
<td>CA2,CA10,CA30</td>
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<tr>
<td>I2</td>
<td></td>
</tr>
<tr>
<td>J1</td>
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<tr>
<td>4) Doors</td>
<td>6) Cracks</td>
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<tr>
<td>--------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>B2</td>
<td>CA10</td>
</tr>
<tr>
<td>CA20</td>
<td>CH3</td>
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<td>CH7</td>
<td>F11</td>
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<td>SF6</td>
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<td>UK15,UK21</td>
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<table>
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<th>5) Floors</th>
<th>7) Ceilings</th>
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<tbody>
<tr>
<td>B2</td>
<td>CH17</td>
</tr>
<tr>
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<td>NZ1</td>
</tr>
<tr>
<td>CH1,CH17</td>
<td>S3</td>
</tr>
<tr>
<td>D3,D12</td>
<td>USA2</td>
</tr>
<tr>
<td>DK3</td>
<td></td>
</tr>
<tr>
<td>N5</td>
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<td>S1</td>
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<th>8) Stairwells</th>
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Table 13 - Parameters to which Air Infiltration and/or Ventilation are Related

1) Weather/Climate

<table>
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<th>a) General</th>
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<tbody>
<tr>
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<tr>
<td>CA21</td>
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<tr>
<td>CH2,CH5,CH7,CH9</td>
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<tr>
<td>CZ1</td>
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<tr>
<td>F3,F7</td>
</tr>
<tr>
<td>H3</td>
</tr>
<tr>
<td>NL2,NL3</td>
</tr>
<tr>
<td>NZ1</td>
</tr>
<tr>
<td>S7,S10</td>
</tr>
<tr>
<td>TR1</td>
</tr>
<tr>
<td>UK9,UK13,UK20,UK27,UK28,UK31,UK32,UK33,UK34,UK35,USA8,USA29</td>
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<table>
<thead>
<tr>
<th>b) Wind speed</th>
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<tbody>
<tr>
<td>AUS1</td>
</tr>
<tr>
<td>CA14,CA17</td>
</tr>
<tr>
<td>CH3,CH9,CH16</td>
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<tr>
<td>D8</td>
</tr>
<tr>
<td>J3</td>
</tr>
<tr>
<td>S6,S10</td>
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<tr>
<td>SF6</td>
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<tr>
<td>UK11,UK14,UK15,UK16,UK21,UK23,UK24,USA10</td>
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</table>

<table>
<thead>
<tr>
<th>c) Wind direction</th>
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<tbody>
<tr>
<td>CA14,CA17</td>
</tr>
<tr>
<td>CH3,CH9,CH16</td>
</tr>
<tr>
<td>D8</td>
</tr>
<tr>
<td>J3</td>
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<tr>
<td>S6,S10</td>
</tr>
<tr>
<td>SF6</td>
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<td>UK21,UK23,UK24</td>
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<table>
<thead>
<tr>
<th>d) Wind pressure</th>
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<tbody>
<tr>
<td>B9</td>
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<tr>
<td>CA22</td>
</tr>
<tr>
<td>F11,F12</td>
</tr>
<tr>
<td>I2</td>
</tr>
<tr>
<td>USA6</td>
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</table>

<table>
<thead>
<tr>
<th>e) Temperature difference (Stack effect)</th>
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</thead>
<tbody>
<tr>
<td>AU1</td>
</tr>
<tr>
<td>AUS1</td>
</tr>
<tr>
<td>B9</td>
</tr>
<tr>
<td>CA17</td>
</tr>
<tr>
<td>CH3,CH7,CH8</td>
</tr>
<tr>
<td>D8</td>
</tr>
<tr>
<td>DK4</td>
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<tr>
<td>F5</td>
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<tr>
<td>N3</td>
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<tr>
<td>S3,S5,S6,S8,S10</td>
</tr>
<tr>
<td>SF6,SF8</td>
</tr>
<tr>
<td>SU1</td>
</tr>
<tr>
<td>UK4,UK5,UK6,UK11,UK12,UK14,UK15,UK16,UK17,UK23,UK24,USA6,USA8,USA10</td>
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<table>
<thead>
<tr>
<th>f) Humidity</th>
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</thead>
<tbody>
<tr>
<td>AU1</td>
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<tr>
<td>B6</td>
</tr>
<tr>
<td>F4</td>
</tr>
<tr>
<td>S8</td>
</tr>
<tr>
<td>SF8</td>
</tr>
<tr>
<td>SU1</td>
</tr>
<tr>
<td>UK5,UK6,UK11</td>
</tr>
<tr>
<td>USA8</td>
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</table>

<table>
<thead>
<tr>
<th>g) Radiant exchange</th>
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</thead>
<tbody>
<tr>
<td>B4</td>
</tr>
<tr>
<td>DK3</td>
</tr>
<tr>
<td>S8</td>
</tr>
<tr>
<td>UK22</td>
</tr>
</tbody>
</table>
2) Building characteristics/performance

a) Building general (eg type/design)

CA12, CA14, CA17
CH2, CH5, CH9, CH12
F2, F10, F11
I1
UK25, UK27, UK30
USA12, USA13

b) Building envelope performance/openings/leakage distribution and airtightness

AU1
B9
CA11, CA12, CA14, CA17, CA22
CH3, CH12, CH13, CA14
F3, F8
NL3
S3, S4, S6, S10
TR1
UK1, UK8, UK15, UK16, UK18, UK23, UK24, UK27, UK33, UK37
USA7, USA12, USA16, USA20, USA21, USA29

c) Building component performance/purpose provided openings

CA4
CH8
B10
DK1, DK2, DK3
F8
H1
J5
K1
TR1
UK20, UK21, UK34
USA2

d) Building construction type

B1
I1
UK33, UK37

e) Building exposure

CA14, CA17
NL2
UK16, UK24, UK33

f) Internal airflow movement

AUS1
B10
CA25
CH4, CH8, CH11
D1, D4, D10
DK1, DK6
F10, F11
J4, J5
H2
NL1, NL9
NZ1
S3, S5
SF8, SF11
UK13, UK17, UK19, UK24, UK28, UK37
USA4, USA5, USA6, USA17, USA23, USA24

g) Internal air velocities

D10
J5
NL1, NL3
SU1
UK17, UK30
USA2, USA8

h) Turbulent airflows

CA17
CH3
DK2
UK30

i) Internal pressures

D8
F10
<table>
<thead>
<tr>
<th>Topic</th>
<th>UK16, UK23</th>
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</thead>
<tbody>
<tr>
<td><strong>Draughtproofing</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Ventilation systems</strong></td>
<td>CA11, CA12, CA17</td>
</tr>
<tr>
<td></td>
<td>F7, NL6, S5, UK31, UK38, USA4, UK20, UK22</td>
</tr>
<tr>
<td><strong>Heating systems</strong></td>
<td>CA12, F3, UK1, UK20, UK22</td>
</tr>
<tr>
<td><strong>Pollutant levels/transport</strong></td>
<td>B6, CH2, CH6, CH8, CH9, CH11</td>
</tr>
<tr>
<td></td>
<td>F7, N3, NL9, S8, SF8, UK1, UK13, UK15, UK18, USA2, USA5, USA20</td>
</tr>
<tr>
<td><strong>Pollution sources</strong></td>
<td>F7, H2, USA13</td>
</tr>
<tr>
<td><strong>Occupant behaviour</strong></td>
<td>B6, CA17, CH2, CH9, F3, F4, UK1, UK15, UK27, UK33, UK34, UK35, USA13, USA29</td>
</tr>
<tr>
<td><strong>Development of guidelines and standards</strong></td>
<td>CH10, D4, UK9</td>
</tr>
<tr>
<td><strong>Energy consumption/usage</strong></td>
<td>CA11, I1, S3, SF8, SF11, UK7, UK15, USA4, USA20, USA34</td>
</tr>
<tr>
<td><strong>Heat recovery</strong></td>
<td>DK7, USA4</td>
</tr>
<tr>
<td><strong>Heat transfer</strong></td>
<td>B1, CA20, CH9, H2, NZ1, UK3, UK7, UK12, UK17, USA8, USA12, USA19</td>
</tr>
<tr>
<td><strong>Moisture transfer</strong></td>
<td>CA4, NZ1, UK3, USA4, USA8, USA13</td>
</tr>
<tr>
<td><strong>Ventilation/air change rate</strong></td>
<td>AUS1, CH4, CH13, H2, J6, J7, UK12, USA4, USA19, USA24, USA34</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>CH4</td>
<td>CA4, CA12</td>
</tr>
<tr>
<td>I3</td>
<td>NL1</td>
</tr>
<tr>
<td>SF9</td>
<td>I1</td>
</tr>
<tr>
<td>USA12, USA29</td>
<td></td>
</tr>
</tbody>
</table>
Table 14 - Parameters to which Indoor Air Quality is Related

1) Weather/Climate

<table>
<thead>
<tr>
<th>a) General</th>
<th>e) Indoor temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>B5,B8</td>
<td>B9</td>
</tr>
<tr>
<td>BZL1</td>
<td>CA3,CA6,CA15,CA16,CA18,CA23</td>
</tr>
<tr>
<td>CA1,CA2</td>
<td>D7,D11,D13</td>
</tr>
<tr>
<td>CH1</td>
<td>F5,F7,F8</td>
</tr>
<tr>
<td>D5,D11</td>
<td>H4</td>
</tr>
<tr>
<td>F2</td>
<td>J1</td>
</tr>
<tr>
<td>H4</td>
<td>N2,N3</td>
</tr>
<tr>
<td>J1</td>
<td>S2,S3,S9,S11,S13,S15</td>
</tr>
<tr>
<td>N5</td>
<td>USA22</td>
</tr>
<tr>
<td>NL5,NL10</td>
<td></td>
</tr>
<tr>
<td>UK33,UK35</td>
<td></td>
</tr>
<tr>
<td>USA3,USA14,USA15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b) Wind speed</th>
<th>f) Outdoor temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>B7</td>
<td>CA18</td>
</tr>
<tr>
<td>CA3</td>
<td>S3</td>
</tr>
<tr>
<td>D6,D13</td>
<td>USA32</td>
</tr>
<tr>
<td>S2,S9,S11,S15</td>
<td></td>
</tr>
<tr>
<td>USA32</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>c) Wind direction</th>
<th>g) Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>B7</td>
<td>CA6,CA13,CA15,CA16,CA18,CA23</td>
</tr>
<tr>
<td>NL4</td>
<td>D11,D13</td>
</tr>
<tr>
<td>S11,S15</td>
<td>F8</td>
</tr>
<tr>
<td></td>
<td>H4</td>
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<tr>
<td></td>
<td>J1</td>
</tr>
<tr>
<td></td>
<td>N2</td>
</tr>
<tr>
<td></td>
<td>S13,S15,S16</td>
</tr>
<tr>
<td></td>
<td>UK36</td>
</tr>
<tr>
<td></td>
<td>USA22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>d) Wind pressure</th>
<th>h) Solar radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>B7,B9</td>
<td>D11</td>
</tr>
<tr>
<td>BZL1</td>
<td>F3</td>
</tr>
<tr>
<td>D13</td>
<td>S9,S12</td>
</tr>
<tr>
<td>F3</td>
<td>UK26</td>
</tr>
<tr>
<td>J2</td>
<td></td>
</tr>
</tbody>
</table>
2) Pollutants

a) General indoor air quality

CA6, CA7, CA8, CA15, CA16
CA15
D2
NL5
UK2, UK32
USA14, USA15, USA26

b) Pollution concentrations/sources

B8, BZ1
CA2, CA6, CA19
CA15
D2, D6, D9
DK5, DK8, DK9
F7, F8
N1
N2
NL4
UK26, UK36
USA5, USA18, USA22, USA35

c) Bacteria/mould/fungi

CA24, CA6
USA9

d) Carbon oxides (CO2/CO)

B7, B8
CA6, CA23, CA24, CA27, CA28, CA29
D5, D11
F6
J1
N2, NL5
S14, S15, S16
UK39

e) Combustion emissions

I4
S14
USA15, USA27, USA32

f) Dust concentrations

B2, B3
CA6
N2, N3

g) Formaldehyde releases

CA6
S13, S15
USA11

h) Moisture

B3
S14
USA3, USA4, USA26

i) Nitrogen oxides

USA11

j) Noise/sound attenuation

B8
CA1
D13
F2, F3

k) Occupant health/comfort

CA15, CA16
CA15, CH17
F10
N4
NL10
USA18, USA26

l) Odour

CH17
DK9
S14
m) Ozone

CA6

n) Particles

CA24, CA29
F1

o) Radon/Radon daughters

B9
CA2, CA3, CA10, CA30
DK11
J1
USA11, USA15, USA33

p) Tobacco smoke.

D5, D7

q) Thermal comfort

BZL1
CA18, CA27, CA29
J2
NL10
S11
UK26, UK29, UK36

r) Tracer gas research

USA28, USA30

s) Vapour production

D5

t) Volatile organic compounds (VOC's)

CA6, CA29
F1
S13, S15, S16
UK2

3 Physical Variables

a) Air movement.

B7, B8
CA2, CA6, CA15, CA18, CA23, CA30
D7
F3, F7, F8
J2
NL4
S3
UK29, UK36
USA4, USA5, USA9

b) Air change rate/ventilation rate

CA3, CA6, CA23
CH1
UK26
USA4, USA18, USA33

c) Building construction/design/tightness

B2, B5, B9
CA1, CA2, CA10, CA26
CH1
F1, F2, F3
D6
I4
J1
NL5, NL7
S1, S2, S3, S9, S15
UK25, UK33
USA11, USA18, USA31, USA32, USA33

d) Energy conservation

CA9, CA26
F8, F9
N4
NL10
S3, S9
UK26
USA4, USA26, USA32
<table>
<thead>
<tr>
<th>e) Heating systems</th>
<th>g) Geology</th>
<th>h) Occupant behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA26</td>
<td>CA10</td>
<td>B2</td>
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<tr>
<td>D7</td>
<td>USA1</td>
<td>CA1, CA6, CA9, CA26</td>
</tr>
<tr>
<td>NL4</td>
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<td>CH1</td>
</tr>
<tr>
<td>USA4</td>
<td></td>
<td>D5, D11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F9</td>
</tr>
<tr>
<td>f) General ventilation/mechanical ventilation systems</td>
<td></td>
<td>N5</td>
</tr>
<tr>
<td>B3, B9</td>
<td></td>
<td>NL5, NL7, NL10</td>
</tr>
<tr>
<td>CA2, CA3, CA5, CA7, CA8, CA9, CA13, CA26, CA28, CA30</td>
<td></td>
<td>UK33, UK35, UK36</td>
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<td>F1, F2, F4, F9</td>
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<td>USA25, USA32, USA35</td>
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<td>D7</td>
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<tr>
<td>S3</td>
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<tr>
<td>UK10, UK36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA4</td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>i) Standards/guidelines</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section 2
Survey Replies
BELGIUM

REF B1
TITLE
The influence of natural convection in an insulated cavity on the thermal performance.
CONTACT
Lecompte, J
ADDRESS
Laboratory of Building Physics,
K U Leuven,
Kasteel van Arenberg,
B-3030 Heverlee,
BELGIUM.
TEL +32 16 220931  FAX +32 16 22 09 31
TLX ELEKUL 25971
SPECIFIC OBJECTIVES
Quantifying the deterioration of the thermal performance of cavity filling by bad workmanship.
PROJECT DETAILS
The research was structured around three topics. (i) Developing a calculation model for rotative convection around poorly mounted cavity fill. (ii) Analysing the quality of workmanship in partly cavity fill on site. (iii) Simulating reality in hot-box/cold-box tests; comparing test results with model predictions.
BUILDING TYPE
Cavity walls
PARAMETERS
(Not Stated)
STARTDATE 00:00:1987
ENDATE 00:00:1989 TIME 5 person-years
(1 res. FT-5 yrs)
KEYWORDS
Cavities, airflow, stack effect, simulation, natural convection
SELECTED BIBLIOGRAPHY

REF B2
Vapour distribution in two single family houses.
CONTACT

Senave, E
ADDRESS
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Kasteel van Arenberg,
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TLX ELEKUL 25941
SPECIFIC OBJECTIVES
To study the influence of different lay out and door uses on the vapour distribution.
PROJECT DETAILS
The study is part of the Belgium engagement in IEA annex XIV. In two houses of a social estate, the distribution of vapour was analysed. Starting with cooking, a given amount of water in one of the rooms, Relationships were studied between:
(i) The vapour pressure peak and the hygroscopic mass in the room. (ii) The velocity of peak buildup and ventilation. (iii) The distribution in vapour pressure reaction and door use on floor lay out.
BUILDING TYPE
Houses (Residences)
PARAMETERS
Door use, Floor lay out, Hygroscopic mass
STARTDATE 00:00:1987
ENDATE 00:00:1990 TIME 6 person-months
KEYWORDS
Openings, moisture, hygroscopic, dwelling, airflow
SELECTED BIBLIOGRAPHY
(None Stated)

REF B3
TITLE
Hygroscopic mass.
CONTACT
Hens, H
ADDRESS
Laboratory of Building Physics,
K U Leuven,
Kasteel van Arenberg,
B-3030 Heverlee,
BELGIUM.
TEL +32 16 220931  FAX +32 16 29 14 34
TLX ELEKUL 25947
SPECIFIC OBJECTIVES
Studying the influence of an increasing hygroscopic mass and surface on the vapour course.

PROJECT DETAILS
The study is part of the Belgium engagement in IEA annex XIV. In a hot box - cold box apparatus, the course of the vapour pressure during a step of vapour production is analysed as a function of: - Outside air ventilation. - Hygroscopic mass. - Surface condensation on simple glazing and thermal bridges.

BUILDING TYPE
Room
PARAMETERS
Ventilation, hygroscopic mass, condensation.
STARTDATE 00:00:1988
ENDATE 00:00:1990 TIME 6 person-months
KEYWORDS
Moisture, hygroscopic, condensation, ventilation

SELECTED BIBLIOGRAPHY
(Not Stated)

REF B4
TITLE
Model calculation and experimental study of the air thermocirculation due to solar radiation.
CONTACT
Gratia, E
ADDRESS
Universite Catholique de Louvain,
Unite Architecture - Batiment VINCI,
Place du Levant # 1,
1348 Louvain-la-Neuve,
BELGIUM.
TEL +32 010 47 22 23 FAX +32 10 47 21 79
EMAIL deherde@info.ucl.ac.be
TLX 59037 UCL B

SPECIFIC OBJECTIVES
After the observation of the phenomenon of thermocirculation in an experimental cell, elaboration of a simulation model for any airtight volume.

PROJECT DETAILS
The windows are a considerable source of free energy, caused by the sunspace effect, because of this thermocirculation occurs. This phenomenon allows us to get a better uniformity of the internal temperatures and so to avoid the heating of some rooms, while cooling others. The model calculates for an airtight volume the air movement due to the difference between the wall temperatures. It calculates the temperatures, the speed components in the three directions and the pressures at the nodes of the grid. Two graphics programs allows us to visualize the air movement.

BUILDING TYPE
A room with windows
PARAMETERS
The influence of the sun radiation on the thermocirculation
STARTDATE 00:01:1987
ENDATE 00:10:1998 TIME (Not Stated)
KEYWORDS
Natural convection, model, passive solar, air movement, temperature gradient
SELECTED BIBLIOGRAPHY

REF B5
TITLE
Passys. (GEC-Project)
CONTACT
Wouters, Peter
ADDRESS
Belgian Building Research Institute,
Aarlenstraat 53/10,
B-1040 Brussels,
BELGIUM.
TEL +32 2 653 88 01 FAX +32 2 653 07 29

SPECIFIC OBJECTIVES
Outdoor thermal performance testing of building components/Model validation and development/Simplified Design tool Development.

PROJECT DETAILS
Set up of high quality test cells with common procedures and common equipment and instrumentation (12 sites)
- Measurement of airtightness
- Common pressurisation equipment
Development of prototype of PASSYS Tracer Gas Equipment for ACR Measurement in 4 cells. Modelling of airflow (ESP, VENCON)

BUILDING TYPE
Test cell with wall components

PARAMETERS
Outdoor climate; wind; temperature, humidity, solar radiation, performance of south facing wall components.

STARTDATE 01:07:1986
ENDATE 31:12:1991
TIME 29000 person-hours (global project)
(of which 2000 hours on air infiltration)

KEYWORDS
Pressurisation, tracer gas, airflow simulation, airtightness

SELECTED BIBLIOGRAPHY
The PASSYS Test Cells: A unique European network of high quality outdoor test facilities for thermal buildings research, P.Wouters, L.Vandaele, SECA Paris 7 Dec, 1989

REF B6
TITLE
CONTACT
Wouters, Peter
ADDRESS
Belgian Building Research Institute, Aarlenstraat 53/10, B-1040 Brussels, BELGIUM.
TEL +32 2 653 88 01 FAX +32 2 653 07 29

SPECIFIC OBJECTIVES
Study of multizonal airflows.

PROJECT DETAILS
1 Measurements in attic space with N2O and CO2 injection of ACR, temperature and contaminant distribution (50 measuring points) and wind, surface pressures for different ventilation strategies (single sided, cross).
2 Use of movable air intake grilles in 9 apartments
3 Multizonal ventilation efficiency in apartment (tracer gas measurement and simulation.

BUILDING TYPE
Apartment building, attic space

PARAMETERS
Weather (wind, pressures, temp) humidity, CO2 level, use of air intake by occupants.

STARTDATE 00:00:1988
ENDATE 00:00:1991
TIME 5880 person-hours

KEYWORDS
Pressurisation, large openings, inhabitants, occupant, contaminant flow, multizonal, attic, simulation

SELECTED BIBLIOGRAPHY

REF B7
TITLE
Passive humidity controlled ventilation. (CECAERCO-BBRI-TNO-CETIAT)
CONTACT
Wouters, Peter
ADDRESS
Belgian Building Research Institute, Aarlenstraat 53/10, B-1040 Brussels, BELGIUM.
TEL +32 2 653 88 01 FAX +32 2 653 07 29

SPECIFIC OBJECTIVES
Study of airflows in apartments with natural ventilation system with and without hygro-regulated ventilation devices.

PROJECT DETAILS
9 storey apartment building with natural ventilation ducts in kitchen, bathroom and toilet. Pressurisation measurements. Tracer Gas (N2O) measurements in 54 rooms (9 apartments with normal ventilation devices on 9 apartments with hygroregulated ventilation devices). by BBRI-MATE system (60 channels) Constant injection technique. Measurement of airflow
rates, temperatures, CO2 levels, humidity, wind speed direction, wind pressures. Occupied building.

BUILDING TYPE
9 storey apartment building (Residence)

PARAMETERS
Temperature, wind speed and direction, humidity, ventilation system, CO2 level, wind pressure.
STARTDATE 00:00:1987
ENDATE 30:09:1991 TIME (Not Stated)

KEYWORDS
Humidity, natural ventilation, monitoring, carbon dioxide (CO2), tracer gas, demand controlled ventilation (dcv), airflow

SELECTED BIBLIOGRAPHY
2 Wouters P (1989), New ventilation concepts with respect to indoor air quality and energy conservation. Invited paper on Second European Conf. on Architecture Paris 5.12.89
4 Wouters P (1990), WTCB Tijdschrift 1989/2; WTCB Brussels Final Report Phase 1 (87-89) expected March 90.

REF B8
TITLE
Controlled ventilation in dwellings, schools and offices (IRSIA project)
CONTACT
Wouters, Peter
ADDRESS
Belgian Building Research Inst,
Aarlenstraat 53/10,
B-1040 Brussels,
BELGIUM.
TEL +32 2 653 88 01 FAX +32 2 653 07 29

SPECIFIC OBJECTIVES
Study and elaboration of strategies for controlled ventilation.

PROJECT DETAILS
1 Theoretical studies: multizone airflow simulations (VENCON,ESP) on ventilation efficiency, pollutant dispersal, cooking hood effectiveness, climatic factors, large openings, heat transfer.
2 Measurements in lab. and in situ: pressurisation of dwellings and offices, flow characteristics of ventilation grilles, performance of cooking hoods, efficiency of ventilation duct outlets, cross ventilation, reverse flow, indoor air quality.

BUILDING TYPE
Apartment building, terrace residence.

PARAMETERS
Weather, (wind temp. pressure) CO2, flow rates, cooking contaminants, acoustic performance.

STARTDATE 01:12:1987
ENDATE 30:11:1991 TIME 13440 person-hours

KEYWORDS
Pressurisation, airflow simulation, ventilation efficiency, contaminant multizone, air outlet, indoor air quality (IAQ)

SELECTED BIBLIOGRAPHY
2 Wouters P (1989), New ventilation concepts with respect to indoor air quality and energy conservation. Invited paper on Second European Conf. on Architecture Paris 5.12.89
4 Wouters P (1990), WTCB Tijdschrift 1989/2; WTCB Brussels Final Report Phase 1 (87-89) expected March 90.
Experimental study of air diffusion in a large slot ventilated building.

Fissore, Adelqui
University of Liege, Rue Ernest Solvay 21 Bat C3, 4000 Liège, BELGIUM.
TEL +32 041 52 01 80  FAX +32 041 52 54 39
TLX 41397 univg b

An experimental study in reduced scale model for ventilation inside a sheep-fold was made. The ventilating system consisted of two slots in opposite side wall and one in the roof. Omnidirectional prove TSI model 1620 has been used for measurements of mean velocity of the air (temperature was also measured), in one section of the model. Visualisation of airflow has been made by smoke tubes. Some measurements of velocity field are given like a simple semi-empirical model.

BUILDING TYPE
Agricultural, industrial

PARAMETERS
Archimedes number, flow rate for every inlet and geometry.

STARTDATE 00:10:1986
ENDATE 00:03:1990
TIME 4500 person-hours

Future investigations will be carried ou...
KEYWORDS
Indoor air quality (IAQ), tracer gas, office, ventilation system airflow, mycoflora

SELECTED BIBLIOGRAPHY (None Stated)

REF CA2
TITLE
Radon measurements and control technology.
CONTACT
Figley, D A
ADDRESS
Institute for Research in Construction, National Research Council, 110 Gymnasium Road, Saskatoon, SK N OW9.
CANADA.
TEL +1 306 975 4200 FAX +1 306 975 5956

SPECIFIC OBJECTIVES
The development of control techniques for radon entry into basements.

PROJECT DETAILS
1 Measurement of air leakage rates of below grade foundation components using a guarded pressure box technique. 2 Investigation of cost effective air sealing measures for below grade components.

BUILDING TYPE
Detached residences low-rise

PARAMETERS
Radon source strength, wind, temperature difference, neutral pressure plane, mechanically induced airflow.

STARTDATE 00:00:1988
ENDATE 00:00:1991
TIME 2000 person-hours

KEYWORDS
Radon, basements, dwellings, airflow

SELECTED BIBLIOGRAPHY

REF CA3
TITLE
Field trials to assess the validity of the moisture assessment prescriptive procedure. (MAPP).
CONTACT
Szadkowski, Frank
ADDRESS
Energy Mines and Resources Canada, 580 Booth Street, Ottawa, K1A 0E4.
CANADA.
TEL +1 613 995 9043 FAX +1 613 992-5893

SPECIFIC OBJECTIVES
To obtain additional evidence on the extent to which application of the MAPP achieved its intended purpose.

PROJECT DETAILS
The project consisted of field trials of MAPP involving observations in approximately 20 houses in each of four regions: Vancouver, Winnipeg, Toronto-Ottawa, and Halifax The MAPP is a procedure for use by the energy retrofit that can be implemented without causing significant house performance problems associated with the condensation of water vapour on interior surfaces or within wall or attic spaces; and/or to predict the nature and extent of remedial or preventative measures required to avoid such problems. The house trials involved: recording mid-winter indoor relative humidities for a maximum period of about two weeks in each of the trial houses; completion of a comprehensive questionnaire on relevant house characteristics, operation and performance; measurements of surface temperatures and observations on selected windows; observations of moisture conditions on other interior surfaces and in attics and exterior walls; measurements of house ELA; and application of both the comprehensive MAPP and the MAPP Pass procedure to each house.

BUILDING TYPE
Various single family detached houses

PARAMETERS
Direct relationship between infiltration, moisture sources and indoor relative humidities

STARTDATE 00:09:1988
ENDATE 00:09:1989
TIME (Not Stated)

KEYWORDS
Moisture, radon, pressurisation, ventilation system, ventilation rate
SELECTED BIBLIOGRAPHY
1 September 1989, Field Trials to Assess The validity of the Moisture Assessment Prescriptive Procedure.

REF CA4
TITLE
Analysis of the effects of energy retrofit work on equivalent leakage area.
CONTACT
Allerie, Joel
ADDRESS
Energy, Mines, and Resources Canada, 580 Booth Street, Ottawa, Ontario, KIA OB4, Canada.
TEL +1 613 996 8136 FAX +1 613 992-5863

SPECIFIC OBJECTIVES
Obtain Pre-and-post retrofit values of Equivalent Leakage Area and energy usage for energy retrofit work.

PROJECT DETAILS
The project had the contractor measure the ELA before and after execution of three categories of energy retrofit work: window replacement; siding installation; and insulation upgrading. The contractor also used the HOT-2000 computer program (developed by Energy, Mines and Resources, Canada) to estimate energy usage before and after retrofit work. The contractor obtained 52 complete sets of results; all homes are low-rise residential type with a variety of heating systems, exterior wall systems, etc. All homes were occupied in the course of the study. This study obtained field test data which was used to produce a case study fact sheet for every set of data as a summary sheet (certain homes were used twice because such homes had a combination of retrofit measures). The resulting information will be sent to 250 retrofit contractors in Canada. Equally, the information could be used for training courses, workshops, seminars, etc. The contractor has produced slides to this effect.

BUILDING TYPE
Residential Low-rise

PARAMETERS
Following work, contractor checked for combustion backdrafting and for moisture.

STARTDATE 00:00:1981
ENDATE Ongoing till goal reached
TIME (Not Stated)

KEYWORDS
Leakage area, retrofit, energy, heating system, dwellings

SELECTED BIBLIOGRAPHY

REF CA5
TITLE
Building codes designed for ensuring good indoor air quality.
CONTACT
Ferahian, R H
ADDRESS
Consulting Engineer, 4998 de Maisonneuve, 1416 Westmount, Quebec, H3Z 1N2, Canada.
TEL +1 514 484 5492

SPECIFIC OBJECTIVES
(Not Stated)

PROJECT DETAILS
To incorporate in codes and by-laws the most up-to-date research results not only at the design and construction stages of buildings but also for the maintenance of the building systems essential for the health and safety of the occupants to ensure good indoor air quality throughout the useful life of the building. Ongoing representations at the local municipal level (City of Westmount) provincial and federal levels together with appeals to ASHRAE and National Research Council to effect the necessary changes in codes, standards and bylaws. Details in author's papers published in Proceedings of the "Healthy Buildings '88" Conference held in Stockholm in September 1988 and AIVC's 10th annual conference, 1989 held in Espoo, Finland.

BUILDING TYPE (Not Stated)
PARAMETERS (Not Stated)

STARTDATE 00:00:1981
ENDATE Ongoing till goal reached
TIME (Not Stated)

KEYWORDS
Standards, indoor air quality (IAQ), ventilation system

SELECTED BIBLIOGRAPHY
See references in author's paper in proceedings of 10th AIVC Conference, 1989 Espoo, Finland.
REF CA6

**TITLE**
Indoor air quality and ventilation in office buildings.

**CONTACT**
Nguyen, Van Hiep & Goyer, Nicole

**ADDRESS**
505 Boul de Maisonneuve
Ouest, Montreal, Quebec, H3Z 3C2.
CANADA.

**TEL** +1 514 288-1551
**TLX** 05561348

**SPECIFIC OBJECTIVES** *(Not Stated)*

**PROJECT DETAILS**
The study has a bearing on air quality, comfort parameters and ventilation systems. Before taking measures in places of work, a questionnaire was given to the occupants in order to discover how they perceived the air quality and ventilation. The study made at about ten posts of work in each of three buildings, shows an acceptable air quality, as far as chemical contaminants established standards and criteria. In the chapter on ventilation, four types of problem have been identified: losses of fresh air per person which do not reach the ASHRAE recommendation, levels of humidity varying between 10 and 20%, draughts creating a source of discomfort, and defects in the composition of ventilation systems. The results of the study have been used by the administrators of the buildings to bring solutions to the problems identified. Recommendations have also been formulated, with a view to further studies.

**BUILDING TYPE**
3 office buildings

**PARAMETERS**
Temperature in degrees Celcius, Relative Humidity (%), Air speed, Air Changes per Hour, Questionnaires, Dust, Formaldehyde, Volatile Organic Compounds (VOC), Carbon Dioxide (CO2), Carbon Monoxide (CO) Ozone (O3), Nitrogen Oxides (NO), micro-organisms

**STARTDATE** 00:01:1987
**ENDATE** 00:11:1989
**TIME** *(Not Stated)*

**KEYWORDS**
Questionnaire, indoor air quality (IAQ), comfort, ventilation systems

**SELECTED BIBLIOGRAPHY**
3 publications and 16 reports of which the principal ones are:

REF CA7

**TITLE**
The role of moulds in sick building syndrome.

**CONTACT**
Smoragiewicz, W & Boutard, A

**ADDRESS**
505, boulevard Maisonneuve Ouest,
Montreal, Quebec, H32 3C2.
CANADA.

**TEL** +1 514 288-1551
**TLX** 05561348

**SPECIFIC OBJECTIVES**
To identify the major toxins in the moulds in ventilation systems.

**PROJECT DETAILS**
Moulds and their toxins affect the quality of air. These contaminants are not well understood in the conditions which favour their presence in ventilation systems. Samples of mould set aside earlier in the ventilation systems of public establishments will be analysed in the laboratory. The characteristics of the most toxic parts will be determined. The project will identify the principle toxins present in the moulds and the conditions favouring their development. A rapid investigatory test on the terrain will be worked out. The project will permit the development of observation methods for the mould. Also familiarity with the toxins will serve to work out preventive measures for the conception and operation of ventilation systems.

**BUILDING TYPE**
Office, Ventilation systems, Indoor Air Quality (IAQ), Mycoflora

**PARAMETERS**
Toxins and moulds

**STARTDATE** 00:01:1989
Moisture, mould, ventilation systems

SELECTED BIBLIOGRAPHY
Subventions given by Institut de recherche en santé et en sécurité du travail du Québec.

REF C48
TITLE
Microbiological decontamination of ventilation systems.
CONTACT
Lavoie, Jacques
ADDRESS
505 boul de Maisonneuve Ouest,
Montreal, Quebec, H32 3C2.
CANADA.
TEL +1 514 288-1551 TLX 05561348
SPECIFIC OBJECTIVES
To determine the efficiency of different methods of decontamination and propose a schedule for preventive maintenance.
PROJECT DETAILS
Systems of ventilation, heating, humidification and climatisation, in fulfilling their premier function which is to distribute hot or cold air throughout buildings, are also an effective means of propagating the contaminants present in ambient air. Evidently there exist several processes of decontamination or cleaning to protect the (substracts) and homes from microbial growth. The objectives of this research are therefore to determine the effectiveness of the different processes of decontamination and to establish a timetable of effective maintenance of ventilation systems.

Two establishments, from the hospital section have been chosen as study locations. Once these establishments have achieved the decontamination of the identified places according to our recommendations the decontamination will be re-evaluated, with the help of a protocol of the American Conference of Governmental Industrial Hygienists, three times during the year, at different seasons. One of the results will be the diffusion of information to identify and prevent microbial contamination.
In addition, knowledge obtained may be very useful for companies which install and manufacture ventilation systems and for those who clean them.

BUILDING TYPE
2 hospitals
PARAMETERS
Micro-organisms

SELECTED BIBLIOGRAPHY

**REF CA10**

**TITLE**
Residential soil gas sampling techniques.

**CONTACT**
Piersol, Peter

**ADDRESS**
ORTECH International (for CMHC), 2395 Speakman Drive, Mississauga, Ontario, L5K 1B3. CANADA.
TEL +1 416 6022-4111 ext. 545
FAX +1 416 823-1446

**SPECIFIC OBJECTIVES**
Development of techniques for sampling of soil gas which enters residential basements

**PROJECT DETAILS**
Sampling techniques which conveniently and accurately determine the quality and entry rate of soil gas which enters residential basements, were constructed and evaluated. Techniques were developed for sampling floor drains, dump pits, and floor and wall cracks. The techniques will be used in a large survey to characterise entry rates and constituents of soil gas.

**BUILDING TYPE**
Residential - Occupied

**PARAMETERS**
Soil type, water tables, pressure differentials, envelope leakages, foundation type, radon.

**STARTDATE 00:00:1986**
** ENDATE 00:00:1988**
**TIME (Not Stated)**

**KEYWORDS**
Soil gas, measurement, dwelling, basement, radon, occupied, air leakage

**SELECTED BIBLIOGRAPHY**


**REF CA11**

**TITLE**
Air infiltration, formaldehyde and nitrogen dioxide in new homes.

**CONTACT**
Piersol, Peter

**ADDRESS**
ORTECH International (for Yukon Home Buildings), 2395 Speakman Drive, Mississauga, Ontario, L5K 1B3. CANADA.
TEL +1 416 822-411 ext 545
FAX +1 416 823-1446

**SPECIFIC OBJECTIVES**
Measurement of air infiltration, formaldehyde and nitrogen dioxide on newly constructed homes.

**PROJECT DETAILS**
The measurements were made on approximately 75 newly constructed homes in the Yukon, for air infiltration formaldehyde and nitrogen dioxide to determine how the homes of this region were performing regarding indoor air quality.

**BUILDING TYPE**
Residential - occupied

**PARAMETERS**
Airtightness, ventilation system operation, energy consumption

**STARTDATE 00:01:1989**
** ENDATE 00:00:1989**
**TIME (Not Stated)**

**KEYWORDS**
Residential, indoor air quality (IAQ), dwelling, air infiltration

**SELECTED BIBLIOGRAPHY (None Stated)**

52
SPECIFIC OBJECTIVES
To determine the airtightness of houses built using current Canadian regional standard construction practices.

PROJECT DETAILS
Approximately 200 homes in the various regions of Canada were tested for airtightness, neutral pressure location, ventilation systems, fireplaces, heating systems, indoor air quality, air infiltration and builders' comments on airtightness. The results will be used to determine typical air change rates over a typical heating season.

BUILDING TYPE
Residential - occupied.

PARAMETERS
Airtightness, exhaust systems, fireplaces, heating systems, builders' comments on construction practice

STARTDATE 00:00:1987
ENDATE 00:00:1989

KEYWORDS
Airtightness, construction practices, air quality, ventilation systems.

SELECTED BIBLIOGRAPHY

REF CA14
TITLE
Wind-induced internal pressures in buildings.

CONTACT
Stathopoulos, T

ADDRESS
Centre for Building Studies, Concordia University, 1455 De Maisonneuve Blvd West, Montreal, H3G 1MB, CANADA.

TEL +1 514 848-3286 FAX +1 514 848-3198

SPECIFIC OBJECTIVES
Evaluation of wind-induced internal pressures in buildings for different geometries and permeabilities.

PROJECT DETAILS
The project aims at the evaluation of wind-induced internal pressures and the infiltration rates for buildings of different geometries and permeabilities both analytically and experimentally. The experimental work is carried out in the boundary layer wind tunnel of the Centre for Building Studies and will be carried out also in full-scale. The work will target on the deterioration of both mean and fluctuating internal pressures.

BUILDING TYPE
Residential and Industrial

PARAMETERS
Exposure, wind speed and direction, building geometry and permeability.

STARTDATE 00:00:1986
ENDATE 00:00:1992

KEYWORDS
Mould, heat recovery, residential, dwellings, mycoflora.
Internal pressure, wind tunnel, air infiltration, dwelling, industrial

SELECTED BIBLIOGRAPHY

REF CA15
TITLE
Influence of volatile organic compounds and other environmental variables on health status of workers in office buildings.
CONTACT
Broder, I
ADDRESS
University of Toronto,
The GAGE Research Institute,
223 College Street, Toronto, M5T 1R4.
CANADA.
TEL 416-978-5884
SPECIFIC OBJECTIVES
To examine the influence of volatile organic compounds and other environmental variables on the comfort and health of office workers.
PROJECT DETAILS
Indoor air quality (IAQ) and employee comfort and health will be assessed on groups of workers located in the immediate vicinity of either liquid process or dry process photocopiers. The IAQ variables to be measured will include temperature, humidity, carbon monoxide (CO), carbon dioxide (CO₂), particulates, ozone, fungal spores, formaldehyde, volatile organic compounds, air movement and fresh air supply. Employee comfort and health will be assessed using a questionnaire, a symptom diary, nasal epithelial cytology, nasal ciliary activity and a test of mental concentration and short term memory.
BUILDING TYPE
Office buildings
PARAMETERS
(See Project Details)
STARTDATE 01:09:1989
ENDATE 31:08:1991
TIME 7 person-years
KEYWORDS
Volatile organic compounds (VOCs), health, photocopiers, occupants, indoor air quality (IAQ), questionnaire

SELECTED BIBLIOGRAPHY

REF CA16
TITLE
Environmental and health variables of employees before and after non-smoking programme in office buildings.
CONTACT
Broder, I
ADDRESS
University of Toronto,
The Gage Research Institute,
223 College Street,
Toronto, M5T 1R4.
CANADA.
TEL +1 416 978 5884
SPECIFIC OBJECTIVES
To examine the influence of environmental tobacco smoke on employee comfort and health, and on IAQ.
PROJECT DETAILS
IAQ and employee comfort and health is being assessed immediately before, and one year following the introduction of a smoking cessation program in 3 modern office buildings. The IAQ variables being measured include temperature, humidity, particulates, CO, CO₂, and volatile organic compounds. Employee comfort and health is being assessed through the use of a questionnaire and a symptom diary maintained over 7 consecutive days while at work and over one weekend. Exposure to tobacco smoke will be determined by measurement of salivary nicotine.
BUILDING TYPE
Office buildings (Commercial)
PARAMETERS
IAQ variables (Temperature, Humidity, Particulates, CO, CO₂, and volatile organics.

STARTDATE 01:03:1989
ENDATE 31:03:1991 TIME 4 person-years

KEYWORDS
Indoor air quality (IAQ), tobacco smoke, health, office

SELECTED BIBLIOGRAPHY
1 Broder, et. al. Comparison of health of occupants and characteristics of houses among control homes and homes insulated with Urea Formaldehyde Foam (UFFI).

REF CA17
TITLE
Infiltration measurements and modelling at the alberta home heating research facility.

CONTACT
Wilson, David J

ADDRESS

TEL +1 403-4922200 FAX +1 403-4922200

SPECIFIC OBJECTIVES
To determine the effects of windshelter, leakage distribution, mechanical ventilation, and infiltration.

PROJECT DETAILS
Development of predictive models using continuous measurements of air infiltration in six single zone test-houses using SF6 constant concentration. Automated fan pressurisation/depressurisation to characterise leakage of unoccupied building. Passive vent ducts exhaust and supply fans, window opening using computer controlled actuators. Houses in closely spaced rows on rural exposed site provide large variation in wind shelter. Local meteorological towers for wind, temperature and turbulence.

BUILDING TYPE
5 wood frame, 1 brick, single storey (Residences).

PARAMETERS
Wind speed, direction, variability, temperature difference, leakage distribution and vents, shelter, fan ventilation.

STARTDATE 00:00:1980
ENDATE 00:00:1990
TIME 10 to 20 person-years on infiltration

KEYWORDS
Air infiltration, mechanical ventilation, openings, modelling pressurisation, tracer gas

SELECTED BIBLIOGRAPHY

REF CA18
TITLE
The influence of type of heating systems on indoor environment.

CONTACT
Haghighat Fariborz

ADDRESS
Centre for Building Studies, Concordia University, 1455 de Maisonneuve Blvd. West, Montreal, Quebec, H3G 1M8.

TEL +1 514 848-3192 FAX +1 514 848-3198

SPECIFIC OBJECTIVES
To study the thermal comfort in a room under different heating systems.

PROJECT DETAILS
The purpose of this research project is to investigate experimentally the relationship between types of heating systems and the thermal environment, and the effects on human comfort. The measurements were carried out in a three storey building. To determine air
temperature distribution in the room, shielded thermocouples are used to measure room air temperature at five levels above the floor, and at nine locations. The mean radiant temperature is measured using a two-sphere radiometer. The velocity of the air at these locations is measured by the automated flow analysis system. The single tracer gas technique is used to measure the air exchange rate. Predicted Mean Vote and Predicted Percentage Dissatisfied were also measured.

**BUILDING TYPE**
3 storey building

**PARAMETERS**
Outside and inside temperatures, air velocity, relative humidity.

**STARTDATE** 00:05:1987

**ENDATE** 00:05:1991

**TIME** (Not Stated)

**KEYWORDS**
Thermal comfort, heating systems, indoor climate, tracer gas, air movement

**SELECTED BIBLIOGRAPHY**

**REF CA19**

**TITLE**
Development of a model for prediction of air quality in multi-zone buildings.

**CONTACT**
Haghighat, Fariborz

**ADDRESS**
Centre for Building Research, Concordia University, 1455 de Maisonneuve Blvd. West, Montreal, Quebec, H3G 1M8, CANADA.

**TEL** +1 514 848-3192 **FAX** +1 514 848-3198

**SPECIFIC OBJECTIVES**
To develop a predictive stochastic model to predict the indoor air aerosols, and chemically reactive pollutant.

**PROJECT DETAILS**
The work includes computer simulation, as well as field measurement. The study concentrates on modelling of the chemical transformation of aerosols and chemically reactive pollutants. The results of a probabilistic approach of analysing a building's thermal and indoor air quality, have also eliminated any existing doubt about practicality and benefits of pursuing a complex approach of analysis. The detailed steps involved in the study can be listed as: 1) An extensive literature survey on chemical kinetic characteristics of pollutants and their mathematical modelling, 2) The incorporation of kinetic modelling into the existing air quality model, and 3) Field testing.

**BUILDING TYPE**
A three-storey building

**PARAMETERS**
Pollutant concentration

**STARTDATE** 00:05:1989

**ENDATE** 00:05:1991

**TIME** (Not Stated)

**KEYWORDS**
Indoor air quality (IAQ), multizone, computer simulation

**SELECTED BIBLIOGRAPHY**

**REF CA20**

**TITLE**
Intra and interzonal heat and mass transfer in buildings.

**CONTACT**
Haghighat, Fariborz

**ADDRESS**
Centre for Building Studies, Concordia University, 1455 de Maisonneuve Blvd. West, Montreal, Quebec, H3G 1M8, CANADA.

**TEL** +1 514 848-3192 **FAX** +1 514 848-3198

**SPECIFIC OBJECTIVES**
To study the pattern of airflow in a two-zone enclosure and to develop correlations for the
airflow rate between zones under natural and forced ventilation.  

**PROJECT DETAILS**  
A comprehensive model for the airflow in a two-zone enclosure has been developed using the k-epsilon two equation turbulence model to predict the flows through a large opening between two zones, and to study the effects of the size and location of the doorway. The results of a study for natural convection and airflow pattern in a partitioned room with turbulent flow indicated that the flow pattern is quite sensitive to the variations of door height and location, while the convective heat transfer rate is only sensible to variation of door height. Further study of the airflow pattern and the contaminant dispersion in ventilated two-zone enclosure showed that the location of the door not only guides the direction of the air movement, but also affects the strength of the air circulation in the downstream zone, while the upstream zone is less affected by the door position. The result from the validation of the model tend to support the trend identified by other workers. Namely the agreement between the computed Nusselt number and that obtained from experimental measurements, is very good.  

**BUILDING TYPE**  
Two-zone enclosure.  

**PARAMETERS**  
Correlations describing the inter-zone heat and mass convection.  

STARTDATE 00:05:1988  
ENDATE 00:05:1991  
TIME (Not Stated)  

**KEYWORDS**  
K-epsilon turbulence model, interzonal air movement, airflow  

**SELECTED BIBLIOGRAPHY**  
2 F Haghighat et. al. (1990), Three dimensional analysis of airflow patterns and contaminant dispersion in two-zone enclosure, accepted for ASHRAE Winter meeting, 1990.  

**REF CA21**  
**TITLE**  
Study of cladding on public buildings.  
**CONTACT**  
Quirouette, R L  

**ADDRESS**  
Morrison Hershfield Ltd.,  
1980 Merivale Road,  
CANADA.  
TEL +1 613 727-9802  
FAX +1 613 727-8165  

**SPECIFIC OBJECTIVES**  
(Not Stated)  

**PROJECT DETAILS**  
The study of claddings on public buildings is a project involving the investigation, examination, documentation, and analysis of the building envelope performance of various building envelope types (31 buildings) in various geographical locations across Canada. The study focuses on four areas of building envelope concern; structural performance, air and moisture control, rain and melt water penetration and thermal performance. Each of the above areas can be further sub-divided into various sub-categories; corrosion, freeze/thaw action, moisture degradation of materials, loss of heating and/or cooling energy through air leakage and/or poor insulation quality. Study is divided into two parts: The first part deals with a field survey to determine the present condition of all of the buildings involved. The second part involves continuous monitoring of differential air pressures, relative humidities, and temperatures across the building envelope of those buildings in Halifax, Toronto, and Winnipeg over a one year period. This performance data will be related to Canadian environmental weather data.  

**BUILDING TYPE**  
Institutional/Government (public) buildings.  

**PARAMETERS**  
Performance of building envelope/weather.  

STARTDATE 00:05:1989  
ENDATE 00:03:1990  
TIME 2000 person-hours  

**KEYWORDS**  
Public buildings, building envelope, facade, pressure differences  

**SELECTED BIBLIOGRAPHY**  
(Not Stated)  

**REF CA22**  
**TITLE**  
Performance of rainscreen walls.  
**CONTACT**  
Quirouette, R L  
**ADDRESS**
SPECIFIC OBJECTIVES
(Not Stated)

PROJECT DETAILS
Laboratory study of wood frame rainscreen wall systems under static and dynamic pressure loads and water penetration tests. Six types of residential wall construction were tested in an environmental test chamber, under static and dynamic pressure to obtain the pressure distribution across the walls with varying degrees of airtightness. The results of these tests are being compared as a design tool for rainscreen walls. Tests are also being conducted on these walls to evaluate the rain water penetration control performance of the walls with varying degrees of airtightness. The final phase of this study deals with the effect of compartmentalisation on rainscreen wall performance. A half scale test cube designed to have varying airtightness and compartmentalisation, is to be placed in a free air stream with differential air pressures, monitored throughout the wall sections.

BUILDING TYPE
Residential wood frame construction.

PARAMETERS
water penetration control and wind induced air pressure loads on wall components.

STARTDATE 00:11:1988
ENDEATE 00:10:1989
TIME 400 person-hours

KEYWORDS
Rainscreen walls, facade, airtightness, pressure distribution, computer simulation

SELECTED BIBLIOGRAPHY (Not Stated)
SPECIFIC OBJECTIVES
To identify indoor environment parameters, which when amplified, will facilitate the spreading of infectious disease.

PROJECT DETAILS
A purposive sampling of 6 day nurseries have been selected for the study. Different parameters (Temperature (°C); RH (%); CO₂; suspended particulates; Noise; moulds; bacteria) were measured in these natural ventilated buildings. Many other informations were collected (volume; surface; occupation density; methods of cleaning; type of heating system; etc.).

BUILDING TYPE
Day nursery

PARAMETERS
T°C; RH%; CO₂; suspended particulates; noise; moulds; bacteria

STARTDATE 00:03:1989
ENDATE 00:08:1989
TIME 300 person-hours

KEYWORDS
Indoor air quality (IAQ), mycoflora, day nurseries

SELECTED BIBLIOGRAPHY (Not Stated)

REF CA25
TITLE
Integrated heater/ventilator unit (IHVA).

CONTACT
Tremayne, Michael

ADDRESS
Consumers Gas Company Ltd.,
P O Box 650,
Scarborough, Ontario, M1K 5E3.

CANADA.

TEL +1 416 495 5989 FAX +1 416 495 5230

SPECIFIC OBJECTIVES
To determine the performance and reliability of the IHVA under field conditions.

PROJECT DETAILS
The Canadian Gas Research Institute of Toronto, developed a combination furnace/A-A-H-E. This unit uses beds of stone as recuperative heat exchangers. This principle provides for a very high overall efficiency of 86%. The unit burns natural gas and has an output of 40,000 Btu/hr. The ventilation rate is 0.5 ach. By combining the furnace and AAHE, a homeowner can achieve high ventilation levels and very high combustion efficiencies. An equivalent system condensing gas furnace and conventional plate AAHE would have a lower overall system efficiency. Two IHVA units were evaluated in residences in the Toronto area.

BUILDING TYPE
Furnace/Air-Air Heat Exchanger

PARAMETERS
Air flow rates were measured. IAQ measurements were not taken.

STARTDATE 00:11:1987
ENDATE 00:03:1989
TIME 1000 person-hours

KEYWORDS
Ventilation system, combustion, airflow

SELECTED BIBLIOGRAPHY

REF CA26
TITLE
Flair homes energy demo.

CONTACT
Proskiw, G

ADDRESS
1666 Dublin Avenue,
Winnipeg, Manitoba, R3H 0H1.

CANADA.

TEL +1 204 633-6363 FAX +1 204 632.1442

SPECIFIC OBJECTIVES
To document the ventilation and Air Quality characteristics of 24 energy-efficient homes.

PROJECT DETAILS
Measurement of air infiltration, indoor levels of formaldehyde, radon, nitrogen dioxide, CO, CO₂, airborne micro-organisms, temperature and humidity in 20 homes which utilize various building techniques and heating/ventilation systems. Monthly seasonal and annual monitoring.

BUILDING TYPE
Residential

PARAMETERS
Energy consumption, occupant lifestyles, construction techniques, heating/ventilation systems.

STARTDATE 00:00:1985
ENDATE 00:00:1991
TIME (None Stated)

KEYWORDS
Residential, dwelling, indoor air quality (IAQ), air leakage, energy consumption

SELECTED BIBLIOGRAPHY

Released:
1 Proskiw G (1988), Incremental costs of energy conservation systems, EMR.
5 Proskiw G (1988), Interim Report on indoor air quality monitoring of the Flair Homes Energy Demo/CHBA Flair Mark XIV Project. EMR.

Future: Observed field performance of various building envelope systems
Energy performance of 20 energy efficient houses.
Window Air Leakage
Ventilation System Performance
Airtightness of twenty detached houses over a three year period
Final report on Indoor Air Quality monitoring of the Flair Homes Energy Demo/CHBA Flair Mark XIV Project.

All reports are available from Energy, Mines and Resources Canada,
Contact: Program Delivery & Marketing Div, Energy, Mines and Resources Canada, 580 Booth St, Ottawa, Ontario, K1A OE4

SPECIFIC OBJECTIVES

To measure CO₂ Concentrations, air change rates, and thermal comfort conditions in several large office buildings to obtain the data required to verify a theoretical relationship between CO₂ Concentration and Air Change rate. To examine the use of CO₂ concentration as a measurable index of indoor air quality. To examine the use of CO₂ concentration as an index for controlling the ventilation rate. To develop a procedure to assess air change rate and indoor air quality in large office buildings based on CO₂ measurements.

PROJECT DETAILS
(See Specific Objectives)

BUILDING TYPE
Office Buildings

PARAMETERS
CO₂, Degree of Thermal Comfort

STARTDATE 01:04:1990
ENDATE 01:10:1991
TIME 5 person-years

KEYWORDS
Indoor air quality (IAQ), ventilation, carbon dioxide (CO₂), measurements, demand control ventilation (DCV), air change rate.

SELECTED BIBLIOGRAPHY

REF CA28
TITLE
Ventilation effectiveness for typical work stations.

CONTACT
Shaw, C Y & Said, M N

ADDRESS
Institute for Research in Construction, National Research Council Canada, Bldg M-24, Montreal Road, Ottawa, K1A OR6. CANADA.

TEL +1 613 993 9702 FAX +1 613 953 3733

SPECIFIC OBJECTIVES

To examine the influence of various factors such as locations of supply air registers and return air grilles, and office partitions on the ventilation effectiveness of typical work stations. To develop a procedure for measuring ventilation effectiveness at a work station. It is proposed to
conduct modelling and laboratory experiments on a mock-up work station with various typical ventilation supply and return configurations. Work will be expanded to two work stations.

**PROJECT DETAILS**  
*(See Specific Objectives)*

**BUILDING TYPE**  
Office Buildings

**PARAMETERS**  
Ventilation Effectiveness, CO₂  
**STARTDATE**: 01:04:1990  
**ENDATE**: 01:10:1991  
**TIME**: 2 person-years

**KEYWORDS**  
Room modelling; ventilation effectiveness, indoor air quality (IAQ), office

**SELECTED BIBLIOGRAPHY** *(None Stated)*


**REF C430**

**TITLE**  
Testing of indoor radon resolution techniques in central ohio houses.

**CONTACT**  
Scott, A G

**ADDRESS**  
American ATCON/Arthur Scott Associates, 2020 South Millway, Mississauga, Ontario, L5L IK2. CANADA.

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**FAX** +1 416 828 2389  
**EMAIL** compnserve 76266,1115

**SPECIFIC OBJECTIVES**  
Verify performance of sub slab ventilation in basement houses and crawl space ventilation.

**PROJECT DETAILS**  
Experimental systems installed in 20 occupied houses, systems monitored, and modified.

**BUILDING TYPE**  
Crawl space, slab on grade basement

**PARAMETERS**  
Radon, Ventilation and Internal Air Temperatures, Flows in crawl space houses (PFT's).

**STARTDATE**: 00:05:1987  
**ENDATE**: 00:05:1990  
**TIME**: 6000 person-hours

**KEYWORDS**  
Radon, sub-slab ventilation, basements, dwellings, occupied (residence)

**SELECTED BIBLIOGRAPHY**  
REF DK1

TITLE
The airflow from different air terminal devices.

CONTACT
Nielsen, Peter V

ADDRESS
University of Aalborg,
Institute of Building Technology and Structural Engineering,
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DK - 9000 Aalborg.
DENMARK.

TEL +45 98142333  FAX +45 98148243

SPECIFIC OBJECTIVES
To describe the flow from air terminal devices by free jets or wall jets.

PROJECT DETAILS
The flow from different air terminal devices will often take the form of a free jet or a wall jet with the characteristic universal profiles for this type of flow. Experiments are made in a large room, and the coefficient of the jets the turbulence level (Reynold’s number dependence) and the penetration depth of the flow are measured. This piece of information is important for the simplified room air distribution models, ref (4) and the description of the jets is useful as boundary values in airflow simulation programs.

BUILDING TYPE
Air terminal devices giving plane, 3-dimensional or radial wall jets.

PARAMETERS
(Not Stated)

STARTDATE 00:00:1985
ENDATE ongoing  TIME (Not Stated)

KEYWORDS
Air outlets, jets, airflow, turbulence

SELECTED BIBLIOGRAPHY

REF DK2

TITLE
Airflow simulation in ventilated rooms.

CONTACT
Nielsen, Peter V

ADDRESS
University of Aalborg,
Institute of Building Technology and Structural Engineering,
Sohngardsholmsvej 57,
DK - 9000 Aalborg.
DENMARK.

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SPECIFIC OBJECTIVES.
IEA Annex 20 project in co-operation with a number of countries.

PROJECT DETAILS
IEA Annex 20 Project: Airflow patterns within buildings, Subtask A: Room air and contaminant flow. To carry out a survey of existing programmes, data requirements and test cases. To establish an experimental database on room air and contaminant flow. To make airflow simulation with various programmes. The Contributions of Denmark will especially be full-scale isothermal measurements and numerical study of boundary conditions at supply opening and low-turbulent effect in the room airflow, as well as a general work with airflow simulation programmes.

BUILDING TYPE
(Not Stated)

PARAMETERS
(Not Stated)

STARTDATE 00:00:1988
ENDATE 00:00:1991
TIME 2000 person-hours per year

KEYWORDS
Airflow simulation, numerical method, air distribution, database, contaminant flow

SELECTED BIBLIOGRAPHY

Selected Bibliography


REF DK4

Title
An algorithm to determine the vertical temperature gradient in heated and ventilated rooms.

Contact
Overby, Heine & Thode, Mogens Steen-

Address
University of Aalborg,
Institute of Building Technology and Structural Engineering,
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DK - 9000 Aalborg.
DENMARK.

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Specific Objectives
(Not Stated)

Project Details
This project is an experimental examination of the vertical temperature gradient in a laboratory test room. Based on the laboratory measurements a simple model is developed to determine the vertical temperature gradient in a heated room with different kinds of ventilation. The model is assumed to calculate two different air temperatures in the room, the mean temperature in the occupied zone and the mean temperature in the zone above the occupied zone. The model will be implemented in SUNCODE-PC, a thermal analysis program for residential and small commercial buildings. Finally, the improvement of the program is validated, and the simulated results are compared with the laboratory measurements.

Building Type
Heavy and light laboratory test room.
PARAMETERS  
(Not Stated)
STARTDATE  01:09:1988
ENDATE  31:01:1991  TIME  3500
person-hours
KEYWORDS
Temperature gradient, simulation, dwelling, ventilation
SELECTED BIBLIOGRAPHY  
(Not Stated)

REF DK5
TITLE
Contaminant distribution in heated and ventilated rooms.
CONTACT
Heiselberg, Per
ADDRESS
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Institute of Building Technology and Structural Engineering,  
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SPECIFIC OBJECTIVES
To investigate the contaminant distribution in ventilated rooms under different air supply heat load and contaminant source conditions.

PROJECT DETAILS
The investigations are taking place in full-scale test rooms of sizes from 35 m$^3$ to 250 m$^3$ with ventilation after both mixing and displacement principle. The contaminant distribution in the room and the ventilation efficiencies are found for several different air terminal devices at supply flow rates varying from 35 m$^3$/h to 1500 m$^3$/h under both thermal and isothermal conditions.

BUILDING TYPE
Full-scale test room.

PARAMETERS  
(Not Stated)
STARTDATE  (Not Stated)
ENDATE  (Not Stated)  TIME  (Not Stated)
KEYWORDS
Contaminant flow, Ventilation efficiency, Mechanical ventilation, Air outlets, Test room

SELECTED BIBLIOGRAPHY

REF DK6
TITLE
Application of perfluorcarbon tracer gas technique for measuring air changes in homes.
CONTACT
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SPECIFIC OBJECTIVES  
(Not Stated)

PROJECT DETAILS
In order to achieve more knowledge of outdoor air changes in occupied Danish homes, SBI (The Danish Building Research Institute) intends to make measurements in several hundred residential buildings. To do so it is necessary to use a technique which is inexpensive, not time consuming, and yet applicable in almost any house and cause least disturbance to the inhabitants. The Tracer Technology Centre of BNL (Brookhaven National Laboratory) has developed a method which seems to fulfils these demands, using tracer gases of perfluorocarbons in a passive sampling technique. In the pilot study the Indoor Climate Division of SBI will compare this method with other more expensive techniques, making measurements in about 10 different buildings. The objectives of the study are to: 1) gain experience on the variations of the air changes and the internal airflows of occupied homes, 2) to develop procedures for distribution of sources and samplers to the homes, 3) to elaborate instructions to households on how to handle and how to deploy the tubes in the homes, and 4) to gain experience on the practical aspects of the interchanging of equipment and results between BNL and SBI.
BUILDING TYPE
Residential (Occupied)
PARAMETERS
(Not Stated)
STARTDATE 00:05:1986
ENDATE 00:12:1987
TIME 12 person-months
KEYWORDS
Tracer gas, air change rate, perfluorocarbons (PFT), airflow
SELECTED BIBLIOGRAPHY (None Stated)

REF DK7
TITLE
Natural ventilation with heat recovery.
CONTACT
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DTH, Thermal Insulation Laboratory, Building 118, DK-2800 Lyngby, DENMARK.
TEL +45-42883511 FAX +45-42931755
SPECIFIC OBJECTIVES
(Not Stated)
BUILDING TYPE
In buildings with very airtight envelopes, balanced ventilation in mechanical systems with heat recovery (plate type heat exchangers or heat pumps) is very energy efficient and thus preferable. In less airtight buildings balanced ventilation may not be optimal, or mechanical systems may not be wanted for some reasons. So far, the only alternative has been natural ventilation (with or without "help" from fans) without any heat recovery - and extremely dependent on the weather conditions. It is the aim of this project to utilize the stack effect in exhaust air systems (without fans) combined with a certain heat recovery (expected efficiency 20-40%) and fresh air intake that do not cause draft sensation for the occupants. The systems will be examined in the low-energy experimental house at the laboratory.
BUILDING TYPE
Test house (Low Energy)
PARAMETERS
(Not Stated)
STARTDATE 00:02:1989
ENDATE 00:09:1990
TIME (Not Stated)
KEYWORDS
Airtightness, natural ventilation, test house, heat recovery, mechanical ventilation, stack effect, low energy
SELECTED BIBLIOGRAPHY (None Stated)

REF DK8
TITLE
Determination of OLF values for materials in buildings.
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SPECIFIC OBJECTIVES
(Not Stated)
PROJECT DETAILS
The ventilation requirements in buildings are determined by the pollution sources indoors. By using the new unit "olf" the strength of the pollution sources can be quantified. The purpose of the present research project is to measure olf-values for materials used indoors. Architects and building constructors can then use the obtained results and select low-olf materials which will reduce the ventilation requirements, and the energy consumption.
BUILDING TYPE
(Not Stated)
PARAMETERS
Olf
STARTDATE 00:06:1988
ENDATE 00:12:1988
TIME (Not Stated)
KEYWORDS
Odour, energy consumption, pollution sources, building materials
SELECTED BIBLIOGRAPHY

REF DK9
TITLE
Pilot study of ventilation requirements under transient conditions.
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SPECIFIC OBJECTIVES
(Not Stated)

PROJECT DETAILS
Body odour is a major pollutant in many spaces in practice. Whereas other indoor pollutants can often be regulated by use of source control, ventilation is necessary to keep body odour at an acceptable level. Previous studies have identified the ventilation required to satisfy the majority of persons entering an occupied room after being in fresh air for some time. Due to adaptation to body odour, the ventilation required to satisfy the occupants in the same room is much lower. The aim of this pilot study is to investigate the transient conditions often found in practice where people move from one room to another with different odour intensity. The study will be performed in two newly constructed environmental chambers at the Laboratory of Heating and Air Condition. The results of this study will give directions for developing a transient model for ventilation requirements.

BUILDING TYPE
Environmental chambers

PARAMETERS
Body odour
STARTDATE 00:05:1986
ENDATE 00:12:1986
TIME 12 person-months

KEYWORDS
Body odour, pollution sources, test chamber, model

SELECTED BIBLIOGRAPHY (None Stated)

REF DK10
TITLE
Demand controlled ventilation, a study of the scientific foundation.

CONTACT
Fanger, P O
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SPECIFIC OBJECTIVES
(Not Stated)

PROJECT DETAILS
The objectives of this project, are to study especially those characteristics of airborne radon daughters which have a direct or indirect influence on the radiological effectiveness of
remedial air cleaning techniques, such as filtration and electrostatic deposition. In rooms (laboratory and office rooms) with elevated radon levels, a series of particle-removing air cleaning methods are being employed. These methods include the use of mechanical and electro filters, electric field deposition, both with non-ionizing electrodes and with simultaneous ion production and resulting space charge modifications of the fields. The effects of the methods are evaluated by measurements of radon concentration, concentrations and unattached fractions of individual radon daughters, aerosol concentration and other air-characterizing parameters. Preliminary results indicate that it is possible to lower the potential alpha energy concentration by a factor of 5-10 and the radiological dose with 50% by use of filtration systems as well as ionization devices.

**BUILDING TYPE**
Laboratories, Office blocks

**PARAMETERS**
Radon, Mechanical Ventilation System, Aerosols

**START DATE** 00:07:1985
**END DATE** 00:12:1989
**TIME** 24 person-months

**KEYWORDS**
Radon daughters, air cleaning devices

**SELECTED BIBLIOGRAPHY**
(None Stated)

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To study organics and particles in indoor air with relation to heating systems.

**PROJECT DETAILS**
(None Stated)

**BUILDING TYPE**
Single family houses, offices

**PARAMETERS**
(None Stated)

**START DATE** 00:00:1989
**END DATE** (Not Stated) **TIME** (Not Stated)

**KEYWORDS**
Heating systems, organics, particles, indoor air quality (IAQ), dwelling

**SELECTED BIBLIOGRAPHY**
(None Stated)
ENDATE 31:03:1992
TIME 4000 person-hours

KEYWORDS
Residential, dwelling, heating system, ventilation system, indoor climate, energy consumption, simulation, noise, duct

SELECTED BIBLIOGRAPHY

REF SF3

TITLE
Spatiotemporally controlled air distribution system.

CONTACT
Laine, Juhani

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SPECIFIC OBJECTIVES
(None Stated)

PROJECT DETAILS
The aim is to develop design principles for a demand controlled air duct system. Special consideration is given to the flow and noise technique of airflows, pre-adjustment and the stability of the airflows and the performance values of the system's basic devices. The functional capacity and the design principles of a spatiotemporally controlled ventilation system are solved with advanced simulation programs, capable of an overall examination of the air ducts. The correctness of the calculation results is studied experimentally and the bases and examination methodology of the pre-adjustability of the airflows are clarified.

BUILDING TYPE
Air ductwork, airflow controllers

PARAMETERS
Airflows, sound levels, pressures, tightness, thermal forces, duct noise "breakout", pre-adjustability

STARTDATE 01:04:1987
ENDATE 30:10:1989
TIME 2700 person-hours

KEYWORDS
Duct, noise, demand controlled ventilation (DCV), airflow, simulation airtightness

SELECTED BIBLIOGRAPHY

REF SF4

TITLE
A ventilation concept for future dwelling-houses.

CONTACT
Luoma, Marianna

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SPECIFIC OBJECTIVES
To develop ventilation systems for residences.

PROJECT DETAILS
Ventilation systems, suitable for residential buildings in the future, will be analysed in the study. The systems considered should realize the new target levels of indoor air climate while meeting the real ventilation needs of the people. The effect of other disturbances, (such as changes in weather conditions), on ventilation rates and pressure levels in buildings should be eliminated. In addition, the energy economy of different systems will be considered. The
analyses of different systems will be carried out with computer simulations. The target values for ventilation system components as well as the suitability of the present components and the need for product development will be defined. Demand for the internal and external air-tightness of buildings will be presented, and the operation as well as the maintenance costs of different systems will be evaluated.

BUILDING TYPE
Residences

PARAMETERS
CO₂-level
STARTDATE 01:04:1987
ENDATE 31:12:1990
TIME 7000 person-hours

KEYWORDS
Residential, dwelling, demand controlled ventilation (DCV), energy consumption, occupants, simulation

SELECTED BIBLIOGRAPHY
2 Final report will be published at the end of 1990 (in Finnish).

REF SF5
TITLE
The influence of thermal indoor climate on working efficiency in an office building.

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SPECIFIC OBJECTIVES
To study with a computer model, how thermal indoor climate influences working efficiency.

PROJECT DETAILS
The thermal indoor climate and its influence on working efficiency in an office building was compared for three ventilation systems: constant airflow, variable airflow and mechanical cooling. The energy analysis model used was a Finnish heat balance model, which gives hourly the indoor air and surface temperatures. The relationship between working efficiency and indoor temperature was estimated using two literature sources, which are based on laboratory measurements. The results show, that the pay-back time for cooling even in Finnish climate will be only about 1 year, when the increase of working efficiency is accounted.

BUILDING TYPE
Office building

PARAMETERS
Indoor air and surface temperatures
STARTDATE 01:09:1987
ENDATE 31:05:1989
TIME 1000 person-hours

KEYWORDS
Thermal comfort, ventilation systems, computer simulation, indoor air quality (IAQ)

SELECTED BIBLIOGRAPHY

REF SF6
ENDATE 31:12:1989
TIME 1000 person-hours

KEYWORDS
Thermal simulation, commercial, industrial, dwelling, infiltration, ventilation system, Ducts

SELECTED BIBLIOGRAPHY (None Stated)

REF SF7
TITLE
Calculation of contaminant transport in dwellings.
CONTACT
Siren, Kai
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SPECIFIC OBJECTIVES
To develop a method for calculating the transport of contaminants in dwellings.

PROJECT DETAILS
A simple method to calculate the airflows between adjacent rooms has been modified and validated using tracer gas experiments in a test house. This calculation method has been combined with the multi-zone method to calculate contaminant transport between adjacent rooms. The whole method has been realised in a computer code MULTIC. The MULTIC code has been validated using tracer gas measurements.

BUILDING TYPE
Residences

PARAMETERS
Room air temperatures, infiltration airflows, concentration histories of contaminants.

STARTDATE 01:05:1987
ENDATE (Not Stated)
TIME 10000 person-hours

KEYWORDS
Commercial, recirculation, health, questionnaire, office, energy consumption, sick building syndrome (SBS)

SELECTED BIBLIOGRAPHY
Paper to Indoor Air 1990 (Toronto) Summary report of the results in national publication series (in Finnish)

REF SF9
TITLE
The measurement of air exchange rate and internal airflows in buildings.
CONTACT
Sateri, Jorma

**REF SF10**

**TITLE**
The performance of ventilation in residential buildings.

**CONTACT**
Ruotsalainen, Risto

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Helsinki University of Technology, HVAC-laboratory, Otakaari 4, SF-02150 ESPOO, FINLAND.

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**SPECIFIC OBJECTIVES**
The aim of the project is to study the effect of the ventilation on health and comfort in Finnish Residences.

**PROJECT DETAILS**
Over 300 residential buildings have been selected for the study in which information on the performance of ventilation systems has been collected. Both detached or semi-detached houses and blocks of flats are included in the study. The studied ventilation systems are natural ventilation, mechanical exhaust and balanced ventilation. The measurements have covered the ventilation rates of the whole apartment and the bedroom and indoor climate. A questionnaire on health, comfort and satisfaction has been carried out with the measurements. The results of the measurements and the questionnaire are analysed to find out the correlations between; both the ventilation rate and various ventilation systems; and the symptoms and the satisfaction of the people living in the residences.

**BUILDING TYPE**
Residences, (flats, apartments, houses)

**PARAMETERS**
Health, comfort, satisfaction.

**STARTDATE** 00:03:1986
**ENDATE** 00:12:1989
**TIME** 10 person-years

**KEYWORDS**
Ventilation, indoor climate, health, comfort, dwellings, indoor air quality (IAQ)

**SELECTED BIBLIOGRAPHY**

REF SF11
TITLE
Air flow patterns within buildings.
(Finnish participation in IEA Annex 20)
CONTACT
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SPECIFIC OBJECTIVES
To evaluate the performance of room air and contaminant flow simulation techniques.
PROJECT DETAILS
The project is Finnish participation in an international research project "IEA Annex 20, Air Flow Patterns within Buildings, subtask 1 - Room air and contaminant flow". The work has been divided into research items for each 11 participating countries. The final report will be based on reports of individual research items. The results can be used in ventilation design to ensure that fresh air supply and pollutant removal requirements are effectively obtained without undue use of energy resources.
BUILDING TYPE
Office room
PARAMETERS
Air flow rates, cooling/heating
STARTDATE 01:05:1988
ENDATE 30:12:1991
TIME 5000 person-hours
KEYWORDS
Room, airflow, simulation, turbulent flow, contaminant flow, office, commercial, pollution sources
SELECTED BIBLIOGRAPHY (None Stated)
SPECIFIC OBJECTIVES.
PCB-Decontamination of indoor air and office equipment.

PROJECT DETAILS
PCB leaking out of damaged capacitors of lamp-fittings in light appliances and vapors in the indoor air or precipitates office equipment by penetrating in their surfaces. The research purpose is: - to find out the noxious limit of indoor air by PCB-contamination for general places to work in office buildings, - to find out the necessities of decontamination at the office equipment to prevent PCB-contamination to human skin.

BUILDING TYPE
Office building

PARAMETERS
PCB-contamination in indoor air,
PCB-contamination in the surface of office equipment.

STARTDATE 00:03:1989
ENDATE 00:12:1990
TIME (Not Stated)

KEYWORDS
PCB, indoor air quality (IAQ), offices

SELECTED BIBLIOGRAPHY
Bundesministerium fur Raumordnung,
SPECIFIC OBJECTIVES
Simplification of jet laws for axisymmetric and plane isothermal free jets and their application to design air outlets.

PROJECT DETAILS
The ventilation of rooms by free jets requires a sufficient air mixing as well as a guarantee of thermal comfort for people living or working there. Some realized air outlets consist of nozzles or slots arranged at various distances. This has an influence depending on the initial velocity on jet behaviour, especially on the velocity profiles and the penetration depth. In the present study the effect of the initial velocity of the original on free jets is investigated for various outlet geometries. In three testing plants measurements of centerline velocity and velocity profiles are taken for various nozzles, slots and also for realized air outlets. The decrease of centerline velocity is affected by the initial velocity and also by the outlet geometry that is characterised by the pressure drop in the outlet. These relations are considered in the Euler number that is integrated in the jet equations. So far it is possible to predict the jet behaviour for similar outlet geometries by measurement of the pressure drop and the velocities.

BUILDING TYPE
(Not Stated)

PARAMETERS
Development and design of documents.

STARTDATE 01:01:1988
ENDEATE 01:01:1991

TIME 10 000 person-hours

KEYWORDS
Jets, air outlets, airflow, air velocity

SELECTED BIBLIOGRAPHY
1 Dezter R (1972), Beitrag über das Verhalten runder Luftfreistrahlen Diss. Universität Stuttgart.
3 Hanel B & Richter E (1979) Das verhalten von Freistrahlen in verschiedenen

Reynolds-Zahlbereich Luft- und Kaltetechnik, Nr.1.

REF D5

TITLE
Demand controlled ventilating systems. (IEA-Annex 18, German contribution)

CONTACT
Raatschen, Willigert

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SPECIFIC OBJECTIVES
Energy savings with specific control strategy with simultaneous improvement of indoor air quality (IAQ).

PROJECT DETAILS
Evaluation of leading contaminants to control ventilation airflows with respect to occupancy load and tobacco smoke. Evaluation of ventilation strategy to avoid moisture problems in dwellings. Review the State-of-Art sensor market. Set up of sensor test program to check qualification of sensors. Performance test of decentralized and centralized commercial ventilation devices in test houses. Basic experiments concerning distribution of contaminants in rooms. Development of simulation code to calculate energy consumption, verification in field tests.

BUILDING TYPE
Dwellings, apartments.

PARAMETERS
Weather performance sensors, behaviour of occupants (real & simulated) expiration of CO₂, vapour production, tobacco smoke.
REF D6
TITLE
Operation of ventilation systems in the case of polluted outdoor air situations.

CONTACT
Trepte, Lutz

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SPECIFIC OBJECTIVES.
Development of guidelines for the design and operation of ventilation systems in the case of
smog etc.

PROJECT DETAILS
Estimation and modelling of indoor/outdoor relations of pollutants for the following cases:
smog, radioactive emissions and others.
Development of recommendations and measures to avoid annoyance or adverse health
effects in such cases. Summarising lack of knowledge and proposal of further research and
development activities. Development of guidelines (VDI-Richtlinie) in 4 parts (Blatter):
part 1 Fundamentals, part 2 Smog situations, part 3 Radioactive Emissions, part 4 Other
emissions (e.g. chemicals)

BUILDING TYPE
Hospitals, office buildings.

PARAMETERS
Wind, performance of buildings (tightness etc.), source of pollutants.

STARTDATE 00:07:1987
ENDATE Parts 1-3 00:12:1989
Part 4 00:12:1990
TIME 3000 person-hours

KEYWORDS
Indoor air quality, pollution sources, ventilation, standards, guidelines

SELECTED BIBLIOGRAPHY
1 Trepte L (1987), Operation of ventilation plants in the case of polluted outdoor air
situations. Draft version of the guideline VDI 3816 completed, procedure of introduction
started, implementation of parts 1-3 est start Dec. 1990. Betrieb von RLT-Anlagen bei
belastenden Aussenluft- situationen, DKV-Tagungsbereich, 14. Jg.(1987), Koln, pp
501-511

REF D7
TITLE
Advanced ventilation systems for dwellings - laboratory tests for thermal comfort and air
quality

CONTACT
Mayer, Erhard

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SPECIFIC OBJECTIVES
Test of ten different systems with respect to:
distribution of air velocity, air temperature,
tobacco smoke.

PROJECT DETAILS
Mechanical ventilation systems, partly with heat
recovery. Indoor air quality (IAQ) -
measurements by implementation of tobacco
smoke and measuring the decay of 1 micron size
particles.

BUILDING TYPE
The laboratory.

PARAMETERS
Different systems, leak recovery.

STARTDATE 01:01:1988
ENDATE 31:12:1989
TIME 2000 person-hours.
KEYWORDS
Mechanical ventilation systems, tobacco smoke, residences, dwellings, thermal comfort, indoor air quality (IAQ), heat recovery

SELECTED BIBLIOGRAPHY (None Stated)

REF D8
TITLE
Development of methods for the measurement of the air change rate in rooms and buildings
CONTACT
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University Siegen, FB7/Dept. of Physics, Adolf-Reichwein-Str. 5900 Siegen, Fed. Rep. of GERMANY.
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SPECIFIC OBJECTIVES (Not Stated)

PROJECT DETAILS
Construction of a mobile measurement system for tracer gas measurements. Measurement methods: - initial injection (decay method) - constant injection tracer gas: N2O or SF6 gas analyzer principle: infrared absorption. Eight independent channels can be used to - sample simultaneously at various locations in a single room or building - subsequent measurements in different rooms of a building without change of measurement setup.

BUILDING TYPE (Not Stated)

PARAMETERS
Temperature and pressure differences between single rooms and the outside, wind speed and direction

STARTDATE 02:02:1988
ENDATE onging
TIME 4000 person-hours per year

KEYWORDS
Tracer gas, air change rate, pressurisation

SELECTED BIBLIOGRAPHY
3 Heidt F D (1987), Zur Messung des Luftwechsels mit Spurengasmethoden Bauphysik, Bd.9, Nr. 6, 1987, Verlag Ernst und Sohn, Berlin, pp.272-278

REF D9
TITLE
Investigation concerning indoor pollutants.
CONTACT
Marutzky R & Schriever E
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FAX +49 0531-351587

SPECIFIC OBJECTIVES
Screening of emissions from selected building materials with different methods.

PROJECT DETAILS
The crucial points of investigation up to now, were the following building materials: 1) Acid hardened lacquers for furniture 2) Foamed polymers (PUR, PS) 3) Cork plates 4) Wall coverings. The emissions are characterized by different methods, including: a) static Headspace Gas Chromatography b) dynamic Headspace-Gas Chromatography c) Gas Analysis Method d) 1m3-Chambers e) 40m3-Chamber for particular cases As far as possible the time dependence of the chamber concentrations is established.

BUILDING TYPE
Residential and office buildings

PARAMETERS
Emission rates of building material

STARTDATE 01:03:1985
ENDATE 30:06:1990
TIME 12250 person-Hours

KEYWORDS
Indoor pollutants, building materials, pollution sources, measurement

SELECTED BIBLIOGRAPHY
Influence of air velocity in large chamber test upon formaldehyde release of particleboards.

CONTACT
Marutzky, R

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SPECIFIC OBJECTIVES
Air Velocity - Chamber Test - Formaldehyde Release - Particleboards

PROJECT DETAILS
The formaldehyde release of particleboards and other wood based materials is determined in large chambers. Large chamber tests require definite temperature, relative humidity and other test conditions. A precondition for chamber tests is a high air velocity (0.1 m/s). In the project the influence of the air velocity upon the formaldehyde release of particleboards is determined. Depending on thickness, structure and density of the board up to 40 percent of the formaldehyde release in chamber tests is due to the influence of the air velocity.

BUILDING TYPE
(Not Stated)

PARAMETERS
Formaldehyde

STARTDATE 01:01:1988
ENDATE 31:12:1989
TIME 400 person-hours

KEYWORDS
Air velocity, test chamber, formaldehyde, particleboards

SELECTED BIBLIOGRAPHY
Publications in preparation
Carbon dioxide concentration, relative humidity and temperature of the air, greenhouse, weather data of Fulda, real behaviour of occupants.

STARTDATE 00:09:1986
ENDATE 00:05:1988
TIME (Not Stated)

KEYWORDS
Passive solar, hygric behaviour, energy consumption, temperature distribution

SELECTED BIBLIOGRAPHY

REF D12
TITLE
Experimental investigation of a combined air heating/floor heating system followed by tests in a pilot project.
CONTACT
Siegmund, H
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Fa. eht Siegmund GmbH,
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TLX 885202 eht
SPECIFIC OBJECTIVES
Researching parameters of airflow and heat transfer in a hollow space below the floor leading warmed supply air.

PROJECT DETAILS
Measurements determining pressure drop as well as temperature loss of supply air within the floor construction have been taken in the laboratories of the University of Essen. Therefore several fields of research, each with an area of 4 m² to 10 m², were built for different construction types in order to improve economy and comfort of the system. One important aspect is to find out an optimal sectioning between air heating part and floor heating part.

Basing on the results of the measurements theoretical equations have been gained. Finally it is planned to compare the experimental and theoretical results with measurements under realistic conditions in special test rooms as well as in an inhabited house.

BUILDING TYPE
Not yet known

PARAMETERS
None, research concerning components of a heating and ventilation system.

STARTDATE 01:09:1987
ENDATE 31:08:1990
TIME 10000 person-hours per year

KEYWORDS
Heating system, floor, energy conservation, heat transfer, ventilation system

SELECTED BIBLIOGRAPHY
1 Radtke W & Thiel D (1986), Zweikomponenten-Luftheizungs-System.
BMFT Forschungsbericht, 1986.

REF D13
TITLE
Simulation and measurement of airflow within buildings. (similar air).
CONTACT
Furst, Johann
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FAX +49 0406949 568
TLX 211160 romb d
SPECIFIC OBJECTIVES
Simulation and measurement of airflow, air purity in buildings.

PROJECT DETAILS
a) measurements: (i) size 12 x 6 x 4 m construction: wood, glass, plastic material (ii) peltier element, radiator, mechanical ventilation, natural convection. (iii) measurement of temperature, pressure, velocity, humidity, acoustics, N2O tracer gas (iv) measurement system: data acquisition and control system with PC, PT 100, hot-wire anemometers. (v) occupied and unoccupied buildings.

BUILDING TYPE
Commercial, factory, office
PARAMETERS
(Not Stated)
STARTDATE 01:09:1989
ENDATE 01:09:1992
TIME 10 000 person-hours

KEYWORDS
Simulation, measurement, airflow, indoor air quality (IAQ), convection

SELECTED BIBLIOGRAPHY (None Stated)

REF 11
TITLE
Air infiltration induced by heating appliances.

CONTACT
Masoero, Marco

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ITALY.

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SPECIFIC OBJECTIVES
Analyse energy-related and safety problems of operating combustion appliances within inhabited spaces.

PROJECT DETAILS
Theoretical analysis: 1) A mathematical model was developed which determines the pressure and airflow distribution in a building incorporating a heating appliance within the living space. The model takes into account the wind effects, buoyancy-driven air movement and the thermal and fluid dynamic behaviour of the furnace and the chimney. Future refinements shall include the effects of interior partitions, non uniform envelope permeability, and transients (on-off control of furnace). 2) Experimental validation: Measurements will be made in 2 single family houses.

BUILDING TYPE
Residential single-family/multi-family

PARAMETERS
Heating demand building construction and size type of furnace
STARTDATE 00:05:88
ENDATE 00:07:90
TIME 1500 person-hours

KEYWORDS
Heating appliance, mathematical simulation, airflow distribution, thermal simulation, dwelling, flue, energy

SELECTED BIBLIOGRAPHY
1 Fracastoro G V & Masoero M (1988), Air infiltration induced by heating appliances 9th AIVC conference, GENT 1988 2 Final research report to National Research Council of Italy (expected Summer 1990)

REF 12
TITLE
Wind pressure distribution around buildings.

CONTACT
Grosso, Mario

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ITALY.

TEL +39 11-5566578
FAX +39 11 - 5566599

SPECIFIC OBJECTIVES
Modelling wind pressure distributions around buildings, using wind tunnel data sets.

PROJECT DETAILS
The research will be carried out by:
1) Comparing output from the Cp-calculation model developed during the COMIS workshop, held at the Lawrence Berkeley Laboratory (LBL) in conjunction with the multizone infiltration specialists, with the results from wind tunnel tests. 2) Adding new routine to the model, such as routines dealing with Cp distribution on roof spaces and in crawl spaces. 3) Performance wind tunnel tests in order to evaluate, by parametrical analysis, the influence on Cp distribution of the following variables: Terrain roughness - Building height - Building Shape.

BUILDING TYPE
Building Envelope; external surface

PARAMETERS
Surface pressure coefficient
STARTDATE 01:03:1990
ENDATE 30:06:1993
TIME 30 person-months

KEYWORDS
Wind pressure coefficient, model, wind tunnel, multizone
SELECTED BIBLIOGRAPHY
3 Allard F et. al. (1990), User guide to the multizone airflow model: COMIS. AIC TN 29 1990.

REF 13
TITLE
Natural and mechanical ventilation in residential buildings.
CONTACT
Fracastoro, Giovanni Vincenzo
ADDRESS
Università Della Basilicata, Istituto Di Fisica, Via Della Technica, N. 3 85100 Potenza, ITALY.
TEL +0039 971 474659
FAX +0039 971 57477
SPECIFIC OBJECTIVES
Evaluation of contaminant diffusion in rooms.
PROJECT DETAILS
A test facility has been built, made of a divisible 2.50 x 2.50 x 4.0 room, which is mechanically ventilated in different ways. A two components infra-red gas analyser is used to detect internal diffusion between the two parts of the room. The test chamber is equiped with four different grilles for inlet or outlet. The fluidodynamic field is detected by means of six hot wire anemometers which can be moved along the room. Diffusion and removal of pollutants will be simulated. An experimental campaign will also be performed in the field in order to establish the infiltration rates using two-zone modellization in residential buildings.
BUILDING TYPE
Residential
PARAMETERS
Ventilation efficiency
STARTDATE 01:11:1989
ENDATE 31:10:1990
TIME 1200 person-hours
KEYWORDS
Residential, ventilation efficiency, test chamber, dwelling, mechanical ventilation system, air movement

SELECTED BIBLIOGRAPHY
3 Cali, Fracastoro, Vacchelli (1986), Studio con la tecnica dei gas traccianti delle infiltrazioni d'aria in una camera a ventilazione controllata. in Atti del XLI convegno ATI, Napoli, Setembre 1986.

REF 14
TITLE
Operational safety, energy efficiency and indoor air quality in the use of domestic gas appliances.
CONTACT
Masoero, Marco
ADDRESS
Dipartimento di Energetica, Politecnico Di Torino, Corso Duca Degli Abruzzi 24, 10129 Torino, ITALY.
TEL +39 11 5567406
FAX +39 11 556 7499
SPECIFIC OBJECTIVES
To define guidelines for optimal installation and operation of gas appliances.
PROJECT DETAILS
Gas appliances for space heating and hot water production are present in the majority of Italian residences. This research, conducted in collaboration with the National Gas Utility "ITALGAS", is aimed at analysing the interaction between such appliances and the building, in terms of safety of operation, energy consumption and pollutant emission in the indoor space. Two instrumented single family houses, recently completed by ITALGAS, will be used to carry out the experimental part of the research. Theoretical analysis will be
performed using a simulation model developed at the Politecnico Di Torino.

BUILDING TYPE
Residential

PARAMETERS
Gas appliance installation and operation; Building airtightness

STARTDATE 00:01:1990
ENDATE 00:12:1991
TIME 3500 person-hours

KEYWORDS
Energy efficiency, indoor air quality (IAQ), guidelines and standards, simulation, heating appliance

SELECTED BIBLIOGRAPHY

REF 15
TITLE
Anaysis of tracer gas experimental data using parameter estimation techniques.

CONTACT
Cali, M

ADDRESS
Dipartimento di Energetica, Politecnico Di Torino, Corso Duca Degli Abruzzi 24, 10129 Torino, ITALY.
TEL +39 11 5567424
FAX +39 11 5567499

SPECIFIC OBJECTIVES
Improvement of data analysis in multi room ventilation / infiltration problems.

PROJECT DETAILS
Tracer gas data will be processed with the following objectives: - The determination of the time-dependent parameters based on arbitrary tracer gas emission laws. - Evaluation of the influence of experimental uncertainties, mathematical tools are applied to the set of differential equations describing the mass balance of air and tracer gas in each zone. Such tools were originally developed to solve inverse ill-conditioned problems of heat conduction.

BUILDING TYPE
Multizone systems

PARAMETERS
(Not Stated)

STARTDATE 00:01:1989

ENDATE 00:12:1990
TIME 300 person-hours

KEYWORDS
Tracer gas, multizone, air movement, mathematical simulation

SELECTED BIBLIOGRAPHY
1 Cali M (1990), Final report to the National Research Council of Italy. Research Contract. 87.02154.59.
2 Cali M & Borchiellini R (1990), Proc. 11th AIVC Conf.
3 Cali M & Borchiellini R & Coppa P (1990), Proc. 11th AIVC Conf.

REF NL1
TITLE
Exhaust airflows and hood capture efficiency.

CONTACT
Crommelin, R D

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TLX 38071 ZPTNO NL

SPECIFIC OBJECTIVES
To predict airflows and capture efficiencies of exhaust hoods (flanged and unflanged) of different shapes.

PROJECT DETAILS
(i) Measurements of velocities above a table with capture hood. (ii) Measurements of tracer gas concentrations in the exhaust duct to determine the capture efficiencies. (iii) Development of a mathematical model to calculate the velocities and capture efficiency. (iv) Validation of the mathematical model by the measurements.

BUILDING TYPE
Capture hood

PARAMETERS
Flow rate, air movements, air velocity, shape and devices of capture hood.

STARTDATE 01:09:1988

81
ENDATE 31:12:1991
TIME 2000 person-hours

KEYWORDS
Flue, Air velocity, Mathematical simulation, Tracer gas

SELECTED BIBLIOGRAPHY

REF NL2
TITLE
Analysis of ventilation through one opening only.

CONTACT
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TLX 38071 ZPTNO NL

SPECIFIC OBJECTIVES
To determine the ventilation rate through one opening, by fluctuations due to turbulence.

PROJECT DETAILS
The study will involve a literature study, measurements on site, and of scale models, to study the possibilities and limitations in large halls. The aim of the study is to find the relationship between ventilation rates, meteorological and local wind, local turbulence and temperatures.

BUILDING TYPE
Large Halls

PARAMETERS
Climate, air movement, air turbulence, form of openings and flow.

STARTDATE 30:06:1986
ENDATE 30:12:1991
TIME 2000 person-hours

KEYWORDS
Air infiltration, single opening, turbulence, scale model, window measurement

SELECTED BIBLIOGRAPHY

REF NL3
TITLE
Air movement in rooms.

CONTACT
Crommelin, R D

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SPECIFIC OBJECTIVES
To study the effects of outdoor air supply on air movement and indoor-climate.

PROJECT DETAILS
Phase 1; Literature study. Phase 2; Experimental work (scale model). Phase 3; Field measurements/evaluation. Phase 4; Modelling.

BUILDING TYPE
Rooms

PARAMETERS
Climate, air movement, air turbulence, form of openings and flow.

STARTDATE 30:06:1986
ENDATE 31:12:1991
TIME 2000 person-hours

KEYWORDS
Airflow, Room, Indoor Air Quality (IAQ), Openings, Scale model

SELECTED BIBLIOGRAPHY (None Stated)

REF NL4
TITLE
Transport of heat and contaminants in large spaces by airflow.

CONTACT
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TLX 38071 ZPTNO NL

SPECIFIC OBJECTIVES
To predict temperatures and contaminant concentrations in large spaces, such as industrial halls.

PROJECT DETAILS
Transport of heat and dispersion of contaminants in large spaces, such as industrial halls, is studied by measurements in a large number of points and by calculations. Calculations are performed by a multiple-cell model which divides the space into zones.

**BUILDING TYPE**
Large halls

**PARAMETERS**
Heat and contaminant sources, supply and exhaust airflow rates, wind, ventilation openings.

STARTDATE 01:01:1987
ENDATE 01:01:1992
TIME 2000 person-hours.

**KEYWORDS**
Airflow, Dispersion, Indoor Air Quality (IAQ), Mathematical simulation, Contaminant

**SELECTED BIBLIOGRAPHY**

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**REF NL5**
**TITLE**
Research Into Indoor Climate And Health In Office Buildings.

**CONTACT**
Zweers, Tunnie & Preller, Liesbeth

**ADDRESS**
Agricultural University of Wageningen, Dept. of Environ Health, P O Box 238, 6700 AE Wageningen, NETHERLANDS.

**TEL** +31 08270-83376
**FAX** +31 8270-8282

**SPECIFIC OBJECTIVES**
Finding causes of indoor climate and health problems in buildings.

**PROJECT DETAILS**
The investigation will cover up to 60 office buildings which are not known as sick, having a minimum number of inhabitants of 50 people and a maximum number of up to 200. Questionnaires will be distributed between the office workers enquiring about work related symptoms of ill health; indoor climate related complaints, about satisfaction etc. The ventilation system will be characterized and measurements will be made of carbon dioxide (CO₂), lighting and some clear climatic variables. Trial investigations have been carried out in two test buildings and procedures, questionnaires and checklists have been corrected after these trials.

**BUILDING TYPE**
Office buildings

**PARAMETERS**
CO₂ lighting and other climatic variables, prevalence of sick building illnesses

STARTDATE 21:11:1988
ENDATE 00:02:1989 (Report at 31:12:1989)
TIME (Not Stated)

**KEYWORDS**
Sick buildings syndrome (SBS), Offices, Health, Mechanical ventilation system

**SELECTED BIBLIOGRAPHY** (None Stated)

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**REF NL6**
**TITLE**
Ventilation In Industrial Premises.

**CONTACT**
Gids, W F De / Knoll, B

**ADDRESS**
TNO, P O Box 217, 2600 AE Delft, NETHERLANDS.

**TEL** +31 15 696026
**FAX** +31 15 616812
**TLX** 38071

**SPECIFIC OBJECTIVES**
To study the effects of local ventilation systems.

**PROJECT DETAILS**
- Measurements with tracer gases on the efficiencies of local exhaust hood systems.
- Studies on local displacement systems.
- Local protection of people by personal fan systems
- Airflow through large openings, disturbing local systems.

**BUILDING TYPE**
Industrial Buildings

**PARAMETERS**
Vent systems, Local exhaust, Local displacement, ventilation efficiency

STARTDATE 00:00:1988
ENDATE 00:00:1992
TIME 3500 person-hours

**KEYWORDS**
Industrial, Mechanical ventilation system, Tracer gas, Displacement ventilation, Flue

SELECTED BIBLIOGRAPHY
(Non Stated)

REF NL7
TITLE
Indoor Air Quality In Airtight Houses.
CONTACT
Gids, W F De
ADDRESS
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TEL +31 15 696026 FAX +31 15 616812
TLX 38071
SPECIFIC OBJECTIVES
Studying problems of indoor air quality in dwellings, due to high levels of airtightness and inadequate use of the ventilation system.

PROJECT DETAILS
Measurements and model studies on exposure of pollutants by occupants: Studies on:-
- Advanced ventilation systems.
- Develop strategies.
- Producing proposals for standards and test methods.
- Multizone efficiency.
- Distribution of pollutants.
- Effects of Occupants.

BUILDING TYPE
Residences

PARAMETERS
Building airtightness; Occupant behaviour, ventilation systems

STARTDATE 00:00:1988
ENDATE 00:00:1992
TIME 2800 person-hours

KEYWORDS
Ventilation systems, Ventilation strategies, Airtightness, Indoor Air Quality (IAQ), Multizone, Dwelling

SELECTED BIBLIOGRAPHY (Non Stated)

REF NL8
TITLE
Database On Air Leakage And Pressure Coefficients Of Buildings.
CONTACT
Gids, W F De
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TEL +31 15 696026 FAX +31 15 616812
TLX 38071
SPECIFIC OBJECTIVES
To establish a database on air leakage and pressure coefficients.

PROJECT DETAILS

BUILDING TYPE
Residences; non-residential buildings

PARAMETERS
Air leakage; pressure differences

STARTDATE 00:00:1988
ENDATE 00:00:1992
TIME 3500 person-hours

KEYWORDS
Database, Pressure Coefficients, Air leakage, Database, Commercial, Industrial

SELECTED BIBLIOGRAPHY (Non Stated)

REF NL9
TITLE
CONTACT
Phaff, J C
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TLX 38071
SPECIFIC OBJECTIVES
To develop models and interaction between models to evaluate ventilation, energy and indoor air quality.

PROJECT DETAILS
Phase 1: Study of separate models. Phase 2: Updating the separate models Phase 3: Formulation of input data Phase 4: Network system developed Phase 5: Tests on interaction
and evaluation Phase 6: Description of the complete system.

BUILDING TYPE
Residential houses and apartments

PARAMETERS
Occupants behaviour and experience; subjective health effects, thermal comfort; Energy use;
In/Outdoor climate

STARTDATE 00:00:1980
ENDATE ongoing
TIME 1000 person-hours/year

KEYWORDS
Occupant behaviour, Questionnaires, Window, Comfort, Health Heating ventilation systems,
Test chamber

SELECTED BIBLIOGRAPHY

SPECIFIC OBJECTIVES
Which minimal ventilation can be attributed to the responsibility of the occupants.

PROJECT DETAILS
To support the governmental building policy a study; if performed will study the rate of exposure of occupants to polluting agents at conditions of minimal and reasonable occupant behaviour with respect to the use of ventilation devices in residential buildings. What is considered to be a reasonable minimal use of ventilation devices by the occupants will be measured. Pollutants emitted from building materials will also be monitored. The assessment will be based on case studies and surveys of the actual ventilation behaviour in different houses and apartments with different ventilation provisions.
**NEW ZEALAND**

*REF NZ1*

**TITLE**
Air Infiltration and Ventilation In Buildings.

**CONTACT**
Bassett, M R

**ADDRESS**
Building Research Association of New Zealand,
Private Bag, Porirua,
NEW ZEALAND.

**TEL** +64 04 (357-600)  **FAX** +64 04 356070
**TLX** 30256

**SPECIFIC OBJECTIVES**
To investigate infiltration airflows that transfer heat and moisture.

**PROJECT DETAILS**
1) Investigation of airflows from living space of houses into the construction cavities of cathedral ceilings. A passive tracer technique is being used in a group of 6 houses in cold and warm parts of New Zealand. 2) Air tightness tests on office buildings using the air handling system to provide a pressure across the envelope. Tracer gases are being used to measure airflow rates in ventilation system ducts.

**BUILDING TYPE**
All

**PARAMETERS**
(Not Stated)

**STARTDATE** (Not Stated)
**ENDATE** (Not Stated)
**TIME** (Not Stated)

**KEYWORDS**
Tracer gas, Residential, Commercial, Industrial, Public Buildings, Dwelling, Airflow, Ventilation, Infiltration

**SELECTED BIBLIOGRAPHY** *(None Stated)*

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**NORWAY**

*REF N1*

**TITLE**
The Relationship Between Indoor And Outdoor Concentrations Of Pollutants In Norwegian Houses.

**CONTACT**

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Braathen, Ole-Anders

**ADDRESS**
Norwegian Institute of Air Research,
P O Box 64
N-2001 LILLESTROM,
NORWAY.

**TEL** +47-6-81-41-70  **FAX** +47 6 81 92 47

**SPECIFIC OBJECTIVES**
To study how indoor air concentration of pollutants varies with the outdoor air concentrations. This study constitutes a part of a major study of health effects of exposure in the Grenland area in Norway.

**PROJECT DETAILS**
The measurements were carried out in 15 buildings, twice in 1988, (once in the Winter and then again in the Summer). The 15 buildings included both houses and apartments, and most of them had natural ventilation. The concentrations of SO2, NO2, suspended particulate matter (in two size fractions), Cl, NO3 and SO4 were measured simultaneously inside and outside the houses, and formaldehyde was measured inside only. The houses were occupied while the measurements were carried out.

**BUILDING TYPE**
Residences (houses and apartments)

**PARAMETERS**
Pollutant concentrations

**STARTDATE** 00:09:1987
**ENDATE** 00:09:1990
**TIME** (Not Stated)

**KEYWORDS**
Residences, Pollutant sources, Dwelling, Indoor Air Quality (IAQ)

**SELECTED BIBLIOGRAPHY**

---

*REF N2*

**TITLE**
Ventilation By Demand.

**CONTACT**
Drangsholt, Finn

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SPECIFIC OBJECTIVES
Achieve good indoor air quality with minimum fresh air supply.

PROJECT DETAILS
An auditorium with displacement ventilation and seats for 300 students has been equipped with a demand controlled ventilation system (DCV). CO₂, temperature and humidity have been used as parameters to control the air flow (0 - 12000 m³/h). Temperature, humidity and CO₂ concentrations have been measured every 10 minutes at 20 locations inside the room. Aerosols have been measured in the exhausted air flow. Air exchange efficiency has been measured with N₂O. Further investigations will be carried out with 3-d numerical computer program (Fluent. Kameleon).

BUILDING TYPE
Auditorium

PARAMETERS
CO₂, Humidity, Temperature and dust

START DATE 00:10:1989
END DATE 00:07:1991
TIME 4000 person-hours

KEYWORDS
Ventilation, Indoor Air Quality (IAQ), Demand controlled ventilation (DCV), Field study, Survey,

SELECTED BIBLIOGRAPHY
consequences of energy consumption, another is higher investment costs. But the rise in total cost per square meter is marginal because wage-related costs totally dominate.

**BUILDING TYPE**
Office buildings

**PARAMETERS**
Indoor air quality, total costs, wage-related costs, health

**STARTDATE** 00:00:1988
** ENDATE** 00:00:1990
** TIME** 600 person-hours

**KEYWORDS**
Indoor Air Quality (IAQ), Building materials, Mechanical ventilation system

**SELECTED BIBLIOGRAPHY**

**LOCAL HEATING AND VENTILATION IN STAVE CHURCHES.**

**CONTACT**
Sorlie, Rolf

**ADDRESS**
SINTEF, Applied Thermodynamics, 7034 Trondheim-NTH, NORWAY.

**TEL** +47 7 59 38 63 **FAX** +47 7 59 38 59

**SPECIFIC OBJECTIVES**
To study different heating and ventilation systems to reduce damage on art pieces to changing indoor climate.

**PROJECT DETAILS**
Part 1: Measurements in laboratory.
Part 2: Measurements in a church.
Study: Natural and Mechanical Ventilation systems. Heating systems: Floor heating, convector, heat foil at/under the seals.
Measurements: Temperature, Relative Humidity, Air Velocity, Length extension of wood materials.
Instrumentation: Menu driven software systems allows the computer to receive, display and log acquired in real time from Schlumberger

**ISOLATED MEASUREMENT PODS (IMPS).** Occupied building in the second part.

**BUILDING TYPE**
Stave Church

**PARAMETERS**
Weather, Occupant Behaviour

**STARTDATE** 00:00:1989
** ENDATE** 00:00:1991
** TIME** 1000 person-hours

**KEYWORDS**
Church, Measurement, Heating and Ventilation systems, Simulation

**SELECTED BIBLIOGRAPHY**
the mechanical ventilation system in 50 random apartments, and an enquiry directed to all occupants in the area. The inquiry focuses on symptoms which are characteristic of sick-building syndrome. The 17 buildings included in the project are concrete buildings with concrete ground, concrete beams, concrete wall structure, rough casted and flat roofs. Mechanical ventilation systems exhaust ventilation; via ventilation ducts in the kitchens, bathrooms and separate toilets, and intake air via ventholes in the window frames. Central heating system, oil, hot water circulating system to apartment radiators each with separate thermostats. Liquid case in based putty is direct on the concrete floor, parquet floor of oak or sheetings of plastic of wall-to-wall carpeting.

BUILDING TYPE
455 apartments

PARAMETERS
Swedish construction standards

STARTDATE 25:01:1988

ENDATE 25:01:1990

TIME (Not Stated)

KEYWORDS
Apartments, Sick building syndrome (SBS), Occupancy

SELECTED BIBLIOGRAPHY

REF S2

TITLE
Making The Use Of Electricity More Efficient In Electrically Heated One-Family Houses - Monitoring And Evaluation.

CONTACT
Blomsterberg, A

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National Testing Institute,
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5-50115 Boras,
SWEDEN.

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SPECIFIC OBJECTIVES
To evaluate indoor climate and energy performance before and after improvements.

PROJECT DETAILS
Improvements including; making the use of electricity more efficient in six one-family naturally ventilated houses. Purpose provided ventilation system consists of vertical shafts and supply vents, with no fan. Examples of measurements which will be taken are; pressurisation, constant concentration tracer gas (N2O), indoor thermal comfort. The following parameters will be monitored continuously: indoor and outdoor temperatures, the use of electricity (heating, domestic hot water, household) in the occupied building. This is one of four parallel projects. All in all, 30 houses will be retrofitted and monitored.

BUILDING TYPE
One-family house.

PARAMETERS
temperature, wind, airtightness.

STARTDATE 01:01:1988

ENDATE 31:12:1990

TIME approx. 1000 person-hours

KEYWORDS
Infiltration, Ventilation, Retrofit, pressurisation, Tracer gas, Thermal comfort

SELECTED BIBLIOGRAPHY
1 Final report 31-12-1990

REF S3

TITLE
Warm Air Heating In A Block Of Flats

CONTACT
Blomsterberg, A

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National Testing Institute,
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5-50115 Boras,
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SPECIFIC OBJECTIVES
To evaluate a system for warm air heating in an apartment house.

PROJECT DETAILS
The indoor thermal climate, the air quality and the energy consumption will be monitored and evaluated. The warm air is blown into the individual rooms from inlets located in the partitions up by the ceiling. There is no recirculated air. The supply and exhaust can be varied between 0.7 ach and 1.2 ach. Examples of measurements which will be taken are: pressurisation, constant concentration tracer gas (N2O), air change efficiency, temperature efficiency, indoor thermal comfort. The following parameters will be monitored continuously: indoor, outdoor, and duct
temperatures, household and heating energy consumption etc. in the occupied building.

**BUILDING TYPE**
Block of Flats/Apartments

**PARAMETERS**
Thermal environment, Indoor Air Quality, Energy

**STARTDATE** (Not Stated)
**ENDATE** (Not Stated)
**TIME** (Not Stated)

**KEYWORDS**
Thermal Comfort, Tracer Gas, Measurement, Indoor Air Quality (IAQ), Airtightness, Energy consumption

**SELECTED BIBLIOGRAPHY**
1. Blomsterberg A et al. (1989), Warm air heating in apartment houses - pilot study, National Testing Institute, 21-06-1989
2. Blomsterberg A et al. (1989), Pre-monitoring diagnostic tests of an apartment house NTI 31-12-1989
3. Blomsterberg A et al. (1990), Pre-monitoring diagnostic tests of four apartments with warm air heating. NTI, 31-07-1990

**REF S5**

**TITLE**
Tracer Gas Techniques For Air Flow Estimations.

**CONTACT**
Mattson, Jan-Bertil

**ADDRESS**
Department of Building Science, Lund University, P O Box 118, S-221 00 Lund, SWEDEN.

**SPECIFIC OBJECTIVES**
To study how impulse responses with tracer gas can describe air movements in a room.

**PROJECT DETAILS**
The aim of the project is to find a method to define how the supply air is distributed in a room, by studying the relationship between tracer gas supply sequences and measured gas concentration. The experiments are taken place in rooms with mechanical ventilation. Tracer gas (N2O) is supplied in sequences at the inlet air grille, and impulse responses are measured in different places in the room and in the exhaust grille.

**BUILDING TYPE**
Mechanical ventilation.

**PARAMETERS**
Unoccupied room without windows or any other affecting parameters

**STARTDATE** 01:05:1989
**ENDATE** 30:06:1990
**TIME** 1600 person-hours

**KEYWORDS**
Tracer Gas, Mechanical ventilation system, Tracer gas, Airflow simulation

**SELECTED BIBLIOGRAPHY** (Not Stated)
Type of mechanical ventilation system, supply airflow rate location of supply - and extract points. Temperature of supply air.

STARTDATE (Not Stated)
ENDATE (Not Stated)
TIME (Not Stated)

KEYWORDS
Ventilation Efficiency, Mechanical ventilation system, Test chamber, Heating system, Pressurisation, Tracer gas

SELECTED BIBLIOGRAPHY
1 Sandberg M (1989), The multi-chamber theory reconsidered from the viewpoint of air quality studies Buildings and environment 1989

REF 56
TITLE
Ventilation And Airtightness versus Energy Balance And Indoor Climate In Residential Buildings.

CONTACT
Blomsterberg, A

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Lund Institute of Technology,
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S-22100 Lund,
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TEL + 46 46 104852 FAX + 46 46 104717

SPECIFIC OBJECTIVES
To clarify the influence of ventilation and airtightness on energy and indoor climate. To recommend methods, and evaluate performances.

PROJECT DETAILS
Most of the work is based on previous projects where experimental buildings were performance monitored and evaluated. The buildings were either of wood-frame construction or wood-frame and concrete construction. The ventilation system was natural or mechanical. The mechanical systems were either balanced or extract only ventilation. The heating systems were electric warm air (exhaust air heat pump), electric baseboard or hydronic). The following measurements were taken: constant concentration tracer gas (N2O), tracer gas (N2O) decay (air change efficiency), fan pressurisation, indoor temperatures, energy consumption, weather etc. A simplified theoretical approach (LBL model) and a multi-zone network approach (MOVECOMP -PC(R) were used.

BUILDING TYPE
Detached one-family house and townhouse (Residence)

PARAMETERS
wind, temperature, airtightness etc.

STARTDATE 01:01:1987
ENDATE 30:06:1990
TIME 2000 (not including the measurements, which were performed during 1982-1986)

KEYWORDS
Airtightness, Ventilation system, Indoor climate, Tracer gas, Pressurisation, Multizone, Simulation, Dwelling

SELECTED BIBLIOGRAPHY
6 Blomsterberg A (1989), Ventilation and airtightness in Energy, balance analysis, 10th
AIVC Conference, Final paper from Lund Inst of Technology

REF S7
TITLE
Air Infiltration Analysis Based On Probabilistic Methods.
CONTACT
Handa, Kamal
ADDRESS
Building Aerodynamics Research Group,
Dept of Structural Design,
Chalmers University of Technology,
S-41296 Gothenburg,
SWEDEN.
TEL + 46 31 72 10 00 FAX +46 31 72 24 85

SPECIFIC OBJECTIVES
An all-embracing aim for research is to formulate models, which describe the distribution and mutual relationship between different climatic parameters or driving forces.

PROJECT DETAILS
The research can be expected to give basic data for a risk analysis and for the estimation of requisite safety factors.
(a) (i) wood
(ii) natural and mechanical ventilation
(iii) pressure measurements (full scale measurements)
(b) probabilistic methods, spectral analysis.

BUILDING TYPE
House, Residence

PARAMETERS
Climatic factors
STARTDATE 00:00:1989
ENDATE 00:00:1992 TIME (Not Stated)

KEYWORDS
Model, Residence, Dwelling, Infiltration, Ventilation system

SELECTED BIBLIOGRAPHY

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117 80 Stockholm,
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SPECIFIC OBJECTIVES
Passive emission and sampling of a tracer gas is proposed to determine the Air Change Rate.

PROJECT DETAILS
Within the framework of ICOM, different International Committees are working continuously. One of these is the Committee for Architecture and Museum Technology (ICAMT). At the global conference in Buenos Aires in October 1986, ICAMT discussed a Swedish paper "Climate Control in Old Museum Buildings" and recommended further investigations on how to improve museum buildings in order to decrease the damage to collections caused by rapid changes of indoor temperature, humidity, and daylight, as well as that caused by gaseous pollutants. At the ICAMT Technical Meeting in Budapest in October 1988, the Committee discussed another Swedish paper, "Air Infiltration in Museum Buildings". This paper suggested the use of tracer gas techniques to establish the air change performance of museum buildings. The committee supported the idea of a simple passive measurement system for a preliminary classification of museum buildings. Following investigations of possible measurement methods, a technique involving the passive emission and sampling of a tracer gas, developed by Dr Russel Dietz at the Brookhaven National Laboratory, is proposed in this report. The method is simple to perform and most of the work can be undertaken by museum staff. It is intended that the measurements should be taken while the museum is operating under normal conditions, i.e. irrespective of whether the air conditioning is on or off or whether a successful exhibition with many visitors is being staged. The results from the measurements are presented as the air change rate for the museum building. A classification system for museums, based on the air change rate has been devised. This will give museum staff a tool which allows them to assess the infiltration performance of their museum buildings, exhibition halls or store rooms in

REF S8
TITLE
Air Infiltration in Museum Buildings.
CONTACT
Holmberg, Jan G
office rooms. Model validations are conducted by comparison of the real and generated data.

**BUILDING TYPE**
Four offices (Commercial)

**PARAMETERS**
Ambient temperature, time of day

**STARTDATE** 00:01:1989  
**ENDATE** 00:12:1989  
**TIME** 12 person-months

**KEYWORDS**
Simulation, Window, Door, Openings, Airflow, Occupant, Office

**SELECTED BIBLIOGRAPHY**
1. Fritsch R et al. (198?), A stochastic model of user behaviour regarding ventilation, proposed to Building and Environment.

**REF CH8**
**TITLE**
Numerical Prediction Of Air Flow In Single Rooms.

**CONTACT**
Moser, Alfred

**ADDRESS**
Energy systems laboratory,  
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SWITZERLAND.

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**TLX** 817 379 ehlg ch

**SPECIFIC OBJECTIVES**
Evaluate and test numerical methods and develop airflow design tool.

**PROJECT DETAILS**
This work is a subproject of a Swiss national project "energy relevant airflows in buildings", ERL, which is supported by government and industry. ERL is structured in (a) single room, (b) multi-zone airflow and (c) ventilation systems. The subproject reported here belongs to task A. The finite-volume fluid flow simulation code 'PHOENICS', which employs the K/EPSILON - turbulence model, is tested against LDA- measurements carried out within ERL. Model improvements were realized with respect to buoyancy, Low-Reynolds-Number, and near-wall effects. Prediction of mixed-convection heat transfer is of particular interest.

**BUILDING TYPE**
Residential, office, commercial

**PARAMETERS**
Steady-state, wall temperatures given, desired output, flow field, turbulence, temperatures, comfort, concentrations.

**STARTDATE** 00:07:1986  
**ENDATE** 00:07:1992  
**TIME** (Not Stated)

**KEYWORDS**
Flow field, Turbulence, Heat transfer, Simulation, Multizone, Energy, Ventilation system, Turbulence

**SELECTED BIBLIOGRAPHY**
1. Chen Qingyan at al. (1990), Prediction of buoyant, turbulent flow by a Low-Reynolds-Number k-epsilon model, Symposium paper, ASHRAE Winter meeting, Atlanta, Feb. 1990. B.

**REF CH9**
**TITLE**
IEA Annex 20, Air flow patterns within buildings (international project)

**CONTACT**
Moser, Alfred (Operating Agent Switzerland)

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**SPECIFIC OBJECTIVES**
To evaluate the performance of single and multi-zone air and contaminant flow simulation techniques.

**PROJECT DETAILS**
Prediction of airflow patterns within rooms and through buildings by numerical methods will help the engineer to design ventilation systems for high energy efficiency, good thermal comfort, and acceptable indoor air quality. Simulation techniques are evaluated and extended in this project by comparison with measurements and by development and testing of new algorithms and models. Guidelines for simulation, handbooks for measurement techniques, and experimental data will be produced.

**BUILDING TYPE**
Residential, office, commercial

PARAMETERS
Weather, wind, building components, heat load, occupant behaviour, pollution.
STARTDATE 01:05:1988
ENDATE 01:11:1991
TIME (Not Stated)

KEYWORDS
Ventilation, Infiltration, Measurement, Simulation, Airflow, Thermal comfort, Energy, Indoor Air Quality (IAQ)

SELECTED BIBLIOGRAPHY
See AIVC's AIRBASE.

REF CH10
TITLE
Demand And Basic Regulations For Air Conditioning.

CONTACT
Steinemann, Urs
ADDRESS
Schweizerischer Ingenieur- und Architekten-Verein SIA,
Selnaustrasse 16,
CH-8039 Zurich,
SWITZERLAND.
TEL +41 1 201 15 70

SPECIFIC OBJECTIVES
Swiss Standards SIA 382/1 - 3

PROJECT DETAILS
The project leads to the following three Swiss Standards: SIA 382/1 Luftungstechnische Anlagen "Technische Anforderungen" (Basic regulations for VAC-Systems) SIA 382/2 Kuhlleistungsbedarf von Gebauden" (Cooling load) SIA 382/3 "Bedarfsermittlung fur luftungstechnische Anlagen" (demand of air conditioning).

BUILDING TYPE
(Not Stated)

PARAMETERS
(Not Stated)

STARTDATE 00:00:1987
ENDATE SIA 382/1 + 3.2. 00:00:1989
SIA 382/2: 00:00:1990
TIME 6000 person-hours

KEYWORDS
Standards, Ventilation, Heat transfer

SELECTED BIBLIOGRAPHY
Schweizerischer Ingenieur- und Architekten-Verein

Postfach, CH-8039 Zurich (Switzerland) - SIA V 382/1
Luftungstechnische Anlagen - Technische Anforderungen April 1989 - SIA V 382/3
Bedarfsermittlung fur luftungstechnische Anlagen April 1989

REF CH11
TITLE
Computer Model Inter-Zonal Air Flow And Contaminant Transport (Infiltration And Ventilation).

CONTACT
Dorer, Viktor
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EMPA,
Section 175,
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SWITZERLAND.
TEL + 41 01 823 5511
FAX +41 01 821 62 44

SPECIFIC OBJECTIVES
Development of a computer model for multizone infiltration and ventilation simulation.

PROJECT DETAILS
The project is a part of the Swiss research project on "Energy Relevant Air Flow Patterns within Buildings", Subpart B: Multizone Air Flow. This Subpart B concentrates on improving data and techniques for input parameters as meteo data, wind pressure data, occupant behaviour, as well as on the development of new algorithms for large opening airflow description. The results of each of these projects will be included in the computer model as new routines and improved databases. A contribution to the "Comis" project at the LBL has been made in the frame of this project.

BUILDING TYPE
Multizone.

PARAMETERS
(Not Stated)

STARTDATE Phase 1 01:01:87
ENDATE Phase 1 31:12:89
TIME 5,000 person-hours

Phase 2 31:12:91

KEYWORDS
Multizone, Computer simulation, Airflow, Energy, Occupant

SELECTED BIBLIOGRAPHY
In German:
**REF CH12**

**TITLE**
Leakage and Leakage Distribution Data-Bank For Swiss Buildings.

**CONTACT**
Hartmann, Peter & Steinemann, Urs

**ADDRESS**
EMPA, Section 175, Ueberlandstr, CH-8600 Dubendorf, SWITZERLAND.

**TEL** +41 01 823 4175

**FAX** +41 01 821 6244

**SPECIFIC OBJECTIVES**
To establish a data bank for leakage data of buildings and all relevant external and internal components; to include as much as possible also leakage distribution information.

**PROJECT DETAILS**
1. To analyse existing data.
2. To develop a suitable structure of the data bank, in close cooperation to the project leaders of the multizone-calculation program which is under development (V Dorfer/P Hartmann, EMPA). This data bank is also coordinated with the work in IEA Annex 20 and in the ongoing period of the AIVC.
3. To define needs and "holes" of data.
4. To collect this data in corresponding subtasks.
5. To finalize the data bank in order to - validate the program(s) and to deliver input data to planners. This project is a follow up project of - a project about leakage in residential buildings (U. Steinemann) - and a project on leakage in wooden buildings (H.R. Preisig/EMPA).

**BUILDING TYPE**
Whole buildings, different constructions internal and external components.

**PARAMETERS**
(Not Stated)

**STARTDATE** Evaluation phase end 00:00:1989

**ENDATE** 00:00:1991

**TIME** 1660 person-hours

**KEYWORDS**
Database, Leakage, Leakage Distribution, Multizone, Airtightness, Dwelling

**SELECTED BIBLIOGRAPHY** (None Stated)
Measurements Of The Airtightness Of Typical Swiss Residential Buildings.

CONTACT
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SPECIFIC OBJECTIVES
Overview of real airtightness of Swiss residential building/input parameters for air infiltration models.

PROJECT DETAILS
Measurements in buildings:
(i) Multi-storey residential buildings
(ii) Natural ventilation or extract air systems, central heating system
(iii) Pressurisation and tracer gas measurements.
(iv) Pressurisation test with blower door, tracer gas measurements with decay-method.
(v) Measurements in occupied and unoccupied buildings.

BUILDING TYPE
Multi storey residential buildings

PARAMETERS
(Not Stated)
STARTDATE 00:00:1984
ENDATE Part 1: 00:00:1985 / Part 2: 00:00:1990
TIME 4000 person-hours

KEYWORDS
Airtightness, Pressurisation, Mechanical ventilation, Natural system, Blower door, Dwelling

SELECTED BIBLIOGRAPHY
1 Urs Steinemann & Peter Hartmann (1984), Planungshilfsmittel zur Kontrolle des Luftaustausches in Gebauden Schweizer Ingenieur und Architekt, Heft 33-34.
2 Urs Steinemann (1985), Neff-Projekt Nr.226 - Kurzfassung des Berichtes zu Phase 1 mit Messungen an fünf Mehrfamilienhausern, Februar 1985.

Displacement Ventilation.

CONTACT
Kegel, B

ADDRESS
Sulzer Bros Ltd., Plant and Build Serv.Group, 8401 Winterthur, SWITZERLAND.

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FAX +41 052 23 84 47
TLX 896 060 20

SPECIFIC OBJECTIVES
Temperature gradient, air velocities air quality, comfort investigations.

PROJECT DETAILS
Measurements in a test room in Sulzer Laboratory of dimensions 6.50 x 4.50 x 2.65 m. The ventilation system is Displacement, with Repus diffuser exhaust air fittings, with Internal Loads of 10-55 w/m², different heat sources. Winter and Summer conditions were investigated. Additional numerical simulation of the test cases. Different control algorithms were tested.

BUILDING TYPE
Well insulated test room

PARAMETERS
(Not Stated)
STARTDATE 00:01:1989
ENDATE 00:12:190
TIME 24 person-months

KEYWORDS
Air velocity, Temperature gradient, Numerical simulation, Test room

SELECTED BIBLIOGRAPHY
2 Prochaska V & Kegel B (1990), Control Algorithms for rooms with displacement ventilation Room Vent 90, Oslo.
Hertig, J-A
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1015 Lausanne,
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TEL +41 021/693 24 93
FAX +41 021/693 28 63
SPECIFIC OBJECTIVES
(Not Stated)
PROJECT DETAILS
Objectives of the Climatological Data Transfer Project: The main goal of this study is to set up a methodology and a modelling system capable to determine the climatic exposure of buildings situated in a particular location of Switzerland, on the basis of corrected data obtained from the automatic meteorological station network "ANETZ". It has been observed that certain parameters, in particular wind velocity and direction, are perturbed by the proximity of other instruments, the presence of obstacles (trees, buildings), and the complexity of Swiss topography. Consequently, the first phase of the project consisted in visiting each station in the ANETZ network in order to draw up an inventory of potential problems. The second phase aims to establish corrections to the perturbed data mentioned above, while at the same time investigating the representativity of the ANETZ network. The corrections are determined by means of windtunnel tests on topographical models as well as on anemometers or special configurations of obstacles. The last step is to set up a numerical model which would provide the correct data from the network data base.

BUILDING TYPE
(Not Stated)
PARAMETERS
Wind and meteorological data.
STARTDATE 00:03:1987
ENDATE 00:12:1989
TIME 5000 person-hours
KEYWORDS
Climatological Parameters, Weather, Wind tunnel,
SELECTED BIBLIOGRAPHY
2 Hertig J-A (1989), Quelques aspects de la simulation et des mesures du vent dans la couche limits atmospherique, Fach Kollokium 89/1, ISM-Zurich, LASEN-EPFL.

REF CH17
TITLE
Simplified Model With Database Of Computed Flow Fields.
CONTACT
Chen, Qingyan
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Energy Systems Lab.,
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SPECIFIC OBJECTIVES
To develop a concept for a design tool to assess indoor airflow, thermal comfort and air quality in offices.
PROJECT DETAILS
A number of typical flow patterns are precalculated by PHOENICS flow code for small offices. Thermal comfort will be determined from air velocity, temperature, and turbulence intensity distributions. Using the new units for indoor air quality - the olf and decipol, indoor air quality can be calculated for the odours from occupants, books, floor, ceiling and walls. The computations also provide the distributions of contaminant concentration. The data base concerns different room sizes, space loads, and air supply locations with a displacement ventilation system. The influence of thermal source locations, air supply parameters such air velocity and temperature, and window size, etc. on airflow patterns are also discussed. The database will be compiled as a handbook with detailed theoretical analyses.

BUILDING TYPE
Office
PARAMETERS
Olf, Decipol, Contaminant concentration, comfort due to indoor air quality (percentage dissatisfied occupants).
UNITED KINGDOM

STARTDATE 00:06:1989
ENDATE 00:12:1990
TIME 13 person-months

KEYWORDS
Airflow simulation, Thermal comfort, Indoor Air Quality (IAQ), Handbook, Odour, Occupant, Contaminant

SELECTED BIBLIOGRAPHY
7 Chen Q (1989), Comfort and energy consumption analysis in buildings with radiant panels, Energy and Buildings (in press), (This paper was presented in the Second CLIMA 2000 World Congress of Heating Ventilating, Refrigerating and Air-Conditioning, Sarajevo, 1989 and was awarded No.1 Best Poster by the Scientific Committee).

Modelling Of Air Movement Within Buildings

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SPECIFIC OBJECTIVES
To model the physics of airflow, driven by natural ventilation in domestic and industrial buildings.

PROJECT DETAILS
Mathematical and small-scale laboratory modelling (using water tanks) to investigate the physical processes relevant to air movement in buildings. Flow visualisation, predictions of flow patterns, measurements of flow velocities and temperature distributions. Development of an "expert-system" for use by architects and ventilation engineers.

BUILDING TYPE
Domestic, Commercial, "Atria"

PARAMETERS
Weather, performance of building components, effects of the heating systems

STARTDATE 00:00:1985
ENDATE ongoing TIME (Not Stated)

KEYWORDS
Ventilation, Airflow simulation, Modelling, Expert-system, Domestic, Industrial, Dwelling

SELECTIVE BIBLIOGRAPHY
1 P F Linden & J E Simpson (1985), Bouyancy driven flow through an open door AIR 6, pp4-5
2 G F Lane-Serff et. al. (1987), Transient flow through doorways produced by temperature differences Proceed. Room Vent 1987 Stockholm

REF UK2

TITLE
Review Of Volatile Organic Pollutants In Indoor Air

CONTACT
Prior, Josephine

ADDRESS
UK Building Research Establishment,
SPECIFIC OBJECTIVES
To write a review of current knowledge concerning the native, incidence and health effects of volatile organic indoor pollutants.

PROJECT DETAILS
(Not Stated)

BUILDING TYPE
Residential (House, Apartment), Commercial (Office block), School

PARAMETERS
(Not Stated)

STARTDATE 00:10:85
ENDATE 00:11:89
TIME (Not Stated)

KEYWORDS
Dwelling, Commercial, School, Volatile organic compounds (VOC's), Air pollutants, Indoor Air Quality (IAQ)

SELECTIVE BIBLIOGRAPHY
2 Lebret E, (1985), Air pollution in Dutch Homes. An explanatory study in environmental epidemiology Dept of Air Pollution, Dept of Envir Tropical Health Wageningen Agricultural Univer R-138
3 IEA (1987), Energy conservation in buildings and community systems programme ANNEX IX 'Minimum Ventilation Rates' Final report of working phases I & II (Nov 87).

REF UK4
TITLE
Flow In Doors And Stairwells
CONTACT
Littler, J, Riffat, S, Walker, J
ADDRESS
The Polytechnic of Central London, Research In Building Group, 35 Marylebone Road, London, NW1 5LS.
UNITED KINGDOM.
TEL +44 (071) 486 5811
FAX +44 (071) 224 0143
TLX 25964

SPECIFIC OBJECTIVES
To measure airflows in 2-storey houses.

PROJECT DETAILS
Airflows were measured using two SF6 portable kits developed at the Polytechnic of Central London.
London, and by an energy monitoring company. Flows were measured in doorways and between floors of a 2-storey house, where the flow path was up and downstairs. Both were maintained at a variety of different temperatures.

**BUILDING TYPE**
2-storey houses (Residences)

**PARAMETERS**
Change in temperature
STARTDATE 00:00:1987
ENDATE 00:00:1989 TIME (Not Stated)

**KEYWORDS**
Dwelling, Residences, Tracer gas, Airflow, Openings

**SELECTIVE BIBLIOGRAPHY**

**REF UK5**
**TITLE**
Moving And Cooling Air Without Use Of Energy (Provisional title)

**CONTACT**
Fitzgerald, D

**ADDRESS**
Dept. of Civil Engineering, The University of Leeds, Leeds, West Yorkshire, LS2 9JT.
UNITED KINGDOM.
TEL +44 (0532) 431751 / 332299(DL)
FAX +44 (0532) 332265
TLX 556473 / 557939

**SPECIFIC OBJECTIVES**
If the surface of the cavity wall is wet, the air, if unsaturated will move down the wall, because evaporation will cool the air. This is only the case if the air can enter at the top, and leave at the bottom. The air will then enter the room, providing ventilation and cooling, without the use of electricity.

**PROJECT DETAILS**
The wet surfaces within the cavity wall are provided by natural matting easily available in urban Egypt. Observations about the behaviour of the air within the cavity and the associated "theory" do not agree. Observations are complete, but analysis continues.

**BUILDING TYPE**

Traditional working class houses (Residences) in Cairo and climatically similar places.

**PARAMETERS**
The air entering the rooms to be ventilated will be cooler and moister than the air outside.
STARTDATE 00:00:1987
ENDATE 00:00:1989
TIME 2 person-years

**KEYWORDS**
Cavities, Ventilation, Cooling, Energy conservation, Air movement, Dwelling

**SELECTIVE BIBLIOGRAPHY**

**REF UK6**
**TITLE**
The Solar Chimney

**CONTACT**
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**SPECIFIC OBJECTIVES**
To increase ventilation, when the air outside is cool enough to be used for ventilation, without the use of electricity.

**PROJECT DETAILS**
In Southern Algeria, as in many other Third World countries windows are kept closed throughout the day, as the air outside is too warm to be used for ventilation. When the outside temperature has dropped to about 30 Degrees Celsius windows are then opened. It is then, that the "solar chimney" is designed to help. It is simply a wall outside the sunward wall (the west wall, at low latitudes), joined at the bottom, to the room which is to be ventilated. The cavity is shuttered at both top and bottom during the day when the sun heats up the walls. To increase the ventilation, both shutters are opened, and the enclosed warm air escapes due to bouyancy. The flow of air continues until the solar warmth in the walls is exhausted. After a day's exposure to the sun, the solar chimney will work for 15 to 20 hours. Thus it can be used for much more than helping ventilation; such as the moving of air (for example, for the drying of...
agricultural produce) when there is no electricity. Bouchair and Fitzgerald have shown that the system works, and have shown how to develop the idea in a way that is both efficient and cheap, (remembering that it is intended for people living in the Third World).

**BUILDING TYPE**
Single storey buildings of stone, brick or other high thermal capacity material.

**PARAMETERS**
The nature of outdoor air itself.

**STARTDATE** 00:00:1986
**ENDATE** 00:00:1989 (completed)
**TIME** 2 to 3 person-years

**KEYWORDS**
Passive Solar energy, Energy conservation, Ventilation, Cavities, Airflow

**SELECTIVE BIBLIOGRAPHY**

**REF UK7**
**TITLE**
Solar Induced Ventilation In The Algerian And Similar Climates

**CONTACT**
Bouchair, A

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**SPECIFIC OBJECTIVES**
To improve the thermal comfort, by promoting night ventilation using a sun-warmed cavity.

**PROJECT DETAILS**
The project was designed from a model (3 metres long; 2 metres wide and 2 metres high); constructed from various materials such as wood, insulation board and aluminum sheets. An electrically heated cavity provided the natural ventilation, which was measured by a thermistor-anemometer, in an unoccupied room. Observations were made under steady state conditions in a laboratory. The cavity had two heated-panelled walls of almost equal size, one fixed in position on the side of the room, while the other was movable. The end walls were variable in size and constructed from insulating board. A simulated room was constructed from wood. A data logging system was used, and theoretical predictions were made using heat and mass balances throughout the whole system, for both steady state conditions. In the unsteady state, the finite differences approach was used.

**BUILDING TYPE**
(Not Stated)

**PARAMETERS**
(Not Stated)

**STARTDATE** 00:10:1985
**ENDATE** 00:04:1989
**TIME** (Not Stated)

**KEYWORDS**
Ventilation, Cavities, Comfort, Hot climates, Passive solar, Unoccupied, Rooms, Scale model

**SELECTIVE BIBLIOGRAPHY**

**REF UK8**
**TITLE**
The Development Of A System To Measure The Airtightness Of Buildings With Low Pressure Differences

**CONTACT**
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Manchester, M60 1QD.
UNITED KINGDOM.
TEL + 44 (061) 236 3311
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SPECIFIC OBJECTIVES
To develop a system for the measurement of airtightness of buildings at low pressure differences and to use the system to measure the airtightness of a number of other buildings.

PROJECT DETAILS
The purpose of the project is to construct an apparatus to measure the airtightness of a building using AC pressurisation (also known as infrasonic), to calibrate the method and apparatus using artificial leaks and other elements connected to a very stiff and airtight chamber, and to use the calibrated method to measure the airtightness of some buildings. Results from laboratory and field trials will be compared with results from fan pressurization.

BUILDING TYPE
All

PARAMETERS
(Not Stated)

STARTDATE 01:06:1987
ENDATE 31:08:1991
TIME 8000 person-hours

KEYWORDS
Airtightness, Pressurisation, Infrasonic, Test chamber

SELECTIVE BIBLIOGRAPHY
(Not Stated)
SPECIFIC OBJECTIVES
To investigate factors that reduce dust concentrations in livestock buildings.

PROJECT DETAILS
The investigation included methods and equipment for cleaning air in livestock buildings, but due to the Government's new market-review of research this has had to be curtailed. The study now includes the factors which contribute to the dust laden atmosphere and ways of reducing the dust level by methods other than separation.

BUILDING TYPE
Intensive livestock buildings, which are mechanically ventilated.

PARAMETERS
Feeding system, flooring type, animal activity, ventilation and husbandry tasks.

STARTDATE 01:04:1988 (Current phase)
ENDATE 31:12:1992
TIME 250 person-days / year

KEYWORDS
Livestock, Dust, Indoor Air Quality (IAQ)

SELECTIVE BIBLIOGRAPHY
2 Carpenter GA et al. (1986), The effects of air filtration on air hygiene and pig performance in early winter accommodation Animal Prod 43, pp505-15.
3 Carpenter GA et al. (1986), Effect of internal air filtration on the performance of broilers and the aerial concentrations of dust and bacteria, British Poultry Sci 27, pp471-80.
Heat is transferred within an enclosed space both by convection and radiation; neither dominates the other. Heat flow to the walls by convection is driven by volume-averaged air temperature, \(T_{uv}\). The radiative exchange is much more complicated, but work under this project has shown that the radiant exchange can be handled as though "driven" by the radiant star temperature, \(T_{rs}\), a network construct, that radiant energy input can be treated as though input at \(T_{rs}\), and that \(T_{rs}\) is a fair approximation to the average observable radiant temperature in the enclosure. Two index temperatures can be derived from \(T_{av}\) and \(T_{rs}\): (i) The rad-air temperature, \(T_{ra}\); this is a low impedance node and \(T_{ra}\) can be said to drive the ventilation loss to outside and merged convective and radiation losses to solid surfaces (ii) The comfort temperature, \(T_c\); this is a high impedance node and is often taken to be the arithmetic mean of \(T_{rs}\) and \(T_{av}\). This scheme provides a logically rigorous approach to handling room heat exchange.
order to minimise the accumulation of flammable gas-air mixture within.

BUILDING TYPE
Full scale housing, domestic kitchen 20 m³ test cell, etc

PARAMETERS
Air within enclosures affects gas concentration buildup, flow of air within, and weather.

STARTDATE 00:04:1985
ENDATE 00:04:1992
TIME 25 person-years

KEYWORDS
Natural gas, Vented, Airflow

SELECTIVE BIBLIOGRAPHY

REF UK14
TITLE
Air Infiltration Into Modern, Small Factory Units

CONTACT
Fletcher, B

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Health and Safety Executive,
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FAX +44 (0741) 3034

SPECIFIC OBJECTIVES
(None Stated)

PROJECT DETAILS
(i) Sizes 170-700 m³ usually brick built with block interior. (ii) Unventilated. (iii) Tracer gas decay method (R-12). (iv) Micron infrared gas analyser. (v) Unoccupied. Factory units are in different blocks; infiltration to be related to the weather factor, (ie Wind speed and direction, temperature differences) Follow up work carried out in large exposed workshop.

BUILDING TYPE
Modern factory block, single storey (commercial)

PARAMETERS
Wind speed and direction, temperature difference

STARTDATE 00:00:1988
ENDATE 00:12:1989
TIME (None Stated)

KEYWORDS
Factory, Unoccupied, Tracer gas, Air infiltration

SELECTIVE BIBLIOGRAPHY (None Stated)

REF UK15
TITLE
Air Leakage Identification, Quantification, And Control On Industrial And Commercial Buildings

CONTACT
Lawson, Douglas

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Building Sciences Ltd,
Birchwood, PO Box 238A,
Sutton, Surrey, KT7 OUA.
UNITED KINGDOM.
TEL +44 (081)-398-2390
FAX +44 (081)-399-5735

SPECIFIC OBJECTIVES
On commercial basis provide air leakage control services to customers with comfort or energy problems.

PROJECT DETAILS
All types of buildings handled, with and without mechanical ventilation. Heating by oil, gas, district hot water, etc. Buildings almost always occupied. Leakage usually visually identified with use of a smoke pencil. If necessary a part of a building (eg an exterior wall office) can be depressurised using our blower door to highlight the air leakage. Having identified all rectifiable leakage cracks, gaps and holes in the envelope an equivalent leakage area is calculated using Ashrae and Public Works Canada formulae. Based on windage only an average air leakage is calculated and using degree days a yearly cost of leakage is calculated. A cost to rectify is provided and a simple payback period.

BUILDING TYPE
Mainly offices and commercial

PARAMETERS
Temperature and wind energy usage, Staff Comfort Reduction infill air contaminants

STARTDATE Canada 00:06:1970; UK 00:10:1986
ENDATE Ongoing
TIME Ongoing

KEYWORDS
Commercial, Office, Air leakage, Comfort, Depressurisation, Tracer gas, Occupant
behaviour, Energy, Heating System, ventilation system

SELECTIVE BIBLIOGRAPHY

REF UK16
TITLE
Ventilation In Dwellings
CONTACT
Stephen, R K
ADDRESS
Building Research Establishment, Garston, Watford, Hertfordshire, WD2 7JR. UNITED KINGDOM.
TEL +44 0923-894040
FAX +44 0923-664010
TLX 923220

SPECIFIC OBJECTIVES
To provide information on air movement and air leakage rates and routes in dwellings. To provide design guidance in relation to natural and mechanical ventilation on air movement and the control of pollutants. To contribute to various codes and standards.

PROJECT DETAILS
1 Investigate the effectiveness of ventilation openings using models and field trials, including air leakage and tracer gas measurements. 2 Develop BREVENT model to provide advice on ventilation provisions. 3 Develop test procedure for, and carry out measurements of, the flow characteristics of ventilation openings. 4 Investigate various aspects of draughtproofing of doors and windows. 5 Carry out program of field trials and modelling of passive stack ventilation systems in dwellings. 6 Investigate factors affecting entry of radon and landfill gases into buildings and the implications for ventilation design.

BUILDING TYPE
Residences

PARAMETERS
Wind, temperature, draughtproofing, air leakage, location

STARTDATE  (Not Stated)
ENDATE  (Not Stated)
TIME  (Not Stated)

KEYWORDS
Dwelling, Air infiltration, Air leakage, Draughtproofing, Passive stack ventilation, Computer simulation, Radon, Landfill gas

SELECTIVE BIBLIOGRAPHY

REF UK17
TITLE
Development Of A Computational Fluid Dynamics Program (ARIA), For Air Distribution Design
CONTACT
Awbi, HB
ADDRESS
Napier Polytechnic, Mechanical and Industrial Eng. Dept, Colinton Road, Edinburgh, SCOTLAND, EH10 5DT. UNITED KINGDOM.
TEL +44 031-444-2266
FAX +44 031-452-8532

SPECIFIC OBJECTIVES
To develop and validate a three-dimensional CFD program for simulating the airflow inside and outside buildings.

PROJECT DETAILS
The finite volume method is used to solve, by iteration Navier-Stoke's equation, the enthalpy equation, and a concentration equation in a three-dimensional co-ordinate system. The k-epsilon turbulence model is used to describe the Reynolds stress and the turbulent heat fluxes. The output is in the form of velocity vectors in 2-D slices and 3-D view; velocity, temperature, and concentration colour contours etc. Validation has been carried out on some flow problems.

BUILDING TYPE
N/A

PARAMETERS
N/A

STARTDATE 00:01:1985
ENDATE Indefinite
TIME 10000 person-hours (to date)

KEYWORDS
Computer simulation, Fluid dynamics, Airflow simulation, Heat transfer

SELECTIVE BIBLIOGRAPHY

REF UK18
TITLE
Wansbeck General Hospital - Ashington
CONTACT
Haworth, John / Throp, Bernard
ADDRESS
Powell Moya and Partners, 21 Upper Cheyne Row, London, SW3 5JW, UNITED KINGDOM.
TEL +44 071-351-3882
FAX +44 071-351-6307

SPECIFIC OBJECTIVES
300 bed district general hospital - value 21m. To design a low energy hospital to consume 40% of the energy of a "normal" hospital, St Mary's Hospital, Isle of White. The first low energy hospital was designed to consume 50% of normal.

PROJECT DETAILS
a) i) Ventilation is a combination of natural and mechanical. Building envelope is designed for 0.6 air changes per hour infiltration. In winter windows are closed and 1 A/C mechanical ventilation is provided to give 1.5 A/C total. The winter ventilation plant is provided with heat recovery.
ii) When first template is complete on site, it will be pressure tested to determine leakage.
b) A building envelope design incorporating an airtight membrane has been developed. A mock up was constructed and tested to validate the design.

BUILDING TYPE
District General Hospital

PARAMETERS
It is hoped that 0.5 A/C infiltration plus 1.0 A/C mechanical ventilation will provide acceptable indoor air quality without opening windows.

STARTDATE 05:06:1989
ENDATE 04:06:1992
TIME (Not Stated)

KEYWORDS
Hospital, Low-energy, Ventilation system, Indoor Air Quality (IAQ), Airtightness

SELECTIVE BIBLIOGRAPHY
1 The second low energy hospital study report.

REF UK19
TITLE
Measurements Of Airflow In Ducts Using Tracer Gas Techniques
CONTACT
Riffat, S B
ADDRESS
Loughborough University of Technology, Dept of Civil Engineering, Loughborough, Leicestershire, LE11 3TU. UNITED KINGDOM.
TEL +44 0509-262171 ext. 2616
FAX +44 0509-610231

SPECIFIC OBJECTIVES
Measurement of airflow in ducts using tracer gas techniques.

PROJECT DETAILS
The work is concerned with the use of different types of tracer gas techniques for measurement airflow in ducts. Measurement of tracer gas concentration, air velocity and pressure distribution at various distances from the duct's wall and inlet were made. Measurements of airflow were made using constant injection, pulse injection, and decay techniques are compared with measurements made using hot-wire anemometers and pitot tubes.

BUILDING TYPE
Ducts
PARAMETERS
Ducts: Airflow rate at different Reynolds numbers.
STARTDATE 00:00:1988
ENDATE 00:00:1990
TIME 100 person-hours

KEYWORDS
Tracer gas, Ducts, Airflow, Pressure tests, Air velocity

SELECTIVE BIBLIOGRAPHY

REFERENCE UK20
TITLE
Modelling Of Three Dimensional Conjugate Convection-Conduction Heat Transfer Processes And Turbulence In Building Spaces
CONTACT
Potter, S E & Underwood, C P
ADDRESS
Newcastle Polytechnic,
Dept of Construction,
Ellison Buildings, Ellison Place,
Newcastle upon Tyne, NE1 8ST.
UNITED KINGDOM.
TEL +44 (091) 2326002

SPECIFIC OBJECTIVES
Prediction of air movement and thermal cells in mechanically and non-mechanically ventilated spaces.

PROJECT DETAILS
Three-dimensional conjugate convection/conduction model using classical Navier-Stokes equation set with k - epsilon turbulence model and standard logarithmic wall functions. Applicability of simple constant effective viscosity model will be explored in low Reynolds's number applications, in relation to the less computer efficient k - e model.
Particular interest in thermal influence of adjacent zones on air movement in a central subject zone, and the geometry and positional design of mechanical air terminal devices. Limited model verification intended using existing data sets produced by other workers.
BUILDING TYPE
Any (with an emphasis on commercial)
PARAMETERS
Climate data, performance of building components and (of greater emphasis here) HVAC system.

REFERENCE UK21
TITLE
Development Of A Microprocessor Controlled Tracer Gas System And Measurement Of Ventilation In A Scale-Model
CONTACT
Riffat, S B
ADDRESS
Loughborough University of Technology,
Dept of Civil Engineering,
Loughborough, Leicestershire, LE11 3TU.
UNITED KINGDOM.
TEL +44 0509-263121 ext 2616
FAX +44 0509-610231
TLX 347282

SPECIFIC OBJECTIVES
Development of a microprocessor controlled tracer gas system which is capable of collecting a large number of tracer gas samples at short or long intervals.

PROJECT DETAILS
The work is concerned with the development of a tracer gas system which could be used for accurate measurement of airflow through openings, e.g. cracks, windows and doorways. The sampling speed of the system can be adjusted so that a larger number of tracer gas samples can be collected during the transient period of an experiment and smaller number during the dominant period. This technique minimises the error in the term dC/dt (Delta C over Delta t) and hence allows an accurate estimation of airflow rate to be made.
Measurement of window ventilation and interzone air movement have been made in a scale model.
BUILDING TYPE
Scale model of a house
PARAMETERS
Wind speeds and direction, and area of the windows
STARTDATE 01:10:1988
ENDATE 01:10:1990
TIME 120 person-hours
KEYWORDS
Tracer gas, Ventilation, Scale model, Multizone, Airflow

SELECTIVE BIBLIOGRAPHY
1 Development of a microprocessor controlled tracer gas system and measurement of ventilation in a scale model - 10th AIVC Conf. Finland, 1989.

REF UK22
TITLE
Newham Hybrid Solar Roofspace Heating System
CONTACT
Tindale, Andrew
ADDRESS
Polytechnic of Central London, Research Building, 35 Marylebone Road, London, NW1 5LS. UNITED KINGDOM.
TEL 01 486 5811
SPECIFIC OBJECTIVES
To demonstrate the effectiveness of solar roofspace technology in the UK
PROJECT DETAILS
Six 35m² floor area two storey houses in Plaistow, East London, were retrofitted with solar roofspace heating systems. The houses are inter-war local authority with solid floors and cavity filled walls, double glazed and fully draughtstriped. Ventilation tests played a relatively minor role in the experimentation. Three ventilation assessment techniques were used on the houses, each with a different objective: 1) Pressurisation tests to give relative uniformity of roofspaces and house construction. 2) Tracer gas tests gave absolute values of ventilation in one house and roofspace and 3) Air speed measurements showed solar heated air delivery rates.
BUILDING TYPE
Local authority residential, inter-war, brick
PARAMETERS
State of various vents (automatically and manually operated)
STARTDATE 00:00:1985
ENDATE 00:06:1989
TIME 6300 person-hours (approx)
KEYWORDS
Solar energy, Roof-spaces, Passive solar, Tracer gas, Pressurisation

SELECTIVE BIBLIOGRAPHY
2 A Tindale et. al. (1989), Hybrid solar roofspace heating systems Final report to CEC, August 1989.

REF UK23
TITLE
Ventilation In Non-Domestic Buildings.
CONTACT
Perera, M D A E S & Walker, R R
ADDRESS
Building Research Establishment, Garston, Watford, Herts., WD2 7JR UNITED KINGDOM.
TEL +44 0923-894040
FAX +44 0923-664010
SPECIFIC OBJECTIVES
To develop, validate and provide methods for measuring ventilation and controlling infiltration in large and complex non-domestic buildings and to identify the factors which determine the magnitude of natural ventilation.
PROJECT DETAILS
a) To measure leakage characteristics of large non-domestic buildings using the multifan pressurising system, BREFAN. b) To measure ventilation rates in large buildings using the BRE simplified infiltration measurement (BRESIM) technique. c) To develop passive techniques, using perfluorocarbons, to measure average infiltration and ventilation rates. d) To measure infiltration rates and air tightness of large, single-celled buildings and compare with prediction procedures. e) To measure
ventilation effectiveness in office buildings. f) To establish surface pressure-coefficient database from wind tunnel measurements and to enhance the user-friendly BREEZE multicell airflow computer program.

BUILDING TYPE
Large non-domestic commercial and public buildings

PARAMETERS
Wind, temperature, draughtproofing, air leakage

STARTDATE (Not Stated)
ENDATE (Not Stated)
TIME (Not Stated)

KEYWORDS
Non-domestic, Air infiltration, Air leakage, Multicell computer simulation, Tracer gas, Passive perfluorocarbon techniques (PFT), Pressurisation

SELECTED BIBLIOGRAPHY
Various publications - Consult AIVC Airbase

SPECIFIC OBJECTIVES
1 To determine the validity of the multizone model as a tool for measuring and predicting air movement patterns in industrial buildings, and 2. To determine the indices of air change efficiency and ventilation effectiveness which are most suitable for describing air quality in industrial buildings.

PROJECT DETAILS
Since the early 1980's the ESP system has been equipped to perform building air flow simulation based on a zonal mass balance technique. This project aims to extend this facility in two related aspects: 1 To improve the speed of convergence of the solution of the non-linear flow equations. 2 To extend the approach by the introduction of additional characteristic equations to represent plant-side flow regimes. The objective is to produce a simultaneous solution of the fluid and thermal processes associated with the building and its plant.
be used. Tracer gas measurements on laboratory models are being carried out to provide (i) data to validate the theoretical work, (ii) comparisons between methods of measuring air change efficiency, and (iii) a test bed facility for measurement techniques. The project includes a program of field measurements in industrial buildings.

BUILDING TYPE
Large single cell/industrial

PARAMETERS
Size of zone, and subdivision of zone.
STARTDATE 00:09:1987
ENDATE 00:09:1992
TIME 12000 person-hours

KEYWORDS
Infiltration, Tracer gas, Scale model, Ventilation effectiveness, ventilation efficiency, Air movement, Air change rates, Industrial

SELECTED BIBLIOGRAPHY
2 Lawrence G V & Waters J R (1987), Measurements of Infiltration and air movement in five large single cell buildings. 8th AIVC Conference, September 1987.

REF UK26
TITLE
Improvement In The Working Environment
CONTACT
Winch, G W
ADDRESS
University of Manchester, Dept. of Architecture, Manchester, M13 9PL, UNITED KINGDOM.
TEL +44 061 276 6934
FAX +44 061 275 6934

SPECIFIC OBJECTIVES
Instrumented studies of work spaces to secure improvement in air quality and thermal comfort.

PROJECT DETAILS
Quantitative studies of various work spaces to analyse problems and assess causative factors and remedial measures, e.g. airborne particulates and gaseous contaminants, air temperature and motion, air humidity, surface temperatures, ventilation rates, noise levels, lighting levels, etc.

BUILDING TYPE
All types

PARAMETERS
Ventilation rate, thermal comfort, contaminant levels, energy factors.
STARTDATE 01:01:1974
ENDATE ongoing
TIME (Not Stated)

KEYWORDS
Health, Environment, Sick Building Syndrome (SBS), Retrofit, Solar radiation, Indoor Air Quality (IAQ), Thermal comfort, Energy conservation

SELECTED BIBLIOGRAPHY

REF UK27
TITLE
Airflow Characteristics Of Buildings.
CONTACT
Croome, D J & Yusof, M Z M
ADDRESS
University of Reading, Dept of Construction Management, Whiteknights, P O Box 219, Reading RG6 2BU, UNITED KINGDOM.
TEL +44 0734 875123
FAX +44 0734 313856
TLX 847813

SPECIFIC OBJECTIVES
In order to plan buildings the interaction between energy and environmental parameters needs to be understood. This includes the effect of occupants. The airflow characteristic is defined by the entrance, corridor, door and window interaction. Between all shut and all open, there are a range of conditions that can occur which effect comfort and energy. This research programme is aiming to carry out field trials in several different types of building and: (i) Explore the interaction between ventilation with occupancy patterns and internal buildings
form. (ii) Test various modelling techniques and develop one method which can be incorporated into a design method. (iii) Compare measurements of air change rate and air movement with prediction. (iv) Assess the thermal comfort in the selected spaces based on ISO 7730 but also derive a freshness component. (v) Study the relationship between weather patterns and indoor air patterns.

**PROJECT DETAILS**

a) Measurement in building: (i) brick type construction; (ii) naturally ventilated, and hot water radiators, (iii) tracer gas measurements, temperature, air velocity and comfort level measurements, (iv) instrumentations: thermistors for temperature, constant temperature anemometer for room air velocity, thermal comfort meter and indoor environmental analyser. Infra-red gas analyser for ventilation measurement. Data Logging system, (v) type of occupancy: occupied and unoccupied. b) Theoretical/model calculations using existing methods/model, such as the BRE and LBL models.

**BUILDING TYPE**

Schools

**PARAMETERS**

a) weather (temperature, window humidity, solar radiational, b) windows and doors, c) occupancy patterns (real and simulated) d) building orientation

**STARTDATE** 00:03:1989

**ENDATE** 00:09:1993

**TIME** (Not Stated)

**KEYWORDS**

Natural ventilation, Airflow, Occupant behaviour, Thermal comfort Energy conservation, Air change rates

**SELECTED BIBLIOGRAPHY.**

1) Yusof M Z M & Croome D J (1990), Building Planning and Ventilation: Effects of Natural Ventilation via Windows and Doors linked by Corridor/Passageway, (to be presented at Roomvent 90 International Conference in Oslo, 13-15 June 1990)
Energy, Comfort and Air movement

STARTDATE 00:00:1986
ENDATE 00:00:1990
TIME 19200 person-hours

KEYWORDS
Factory, Energy consumption, Air movement, Thermal comfort

SELECTED BIBLIOGRAPHY (None Stated)

REF UK30
TITLE
Airflow Modelling Using Computational Fluid Dynamics.
CONTACT
Whittle, Geoff E
ADDRESS
Arup Research and Development, 13, Fitzroy Street, London, W1P 6BQ. UNITED KINGDOM.
TEL + 44 071 636 1531 ext. 3437
FAX + 44 071 436 7109
TLX 295341 OVARPT G

SPECIFIC OBJECTIVES
To develop computational fluid dynamics (CFD) methods for airflow modelling in buildings.

PROJECT DETAILS
An in house CFD code (AIRFLO) is under development to predict air movement, temperature distribution and ventilation effectiveness in buildings. The code is a finite volume, Navier Stokes solver which uses a pressure coupled formation. Applications include most types of non-domestic buildings, including offices, large spaces such as atria and process environments. Areas of specific modelling interest include turbulence, improving convergence rate for (High Rayleigh number), buoyant flows, transient simulation for inherently non-steady flows, interaction with (dynamic) thermal model and improving useability.

BUILDING TYPE
Non-domestic buildings

PARAMETERS
Building geometry, fabric, system, weather

STARTDATE 00:04:1988
ENDATE Ongoing (Reviewed annually)
TIME 1600 person-hours / year

KEYWORDS
Air movement, Temperature distribution, Fluid Dynamics, Airflow

SELECTED BIBLIOGRAPHY

1 Whittle G E et. al. (in preparation)
Comutation of conduction, convection and radiation in the perimeter zone of an office space.

REF UK31
TITLE
The Development Of A Methodology For The Categorisation Of Ventilation Systems.
CONTACT
Limb, Mark
ADDRESS
Air Infiltration And Ventilation Centre, University of Warwick Science Park, Barclays Venture Centre, Sir William Lyons Road, Coventry, CV4 7EZ, UNITED KINGDOM.
TEL +44 0203 692050
FAX +44 0203 416306

SPECIFIC OBJECTIVES
The aim is to examine the ventilation systems typically used in different regions of the world, and try to relate their characteristics, to the ventilation design criteria, building type and climate of that region.

PROJECT DETAILS
The project falls naturally into 4 sections:
1 - Ventilation Design Criteria. This section will review national codes and standards, with the aim of identifying present environmental criteria used for the design of ventilation systems.
2 - Regional Climate. This section will identify a climatic classification system, which will allow the characterisation of climatically similar areas in a manner appropriate to building design.
3 - Construction Methods. This section will highlight the construction methods currently employed in various climatically similar areas.
4 - Ventilation Systems. The final section will be the most substantial and constitute the greater part of the work. Firstly methods of providing ventilation will be surveyed, and systems will be classified by the methods air is introduced, circulated and extracted from the building. A survey will be circulated in order to obtain the information for this section. A preliminary classification of systems will be adopted initially, and changed in the light of replies. Secondly parameters will be sought which will provide an adequate description of the systems, such as parameters that can be used to establish
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correlations with building type, climate classification and regional characteristics. Thirdly, the comparisons which provide the strongest correlations will be used to prepare a general ventilation classification system which can be used by designers to identify the most favourable strategy for a specific design problem.

**BUILDING TYPE**

All

**PARAMETERS**

Ventilation systems, Ventilation design criteria, Climatic parameters Construction methods.

**STARTDATE 00:10:1989**

**ENDATE 00:06:1992**

**TIME 2800 person-hours**

**KEYWORDS**

Ventilation systems, Ventilation strategies, Survey, Climatic parameters

**SELECTED BIBLIOGRAPHY**


2 Colthorpe K (1990), A review of building airtightness and ventilation standards. Pub. IEA\AIVC publication (In print)

**REF UK32**

**TITLE**

Air Infiltration And Ventilation Centre's Numerical Database.

**CONTACT**

Piggins, James

**ADDRESS**

Air Infiltration and Ventilation Centre, University of Warwick Science Park, Barclays Venture Centre, Sir William Lyons Road, Coventry, CV4 7EZ, UNITED KINGDOM.

TEL +44 (0203) 692050

FAX +44 (0203) 416306

TLX 312401

**SPECIFIC OBJECTIVES**

To produce a numerical database of air infiltration and ventilation related information.

**PROJECT DETAILS**

This project will produce a numerical database of core data from as many available sources as possible, and present them in an easily accessible form for use by researchers and specialist consultants. The whole database will be available on disc and selected portions in printed form. The subject areas covered will be: Basic climatic data, International standards, Wind pressure coefficients and associated algorithms, Building and component leakages, Air change rates, Interzonal air flow, Ventilation effectiveness, Airflow patterns, Pollutant transport, Occupant effects, Ventilation heat loss and Cost effectiveness data.

**BUILDING TYPE**

All

**PARAMETERS**

All

**STARTDATE 00:06:1989**

**ENDATE 00:04:1992**

**TIME 1350 person-hours**

**KEYWORDS**

Database, Ventilation, Infiltration, Climatic parameters, Weather

**SELECTED BIBLIOGRAPHY**


**REF UK33**

**TITLE**

Ventilation and Heat Recovery.

**CONTACT**

Lilly, J P

**ADDRESS**

British Gas Plc.

Watson House, Peterborough Road, London, SW6 3HN.

UNITED KINGDOM.

TEL +44 071 736 1212 ext. 3043

FAX +44 071 731 1648

TLX 919082

**SPECIFIC OBJECTIVES**

1. To develop theoretical and experimental methods for determining ventilation and indoor air quality.

2. To develop practical domestic heating and ventilating systems for the improvement of the indoor environment for temperate maritime climates.

**PROJECT DETAILS**

1(a) Refinement of British Gas multi-cell ventilation model with intercell flows validated
with wind tunnel data and measurement in unoccupied dwellings. (b) Continued refinement of constant concentration, emission and decay ventilation measurement techniques in all building types (SF6, N2O). (c) Use of pressurisation tests in all building types. 2 Development of combined heating and mechanical ventilation/heat recovery systems for traditional and low energy dwellings.

**BUILDING TYPE**
Objective: 1 All buildings Objective: 2 Domestic and low energy buildings.

**PARAMETERS**
Weather conditions, occupant behaviour building construction, leakage area, exposure, tracer gas measurements, mathematical models.

**STARTDATE** 01:04:1989
**ENDATE** 31:03:1991
**TIME** 25000 person-hours

**KEYWORDS**

**SELECTED BIBLIOGRAPHY**

**REF UK34**
**TITLE**
A Model For Robust Prediction Of Infiltration And Ventilation.

**CONTACT**
Alexander, D K

**ADDRESS**
Welsh School of Architecture, UWCC, PO Box 25, Cardiff, CF1 3XE.

**UNIVERSITY OF WELSH COMMENAL COLLEGE**
**TEL** +44 0222 874000 ext. 5959
**FAX** +44 0222 874192

**SPECIFIC OBJECTIVES**
To develop and explore utility of, a multicell infiltration model with inbuilt Monte-Carlo methods.

**PROJECT DETAILS**
A multicell infiltration model is enhanced to include Monte-Carlo methods in its procedures, so that input parameters (Such as crack areas, pressure coefficients, wind direction) can be statistically perturbed. The resulting model should provide both a more robust estimate of infiltration and pathways than a single parameter run, and a measure of uncertainty in the result.

**BUILDING TYPE**
Domestic (Residence)

**PARAMETERS**
Component leakage, Weather conditions, Occupant behaviour

**STARTDATE** (Not Stated)
**ENDATE** (Not Stated)
**TIME** (Not Stated) (Persona/ Research)

**KEYWORDS**
Infiltration, Airflow simulation, Multizone, Dwelling, Air leakage

**SELECTED BIBLIOGRAPHY**
methodology. Performance terms of Energy, Amenity and cost will be evaluated. As part of this programme, some measurements of ventilation parameters, i.e., leakage, infiltration, air quality, window opening etc, will be undertaken in many of the buildings as the design/intent dictates.

**BUILDING TYPE**
Domestic; non domestic

**PARAMETERS**
Computer performance, occupant behaviour, meteorological conditions

**STARTDATE** 00:00:1985
**ENDATE** 00:00:1991
**TIME** (Not Stated)

**KEYWORDS**
Measurement, Passive solar, Infiltration, Indoor Air Quality (IAQ), Occupant behaviour

**SELECTED BIBLIOGRAPHY**

**REF UK36**
**TITLE**
Environmental Comparison Between Air Conditioned And Non Air Conditioned Buildings.

**CONTACT**
Potter, I N

**ADDRESS**
B.S.R.I.A, Old Bracknell Lane West, Bracknell, Berkshire, RG12 4AH.
UNITED KINGDOM.
TEL 0344 426511
FAX 0344 487575

**SPECIFIC OBJECTIVES**
Determine symptom prevalence between the two groups of buildings.

**PROJECT DETAILS**
The difference in the environmental conditions in air-conditioned, mechanically ventilated, and naturally ventilated buildings is being examined. This involves using a thermal comfort meter, luminance contrast meter, 1/3 octave band noise level meter, CO₂ analyser, respirable particle mass monitor, and ion concentration analyser. Room air movement surveys and humidity measurements are also made. Occupants clothing and activity levels will be assessed. In addition particle size counts between 0.3 - 10 microns, formaldehyde levels, carbon monoxide concentrations and degree of light flicker will be investigated where considered appropriate. A doctor administered questionnaire will be used to characterize each building and used to examine any relationship between symptoms and the environmental parameters measured.

**BUILDING TYPE**
Offices

**PARAMETERS**
(See Project Details)

**STARTDATE** 00:04:1989
**ENDATE** 00:04:1992
**TIME** 2500 person-hours

**KEYWORDS**
Indoor Air Quality (IAQ), Office, Measurements, Questionnaire

**SELECTED BIBLIOGRAPHY** (None Stated)

**REF UK37**
**TITLE**
Ventilation Heat Loss In Factories And Warehouses.

**CONTACT**
Potter, I N

**ADDRESS**
BSRIA, Old Bracknell Lane West, Bracknell, Berkshire, RG12 4AH.
UNITED KINGDOM.
TEL 0344 426511 FAX 0344 487575

**SPECIFIC OBJECTIVES**
Measure the air leakage characteristics of factory and warehouse buildings using a mobile pressurisation test facility.

**PROJECT DETAILS**
Growing evidence and recent BSRIA studies show that in factory and warehouse type buildings the actual leakage rates are significantly higher than necessary. This project provides a purpose assembled mobile measurement platform which can be reversed up to a door without intrusion to the electrical system of the building to provide the necessary
air tightness of the building by measuring its pressure/flow characteristics. During this project at least twelve units of different construction types will be tested, establishing a reference database for relatively large open cell structures. In addition it will identify the more inefficient construction types and provide data for more accurate sizing of heating and/or de-humidification plant.

**BUILDING TYPE**
Factories and Warehouses

**PARAMETERS** *(Not Stated)*

**START DATE** 00:04:1989
**EN DATE** 00:12:1990
**TIME** 1000 person-hours

**KEYWORDS**
Air leakage, Pressurisation, Heat loss

**SELECTED BIBLIOGRAPHY** *(None Stated)*

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**REF UK38**

**TITLE**
Fresh Air Controllers.

**CONTACT**
Jones, T J

**ADDRESS**
BSRIA,
Old Bracknell Lane West,
Bracknell, Berkshire, RG12 4AH.
UNITED KINGDOM.
TEL 0344 426511
FAX 0344 487575

**SPECIFIC OBJECTIVES**
Design criteria for the control of minimum fresh air requirements, particularly in VAV mechanical ventilation systems.

**PROJECT DETAILS**
A number of fresh air/recirculated arrangements will be investigated under laboratory conditions to examine their ability to control the fresh air requirements, namely constant volume, and single and dual duct variable air volume (VAV) systems. Each system will be constructed following current design procedures. The control characteristics of damper actuators to various controllers and the effect of sensor location and duct layout will be investigated. The adequacy of fresh air supply over a full turndown range of airflow rates, given the response of the damper actuators to the controller to be addressed. The experience gained from this investigation will be used to provide recommendations for commissioning these systems, with respect to maintaining fresh air requirements.

**BUILDING TYPE**
Offices and Commercial buildings

**PARAMETERS** *(Not Stated)*

**START DATE** 00:09:1989
**EN DATE** 00:12:1990
**TIME** 500 person-hours

**KEYWORDS**
Controllers, Fresh air, VAV, Mechanical ventilation system, Guidelines

**SELECTED BIBLIOGRAPHY** *(None Stated)*

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**REF UK39**

**TITLE**
Performance Of CO2 Controlled Mechanical Ventilation Systems.

**CONTACT**
Booth, W B

**ADDRESS**
BSRIA,
Old Bracknell Lane West,
Bracknell, Berkshire, RG12 4AH.
UNITED KINGDOM.
TEL 0344 426511
FAX 0344 487575

**SPECIFIC OBJECTIVES**
Review the use of CO2 controlled mechanical ventilation systems, and assess the possible energy savings.

**PROJECT DETAILS**
Many types of buildings, eg theatres, retail store and entertainment establishments experience highly variable occupancy levels. The greater the fresh air supplied to a building may be significantly greater than required during reduced building usage. As occupants raise the level of CO2 by respiration, the fresh air supplied could be controlled as a function of occupancy density. Previous studies have highlighted the potential energy savings of such systems, and they have now become more widespread. This project will extend previous studies to include the reliability of such systems and identify those building types which may need modification of their systems and/or unsuitable for this type of control regime.

**BUILDING TYPE**
Buildings with variable occupancy

**PARAMETERS**
CO2

**START DATE** 00:04:1989
**ENDATE** 00:04:1990
**TIME** 500 person-hours
**KEYWORDS**
Carbon dioxide (CO2), Controls, Occupancy levels, Demand Controlled Ventilation (DCV)
**SELECTED BIBLIOGRAPHY** (None Stated)

**UNITED STATES OF AMERICA**

**REF USA1**
**TITLE**
The Relationship of High Residential Radon Readings With Geological Faults
**CONTACT**
Lane, Fletcher
**ADDRESS**
Home Conserv, 40 Wilson Blvd, Eagleville, PA, 19403 USA.
**TEL** +1 215-296-8737
**SPECIFIC OBJECTIVES**
To determine if surface faults can be used to predict a high probability of high radon readings.
**PROJECT DETAILS**
All types of residential and commercial structures less than 3 stories, may be tested, using a 3-month testing device and an Alpha-Track etch unit. The type of heating and ventilation system will also be noted, as well as the time of year of the test; since Winter is believed to produce the highest levels of Radon (due to heating system De-pressurisation). The water supply system (public, private) will also be noted, as private wells may offer an additional entry point.
**BUILDING TYPE**
Residential and Commercial (less than 3 stories)
**PARAMETERS**
The distances of high readings (4pCi/L) taken from PA Geological Survey - ie via Indentified surface faults.
**STARTDATE** 00:02:1989
**ENDATE** 00:00:1992
**TIME** 450 person-hours
**KEYWORDS**
Radon, Geology, Residential, Commercial
**SELECTED BIBLIOGRAPHY**

1 Sachs H M et. al. (1982), Regional geology and radon variability in buildings, Environ Int., Vol 8, pp97-103.

**REF USA2**
**TITLE**
Measurement Of Ventilation In A Scale Model Enclosure
**CONTACT**
Kuehn, Thomas H & Ramsey, James W
**ADDRESS**
University of Minnesota, Dept. of Mechanical Engineering, 111 Church Street SE, Minneapolis, MN. 55455-0111, USA.
**TEL** +1 612-625-4520
**FAX** +1 612-625-6069
**SPECIFIC OBJECTIVES**
To measure air velocity magnitude and direction, turbulence intensity, local temperature and local tracer gas concentrations.
**PROJECT DETAILS**
A scale model of a commercial office area is being constructed to perform measurements with various ceiling diffusers and return grilles and office furnishing configurations. The chamber will contain temperature controlled walls for buoyant measurements and access for flow visualisation. Data will be obtained using a computer controlled robotic data acquisition system. The chamber can be used to simulate heating or cooling situations with local hot or cold spots to simulate windows or unit heaters, The data will be used to check existing computer simulation codes for the prediction of indoor velocity and contaminant gas concentration as a function of configuration, air supply rate and buoyancy.
**BUILDING TYPE**
(Not Stated)
**PARAMETERS**
(Not Stated)
**STARTDATE** 00:01:1989
**ENDATE** 00:12:1991
**TIME** 5000 person-hours
**KEYWORDS**
Measurement, Scale model, Test chamber, Turbulence
**SELECTED BIBLIOGRAPHY** (None Stated)
**REF USA3**

**TITLE**
Measurements Of Moisture Permeability And Equilibrium Moisture Content Of Common Building Materials In The United States

**CONTACT**
Kuehn, Thomas H & Ramsey, James W

**ADDRESS**
University of Minnesota, Dept of Mechanical Engineering, 111 Church Street SE, Minneapolis, MN 55455-0111, USA.

**TEL** +1 612-625-4520

**FAX** +1 612-625-6069

**SPECIFIC OBJECTIVES**
To measure moisture permeability and equilibrium moisture content of common building materials in the US.

**PROJECT DETAILS**
A new moisture permeability chamber has been designed and constructed to obtain moisture permeability measurements under both isothermal and non-isothermal conditions. Each side of the test specimen maintained at a set humidity level. Initial tests are being performed for isothermal conditions with gypsum board. Later tests will be conducted under temperature and moisture concentration gradients. An equilibrium moisture apparatus is also being constructed to measure the equilibrium moisture content of typical building materials and to serve as a pre-conditioning chamber for the permeability tests.

**BUILDING TYPE**
Interior construction materials

**PARAMETERS**
Moisture adsorption-desorption, transient moisture storage in building materials.

**STARTDATE** 00:00:1987

**ENDATE** 00:12:1990

**TIME** 3000 person-hours

**KEYWORDS**
Adsorption, Moisture, Indoor climate

**SELECTED BIBLIOGRAPHY**
(None Stated)

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**REF USA4**

**TITLE**
Complete Airtight Housing Manual

**CONTACT**
Stum, Karl R

**ADDRESS**
Enviro-Sun, 1643 North 645 West, Orem, Utah 84057, USA.

**TEL** +1 (801)224-1274

**FAX** +1 (801) 226-1196

**SPECIFIC OBJECTIVES**
To publish a manual for designing and building airtightened houses.

**PROJECT DETAILS**
The manual will cover all aspects of designing and building airtightened houses, including theory and practical applications (illustrated) of moisture and air movement, indoor air quality, theory, control and codes, methods of venting, heat recovery methods, simplified air change and related calculations, and complete economic analyses.

**BUILDING TYPE**
Residential

**PARAMETERS**
Instruct designers and builders on superior methods to control air leakage and indoor air quality, including background theory.

**STARTDATE** 00:00:1986

**ENDATE** 00:12:1989

**TIME** 600 person-hours

**KEYWORDS**
Air Infiltration, Indoor Air Quality (IAQ), Airtightness, Mechanical ventilation, Air change rate

**SELECTED BIBLIOGRAPHY**
3 Stum K R (1988), Predicting the Contributing Effects of Occupants on the Total Air Change in Houses.

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**REF USA5**

**TITLE**
The Development Of CONTAMps88 and CONTAMps89: A Professional Series Of Programs For Indoor Air Quality Analyses.

**CONTACT**
Axley, J

**ADDRESS**
Building Technology Program, Department of Architecture,
SPECIFIC OBJECTIVES
The objective of the project is the development of a professional series of indoor air quality analysis programs, directed towards the day-to-day needs of the professional communities involved in building design, construction, and operation (e.g., building engineers, architects, hygienists, health officials, and operators). These programs will be based, from a theoretical point of view, on the mathematical and numerical procedures contained in the NIST (NBS) IAQ Model, developed at NIST over the past three years and, from a user’s point of view, upon the development of a graphical user’s interface that stresses the diagrammatic representation of a given building airflow system.

PROJECT DETAILS
The project will involve the completion of the first member of the Professional Series, CONTAMps88, a contaminant dispersal analysis program whose development was initiated at NIST with the encouragement of the Environmental Protection Agency, followed by the development of the second member of the Professional Series, CONTAMps89. The primary objective in the development of CONTAMps88 is the development of a workable graphical users’ interface based on conventional airflow system diagrammatic conventions. This program is, therefore, being developed using the advanced program development systems for graphic users’ interfaces available only on Macintosh microsystems. CONTAMps88 will then be exported to the IBM PC microsystems, so that the results of this work can realize the widest distribution, and some additional capabilities added to develop the second member of the series, CONTAMps89. Both programs will be developed utilizing advanced data structures and numerical procedures that will provide the computational framework needed for the integration of building network airflow analysis, with contaminant dispersal analysis in future generations of the series.

BUILDING TYPE
Applies to whole buildings with flow systems or arbitrary complexity and is, therefore, not limited to a specific building type.

PARAMETERS
These programs relate the spatial and temporal variation of contaminant concentration to airflow into, out of, and within building systems, contaminant generation characteristics, and the kinetic characteristics of other (nonflow) mass transport processes that may affect the dispersal of contaminants in whole-building airflow systems of arbitrary complexity.

STARTDATE 01:04:1989
ENDATE 01:04:1990
TIME 2000 person-hours

KEYWORDS
Indoor Air Quality (IAQ) simulation,
Contaminant distribution

SELECTED BIBLIOGRAPHY
6 Axley J (1987), Indoor Air Quality Modelling Phase II, Report NBSIR 87-3661 USDOC,NBS, Gaithersburg, MD1987
8 Axley J (1988), Progress Toward a General Analytical Method For Predicting Indoor Air
Pollution in Buildings: Indoor Air Quality
Modeling Phase III Report NBSIR 88-3814
USDOC,NBS, Gaithersburg, MD 1988
9 Axley J (1989) Multi-Zone Dispersal Analysis
by Element Assembly, Building and
Environment Vol24, No2: pp 113-130, 1989
10 Grot R & Axley J (1987), The development
of a Model for the Prediction of Indoor Air
Quality in Buildings, Proceedings of the 8th
AIVC Conference: Ventilation Technology
Research and Application 1987.

REF USA6
TITLE
The Development Of DTFAM: A Program For
The Analysis Of The Coupled Airflow And
Thermal Problem In Whole-Building
Simulation
CONTACT
Axley, J W (1) and Grot, R (2)
ADDRESS
1. Building Technology Program,
Dept of Architecture,
Massachusetts Institute of Technology,
2A313, Building 226,
National Institute of Standards and Technology,
Gaithersberg, MD, 20899, USA.
2. Indoor Air Quality and Ventilation Group,
National Institute of Standards and Technology
13-437, 77 Massachusetts Avenue,
Cambridge, MA 02139, USA.
TEL 1. + 1 (617) 258-7352
2. + 1 (301) 975-6430
SPECIFIC OBJECTIVES
The objective of the project is the development
of a theoretical and computational
implementation of an approach to solve the
coupled airflow and thermal problem in whole
building systems.
PROJECT DETAILS
This project will integrate discrete methods of
building thermal analysis and building airflow
analysis developed earlier at NIST and
implemented in the programs AIRMOV,
AIRNET, and DTAM1 to develop an approach
to the coupled airflow and thermal analysis
problem in building simulation. The theoretical
framework has been set and a first
implementation of this theory has been
completed in the program DTFAM (Discrete
Thermal and Flow Analysis Method) First
numerical investigations using this program will
be initiated presently.
BUILDING TYPE
Applies to whole buildings with flow and
thermal systems or arbitrary complexity and is,
therefore, not limited to specific building type
PARAMETERS
DTFAM and the underlying theory relate the
spatial and temporal variation of system
temperatures, pressures, and discrete flow rates
to thermal and airflow driving forces and the
physical parameters that are chosen to
classify the thermal and airflow
characteristics of whole-building systems
STARTDATE 00:10:1988
ENDATE 00:04:1990
TIME (Not Stated)
KEYWORDS
Airflow simulation
SELECTED BIBLIOGRAPHY (Not Stated)

REF USA7
TITLE Determination Of Interzonal Air
distribution Using A Single Tracer Gas
CONTACT
Crawford, R
ADDRESS
1206 W Green Street,
Urbana, IL 61801,
USA.
TEL 1. + 1 (217) 333-4108
2. + 1 (217) 244-6534
SPECIFIC OBJECTIVES
Determine volumetric airflow rates and effective
zone volumes in buildings using pulsed tracer
gas concentration data.
PROJECT DETAILS
State-space control theory and system
identification techniques are being developed
for this application. A laboratory test facility
with three well-mixed zones (15m³, 15m³, and
30m³) and controlled interzonal airflow rates
(05 to 50 l/s) has been built to validate the
developed procedure using CO₂ as a tracer gas.
A computer-based data acquisition and control
system is used to control and measure the CO₂
pulse injections, interzonal airflow rates, and
CO₂ zone concentrations
BUILDING TYPE
Controlled laboratory test facility
PARAMETERS
Tracer gas concentrations
ATTIC VENTILATION PROJECT

CONTACT
Rose, William B

ADDRESS
Small Homes Council,
University of Illinois,
1E St Mary's Road,
Champaign, IL 61820,
USA.

TEL +1 (217)-333-1801
FAX +1 (217)-244-2204

SPECIFIC OBJECTIVES
To measure residential attic performance - heat, moisture, air movement.

PROJECT DETAILS
Eight residential attic assemblies are constructed above controlled spaces. Each study bag measures 8 inches x 20 inches. Three variables are studied: attic volume (flat ceiling/vaulted ceiling); attic connection to outdoor air (coupled/uncoupled); attic connection to indoor air at 70°F 50%RH (coupled, uncoupled). Measured values in each bay are: wood moisture content, surface temperature, air temperature, air humidity, moisture flux (between sheathing surface and attic air), air velocity through openings, heat flux, weather. Air flow measurements will be compared to tracer gas results to verify actual air flow rates.

BUILDING TYPE
Residential attic

PARAMETERS
Semi-quantitative "severity index" based upon colony count per square inch, air velocity, and additional dispersion model parameters

STARTDATE 00:00:1988
ENDATE 31:12:1990

KEYWORDS
Residential, Dwelling, Attic, Tracer gas

SELECTED BIBLIOGRAPHY
(Not Stated)
SPECIFIC OBJECTIVES
Quantify the reduction in leakage area due to AIB’s for single-wide and double-wide "mobile" homes.

PROJECT DETAILS
In the first phase of the project, existing measurements, obtained with a decay tracer gas technique, measurements of gas decay, wind speed, indoor and outdoor temperatures for 708 hours in Winter, Spring and Summer were used to estimate the equivalent leakage areas of two single-wide HUD-code manufactured homes: one caulked, and one with AIB. In the second phase of the project, blower door tests will be undertaken on both single-wide and double-wide homes. An attempt will be made to characterise the reduction in leakage areas as a function of envelope surface area, wall surface area, or some other physical characteristic of these homes.

BUILDING TYPE
"Mobile" homes, factory-produced

PARAMETERS
Wind speed, indoor air temperature, outdoor air temperature

STARTDATE 00:00:1988
ENDATE 00:00:1991
TIME 1800 person-hours

KEYWORDS
Leakage area, Mobile-homes, Tracer gas, pressurisation, Blower doors

SELECTED BIBLIOGRAPHY
1. TulucA A N, Sherman M H, & Krrarti M, (1990) (No Title Stated)
leakiness and overall heating system efficiency; validated by comparison to long-term monitored data, computer simulation, and uncertainty analysis.

BUILDING TYPE
House (Residential)

PARAMETERS
Performance of the building envelope and heating system
STARTDATE 00:09:1988
ENDATE 00:07:1990
TIME 4000 person-hours

KEYWORDS
Building performance, Heating systems, Measurement, Energy, Retrofit, Tracer gas, Simulation, Dwelling

SELECTED BIBLIOGRAPHY
1 Duffy J J & D H Saunders (1987), Low cost methods for evaluation of the space conditioning efficiency of buildings, University of Lowell report to NAHB National Research Center.


REF USA13
TITLE Northwest Residential Infiltration Survey (NORIS)
CONTACT Parker, Graham B
ADDRESS Battelle Pacific Northwest Laboratories, Battelle Blvd, Richland, WA, 99352, USA.
TEL +1 (509) 375-3805
FAX +1 (509) 375-3614

SPECIFIC OBJECTIVES
Measure the infiltration and ventilation characteristics of new (post 1980), electric-heat single family detached homes in the Bonneville Power administration service area.

PROJECT DETAILS
NORIS was conducted in two cycles Cycle I was carried out during the 1987/88 heating season; cycle II was carried out during the 1988/89 heating season. The homes studied in cycle I were a statistically representative sample of occupied single-family detached homes, without "special" mechanical ventilation, constructed after January 1st, 1980 in the region (Oregon, Washington, Idaho and 17 countries west of the Continental Divide in Montana). Cycle II homes were occupied homes with non-heat recovery ventilation systems which met the April 1987 Super Good Cents (SGC) energy efficient construction specifications developed for the region. Five (5) ventilation systems were available in the SGC homes: 1) integrated spot and whole house system; 2) ducted central exhaust systems; 3) discrete spot and whole house system 4) whole house system integrated with a central forced air heating and cooling system; and 5) discrete spot and whole house system with distributed exhaust and central supply. Two techniques were employed to measure ventilation and infiltration: blower door leakage test combined with the Sherman-Grimsrud infiltration model and the time-averaged perfluorocarbon tracer technique (PFT). The PFT technique was used in up to a 3-zone configuration in a home for a minimum of a one week exposure period during the heating seasons. In addition, occupant characteristics and structure characteristics data as well as heating system and ventilation system characteristics and operation data were acquired. Occupant activities records were also kept during the time period of the PFT testing. A total of 140 homes were tested in cycle I and 189 homes in cycle II NOTE: The project was a cooperative effort between Batelle, Bonneville, Washington State Energy Office, Idaho, Dept. of Water Resources, Oregon Dept of Energy, Montana Dept of Natural Resources and Ecotope Inc.

BUILDING TYPE
Single family detached electrically-heated residences

PARAMETERS
PFT air exchange compared to blower door air exchange rate. Air exchange rate compared to: 1) architecture, 2) heating system type, 3) use of wood as fuel, 4) occupant perceptions of odour and moisture and drafts, 5) presence of moisture, 6) occupant activities.

STARTDATE 00:07:1987
ENDATE 00:07:1989
TIME 12000 person-hours

KEYWORDS
Residences, Tracer Gas, Blower doors, Pressurisation
SELECTED BIBLIOGRAPHY
5. Hadley, D L (1989), Results of a pre-field measurement program fan pressurisation comparative test. BN-SA-2645 Proceedings of the "ASTM symposium on air change rate and air tightness in buildings", Atlanta, Georgia April, 1989.

SPECIFIC OBJECTIVES
To quantitatively assess effects of ventilation rates on IAQ and related parameters, and to evaluate occupant perceptions of IAQ and comfort.

PROJECT DETAILS
18-storey (100,000 sqft) office building will be monitored at 25 randomly selected locations in the building during the summer and the winter. HVAC system will be operated at 2 different damper settings (20 cfm/person, 35 cfm/person). Measurement parameters include CO₂, CO, O₂, RSP, T, RH, Air velocities, Bioaerosols, VOC’s, Formaldehyde, Nicotine, and Air Exchange. Occupant survey questionnaire will also be administered.

BUILDING TYPE
Commercial Office

PARAMETERS
Indoor Air Quality (IAQ), HVAC, Weather

STARTDATE 00:07:1989
ENDATE 00:04:1990
TIME 2000 person-hours

KEYWORDS
Office, Ventilation effectiveness, Indoor Air Quality (IAQ), Energy, Comfort, Mechanical ventilation, Dwelling

SELECTED BIBLIOGRAPHY
Monitoring and occupant survey plan (GEOMET Report No IE-2109).

REF USA14
TITLE
Experimental Testing In GEOMET Research Houses.

CONTACT
Nagda, Niren L

ADDRESS
GEOMET Technologies Inc, 20251 Century Boulevard, Germantown, Maryland 20874, USA.

TEL +1 (301) 428-9898
FAX +1 (301) 428-9482

SPECIFIC OBJECTIVES
Controlled testing of residential space-conditioning systems, indoor pollutant sources, and natural infiltration.

PROJECT DETAILS
Two contemporary homes of wood-frame split foyer construction (1100 sq ft living space) built.
side by side to identical specifications in 1982. Measurement parameters include indoor comfort parameters (air temperature, mean radiant temperature, relative humidity, air velocity), natural infiltration and interzonal airflows (using automated tracer gas methods) energy consumption, indoor air quality (combustion products, particulates, organics, radon), and outdoor environment (temperature, humidity, winds, barometric pressure, solar radiation, precipitation). Experiments and controlled testing conducted in the research houses includes (1) effects of energy conservation strategies on indoor air quality and natural infiltration, (2) performance testing of gas and electric appliances, (3) pollutant transport indoors, and (4) performance testing of indoor pollutant control strategies. Project-specific data bases are incorporated into evaluation and development models. Work is conducted for a variety of Government and private sector clients.

BUILDING TYPE
Residential houses

PARAMETERS
Weather, Comfort, Real/simulated Occupancy, Indoor Air Quality (IAQ)

STARTDATE 00:00:1982
ENDATE ongoing TIME (Not Stated)

KEYWORDS
Residential, Indoor Air Quality (IAQ), Energy conservation, Infiltration, Tracer gas

SELECTED BIBLIOGRAPHY
the plan of action to implement the
3-dimensional computer program.

BUILDING TYPE
(Not Stated)
PARAMETERS
(Not Stated)
STARTDATE 01:04:1988
ENDATE 31:03:1990
TIME 30 person-months
KEYWORDS
Air distribution, Airflow simulation

SELECTED BIBLIOGRAPHY (Not Stated)

REF USA18
TITLE
Indoor Air Quality Evaluation Of Three Office
Buildings (Two Of Conventional Construction
Designs, And One Of Special Designs To
Reduce Indoor Air Contaminants)
CONTACT
Bayer, Charlene W
ADDRESS
Georgia Tech. Research Corporation,
Centennial Research Building,
Atlanta, GA, 30332-0420,
USA.
TEL +1 404-84-3825
FAX +1 404-894-3120
TLX 542507 GTRCOCAATL

SPECIFIC OBJECTIVES
(Not Stated)
PROJECT DETAILS
To evaluate the indoor air quality of three office
buildings in relation to the construction
techniques, ventilation rate, indoor pollutant
concentration, and human health and comfort

BUILDING TYPE
(Not Stated)
PARAMETERS
(Not Stated)
STARTDATE 01:12:1986
ENDATE (Not Stated)
TIME (Not Stated)
KEYWORDS
Indoor Air Quality (IAQ), Commercial, Office

SELECTED BIBLIOGRAPHY (Not Stated)

REF USA19
TITLE
Assessment And Modification Of Standard
Hourly Methods For Predicting The
Performance Of Ventilative Cooling
CONTACT
Pederson, C O
ADDRESS
University of Illinois at Urbana-Champaign,
144 Mechanical Engineering Building,
1206 W Green Street,
Urbana, IL 61801,
USA.
TEL +1 217-333-2072

SPECIFIC OBJECTIVES
(Not Stated)
PROJECT DETAILS
Controlled experiments were conducted to
quantify the heat transfer characteristics of a
ventilated room. The experiments and
subsequent analysis:
1 determined the limits of applicability of a
current detailed calculation procedure, and
2 provided modifications as necessary to this
procedure to extend its range of usefulness
under the high rates of ventilation.

BUILDING TYPE
(Not Stated)
PARAMETERS
(Not Stated)
STARTDATE 01:09:1987
ENDATE 31:12:1989
TIME 38 person-months
KEYWORDS
Ventilation rate, Energy, Rooms

SELECTED BIBLIOGRAPHY (Not Stated)

REF USA20
TITLE
Control Of Outside Air And Building
Pressurisation In VAV Systems
CONTACT
Howell, R H & Sauer, H J
ADDRESS
University of Missouri-Rolla,
211 Parker Hall,
Rolla, MO 65401,
USA.
TEL + 1 314-341-4638

SPECIFIC OBJECTIVES
(Not Stated)
PROJECT DETAILS
Develop a methodology, preferably adaptable to
manual calculation and to personal computer
calculations, by which to compare operating
cost, ventilation air quantity and building
pressurisation resulting from various means of
outside air and return air/relief air control in
variable air volume air conditioning systems, and to evaluate and compare typical representative systems.

**BUILDING TYPE**
*(None Stated)*

**PARAMETERS**
*(None Stated)*

**STARTDATE** 01:09:1988

**ENDATE** 31:08:1990

**TIME** 16 person-months

**KEYWORDS**
VAV, Pressurisation, Ventilation system, Indoor Air Quality (IAQ)

**SELECTED BIBLIOGRAPHY** *(None Stated)*

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**REF USA21**
**TITLE**
A Round-Robin Test Of Fan Pressurization Devices

**CONTACT**
Murphy, William E

**ADDRESS**
129 Agricultural Engineering Building, Agricultural Engineering Dept, Lexington, KY 40546-0075, USA.

**TEL** 606-257-2666

**SPECIFIC OBJECTIVES** *(Not Stated)*

**PROJECT DETAILS**
To evaluate the accuracy, precision and repeatability of different blower doors on the market, as well as to determine the effect of the operator on the precision of the readings. Four blower doors will be used to test 4 houses by 3 operators with three replications each. The contractor will compile all data and perform an analysis as outlined in ASTM E691-79 to determine precision and percent deviations between the different doors, operators, and tests. In addition thermographic scans of each house will be performed as a qualitative measure of where the air leakage occurs. The doors will also be tested on a standard test chamber to quantify absolute errors.

**BUILDING TYPE**
*(None Stated)*

**PARAMETERS**
*(None Stated)*

**STARTDATE** 01:01:1989

**ENDATE** 13:10:1989

**TIME** 80 person-months

**KEYWORDS**
Pressurisation, Blower doors, Air leakage

**SELECTED BIBLIOGRAPHY** *(None Stated)*

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**REF USA22**
**TITLE**
Reassessment Of Formaldehyde In Homes Insulated With UFFI

**CONTACT**
Toal, Brian

**ADDRESS**
Connecticut Health Dept, 150 Washington Street, Hartford, CT 06106, USA.

**TEL** +1 203-566-8167

**SPECIFIC OBJECTIVES**
Document decreased formaldehyde levels in homes with ageing UFFI.

**PROJECT DETAILS**
30 occupied homes with ageing UFFI were measured with chromotropic acid for formaldehyde in two different rooms.

**BUILDING TYPE**
Residential (Houses)

**PARAMETERS**
Humidity and temperature

**STARTDATE** 00:06:1987

**ENDATE** 00:12:1987

**TIME** 900 person-hours

**KEYWORDS**
Formaldehyde (UFFI), Residential dwelling, Occupied

**SELECTED BIBLIOGRAPHY**

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**REF USA23**
**TITLE**
Computer Modelling Of Air Movement In Slot-Ventilated Enclosures

**CONTACT**
Albright, Louis D

**ADDRESS**
Cornell University, 206 Riley-Robb Hall, Ithaca, NY 14853, USA.

**TEL** +1 607-255-2483

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FAX +1 607-255-1836
EMAIL KF5J@cornella (bitnet)
TLX 6713054

SPECIFIC OBJECTIVES
Develop analysis method to use as a tool for designing ventilation systems in slot-ventilated agricultural buildings.

PROJECT DETAILS
The k-epsilon model of turbulence transport is being used. Effects of obstructions within a ventilated space, nonisothermal ventilation jets, and boundary conditions are being investigated to develop a workable computer model that predicts airflows that compare well with experimental data.

BUILDING TYPE
Slot-ventilated animal housing barns and greenhouses

PARAMETERS
k-epsilon
STARTDATE 00:00:1983
ENDATE 00:00:1992 TIME (Not Stated)

KEYWORDS
k-epsilon turbulence model, Slot-ventilation, Recirculation, Airflow, Jets.

SELECTED BIBLIOGRAPHY (None Stated)

REF USA24
TITLE
Measurements Of Airflow In Buildings
CONTACT
Harrje, David T
ADDRESS
Centre for Energy & Environmental Studies, Princeton University, Princeton, NJ 08544, USA.
TEL +1 609 258 5190
FAX +1 609 258 6260 or 6744
EMAIL Bitnet DTHarrje @PUCC

SPECIFIC OBJECTIVES
Measurements of airflows in buildings CCTG System Conversion to a two Tracer Gas System.

PROJECT DETAILS
To measure interzonal flows more than a single gas is preferred. The constant concentration approach to multizone airflow measurements has used methods of tracer gas depletion to individual zones as a method of measuring interzone flows Bohac-Harrje in the 8th AIVC conference. The quicker method is to use multiple tracers. During the next few months we will be making measurements using SF6 and one of the freon gases in a two gas CCTG systems to better document internal airflows. Software will follow the developments of the Collet-Egedorf system at the Teknologisk Institut in Denmark.

BUILDING TYPE
Single or Multifamily buildings (Residences)

PARAMETERS
Stated in measured airflow and air changes per hour (ach)
STARTDATE 15:04:1989
ENDATE 00:02:1990
TIME 750 person-hours

KEYWORDS
Tracer gas, Airflow measurement, Interzonal air movement, Dwelling, Air change rate

SELECTED BIBLIOGRAPHY
recommended? 3) Does the public understand that a screening does not correlate with annual radon exposure? 4) What is the difference between charcoal screening test and a track etch device. 5) Does the public perceive radon mitigation as easy or costly? Issues will be addressed by a questionnaire.

**BUILDING TYPE**
Residences (Homes)

**PARAMETERS**
The Report will try to identify factors that affect public decision to test or not test their homes

**STARTDATE** 01:06:1989  
**ENDATE** 09:09:1990  
**TIME** (Not Stated)

**KEYWORDS**
Radon, Occupant behaviour, Questionnaire, Dwelling

**SELECTED BIBLIOGRAPHY**
(Not Stated)

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**REFERENCE**  USA26  
**TITLE**  Household Energy Study.  
**CONTACT**  Greiner, Tom  
**ADDRESS**  Iowa State University, 200 Davidson Hall, Ames, IA 50011, USA.  
**TEL** +1 515-294-6360  
**FAX** +1 515-294-0907  

**SPECIFIC OBJECTIVES**
1) To obtain data on Iowa homes.  
2) To characterize energy use.  
3) To determine the extent of moisture problems.  
4) To determine the extent of radon problems.  
5) To determine homeowner attitudes.

**PROJECT DETAILS**
A random survey of 334 Iowa homes was conducted during March and April 1988. A large database has been developed on energy efficiency, age of home, heating systems, moisture problems, radon levels and attitudes toward energy, air quality and health. Homes that were tighter (as shown by energy use) had a greater number of moisture problems. Approximately one-half of the homes failed the radon screening test.

**BUILDING TYPE**
Detached single-family residence

**PARAMETERS**
Energy-efficiency, moisture

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**REFERENCE**  USA27  
**TITLE**  A study Of Residential Combustion Venting Failures.  
**CONTACT**  Greiner, Tom  
**ADDRESS**  Iowa State University, 200 Davidson Hall, Ames, Iowa 50011, USA.  
**TEL** +1 515-294-6360  
**FAX** +1 515-294-0907  

**SPECIFIC OBJECTIVES**
1) Instrument homes with venting failure.  
2) Monitor Air Quality.  
3) Monitor pressure differences.

**PROJECT DETAILS**
Three homes with water heater combustion venting failures were studied. Findings were that 1) Thermocouples can be used at dilution gap to monitor venting performance.  
2) Carbon monoxide (CO) can reach dangerous concentrations in low-volume mechanical rooms.  
3) Neither carbon monoxide (CO) nor carbon dioxide (CO2) concentrations give accurate indications of flue gas spillage in large rooms.  
4) Spillage temperatures may not be consistent around the hood.  
5) Faulty vent design and/or maintenance can result in venting failure.

**BUILDING TYPE**
Single family or duplex (Residence)
PARAMETERS
Vent failure
STARTDATE 00:00:1987
ENDEDATE 00:00:1989
TIME 2000 person-hours

KEYWORDS
Combustion, Indoor Air Quality (IAQ), Pressure differences, Dwelling Vented, Carbon monoxide (CO)

SELECTED BIBLIOGRAPHY

REF USA28
TITLE Ventilation Monitor
CONTACT Solarte, Luis
ADDRESS Alnor Instrument, 7555 N. Linder Av. Skokie Illinois, 60077, USA.
TEL +1 (312) 677 - 3500
FAX +1 (312) 677 - 3539

SPECIFIC OBJECTIVES
The development of an instrument to be used in indoor air quality analysis.

PROJECT DETAILS
Working with the most key people in the USA, to come up with the specifications needed for the analysis commonly performed.

BUILDING TYPE
Whichever is required

PARAMETERS
The use of tracer gas to determine different parameters influencing indoor air quality
STARTDATE 00:01:1989
ENDEDATE Ongoing TIME N/A

KEYWORDS
Tracer gas, Survey, Indoor Air Quality (IAQ)

SELECTED BIBLIOGRAPHY (Not Stated)

REF USA29
TITLE Northwest Residential Infiltration Study
CONTACT Thor, Philip
ADDRESS Bonneville Power Administration, P O Box 3621, Portland, Oregon 97208, USA.
TEL +1 (503) 230 - 3098

SPECIFIC OBJECTIVES
To measure the ventilation rate and air tightness of typical Northwest Homes.

PROJECT DETAILS
The project consisted of Fan Pressurisation and passive perfluorocarbon tracer gas tests on a random sample of 140 homes, (built to current construction standards) and 50 homes built to energy efficient standards in the Pacific Northwest region of the United States. The standard construction sample is largely light wood frame constructed single family detached buildings with electric heat. The energy efficient buildings are a similar set of homes, with greater levels of insulation tighter construction standards and mechanical ventilation systems. Homes were measured during the winter heating season for a two week period.

BUILDING TYPE
Single family detached (Residence)

PARAMETERS
Equivalent leakage area, Effective ventilation rates, Weather, decurant behaviour.
STARTDATE 00:00:1987
ENDEDATE 00:00:1990
TIME 6000 person-hours

KEYWORDS
Tracer gas, Passive Perfluorocarbon Techniques (PFT), Blower door, Infiltration, Airtightness, Mechanical ventilation system, Dwelling Pressurisation

SELECTED BIBLIOGRAPHY
2 Northwest Residential Infiltration Survey (1988), Study design and sample, June 16, 1988, Ecotope, Inc. Seattle, WA.

REF USA30

TITLE
Ventilation Research: Tracer Gas Measurement Techniques

CONTACT
Sherman, Max

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Lawrence Berkeley Laboratory, Berkeley, California, USA.

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FAX +1 (415) 486.6658
EMAIL MHSherman@LBL.Gov

SPECIFIC OBJECTIVES
Use and develop tracer gas techniques to improve the understanding of ventilation process.

PROJECT DETAILS
3 phase: 1) Development of a multiple tracer measurement technique for the estimation of multizone ventilation. 2) Development of analysis tools for use in reducing tracer gas data 3) development of standards and guidelines related to ventilation measurement.

BUILDING TYPE
Dwellings to medium sized buildings (Residence, Office, Factory)

PARAMETERS
Tracer Gas Measurement Techniques

STARTDATE (Not Stated)
ENDOR (Not Stated)
TIME 1 full time equivalent

KEYWORDS
Tracer gas, Ventilation, Commercial, Dwellings

SELECTED BIBLIOGRAPHY

REF USA31

TITLE
Development Of A Multizonal Infiltration And Ventilation Model

CONTACT
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TLX 910.336.2037 lblberk

SPECIFIC OBJECTIVES
Model development

PROJECT DETAILS
COMIS not only takes crack flow into account but also covers flow through large openings, single-sided ventilation, cross ventilation and HVAC-systems. The model contains a large number of modules which are peripheral to a steering program. COMIS can also be used as a basis for future expansion in order to increase the ability to simulate buildings. Special emphasis has been given to the input routines so that the final program should not only be user-tolerant but user-friendly. It is being developed in such a way that it can be used
either as a stand-alone infiltration model or as an infiltration module of a building simulation program. The input procedure is therefore being developed in such a way that either the COMIS input modules can be used or only the input/output interface. This makes it possible for the user to connect the program with other software (e.g., CAD-systems).

**BUILDING TYPE**

*(Not Stated)*

**PARAMETERS**

Air flow through cracks, Ventilation systems

**STARTDATE 00:10:1988**

**ENDATE 00:09:1993**

**TIME (Not Stated)**

**KEYWORDS**

Mathematical simulation, Ventilation, Airflow simulation, Multizone, Crack, Air leakage

**SELECTED BIBLIOGRAPHY**

3. COMIS Newsletters
4. COMIS Fundamentals and COMIS User Guide (will be published as AIVC Publications).

**REF USA32**

**TITLE**

Indoor Air Pollution Exposure Assessments.

**CONTACT**

Traynor, Greg

**ADDRESS**

Lawrence Berkeley Laboratory, 1 Cyclotron Rd, MS:B44B Berkeley, CA 94720, USA.

**TEL +1 (415) 486 5729**

**FAX +1 (415) 486 6658**

**SPECIFIC OBJECTIVES**

To assess, via measurements and modelling, indoor air pollution concentrations and the factors that affect these concentrations.

**PROJECT DETAILS**

The factors that affect indoor air pollution concentrations, based on experimental research, can be mathematically combined to predict indoor air pollution levels. Initial research has concentrated on indoor concentrations of combustion-generated pollutants because of the existence of source usage information and models. Future work will address the sensitivity of the model to various input factors and will expand the model to include other important indoor pollutants.

**BUILDING TYPE**

Residences

**PARAMETERS**

Volume, specific leakage area, appliance usage rates, appliance emission rates, outside temperature and wind speed, misc. energy parameters.

**STARTDATE 00:00:1986**

**ENDATE Ongoing**

**TIME (Not Stated)**

**KEYWORDS**

Mathematical simulation, Indoor air Quality (IAQ), Combustion, Occupant behaviour, Dwelling, Energy

**SELECTED BIBLIOGRAPHY**


**REF USA33**

**TITLE**

Radon Pressure Differential

**CONTACT**

Cummings, Jim

**ADDRESS**

Florida Solar Energy Center, 300 State Road 401, Cape Canaveral, FL 32920, USA.

**TEL +1 407 783 0300 ext. 115**

**FAX +1 407 783 2571**

**SPECIFIC OBJECTIVES**
To assess pressure differences which exist in Florida homes as a result of natural and mechanical forces.

**PROJECT DETAILS**

Approximately four-hour tests in 70 homes. Air Changes per Hour 50 is determined by blower door. ACH 50 is measured again with all supply and return registers sealed by paper and tape. Pressure differences are measured from the main body of the house to outdoors, subslab (subfloor) and various rooms when AH (air handler) is turned on, when interior doors are closed, and when exhaust fans (dryer, etc.) are operating and when everything is off.

Approximately five hour tracer gas (decay) tests (SF6) in 50 of the 70 homes. 1.33 hrs x 4 tests, with AH off, Ah on, exhaust fans on, and Ah/on/doors closed.

**BUILDING TYPE**

Single family homes; 0-5 years old

**PARAMETERS**

Air Changes / Hour on; ACH off; Return leak fraction, CFM

**STARTDATE** 00:08:1989

**ENDATE** 00:09:1990

**TIME** 6000 person-hours

**KEYWORDS**

Radon, Blower doors, PFT, Tracer gas, Pressurisation, Sub-slab ventilation, Air Change rate

**SELECTED BIBLIOGRAPHY**

1 Tyson J et. al. (1990), Draft technical report, radon pressure measurement project., April 1990. Florida Solar Energy Center, Cape Canaveral, Florida.


4 Cummings J & James B (1989), Tracer gas as a practical field diagnostic tool for assessing duct system leaks., Proc. of the Symposium on...
Improving building Systems in hot and humid climates. Oct. 3-4, 1989, Dallas, Texas.

5 Cummings et. al. (1990), Impacts of duct leakage on infiltration rates, space conditioning, energy use and peak electrical demand in Florida homes. Draft, prepared for ACEEE 1990 Summer study.

REF USA35
TITLE Indoor Air Quality Study In Greater Boston.
CONTACT Spengler, John D & Yanagisawa, Yukio
ADDRESS Harvard School of Public Health,
665 Huntington Avenue,
Boston, MA 02115,
USA.
TEL +1 (617) 432-1165
FAX +1 (617) 432-3349
SPECIFIC OBJECTIVES
To reveal relationships among indoor NO₂ concentration, air infiltration rate and house characteristics.

PROJECT DETAILS
Subject houses were selected to represent the total population of the Boston Standard Metropolitan Statistical Area (SMSA). A 2-stage sampling scheme incorporating stratification by range fuel was used for sampling and logistical efficiency. A total of 973 housing units were identified with 581 agreeing to participate in the monitoring and 501 were actually monitored in the Winter of 1985. The house characteristics questionnaire consisted of five categories;
1) Setting and home type.
2) Heating system and fuel.
3) Cooking and water heating fuel.
4) Ventilation
5) Participants.
Two types of tracer gases, perfluoro monomethyl cyclohexane (PMCH) and perfluoro dimethyl cyclohexane (PDCH), were used for the air infiltration rate measurements. These gases were released in the house through permeation tube capsules whose emission rates were gravimetrically measured prior to the study. Tracer gases were passively sampled by activated charcoal (Ambersorb 347) in capillary absorption tubes (CAT) placed in the kitchen, living room and bedrooms. After exposing CAT’s to indoor air for two weeks, the amount of the adsorbed tracer gas was analyzed with a GC/ECD. NO₂ concentrations were measured several indoor microenvironments with a passive sampler (Palmes Tube).

BUILDING TYPE
Residential house
PARAMETERS
To find these parameters is one of the objectives of this study.
STARTDATE 00:00:1984
ENDATE ongoing TIME (Not Stated)
KEYWORDS Indoor Air Quality (IAQ), Gas appliances, Combustion, Tracer gas, Air infiltration, Dwelling, Questionnaire, Heating system

SELECTED BIBLIOGRAPHY
2 Yanagisawa Y et. al. (1990), Relationships among indoor NO₂, air exchange rate and house characteristics of residential houses in Boston. Proc. 5th inter. Confer. on Indoor Air Quality and Climate, July 29 - August 3, 1990.
3 Yanagisawa Y (1990), Placement of tracer gas sources and samplers to measure infiltration rate. (Submitted to Indoor Air).

AIVC NON PARTICIPATING COUNTRIES
AUSTRALIA

REF AUS1
TITLE Ventilation Of Buildings.
CONTACT Biggs, K L
ADDRESS CSIRO,
Australia Division of Bldg. & Construction
Engineering,
P O Box 56,
Graham Road, Highett, Victoria, 3190
AUSTRALIA.
SPECIFIC OBJECTIVES
To measure infiltration, ventilation and air conditioning parameters in office buildings.

PROJECT DETAILS
Sulfur Hexafluoride (SF6) tracer gas with gas chromatography/electron capture detection. (possibly at some later date may use other tracer gases for multiple tracer studies). Planned to locate GC, in the building being investigated, for on-line measurements, combined with grab-bag sampling for subsequent analysis e.g. after hours. The principal interest is in the adequacy of air quality rather than infiltration/energy consumption concerns (air intake/distribution effectiveness). Maybe of possible interest, efficiency of exhaust systems too.

BUILDING TYPE
Office buildings mainly, but any unoccupied building.

PARAMETERS
Outdoor air intake into AC system; AC parameters relevant to air distribution; temperature and wind data.

STARTDATE 00:07:1989
ENDATE est 00:06:1990 TIME (Not Stated)

KEYWORDS
Tracer gas, Sulphur Hexafluoride (SF6), Unoccupied, Office, Ventilation Air distribution

SELECTED BIBLIOGRAPHY
1 Biggs K L et. al. (1987), Air infiltration rates in some Australian houses. Austr. Inst. of Building papers, vol 2, pp49-61.
2 Biggs K L et. al. (1986), The tightness of houses in: Air permeability of some Australian houses. Build. and Envir. vol 2, pp89-96.

AUSTRIA

REF AU1
TITLE
Critical Climatological Data In Design Of Building Envelope And Heating System.

CONTACT
Stoecher, H

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Technische Universitaet Wien, Karlsplatz 13, A-1040 Wien, AUSTRIA.
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FAX +43 222-5054800

SPECIFIC OBJECTIVES
Which combination of outdoor temperature and wind velocity bas to be applied in the design of the building envelope and the heating system, with data from Austrian meteorological stations.

PROJECT DETAILS
Preparatory theoretical work for new Austrian Standards.

BUILDING TYPE
Various.

PARAMETERS
Outdoor temperature, wind velocity, air humidity, indoor temperature, humidity, Building environmental parameters.

STARTDATE 00:00:1988
ENDATE 00:00:1990
TIME 500 person-hours

KEYWORDS
Meteorological, Heating system, Building envelope, Standards

SELECTED BIBLIOGRAPHY (None Stated)
ventilation, (such as wind speed and direction, shape of the atmospheric boundary layer, temperature difference, thermal stratification etc.), and to also calculate the wind pressure coefficients internally. To couple this program to a building thermal simulation program in order to assess the impact of the ventilation system on the occupants' thermal comfort.

BUILDING TYPE
Industrial (factory)

PARAMETERS
Weather - performance of building;
Components - source of pollution
STARTDATE 00:01:1988
ENDATE 00:01:1990
TIME 3000 person-hours

KEYWORDS
Natural ventilation, Thermal simulation, Thermal comfort, Mathematical simulation

SELECTED BIBLIOGRAPHY
Ventilation Efficiency.

Bienfait, D
Centre Scientifique et Technique du Batiment,
84 Avenue Jean Jaures,
77420 Marne La Vallee Cedex 2,
FRANCE.
TEL +33 1 64 68 82 82
FAX +33 1 64 68 83 50

Comparing the performance of the different ventilation systems.

Assessment of the efficiency of each ventilation system with regard to energy consumption and air quality. This assessment shall be carried out with the assistance of a computer code including different items such as condensation, CO2 concentration, etc.

House, building

Wind, Pollution sources
STARTDATE 00:09:1987
ENDATE 00:09:1990
TIME 2000 person-hours

Wind pressure, Dwelling, Pollution sources

Modelling of Interzonal Heat and Mass Transfer
(Specific topic: Great Apertures)

PROJECT DETAILS
(a) (i) Real scale experimental test cell.
Construction type: Multilayer manufactured components
(ii) Mechanical ventilation system
(variable - turnable - airflow)
Heating system: electric convectors
(iii) Air velocities in the
doorway (9 probes on a moveable cane)
Air temperature, surface temperature
Air flows at outlet and inlet of the mechanical ventilation
system. (iv) Air velocities: omnidirectional
probe and thermistor for measuring

Specific tapie: Great Apertures

TITLE
PROJECT DETAILS Technology Of Mechanical Ventilation Systems.

CONTACT
Riberon, J

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Centre Scientifique et Technique du Batiment,
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FRANCE.

TEL +33 1 64 68 82 82X.
FAX +33 1 64 68 83 50

SPECIFIC OBJECTIVES
To study the operating of mechanical ventilation
systems (both standard and humidity controlled)

BUILDING TYPE
House (Residence)

PARAMETERS
(a) Temperature, Wind, Sun (Solar) (b) Internal
doors (c) Simulated behaviour of occupants
(d) - (e) Influence of heating system

STARTDATE 00:06:1986
ENDATE 00:12:1990

TIME 8000 person-hours over 4.5 years

KEYWORDS
Mixed convection, Stratified temperatures,
Mechanical ventilation system, Heating system,
Airflow, Simulation

SELECTED BIBLIOGRAPHY
1 Some publications Internal heat transfers and
heating needs of buildings R
Pelletrret/International Congress on B.E.M.
Lausanne/Switzerland/09.28.- 10.02 1987 A new
model to compute airflow patterns R Pelletrret &
H Khodr/Building simulation '89

2 Reports: CSTB/ECS/86-408
CSTB/DPE/87-500 CSTB/DPE/87-478
CSTB/DPE/88-630

3 PhD: Internal heat and mass transfer in
buildings A Lamrani/March 1987 Mixed
convection in large openings H Khodr/expected
in September 1990

REF F4
TITLE
Technology Of Mechanical Ventilation Systems.

CONTACT
Riberon, J

ADDRESS
Centre Scientifique et Technique du Batiment,
84 Avenue Jean Jaures,
77420 Marne La Vallee Cedex 2,
FRANCE.

TEL +33 1 64 68 82 82X.
FAX +33 1 64 68 83 50

SPECIFIC OBJECTIVES
To study the operating of mechanical ventilation
systems (both standard and humidity controlled)

BUILDING TYPE
House (Residence)

PARAMETERS
(a) Temperature, Wind, Sun (Solar) (b) Internal
doors (c) Simulated behaviour of occupants
(d) - (e) Influence of heating system

STARTDATE 00:06:1986
ENDATE 00:12:1990

TIME 8000 person-hours over 4.5 years

KEYWORDS
Mixed convection, Stratified temperatures,
Mechanical ventilation system, Heating system,
Airflow, Simulation

SELECTED BIBLIOGRAPHY
1 Bienfait D & Lalba F (1987), Advanced venti-
lation systems in France. IBCEM '87, Lausanne

2 Riberon J (1988), Les installations de VMC en
maison individuelle. CSTB - GEC -

3 Riberon J (1989), Etude du vieillissement des
hygrostats RANCO. CSTB - GEC-89-4702,
Champs sur Marne, 23 fevrier 1989.

4 Anon (1989) Pathologie des installations de
ventilation mecanique et systemes
HYGROREGLAGES. SOPHIA ANTIPOLIS, SEPTEMBRE 1989.

REF F5
TITLE
AERO THERMAL ENGINEERING WITH REGARD TO
INDOOR ROOMS.
CONTACT
BIENFAIT, D.
ADDRESS
CENTRE SCIENTIFIQUE ET TECHNIQUE DU BATIMENT,
84 AVENUE JEAN JAURES,
77420 MARNE LA VALLEE CEDEX 2,
FRANCE.
TEL + 33 1 64 68 82 82
FAX + 33 1 64 68 83 50
TLX 694.282 F
SPECIFIC OBJECTIVES
BETTER KNOWLEDGE OF STRATIFICATION PHENOMENA
WITHIN PREMISES.
PROJECT DETAILS
RESEARCH ON MODELS DESIGNED FOR THE PREDICTION
OF TEMPERATURE FIELDS WITHIN PREMISES.
SUITABILITY FOR USE IN LARGE PREMISES.
MEASUREMENTS OF THE STRATIFICATION GENERATED BY
DIFFERENT TYPES OF HEATING SYSTEMS. DESIGN OF
DESTRATIFICATION DEVICE.
BUILDING TYPE
COMMERCIAL, FACTORY, OFFICE
PARAMETERS
PERFORMANCE OF THE SHELL COMPONENTS, AIR
TEMPERATURE
STARTDATE 00:10:1988
ENDATE 00:10:1991
TIME 3000 PERSON-HOURS
KEYWORDS
TEMPERATURE GRADIENT, MEASUREMENT,
MODELLING, THERMAL, FACTORY, OFFICE BUILDING
COMPONENTS
SELECTED BIBLIOGRAPHY
1 E HUTTER & J RIBERON (1989), STUDY OF
THERMOCONVETIVE PHENOMENA INSIDE ROOMS.
EXPERIMENTATIONS AND MODELLING. CIB W 67
SOPHIA ANTIPOLIS, APRIL 17-18 1989.
2 MESURE DES TEMPERATURES DANS DES LOCAUX DE
GRAND VOLUME CSTB GEC NO.4826-FR. SOCQUET,
JULY 1989.

REF F6
TITLE
CARBON MONOXIDE IN DWELLINGS.
CONTACT
BIENFAIT, D.
ADDRESS
CENTRE SCIENTIFIQUE ET TECHNIQUE DU BATIMENT,
84 AVENUE JEAN JAURES,
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FAX + 33 1 64 68 83 50
TLX 694.282 F
SPECIFIC OBJECTIVES
INVESTIGATION OF CARBON MONOXIDE PRODUCTION
AND HOW TO REDUCE IT.
PROJECT DETAILS
CARBON MONOXIDE IN DWELLINGS MAY BE PRODUCED
EITHER BY UNVENTED (COOKERS..) OR VENTED (GAS
HEATERS..) APPLIANCES. WORK PROGRAMME:
BIBLIOGRAPHY: STATISTICS ON CASUALTIES. -
INVESTIGATION IN ACTUAL HOUSES. - MODELLING OF
VENTED APPLIANCE, FLUE SHAFT AND WIND EFFECT IN
ORDER TO INVESTIGATE ESPECIALLY IN TRANSIENT
CONDITIONS, THE PRODUCTION OF POLLUTANT AND THE
POSSIBILITY OF REVERSE FLOW.
BUILDING TYPE
RESIDENCES (DWELLING)
PARAMETERS
CO (CARBON MONOXIDE)
STARTDATE 00:00:1989
ENDATE 00:00:1993
TIME 2500 PERSON-HOURS
KEYWORDS
CARBON MONOXIDE (CO), VENTED, UNVENTED,
DWELLINGS
SELECTED BIBLIOGRAPHY
1 BIENFAIT D (1989), LE MONOXYDE DE CARBONE
DANS L'AIR INTERIEUR. SOPHIA-ANTIPOLIS, 19 ET 20
SEPTEMBRE 1989.
This project is aimed at improving the design and dimensioning of natural ventilation systems.

**PROJECT DETAILS**
The development of computer codes intended to predict the flow rates, both in single-family and multi-family dwellings; calculation of air transfers between rooms of the same building. Experimental survey intended for field measurements: typology of natural ventilation systems: measuring of the pressure and heat losses in vertical shafts.

**BUILDING TYPE**
House, apartment, Residence

**PARAMETERS**
Temperature, wind, pollution sources

**START DATE** 00:06:1986
**END DATE** 00:06:1900
**TIME** 3000 person-hours

**KEYWORDS**
Modelling, Natural ventilation system, Interzonal airflow

**SELECTED BIBLIOGRAPHY**

**SPECIFIC OBJECTIVES**
This project is aimed at designing and implementing a specific device suitable for field measurement.

**PROJECT DETAILS**
Depressurisation of the dwelling shall be undertaken using either the existing ventilation system or a specific apparatus. Definition of the methods suitable for each specific dwelling (either house or apartment). Definition of the characteristics of the prototype. Realization of the prototype, as well as testing on different types of dwellings.

**BUILDING TYPE**
House, building, Residence

**PARAMETERS**
Performance of the shell components

**START DATE** 00:04:1989
**END DATE** 00:04:1991
**TIME** 800 person-hours

**KEYWORDS**
Air leakage, Measurement, Airtightness, Blower doors, Depressurise Dwelling

**SELECTED BIBLIOGRAPHY**
apartments. These micro switches register the number, and the cumulative time of opening, over a period of time (15 to 30 days). This will be followed by a statistical analysis of the data and a comparison of the two approaches.

**BUILDING TYPE**
Residence, apartment, Windows, doors

**PARAMETERS**
Window opening (number and time), Ventilation system, Energy consumption

STARTDATE 00:01:1989
ENDATE 00:06:1990
TIME 1000 person-hours

**KEYWORDS**
Window, Occupant behaviour, Ventilation systems, Energy consumption

**SELECTED BIBLIOGRAPHY**
(Not Stated)

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**REF F10**

**TITLE**
Air Movement Within A Three Bedroom House

**CONTACT**
Fleury, B

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FRANCE.

**TEL** +33 72 04 70 37
**FAX** +33 72 04 6254
**EMAIL** Fleury@frlash51
**TLX** 370511 F

**SPECIFIC OBJECTIVES**
The identification and the role permeability, on airflow patterns within buildings.

**PROJECT DETAILS**
- Pressurisation tests, with pressure control of every zone.
- The role of every room.
- To identify the flow behaviour both internally and externally.

**BUILDING TYPE**
Residence, Partitions, air inlets, windows and doors

**PARAMETERS**
Flow rate, Pressure difference, Building and Component quality

STARTDATE 00:04:1989
ENDATE 00:12:1990
TIME 2000 person-hours

**KEYWORDS**
Air movement, Pressure difference, Pressurisation

**SELECTED BIBLIOGRAPHY**

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**REF F11**

**TITLE**
Air Flow Through Building Cracks

**CONTACT**
Fleury B & Gadilhe A

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FRANCE.

**TEL** +33 72 04 70 32
**FAX** +33 72 04 62 54
**EMAIL** Fleury@frlash51
**TLX** 370511 F

**SPECIFIC OBJECTIVES**
Hydrodynamic behaviour of cracks and slots in the low change in pressure range.

**PROJECT DETAILS**
Identification of the flow behaviour of air (both its velocities and pressure changes) for various building components with a perfect control of Pressure changes from (0 delta P2 Pa). In a purpose-built design apparatus. Influence of the geometry of the crack, visualisation of the flow will be by smoke generation.

**BUILDING TYPE**
Air inlet, cracks

**PARAMETERS**
Flow rate, pressure difference, geometry

STARTDATE 00:01:1989
ENDATE 00:06:1990
TIME 400 person-hours

**KEYWORDS**
Cracks, Flow visualisation, Pressure differences, Pressurisation, Airflow

**SELECTED BIBLIOGRAPHY**

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**REF F12**

**TITLE**
Pressure Coefficients

**CONTACT**
Gadilhe A
ADDRESS
ENTPE LASH,
Rue Audin, 69518 Vaulx en Velin Cedex,
FRANCE.
TEL +33 72 04 70 32
FAX +33 72 04 62 54
EMAIL Gadilhe@frlash51 TLX 370511 F
SPECIFIC OBJECTIVES
A comparison of the pressure coefficients by
three approaches: numerical, wind tunnel and
on site.
PROJECT DETAILS
Numerical determination of the pressure
coefficients with a k-e model for two buildings.
Feasability study comparison with wind tunnel
on site experiments and a literature study.
BUILDING TYPE
Building facade
PARAMETERS
Pressure coefficient
STARTDATE 00:06:1987
ENDATE 00:06:1990
TIME 2500 person-hours
KEYWORDS
Wind pressure coefficients, Numerical
simulation, Facade
SELECTED BIBLIOGRAPHY
1 Gadilhe A & Fleury B (1989), Wind pressure
coefficients: A comparison between phoenics
and wind tunnel results. 3rd Inter. Phoenics
2 Fleury B & Gadilhe A (1987), Determination
des coefficients de pression en facade des
batiments. Journees Ventilation, November,
1987.

HUNGARY

REF H1
TITLE
Development Of An Air Leakage Database For
Filtration And Ventilation Calculations.
CONTACT
Balazs, Karoly
ADDRESS
ETI,
The Hungarian Institute for Building Science,
H-1113 David Fu. 6.,
Budapest,

HUNGARY.
TEL +36-1-185-4544
FAX +36-1-166-3766/G3/
SPECIFIC OBJECTIVES.
Database of air leakage of building components.
Measurement of air leakage. Survey and
evaluation of literature data.
PROJECT DETAILS
The project targets the first stage of the
development of an air leakage database for
calculating the filtration and ventilation of
buildings, that can be used in connection with
filtration computer models. Series of pressure
tests will be carried out in typical Hungarian
buildings. Leakage is intended to be determined
either for the unit length of well defined
leaks/around windows and doors or at structural
joints/or for the unit area or structural
components. Results from several
measurements of the same structure and same
installation conditions will be statistically
analysed.
BUILDING TYPE
Traditional masonry buildings and RC panel
structures
PARAMETERS
Pressure difference over the structural
components
STARTDATE 01:07:1989
ENDATE 31:03:1990
TIME 5500 person-hours
KEYWORDS
Pressure tests, Database, Air leakage, Dwellings
SELECTED BIBLIOGRAPHY
Future publications:
1 Air leakage database. Research report/ with
English abstract
2 User's manual for the LEAKBANK software/
English version is not yet decided
3 Some papers on the model in Hungarian and
perhaps foreign technical periodicals/ later in
English.

REF H2
TITLE
Development Of A Multizone Computer Model
Of Filtration And Ventilation.
CONTACT
Balazs, Karoly
ADDRESS
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TEL +36-1-185-4544
FAX +36-1-166-3766/G3/

SPECIFIC OBJECTIVES.
Multi-cell computer model of filtration and
ventilation of buildings linkage to special
databases, user friendly version.

PROJECT DETAILS
The project targets the development of a
multicell computer model of filtration and
ventilation of buildings, that can be used in the
design and analysis of airflows in buildings. The
program is intended to be a design tool. Model
Features: network of nodes/ external, rooms,
ductwork nodes/ connected by a number of flow
paths. Flow paths type: large openings, cracks,
porous structures, different air inlets, outlets,
vents, fans, ducts, HVAC systems. Solving
algorithm: "regula falsi" method. Planned
capacity: no direct restriction on number of
nodes, neither on number of flow paths between
connected nodes. Separate treatment of duct
systems and HVAC provided. Program
Features: Source code in pascal, program
designed for IBM AT and compatible machines,
no graphics in the "minimum requirement"
version, connection between input, calculation
and output module and external databases
through standardized data files in text format.
The minimal requirement version includes the
present state of available knowledge in Hungary.
Objectives of the planned further development:
improvement of modules, extension of
databases, inclusion of single sided ventilation,
interface to CAD systems, linkage to building
thermal models.

BUILDING TYPE
Any type of multicell structure

PARAMETERS
Air change rate, heat demand, indoor migration
of pollutants and smoke.
STARTDATE 01:11:1988
ENDATE 30:11:1989
TIME 4000 person-hours

KEYWORDS
Computer simulation, Multi-zone, Air change
rate, Mechanical ventilation Natural

SELECTED BIBLIOGRAPHY
Future Publications:
1 Reference guide/ English version is not yet
decided
2 User's manual/ English version is not yet
decided
3 Some papers on the model in Hungarian and
perhaps foreign technical periodicals / later in
English

REF H3

A Limited Meteorological Database For The
Analysis Of Thermal Behaviour And
Ventilation Of Buildings

CONTACT
Tomory, Tibor

ADDRESS
ETI,
The Hungarian Institute of Building Science,
H-1113, David Fu. 6.,
Budapest,
HUNGARY.
TEL +36-1-185-4544
FAX +36-1-166-3766/G3/
TLX 224285 eti h

SPECIFIC OBJECTIVES.
A meteorological database and handling
program related to buildings.

PROJECT DETAILS
The project targets the first stage of the
compilation of a meteorological database of
Budapest for calculating the thermal
performance, external thermal and moisture
loads, filtration and ventilation of buildings.
The database is designed to be used in
connection with filtration computer models too.
In its full version the database will be extended,
and it will be based on analyzed data from 5-10
representative regions of Hungary. Data from
many years of observation will be compressed
into a "test reference year" file(s), including
solar data, wind data, air temperature and
humidity.

BUILDING TYPE
(Not Stated)

PARAMETERS
(Not Stated)

STARTDATE 01:07:1989
ENDATE 30:11:1989
TIME 1500 person-hours

KEYWORDS
Meteorological, Database, building envelope

SELECTED BIBLIOGRAPHY
Future Publication:
2 User's manual for the METBANK software/ English version is not yet decided.
3 Some papers on the model in Hungarian and perhaps foreign technical periodicals/ later in English

REF H4
TITLE
Energy Saving And/Or Hygienic Requirements - Real Or Illusory Conflicts?
CONTACT
Zold, A
ADDRESS
Organ TU Budapest,
Bp.1111, Muegyetem rkp 3.
Hungary.
TEL (Not Stated) FAX (Not Stated)

SPECIFIC OBJECTIVES
To establish that even with the appropriate ventilation, energy consumption does not depend on ACH.

PROJECT DETAILS
The necessary conditions for moulding to occur is capillary condensation in the surface finishing. At a given moisture development the higher is the ACH, the lower is the acceptable surface temperature and vice versa. The products of air mass flows and indoor-outdoor temperature differences are the same. This concept has been proved by laboratory experiments, the condition of capillar-condensation has been determined for cca 50 building materials and surface finishing. Diagrams have been elaborated showing the necessary ACH, the surface temperature, the moisture production in the room, the indoor temperature and the weather parameters. The results have been checked by the Hungarian Building Science Institute (K.Balazs) in occupied blacks of flats (prefabricated concrete panels, mechanical exhaust, district heating between 1988 and June 1989, using tracer gas, temperature, RH and wind registration.

BUILDING TYPE
(Not Stated)

PARAMETERS
(See Project Details)
STARTDATE 00:00:1988
ENDATE 00:06:1989

REF J1
TITLE
Indoor Radon Pollution In Residential Buildings.
CONTACT
Ikeda, K & Yoshizawa, S
ADDRESS
The Institute of Public Health,
6 - 1 Shrokane-dai 4 - chome,
Minato-Ku, Tokyo 108,
JAPAN.
TEL +813 441 7111
FAX +813 446 4314
TLX 2418187 INSTPH J

SPECIFIC OBJECTIVES
To study the mechanisms of the indoor build-up of radon, and to establish counter measures.

PROJECT DETAILS
(i) Several experimental houses (unoccupied) and more than ten houses with occupants. Most of the houses have about 100 - 200 m³ of floor area and are constructed with timber frames or concrete blocks. (ii) Most houses do not have forced ventilation systems. (iii) Tracer gas was the main measurement technique, but in one experimental house a depressurisation method was used. (iv) The tracer gases were analysed by an infrared analyser or ECD gas chromatograph. Pressure differences were detected by a diaphragm detector.

BUILDING TYPE
Detached or apartment houses (Residences)

PARAMETERS
Indoor and outdoor temperature and humidities, Most windows and doors were closed, Real, Radon, CO₂
STARTDATE 00:04:1986
ENDATE 00:03:1991 TIME (Not Stated)

KEYWORDS
Radon, Crawl space, Ventilation,
Depressurisation, Tracer gas, Apartment,
Natural ventilation
SELECTED BIBLIOGRAPHY
1 Ikeda K et. al. (1989), Experimental Studies on the indoor Radon and Radon daughter concentration build-up in Japanese houses. Proc. 4th Inter. Conf. on IAQ '89. August 1989.
2 Ikeda K et. al., Experimental Studies on the effects of crawl space ventilation on the IAQ of residential buildings. ASHRAE Trans. (Now in reviewing process)

REF J2
TITLE
Development Of Numerical Prediction Method For Indoor Thermal And Aerial Environment.
CONTACT
Masamitsu, Kaizuka
ADDRESS
Department of Architecture, School of Science and Technology, Meiji University, Higashi Mita 1-1-1, Tama-ku, Kawasaki-shi, JAPAN, T214.
TEL +81044-911-8181
FAX +81 044-932-8840
SPECIFIC OBJECTIVES
Distribution and fluctuation of indoor thermal and aerial environment would be totally predicted.
PROJECT DETAILS
This prediction method will include the variables as follows: 1 Air velocity and pressure 2 Air temperature 3 Surface temperature of surrounding walls 4 Radiation interchanges 5 Heat transfer through wall 6 Thermal comfort indices like Predicted Mean Vote (PMV) or Subjective Environmental Temperature (SET) 7 Concentration of gas
BUILDING TYPE
Residence
PARAMETERS
Room air distribution
STARTDATE 00:00:1985
ENDATE 00:00:1992
TIME 10 person-years
KEYWORDS
Numerical simulation, Thermal comfort, Heat transfer, Dwelling
SELECTED BIBLIOGRAPHY

REF J3
TITLE
Numerical Simulation For Indoor Airflow Induced By Cross-Ventilation.
CONTACT
Katayama, Tadahisa
ADDRESS
6-1 Kasuga-koen Kasuga-shi Fukuoka, 816 JAPAN.
TEL +81-92-573-9611 (ext.409)
FAX +81-92-592-0211
SPECIFIC OBJECTIVES
Indoor airflow distribution by cross-ventilation for effective natural cooling.
PROJECT DETAILS
This project consists of four steps: Step 1: Numerical simulation for the indoor airflow distribution in a room. Constant velocity is given on the inlet opening boundary as forced ventilation. The turbulence models used here are two-equation models and large eddy-simulation. Step 2: Simultaneous numerical simulation for the airflow around the house and for the indoor airflow. The numerical simulation is carried out on the single grid system, including indoor space, which is fixed around the model house. Step 3: Design of new boundary condition for the inlet boundary. When numerical simulation area is limited to the indoor space the boundary condition, which expresses the natural wind blowing into the room, is needed for the inlet opening. Step 4: Estimate of the numerical simulation results. The calculations results are compared with the results of the model experiments to examine the accuracy of numerical simulation. The thermal
comfort in a room with cross-ventilation is examined by thermal comfort index, SET or PMV.

**BUILDING TYPE**
Single unit residential house and apartment house.

**PARAMETERS**
Natural wind condition: wind speed and wind direction. Building condition (window shape, size and position in wall), layout of rooms and partitions.

**STARTDATE** 01:09:1987
**ENDATE** 30:06:1990
**TIME** 6000 person-hours

**KEYWORDS**
Cross-ventilation, Numerical simulation, Airflow

**SELECTED BIBLIOGRAPHY**
6. Tsutsumi J et. al. (1990), (Planning to submit a paper, title is not yet decided) 5th International Conference on Indoor Air Quality and Climate, July 1990.

**REF I4**

**TITLE**
3-Dimensional Numerical Simulation Of Turbulent Air Flow In And Around Buildings Based On The K-Epsilon Model With Generalized Curvilinear Coordinates.

**CONTACT**
Murakami, S, Kato, S, Ishida, Y

**ADDRESS**
Institute of Industrial Science, University of Tokyo, 7-22-1 Roppongi Minato-ku, Tokyo, JAPAN.
TEL +81 03 (402) 6231
FAX +81 03 (746) 1449

**SPECIFIC OBJECTIVES**
We analyse the air distribution in and around a building by the finite difference method based on generalized curvilinear coordinates.

**PROJECT DETAILS**
The air distribution in and around a building with a complicated configuration is well simulated by the finite difference method based on generalized curvilinear coordinates. This project follows proceeding ordinary Cartesian coordinates. Numerical simulations of room airflow by the present method using the k-epsilon method based on curvilinear coordinates are conducted. Its validity and feasibility for application to engineering problems are confirmed by comparing simulation results with the experimental results.

**BUILDING TYPE**
(Not Stated)

**PARAMETERS**
(Not Stated)

**STARTDATE** 00:10:1986
**ENDATE** 00:03:1989
**TIME** 5000 person-hours

**KEYWORDS**
Numerical simulation, Airflow

**SELECTED BIBLIOGRAPHY**
Numerical Study On Diffusion Field As Affected By Arrangement Of Supply And Exhaust Openings In Conventional Flow Type Clean Rooms.

CONTACT
Murakami, S, Kato, S, Suyama, Y

ADDRESS
Institute of Industrial Science, University of Tokyo, 22-1 7 chome Roppongi Minato-ku, Tokyo 106, JAPAN.

TEL + 81 03 (402) 6231
FAX + 81 03 (746) 1449

SPECIFIC OBJECTIVES
We analyse room air distribution and contaminant diffusion affected by the arrangement of supply outlets and exhaust inlets.

PROJECT DETAILS
Room air distribution is greatly affected by the arrangement of supply outlets and, possibly, exhaust inlets. The influence of those arrangements on the flow fields is studied here by numerical simulation based on the k-epsilon two-equation turbulence model. Room airflows in several types of conventional-flow-type clean rooms are analysed from this point of view. The flow fields in such rooms as analysed here, are well modelled as serial combinations of "flow units", each of which is composed of one supply jet and the rising streams around it. When the number of supply outlets is decreased the flow units corresponding to the eliminated supply outlets vanish and the remaining flow units expand. A change in arrangement or in the number of exhaust inlets hardly affects the entire flow field; however, such changes often have a large influence on the contaminant diffusion field.

BUILDING TYPE
Clean room

PARAMETERS
Representative velocity for non-dimensionalization defined by inflow jet velocity, representative length for non-dimensionalization defined by width of supply outlets.

STARTDATE 00:03:1985
ENDATE 00:03:1990
TIME 10000 person-hours

KEYWORDS
Clean room, Numerical simulation, Clean rooms, Indoor climate

SELECTED BIBLIOGRAPHY
2 Kata S et. al. (1988b), Study on diagnostic system for simulation of turbulent flow in room (Part 17). Investigation on each type wall boundary of k-e-2 equation model (No.1). Trans. of annual meeting of SHASEJ, pp 573-576.
3 Nagano S et. al. (1988), Study on diagnostic system for simulation of turbulent flow in room (Part 18). Investigation on each type wall boundary of k-e-2-equation model (No.2). Trans. of annual meeting of SHASEJ, pp 577-580.
4 Murakami S et. al. (1987), Three-dimensional numerical simulation of turbulent airflow in a ventilated room by means of a two-equation model. ASHRAE Trans., Vol 93, Pt 2, pp 621-642.
SPECIFIC OBJECTIVES
To make a prototype enabling a lot of qualitative and quantitative knowledge to become available for designers, engineers and researchers.

PROJECT DETAILS
1 Survey of ongoing project relating to the expert system on ventilation. 2 Development of a program to calculate multi-zone ventilation. 3 Check of the conditions for making the expert system. 4 Making the data structure which describes the building appropriate to the ventilation calculation. 5 Making a prototype with a developing tool of expert system.

BUILDING TYPE
Ventilation system

PARAMETERS
Ventilation rate
STARTDATE 00:10:1988
ENDATE 00:10:1991
TIME 2000 person-hours

KEYWORDS
Expert system, Ventilation, multizone, Ventilation system

SELECTED BIBLIOGRAPHY

REF 17
TITLE
Sensitivity Analysis Of Multizone Ventilation Calculation.

CONTACT
Yoshino, H & Utsumi, Y

ADDRESS
Tohoku University, Miyagi National College of Technology, Aoba, Sendai, 982, JAPAN.

TEL +81 022-222-1800 ext.4651
FAX +81 022 268 3690

SPECIFIC OBJECTIVES
To specify the effect of the parameters relating to multizone ventilation.

PROJECT DETAILS
1 To choose the multizone ventilation calculation program. 2 To set the parameters appropriate to representing each characteristic. 3 To evaluate the effects of the parameters and to make practical recommendation for designers and engineers.

BUILDING TYPE
Multizone buildings

PARAMETERS
Ventilation rate
STARTDATE 00:10:1989
ENDATE 00:10:1992
TIME 1500 person-hours

KEYWORDS
Multizone, Ventilation, Computer simulation

SELECTED BIBLIOGRAPHY
1 Yoshino H et. al. (1989), Measurement of airtightness, Air Infiltration and Indoor Air Quality in ten Detached houses in Sendai, Japan. ASTM Symposium, Air Change Rate and Air Tightness in Buildings. 1989.4.
performed on the sample units and the air infiltration rate was compared with visual assessment results. The effects of type of building, cost, age and type of window, dimensions, source, sealing condition, operation ease, source and number of defects on the air infiltration were determined. The 154 windows were installed into buildings of variable age from new to more than 10 years old.

**BUILDING TYPE**
Residential, commercial and office buildings were included.

**PARAMETERS**
Window (age, type, source, cost, operation classification, sealing condition visible defects, sources of defects, dimensions).

**STARTDATE** 00:04:1988  
**ENDATE** 00:06:1989  
**TIME** Researcher (1950 person-hours), Asist (1950 person-hours)

**KEYWORDS**
Air infiltration rate, Window performance, Dwelling, Window

**SELECTED BIBLIOGRAPHY**
3. Daoud O et. al. (1990), Defects in aluminium windows and their impact on dust and air infiltration, (Under preparation for publication in Building and Environment).
4. Daoud O et. al. (1990), Field Assessment of aluminium windows in Kuwait, (under preparation for publication in Energy and Buildings, U.S.A.)
Moscow, 103754, USSR.

SPECIFIC OBJECTIVES
A mathematical simulation of air conditions in industrial buildings.

PROJECT DETAILS
Obtained the formula for determining air infiltration passing through the enclosing structure on its characteristic part. This formula considers: the distribution pattern of the indoor air temperature over the height of the room; the function of aerodynamic factors of the building; and the humidity of the outdoor and indoor air. The formula is an integral on the area of the surface of the enclosing structure or its characteristic part.

BUILDING TYPE
Large industrial buildings.

PARAMETERS
The period of heating: T (out) = -26°C; v = 3-6m/s; RH = 60%. The period of cooling: T (out) = +30°C; v = 6m/s.

STARTDATE 01:09:1985
ENDATE (Not Stated) TIME (Not Stated)

KEYWORDS
Mathematical Simulation, Industrial, Heating system, Building envelope

SELECTED BIBLIOGRAPHY
Appendix A
Survey Form
Survey of Current Research into Air Infiltration Ventilation and Indoor Air Quality

Title of project

Principal researcher

Organisation

Address

Telephone

Fax

Electronic mail no.

Telex

Date survey form complete

Description of project

Specific objectives

Project details
<table>
<thead>
<tr>
<th>Building and/or component type</th>
<th>Parameters with which infiltration and indoor air quality will be related</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Expected termination date</td>
</tr>
<tr>
<td>Estimated number of man hours</td>
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</tr>
<tr>
<td>Important reports and publications, both past and future (titles, authors, publishers, dates of publication)</td>
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</table>

Please return completed form to: The Air Infiltration and Ventilation Centre, Warwick University Science Park, Barclays Venture Centre, Sir William Lyons Road, Coventry, Great Britain.
Appendix B
Keywords
APPENDIX B

KEYWORDS

A

Adsorption
Aerosols
Air change rate
Air distribution
Air infiltration
Air inlet
Air leakage
Air movement
Air outlet
Air velocity
Airflow
Airflow measurement
Airflow simulation
Airtightness
Anemometer
Apartments
Attic

(See also Weather)

Combustion
Comfort
Commercial
Computer simulation
Condensation
(See also moisture)
Constant concentration
Contaminant flow
Contaminant
Convection
Cooling
Corrosion
Crack
Crawl space
Cross-ventilation

F

Facade
Factory
Field study (See also Survey)
Floor
Flow field
Flow visualisation
Flue
Fluid dynamics
Fluid flow
Formaldehyde
Freons
Fresh air

G

Gas appliances
(See Combustion)
Geology (See also Soil gas)
Guidelines

H

Handbook
Health
Heat balance model
Heat conduction
Heat loss
Heat recovery
Heat transfer
Heating appliance
Heating systems
Hospital
Hot climates
Humidity
Hygrosopic

B

Balconies
Blower doors
(See Pressurisation)
Body odour
Building components
Building envelope
Building materials
Building performance

D

Database
Day nurseries
Decay
Demand controlled ventilation systems (DCV)
Dispersion
Displacement ventilation
Domestic
Draughtproofing
Duct
Dust
Dwelling

C

Calculation
Carbon dioxide
Carbon monoxide
Cavities
Church
Clean room
Climatic chamber
Climatic parameters

E

Energy
Energy conservation
Energy consumption
Energy efficiency
Envelope
Expert system
<table>
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<th>J</th>
<th>K</th>
<th>L</th>
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<td>Indoor air quality (IAQ)</td>
<td>Jets</td>
<td>K-epsilon turbulence model</td>
<td>Landfill gas</td>
<td>Mathematical simulation</td>
<td>Natural convection</td>
<td>Occupant behaviour</td>
<td>Parameter estimation</td>
<td>Multi-family buildings</td>
<td>Radiant exchange</td>
<td>Scale model</td>
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<td>Indoor climate</td>
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<td>Large openings</td>
<td>Measurement</td>
<td>Natural gas</td>
<td>Occupancy</td>
<td>Particleboards</td>
<td>Museum</td>
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<td>Leak age</td>
<td>Mechanical ventilation</td>
<td>Natural ventilation</td>
<td>Occupied</td>
<td>Particles</td>
<td>Mycoflora</td>
<td>Radon</td>
<td>Sensor</td>
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<td>Leakage area</td>
<td>Metal decks</td>
<td>Neutral planes</td>
<td>Odour</td>
<td>Passive perfluorocarbon techniques (PFT)</td>
<td>Indoor climate</td>
<td>Recirculation</td>
<td>Sick building syndrome (SBS)</td>
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<td>Leakage path</td>
<td>Metal roofs</td>
<td>Nitrogen dioxide</td>
<td>Office</td>
<td>Passive solar</td>
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<td>Noise</td>
<td>Olf (See also Odour)</td>
<td>Passive stack ventilation</td>
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<td>Single opening</td>
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<td>Low air velocity</td>
<td>Mixed convection</td>
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<td>Retrofit</td>
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<td>Low-energy</td>
<td>Mobile-homes</td>
<td>Noise</td>
<td>Outdoor pollution</td>
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</tr>
</tbody>
</table>
Tracer gas
Turbulence

U

UFI (See also Formaldehyde)
Unoccupied
Unvented

V

Vapour barriers
Variable air volume (VAV)
Vented
Ventilation
Ventilation effectiveness
Ventilation rate
Ventilation strategies
Ventilation systems
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Wind performance
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Wind tunnel
Window
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Appendix D

AIVC’s Survey of Research & Airbase Databases on Archivist Software
Survey 90 & AIRBASE for your Personal Computer

The AIVC's 1990 Survey of Research and AIRBASE, the AIVC's bibliographic database are now available as a PC version. These databases use Archivist software, from Oxford University Press, and are available from the Air Infiltration and Ventilation Centre, complete with software, for £115. Hardware requirements include at least 7.5 Mb of hard disk space, DOS 3.1 or above and an INTEL 8086 processor or above. Archivist should therefore operate on almost any of the common IBM clones. It also operates efficiently on portable PC's, thus making it extremely mobile.

Features include "free text" searching on the entire database text or the searching of selected fields.

The software is "menu" driven and is exceptionally straightforward to use. Starting with a single search term, e.g. infiltration, the computer develops a retrieved list of all entries containing this term. The search may then be systematically narrowed or widened by using the appropriate function key and entering a new term. Searching is very rapid and normally takes only a few seconds. At any stage, entries may be displayed on the screen, printed out, or stored in an output file for later use. Full instructions with sample searches are provided with the Survey 90 and AIRBASE documentation.

Updating AIRBASE & Survey 90

AIRBASE and Survey 90 are updated regularly. Software updates may be purchased as needed at £20 for each update.

Obtaining AIRBASE & Survey 90

The databases are available directly from the Air Infiltration and Ventilation Centre to participating countries only. They may be ordered by completing the form below and returning it to the AIVC. AIRBASE & Survey 90 come complete with documentation and Archivist software.

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AIRBASE & SURVEY 90 ON ARCHIVIST ORDER FORM

Please provide ______ copies of AIRBASE/SURVEY 90 at £115.00 Sterling each, inclusive of VAT.

[ ] 5 - 1/4" 1.2 Mb [ ] 5 - 1/4" 360 Kb (only as a last resort) [ ] 3 - 1/2" 720 Kb

Backed up using [ ] DOS 3.1 [ ] DOS 3.2 [ ] DOS 3.3 [ ] DOS 3.4

Please enclose updates [ ] quarterly [ ] annually at £20.00 Sterling per update.

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The Air Infiltration and Ventilation Centre provides technical support to those engaged in the study and prediction of air leakage and the consequential losses of energy in buildings. The aim is to promote the understanding of the complex air infiltration processes and to advance the effective application of energy saving measures in both the design of new buildings and the improvement of existing building stock.