INTERNATIONAL ENERGY AGENCY
energy conservation in buildings and
community systems programme

Technical Note AIC 12

1983 Survey of Current Research
into Air Infiltration and Related
Air Quality Problems in Buildings

November 1983

Air Infiltration Centre
Old Bracknell Lane West, Bracknell,
Berkshire, Great Britain, RG12 4AH
This report is part of the work of the IEA Energy Conservation in Buildings & Community Systems Programme.

**Annex V Air Infiltration Centre**

Document AIC-TN-12-83
ISBN 0 946075 11 5

Participants in this task:

Belgium, Canada, Denmark, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom and United States of America.

Distribution: Annex Participants only

Additional copies of this report may be obtained from:

The Air Infiltration Centre,
Old Bracknell Lane West, Bracknell,
Berkshire, RG12 4AH, Great Britain
1983 Survey of Current Research into Air Infiltration and Related Air Quality Problems in Buildings

Martin Liddament
© Copyright Oscar Faber Partnership 1983.

All property rights including copyright are vested in the Operating Agent (The Oscar Faber Partnership) on behalf of the International Energy Agency.

In particular, no part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of the Operating Agent.
CONTENTS

Preface (iii)

Introduction 1

Section 1 3

1.1 Analysis of results 5

1.1 Specific objectives 5

1.2 Project details 7

1.3 Parameters with which air infiltration and air quality are related 9

1.4 Allocation of staff time 9

1.5 Conclusions and discussions 10

Figure 1 12

2 Allocation of staff time 12

2 Approximate distribution by country of staff allocation 13

3 Project distribution among types of organisation 13

Table 1 14

2 Specific objectives 14

3 Project details (a) Measurements 16

3 (b) Other activities 17

4 Project details: Analysis of tracer gas tests 18

5 Project details: Analysis of indoor climate measurements 19

6 Project details: Building type 20

7 Project details: Building occupancy 21

7 Project details: Ventilation system 21

8 Parameters with which air infiltration/air quality are related 22

Section 2 25

Research summaries 25

- Australia 27

- Belgium 27

- Canada 27

- Czechoslovakia 37
- Denmark 37
- Finland 38
- France 39
- Germany 39
- Hungary 41
- Italy 41
- Japan 42
- Netherlands 43
- New Zealand 47
- Norway 48
- Papua New Guinea 48
- Poland 49
- South Africa 49
- Sweden 50
- Switzerland 53
- United Kingdom 54
- United States of America 62
- Yugoslavia 73

Appendix 1 Contributing countries 75
2 Survey form 79
3 Index of principal researchers 83
Preface

International Energy Agency

In order to strengthen cooperation in the vital area of energy policy, an Agreement on an International Energy Program was formulated among a number of industrialised countries in November 1974. The International Energy Agency (IEA) was established as an autonomous body within the Organisation for Economic Cooperation and Development (OECD) to administer that agreement. Twenty-one countries are currently members of the IEA, with the Commission of the European Communities participating under a special arrangement.

As one element of the International Energy Program, the Participants undertake cooperative activities in energy research, development and demonstration. A number of new and improved energy technologies which have the potential of making significant contributions to our energy needs were identified for collaborative efforts. The IEA Committee on Energy Research and Development (CRD), assisted by a small Secretariat staff, coordinates the energy research, development and demonstration programme.

Energy Conservation in Buildings and Community Systems

The International Energy Agency 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, etc. The difference and similarities among these comparisons have told us much about the state of the art in building analysis and have led to further IEA sponsored research.

Annex V Air Infiltration 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 to 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 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 a firm basis for future research in the Participating Countries.

Current participants in this task are Belgium, Canada, Denmark, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom and United States of America.
INTRODUCTION

The Air Infiltration Centre's worldwide survey of current research into air infiltration in buildings provides organisations in participating countries with regularly updated information on on-going research in this field. In particular, one of the major objectives of the survey is to encourage international cross-fertilization of research ideas. The first survey was published in October 1980 and contained an analysis of 65 research summaries received from researchers in 14 countries. The second edition followed in December 1981, with the number of new entries almost doubling to 126. This report contains an analysis of the Centre's third survey of research. It again shows a considerable increase in the number of projects reported, with a total of 187 summaries being received from organisations in 22 countries. A list of contributing countries is reproduced in Appendix 1.

In recognition of the growing importance being attached to the influence of fresh air exchange rates on indoor air quality, the scope of this survey has been specifically extended to include this area of research. A further addition has been to provide an indication of project size in terms of allocation of staff time.

The analysis of results is based on research summaries received from researchers following the distribution of a standardized survey form (Appendix 2) to organisations thought likely to be involved in air infiltration research. To further increase the scale of distribution, the survey form was also reproduced in the May 1983 edition of "Air Infiltration Review". The analysis is presented in two sections. In the first, the results are analysed in terms of specific objectives, project details, parameters with which air infiltration and indoor air quality are related, and allocation of staff time. This information is summarised in tabular form so that the tables may be used as a subject index to the research summaries. The research summaries are reproduced in full in Section 2. Each project is identified by a reference number comprising country identification code (Appendix 1) followed by a number indicating the order in which it appears under the relevant country heading. A list of principal researchers and organisation addresses is contained in Appendix 3.

To facilitate access and regular updating, the research summaries are stored in a computer database which can be rapidly searched using the Air Infiltration Centre's free text retrieval system.

The preparation of this report was only possible as a result of the co-operation of researchers in forwarding details of their studies. The assistance of all who contributed to this survey is acknowledged with gratitude.
Section 1 - Analysis of Results
1.1 SPECIFIC OBJECTIVES

The specific objectives have been divided into fifteen categories (Table 1). These categories, and the range of subjects covered by each, are described in further detail below. In many instances the project objectives encompass several subjects and therefore appear under more than one heading.

The objectives are:

(i) Investigations into indoor air quality and minimum ventilation rates (69 replies)

Over one third of the respondents to the survey cited indoor air quality investigations as a specific objective. This subject has become a key issue because it is recognised that the demands of indoor air quality govern the minimum level of fresh air exchange that is permissible in a building. This, therefore, sets a limiting value for any energy conservation measures involving reduction of air infiltration or ventilation rates. The range of contaminants being investigated is summarised in Section 1.2 and listed in full in Table 4.

(ii) To develop/use techniques to measure/locate sources of air infiltration and air movement (41 replies)

Measurements involving the use of tracer gas, fan pressurization, wind tunnel models, thermography and smoke are being made. Several organisations also report techniques for the measurement of internal and external pressure distributions. Much interest is currently being shown in using techniques to determine air change rates in non-domestic buildings, and developing simplified tracer gas measurement methods. Specific information on measurements is given in Tables 2, 3 and 4.

(iii) To develop/use calculation techniques to predict air infiltration or air flow in buildings (40 replies)

Since the previous survey, the number of projects involving the development or use of calculation techniques has shown a significant increase. The techniques described encompass a wide range of complexity and are being used in all areas of air infiltration research.

(iv) To determine the effect of construction methods and retrofitting techniques on air infiltration/air quality/energy demand (25 replies)

This section includes studies into the performance of airtightness measures, especially as part of a building retrofit. The influence of insulation and weatherstripping is also being assessed. In addition, correlations between airtightness and air infiltration and weather data and airtightness are reported. In many instances the effects of airtightness measures are being assessed in terms of both energy conservation and indoor air quality.
To evaluate the cost/energy effectiveness of airtightness measures and ventilation strategies (19 replies)

The cost effectiveness of any energy conservation strategy must generally be established before such measures gain widespread acceptance. This topic therefore forms a fundamental aspect of many current projects and is being investigated in several countries. This area of research has shown a substantial increase in growth since the previous survey. Studies into the cost effectiveness of new building design, retrofits, ventilation strategies and heat recovery systems are all included in this section.

To study the effects of air infiltration on the performance of heating, ventilation and heat recovery systems (17 replies)

The performance of heating and ventilation systems is considerably influenced by air infiltration, with each system demanding an optimum level of building airtightness to ensure its safe and efficient operation. The approaches covered include natural and mechanical ventilation systems, moisture control, forced air heating systems and air-to-air heat recovery devices.

To develop/recommend airtightness and related standards/guidelines (15 replies)

The need to develop appropriate airtightness standards stems not only from an energy conservation point of view but also from the need to maintain an adequate level of indoor air quality. This subject has therefore taken on considerable importance and several studies are reported. The main emphasis is on recommending appropriate levels of both airtightness and minimum air change rates. Other standards concern measurement methods and heat loss calculations.

To determine air leakage through specific components (14 replies)

The air leakage characteristics of many specific components are being determined. These components include windows, entrances, vents, facades, weatherstripping and thermal insulation.

To determine/measure heat loss from buildings due to air infiltration (9 replies)

The range of subjects covered in this section includes the influence of airtightness and air infiltration on energy usage, heat loss modelling and the influence of ventilation systems on heat loss.

The principal aim of many air infiltration studies is to seek ways of reducing heat loss and, in addition to those projects referenced in Table 1, there are many others in which heat loss measurements appear as a key component. These are listed in Tables 2 and 8.

To determine the effects of occupants on air infiltration (7 replies)

The benefits of energy conserving measures can be significantly affected by the actions of occupants, especially in relation to window and door opening. Several studies are devoted to analysing
the need for opening windows, while others are investigating heat losses due to window opening. The benefits of educating inhabitants in the proper use of heating and ventilation systems are also being analysed. Other projects in which the influences of occupants are being considered are listed in Table 6.

(xi) To develop airtight construction/retrofit techniques (7 replies)

A number of new research projects have been reported concerning the development of airtight construction techniques. Projects described include the development of practical design solutions, devising methods for sealing joints and studies into the performance of air/vapour barriers.

(xii) To determine factors affecting air infiltration (6 replies)

Much of the research reported in this section relates to the influence of wind on air infiltration. The influence of internal pressure distribution on air flow is also considered.

(xiii) To determine building pressure distribution (5 replies)

The building pressure distribution is primarily being determined as a function of wind speed and buoyancy effects. Other parameters include building orientation, shape and location. This category also contains research details on time-averaged pressure measurements being made on building facades.

(xiv) Determination/survey of representative values of air infiltration rates (4 replies)

This section lists projects concerned with determining typical values of air infiltration rate for various buildings.

(xv) To determine the air leakage characteristics of buildings (2 replies)

These projects involve the measurement of air leakage in a large number of dwellings. The objective is to categorize air leakage characteristics of buildings according to typical construction practices.

1.2 PROJECT DETAILS

Project details are summarised in terms of measurements and activities (Table 2), tracer gas methods (Table 3), indoor climate measurements (Table 4), building type (Table 5), occupancy patterns (Table 6) and ventilation systems (Table 7).

The most widely reported measurement involves the use of tracer gas (55 replies), with the concentration decay technique being the most popular method. New developments in tracer gas approaches include "passive" continuous emission methods for long or short duration sampling and multi tracer gas methods for air movement studies. Sulphur hexafluoride and nitrous oxide are the most commonly reported tracer gases, followed by carbon dioxide and per fluoro tracers (PFT).
Air leakage measurements using pressurization methods are also being performed extensively. Both component leakage and whole building measurements are reported. In most instances, direct pressurization or depressurization is used although in one project (CA14) a transient technique is adopted in which a pulse of compressed air is discharged into the building, and in another (US30) alternating (AC) pressurization is used.

Approximately 40% of the organisations making indoor climate measurements are monitoring radon concentrations. This subject has attracted much worldwide interest recently, with projects being reported in Canada, Finland, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States. This interest follows concern regarding the potential carcinogenic properties of the gas. Under certain geological conditions, naturally occurring radon passes from the underlying strata into the building. If the building is poorly ventilated, undesirably high concentrations of the gas can occur. Measurements are being made to determine the extent of the problem, the risk involved and methods to minimise the ingress of radon. Other important pollutants under investigation include moisture, combustion products such as oxides of nitrogen and carbon monoxides, formaldehyde and particles (smoke, dust, etc). A complete list of the pollutants being studied is given in Table 4.

Energy consumption and heat loss measurements continue to form a fundamental part of many projects. These measurements range from a simple analysis of annual fuel consumption records, to detailed measurements of roof, floor and facade heat loss.

Air movement measurements have steadily grown in importance. An understanding of air flow patterns is particularly necessary in order to maximise ventilation efficiency at low air exchange rates. For similar reasons, measurements of a "multi-cell" nature are also becoming more common. Such methods enable the influence of internal partitioning on air movement to be determined.

Other measurements being made include full scale and wind tunnel pressure measurements, both of which provide valuable input for mathematical modelling studies. Finally, leak detection techniques using smoke and thermography are reported.

Research activities mentioned for the first time in the replies include surveys, literature studies, the creation of databases and the preparation of design guidelines (Table 2b). The range of topics included in these activities covers not only air infiltration, air quality and energy studies but also parameters influencing air infiltration rates - particularly climate.

Of the projects for which the type of building in which measurements are being made is stated, just over half relate to single family and apartment dwellings (Table 5). The remaining buildings identified are commercial premises, industrial buildings, schools, hospitals, farm buildings, individual rooms and climatic chambers. Compared with the previous survey, measurements in industrial buildings have increased substantially, while proportionately fewer measurements are being made in single family dwellings.
Where information was provided, 60% of the projects relate to occupied buildings, 14% to simulated occupancy and the remainder are concerned with measurements in unoccupied buildings (Table 6).

Natural ventilation accounts for almost 50% of the systems referenced (Table 7). The continuing popularity of natural ventilation is widespread with organisations in 15 countries referring to such systems. Countries in which natural ventilation is not mentioned include those with particularly severe climates such as Canada, Finland and Sweden. Heat recovery systems are mentioned in several research summaries with both air-to-air systems and exhaust air heat pumps being investigated. Mechanical ventilation systems operated by indoor air quality sensors are also being studied.

1.3 PARAMETERS WITH WHICH AIR INFILTRATION AND AIR QUALITY ARE RELATED

In almost all instances, air infiltration is being related to wind velocity and internal/external air temperatures. Air quality is being related to sources of pollution, building airtightness, air change rates and building location. A complete list of parameters is printed in Table 8. In general, parameters are linked to the various project objectives. Following weather and temperature, the most widely cited parameters are performance of building components, occupant behaviour, air quality and the effect of heating, ventilating and heat recovery systems. The remaining parameters are pressure differences, humidity, structural design, exposure, comfort levels, year of construction, air movement and internal obstructions.

1.4 ALLOCATION OF STAFF TIME AND DISTRIBUTION OF RESEARCH PROJECTS

Information on the staff time allocated to each project was stated in 50% of the survey replies. These results are summarised in Figure 1. The median time allocation for each project is 2000 man hours, while the research effort for 75% of the projects is under 5000 man hours. Thus the typical time being spent on individual projects is in the region of between 1 and 3 man years. There are notable exceptions, however, with long term research projects of over 50,000 man hours of effort being reported in Canada (CA9), the United States (US18) and West Germany (DE1). In total, it is estimated that this survey documents one million man hours of research effort.

The distribution of research effort by country is illustrated in Figure 2. Virtually half of the stated time allocation is accounted for by research in the United States (32.4%) and Canada (16.9%). West Germany (a non-participant in the Air Infiltration Centre) comes third with 14.8%, while the non-participating countries as a whole account for over a fifth of the research time. The United Kingdom comes fourth, followed by the Netherlands and Sweden. The aggregate time stated by organisations in Belgium, Denmark, New Zealand, Norway and Switzerland amounts to just 2.5% of the total. Because response to the survey is entirely voluntary, there is likely to be some distortion in these results, particularly in relation to the non-participating countries (especially France and Eastern Europe) where penetration of the survey was limited. Furthermore, individual
large scale or long term projects can account for a significant slice of a country's total research effort. Nevertheless, it is thought that these results provide a fairly accurate picture for the participating countries and West Germany.

The distribution of projects among types of organisation is illustrated in Figure 3. Approximately 39% of the research projects are being undertaken by universities or polytechnics, 36% by government or public sector research establishments and 25% by private sector organisations.

1.5 CONCLUSIONS AND DISCUSSION

In common with the previous two surveys, this third survey of research has revealed a diverse range of projects, covering all aspects of air infiltration research. Possible areas of weakness include occupancy effects and studies into the long term durability of low leakage structures. There is also still much to be understood regarding the overall energy effectiveness of airtightness measures and the influence on energy demand of choice of ventilation strategy.

Recent concern regarding the possible harmful effects that low air exchange rates may have on indoor air quality is much in evidence. This, perhaps, highlights the need to be sure that design and retrofit approaches are well planned and are conducted in conjunction with a proper programme of measurements. To ensure an acceptable internal environment, coupled with an optimum level of energy efficiency, it is essential that ventilation needs are properly assessed and adequately met. The most frequently reported indoor pollutant is radon but moisture and the products of combustion from cooking and heating appliances are also being extensively investigated.

In recognition of the need to consider ventilation, both in terms of energy conservation and indoor air quality, many countries are preparing and implementing standards or guidelines governing airtightness and minimum air change rates. Much research in the field of minimum ventilation rates is still necessary but it is encouraging to note that progress in this area is being achieved.

A move towards air infiltration studies in non-domestic buildings has resulted in a strengthening of research in multi-cell applications. To support this work, a number of multi tracer gas techniques have recently been introduced.

Instrumentation and measurement techniques still largely remain research tools. Steady-state pressurization instrumentation is available commercially but tracer gas equipment is not available as a complete package. The development of a per fluoro tracer technique for both short and long time-averaged measurements has a good market potential (US14). The passive nature of both the continuous emission source and adsorption tube collector means that expensive site instrumentation may be avoided. Further development at the Lawrence Berkeley Laboratory of the alternating pressurization technique will hopefully yield a portable system for the measurement of air leakage (US30). An advantage of this approach is that the leakage characteristics of the building may be determined at pressures corresponding to those experienced in reality.
Predictive techniques involving the development and application of mathematical models continue to form an essential component of many research projects. Several of these models have also been investigated by the Air Infiltration Centre as part of a validation exercise. The results of this study have shown that excellent agreement between calculated and measured rates of air infiltration are possible but that care must be exercised in specifying both the leakage characteristics of the building and the surface pressure distribution. Further modelling studies, particularly to verify turbulent fluctuation assumptions and air movement predictions are necessary. It is hoped that some of the models investigated by the Centre will become more generally available, especially as design tools.

The analysis of research effort being devoted to each project reveals that these research studies are of a fairly short duration, typically representing between one and two man years of effort. This tends to reflect a general funding policy favouring short term research projects. Nevertheless, the total staff commitment documented in this report is estimated to amount to one million man years.

Information on air infiltration research will continue to be updated and made available to organisations in participating countries. It is envisaged that the results of the next survey will be published in November 1985.
Median value 2000 hrs.

FIGURE 1: Allocation of staff time

Number of man hours (thousands)

Number of projects

0 5 10 15 20

<.5  5-1  1-2  2-3  3-4  4-5  5-6  6-7  7-8  8-9  9-10  10-50 >50
FIGURE 2: Approximate distribution by country of staff allocation
(based on 95 replies, total man hours = 500,000)

United States of America

West Germany

Other non-participants

Netherlands

Sweden

Canada

Belgium, Denmark, New Zealand, Norway & Switzerland

United Kingdom

FIGURE 3: Project distribution among types of organisation

Private Sector Organisations 25%

Universities and Polytechnics 39%

Government and Public Sector Research Organisations 36%
### TABLE 1 - SPECIFIC OBJECTIVES

<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>PROJECT REFERENCE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>(see also Table 4)</td>
<td></td>
</tr>
<tr>
<td>4. To determine the effects of construction methods and retrofiling on air infiltration/air quality/energy demand.</td>
<td>AU1, CA2, CA4, CA6, CA7, CA9, CA11, CA15, CA18, CA28, CA29, CA30, CA37, CH1, CH3, DK4, FI1, IT2, J1, PL1, SE8, US13, US24, US33, US43.</td>
</tr>
<tr>
<td>5. To evaluate the cost/energy effectiveness of airtightness measures and ventilation strategies. To develop performance criteria.</td>
<td>BE1, CA3, CA30, DE1, DE3, DE5, FI1, FI1, IT1, SA1, SE2, SE4, UK9, UK17, UK28, US1, US13, US25, US28.</td>
</tr>
<tr>
<td></td>
<td>contd./</td>
</tr>
</tbody>
</table>
### TABLE 1 - SPECIFIC OBJECTIVES

<table>
<thead>
<tr>
<th>OBJECTIVES</th>
<th>PROJECT REFERENCE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. To determine air leakage through specific building components.</td>
<td>NL5, NL12, NL13, NL17, NL18, SE6, UK2, UK5, UK11, UK13, UK14, US6, US16, US37.</td>
</tr>
<tr>
<td>9. To determine/measure heat loss from buildings due to air infiltration.</td>
<td>CH5, DE4, FI2, IT2, NL1, NZ1, PL1, SE7, UK21.</td>
</tr>
<tr>
<td>(see also Table 2)</td>
<td></td>
</tr>
<tr>
<td>10. To determine the effects of occupants on air infiltration.</td>
<td>BE2, CA11, CA37, NL4, NL9, NL14, NL15.</td>
</tr>
<tr>
<td>11. To develop airtight construction/retrofit techniques.</td>
<td>CA12, CA16, CA19, CA33, FI3, NO2, UK10.</td>
</tr>
<tr>
<td>12. To determine factors affecting air infiltration.</td>
<td>CH5, DE6, F1, NL10, SE5, UK5.</td>
</tr>
<tr>
<td>13. To determine building pressure distribution.</td>
<td>CA32, CA34, PL1, SE1, SE5.</td>
</tr>
<tr>
<td>14. Determination/survey of representative values of air infiltration.</td>
<td>AU1, NO1, US2, US35.</td>
</tr>
<tr>
<td>15. To determine the air leakage characteristics of buildings.</td>
<td>CA19, CA36.</td>
</tr>
</tbody>
</table>
TABLE 2 - PROJECT DETAILS (a) MEASUREMENTS

<table>
<thead>
<tr>
<th>MEASUREMENT</th>
<th>PROJECT REFERENCE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Pressurization tests (DC) (air leakage measurements)</td>
<td>AU1, BE1, BE2, CA4, CA7, CA10, CA15, CA16, CA19, CA30, CA33, CA36, CA37, CH1, DE3, DE7, F11, F13, J1, J2, J4, NL12, NL16, NO2, NZ1, SE4, SE7, UK3, UK9, UK10, UK28, US1, US6, US33, US38, US39, US43, US44.</td>
</tr>
<tr>
<td>(a) whole building</td>
<td>BE1, CA32, CH1, CH5, F1, F11, FI3, IT2, PL1, SE3, UK2, UK5, UK14, UK25, UK26, US37, US47.</td>
</tr>
<tr>
<td>(b) components</td>
<td>CA14, US30.</td>
</tr>
<tr>
<td>4. Indoor climate (odour, moisture, pollution, etc.)</td>
<td>CA3, CA7, CA15, CA29, CA30, DE2, DE3, DE4, DE6, F1, F12, FI4, NL1, NL5, NL13, NL14, SE2, SE3, SE4, SE7, SE8, UK9, UK10, UK15, UK17, UK21, UK28, US24, US25, US33.</td>
</tr>
<tr>
<td>(see also Table 4)</td>
<td>CA34, FI1, NL5, NL8, NL11, NL12, NL13, NL15, NL17, NO2, PNG1, SE3, UK12, UK19, UK24, UK29, UK30, US17.</td>
</tr>
<tr>
<td>5. Energy consumption/heat loss measurements. Heating/cooling system performance</td>
<td>contd./.</td>
</tr>
<tr>
<td>6. Internal pressure/air flow distribution.</td>
<td>contd./.</td>
</tr>
</tbody>
</table>
### TABLE 2 - PROJECT DETAILS (a) MEASUREMENTS

<table>
<thead>
<tr>
<th>MEASUREMENT</th>
<th>PROJECT REFERENCE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Multi-cell investigations (see also Table 5 - commercial premises)</td>
<td>CH2, FI3, H1, J6, NZ1, SE3, UK3, UK7, UK18, UK29, UK30, US14, US28, US45.</td>
</tr>
<tr>
<td>8. Facade pressure distribution/ pressure difference.</td>
<td>CA32, CA34, CH5, J3, NL5, NL8, NL10, NL12, NL16, PL1, SE5, UK26, UK30.</td>
</tr>
<tr>
<td>11. Smoke.</td>
<td>FI3, SE3.</td>
</tr>
</tbody>
</table>

### TABLE 2 - PROJECT DETAILS (b) OTHER ACTIVITIES

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>PROJECT REFERENCE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Surveys</td>
<td>CA19, CA21, CA26, NL1, NL2, NL4, NL14, NO1, NZ1, US21.</td>
</tr>
<tr>
<td>5. Preparation of guidelines</td>
<td>CA24, CA29, CH4.</td>
</tr>
</tbody>
</table>
### TABLE 3 - PROJECT DETAILS: ANALYSIS OF TRACER GAS TESTS

<table>
<thead>
<tr>
<th>(a) TECHNIQUE</th>
<th>PROJECT REFERENCE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Constant concentration</td>
<td>AU1, CH2, SE4, UK3.</td>
</tr>
<tr>
<td>3. Constant emission</td>
<td>CH2</td>
</tr>
<tr>
<td>4. Automatic sampling</td>
<td>UK3</td>
</tr>
<tr>
<td>6. Multi tracer gas</td>
<td>NZ1, UK7, UK9, UK31, US14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(b) TRACER GAS</th>
<th>PROJECT REFERENCE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Carbon dioxide</td>
<td>J2, UK8, UK11, UK13, US8</td>
</tr>
<tr>
<td>2. Carbon monoxide</td>
<td>J4</td>
</tr>
<tr>
<td>3. Ethane</td>
<td>DE7</td>
</tr>
<tr>
<td>4. Krypton85</td>
<td>CZ1</td>
</tr>
<tr>
<td>5. Methane</td>
<td>US26</td>
</tr>
<tr>
<td>6. Nitrous oxide</td>
<td>AU1, BE1, CH2, UK16, UK23, UK26</td>
</tr>
<tr>
<td>9. Ethylene</td>
<td>J4</td>
</tr>
<tr>
<td>POLLUTANT</td>
<td>PROJECT REFERENCE NUMBER</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>1. Allergens</td>
<td>US18</td>
</tr>
<tr>
<td>3. Carbon dioxide</td>
<td>DK1, NL5, NL6, US20, US21, Y1</td>
</tr>
<tr>
<td>5. Carcinogens</td>
<td>CA22</td>
</tr>
<tr>
<td>8. Fungi/mould</td>
<td>CA22</td>
</tr>
<tr>
<td>9. Micro organisms, bacteria, viruses, etc.</td>
<td>CA5, CA22, CA27</td>
</tr>
<tr>
<td>13. Particles (smoke, dust, etc.)</td>
<td>CA9, CA22, DK1, NL2, NL6, UK9, US18, US23, US33, US34, Y1.</td>
</tr>
<tr>
<td>15. Sulphur compounds</td>
<td>US4, US21, US23, Y1</td>
</tr>
<tr>
<td>16. Other</td>
<td>Y1 (ammonia phenol)</td>
</tr>
<tr>
<td>BUILDING</td>
<td>PROJECT REFERENCE NUMBER</td>
</tr>
<tr>
<td>----------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>1. Dwellings (primarily single family, low rise)</td>
<td>AU1, BE1, BE2, CA4, CA7, CA8, CA9, CA10, CA11, CA14, CA15, CA16, CA18, CA19, CA20, CA21, CA22, CA23, CA24, CA25, CA26, CA27, CA28, CA29, CA30, CA31, CA32, CA33, CA36, CA37, CH1, CH2, CH3, CH5, DE1, DE3, DE4, DE7, DK3, FI1, FI3, J1, J3, J4, J5, NL1, NL2, NL3, NL4, NL8, NL9, NL10, NL12, NL16, NL17, NL18, NO1, NZ1, PNG1, SA1, SE1, SE2, SE3, SE4, SE5, SE7, SE8, UK3, UK6, UK7, UK10, UK11, UK16, UK17, UK20, UK21, UK23, UK25, UK28, UK29, US1, US8, US18, US21, US24, US31, US39, US43.</td>
</tr>
<tr>
<td>2. Dwellings (multi-storey)</td>
<td>CH5, DK2, DK4, FI2, FI3, FI4, H1, J1, J3, NL8, NL10, NL14, NL15, PL1, UK18, US19, US38.</td>
</tr>
<tr>
<td>5. Schools (educational buildings, etc.)</td>
<td>CA5, CZ1, DK1, NL3, NL5, PNG1, UK8, UK9, UK13, UK26, US6.</td>
</tr>
<tr>
<td>6. Individual rooms</td>
<td>CH4, DE5, DE6, J2, NL12, NL17, UK19</td>
</tr>
<tr>
<td>7. Climatic chambers</td>
<td>CH4, DK3, SE9, UK5, US16</td>
</tr>
<tr>
<td>10. Other</td>
<td>UK5 (freight containers) FI1 (museum)</td>
</tr>
</tbody>
</table>
### TABLE 6 - PROJECT DETAILS: BUILDING OCCUPANCY

<table>
<thead>
<tr>
<th>OCCUPANCY</th>
<th>PROJECT REFERENCE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Occupied</td>
<td>CA1, CA3, CA9, CA11, CA15, CA37, CH2, CH3, DE1, DE3, DE8, FI2, NL2, NL4, NL5, NL6,</td>
</tr>
<tr>
<td></td>
<td>NL14, NL15, PL1, SA1, SE2, SE7, UK8, UK13, UK16, UK17, UK26, UK31, US6, US14, US20,</td>
</tr>
<tr>
<td>2. Unoccupied</td>
<td>AU1, BE1, CA11, CZ1, DE5, DE7, J1, J2, NL8, PL1, SE4, UK3, UK11, UK17, UK21.</td>
</tr>
<tr>
<td>3. Simulated occupancy</td>
<td>CA11, DE6, H1, IT1, NL5, SE4, UK3, US8.</td>
</tr>
</tbody>
</table>

### TABLE 7 - PROJECT DETAILS: VENTILATION SYSTEM

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>PROJECT REFERENCE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Natural</td>
<td>AU1, BE1, CZ1, CH1, CH3,</td>
</tr>
<tr>
<td></td>
<td>CH5, DE1, DE3, DE4, DE7,</td>
</tr>
<tr>
<td></td>
<td>DK4, J3, NL3, NL5, NL8,</td>
</tr>
<tr>
<td></td>
<td>NL10, NL14, NL15, NL17,</td>
</tr>
<tr>
<td></td>
<td>NL18, NO2, PL1, PNG1, SA1,</td>
</tr>
<tr>
<td></td>
<td>UK3, UK5, UK8, UK9, UK10,</td>
</tr>
<tr>
<td></td>
<td>UK11, UK26, UK31, US6,</td>
</tr>
<tr>
<td></td>
<td>US8, US13, US16, US18,</td>
</tr>
<tr>
<td>2. Mechanical</td>
<td>CA11, CA16, CA29, CA31,</td>
</tr>
<tr>
<td></td>
<td>CA32, CA33, CH5, CZ1, DE3,</td>
</tr>
<tr>
<td></td>
<td>DE7, DK1, FI1, FI2, FI3,</td>
</tr>
<tr>
<td></td>
<td>FI4, H1, J1, NL1, NL4, NL8,</td>
</tr>
<tr>
<td></td>
<td>NO2, PL1, PL2, SE2, SE3,</td>
</tr>
<tr>
<td></td>
<td>SE4, SE8, UK3, UK6, UK9,</td>
</tr>
<tr>
<td></td>
<td>UK13, UK20, US4, US7,</td>
</tr>
<tr>
<td></td>
<td>US10, US16, US18, US22,</td>
</tr>
<tr>
<td>3. Heat recovery systems</td>
<td>CA32, CA33, DE1, FI4, IT1,</td>
</tr>
<tr>
<td></td>
<td>NL13, SE2, SE8, UK9, US1,</td>
</tr>
<tr>
<td>controlled by indoor air quality.</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 8 - PARAMETERS WITH WHICH AIR INFILTRATION/AIR QUALITY ARE RELATED

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>PROJECT REFERENCE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wind velocity</td>
<td>In almost all instances air infiltration is related to these parameters.</td>
</tr>
<tr>
<td>4. Air quality/sources of pollution/health problems</td>
<td>BE1, CA1, CA2, CA4, DE6, IT2, SE7, UK10, UK28, US33.</td>
</tr>
<tr>
<td>5. Effect of heating, ventilation or heat recovery system.</td>
<td>BE2, IT2, NO2, SA1, SE2, SE6, UK2, UK13, UK14, UK20, US29.</td>
</tr>
<tr>
<td>7. Envelope pressure/pressure difference</td>
<td>CA3, CA11, CH2, CH3, DE1, DE2, DE3, FI2, H1, IT1, J5, NL2, NL4, NL5, NL6, NL9, NL12, NL13, NL14, NL15, SE4, SE7, UK3, UK8, UK9, UK13, UK14, UK17, UK21, US22, US23, US24, US33, US36, Y1.</td>
</tr>
<tr>
<td>9. Occupants (including window/door opening habits, activities, etc.)</td>
<td></td>
</tr>
<tr>
<td>11. Structural design, geometry, building dimensions, materials</td>
<td></td>
</tr>
</tbody>
</table>

contd./
TABLE 8 - PARAMETERS WITH WHICH AIR INFILTRATION/AIR QUALITY ARE RELATED

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>PROJECT REFERENCE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>12. Terrain/exposure of building</td>
<td>CA34, NL10, NL18, NO2, NZ1</td>
</tr>
<tr>
<td>13. Year of construction</td>
<td>FI3</td>
</tr>
<tr>
<td>15. Comfort levels</td>
<td>CA4, DK4, PNG1, UK1, UK2</td>
</tr>
<tr>
<td>16. Other</td>
<td>UK7 (air movement)</td>
</tr>
<tr>
<td></td>
<td>UK18 (internal obstacles)</td>
</tr>
</tbody>
</table>
SECTION 2 - RESEARCH SUMMARIES
AUSTRALIA

#REF AUI Air infiltration characteristics of buildings
PRINCIPAL RESEARCHER(S) K.L. Blighs
ADDRESS Commonwealth Scientific and Industrial Research Organisation CSIRO
Division of Building Research
PO Box 56
Highton
Victoria 3190
Australia
Telephone: (03) 555 0333
Telex: 33766 AA
SPECIFIC OBJECTIVES
Air infiltration rates of typical Australian houses. Measurement of their overall permeability at 50 Pa pressure difference. Correlation of the two sets of measurements. Study of the effect of constructional details on infiltration rates.
PROJECT DETAILS
Houses are usually single-storey, detached dwellings 120-200 m² in plan area, of timber frame construction with brick cladding, but some are of full brick with cavity brick external walls. Naturally ventilated, with gas or electric heating. Infiltration rates are determined using a modified constant concentration technique with N₂O tracer gas. Permeability is measured by the pressurization technique. Unoccupied houses are studied.
PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather (wind speed and direction, indoor/outdoor temperature difference), surface area of building, degree of exposure to weather, permeability.
START DATE 01:01:1979
END DATE on-going

BELGIUM

#REF BEI Integration of energy saving techniques for dwellings
PRINCIPAL RESEARCHER(S) Ir. M. Guillaume
ADDRESS Belgian Building Research Institute
Lombardstreet 41
B-1000 Brussels
Belgium
Telephone: (02) 653 88 01
Telex: 25682 CETEX B
SPECIFIC OBJECTIVES
Global efficiency of some heating systems in thermally insulated houses.
PROJECT DETAILS
2 single houses, 8x13 m floor, brick, natural ventilation, electrical and oil system, N₂O tracer gas, unoccupied buildings, pressurization, air leakage of windows and doors. Theoretical/model calculation. Temperature without heating.
PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Outside temperature, wind velocity and orientation, energy consumption, indoor resultant temperature, performance of windows and doors.
START DATE 01:01:1981
END DATE 01:02:1985
APPROX NO MAN HOURS 20,000
BIBLIOGRAPHY
Guillaume, M. Integration of energy saving techniques for dwellings EEC, 7 May 1982
Guillaume, M. Global efficiency of some heating systems in well thermal insulated houses CIB-S-H, September 1983

Guillaume, M. Integration de differences possibilites d ' economie d ' energie dans le domaine de l ' habitation. EEC DEXII, November 1983

#REF BEZ Case studies of low energy houses (air infiltration)
PRINCIPAL RESEARCHER(S) Ir. P. Caluwaerts
ADDRESS Belgian Building Research Institute
Lombardstreet 41
B-1000 Brussels
Belgium
Telephone: (02) 653 88 01
Telex: 25682 CETEX B
SPECIFIC OBJECTIVES
Analysis of measurement and prediction techniques of air infiltration. Influence of building users.
PROJECT DETAILS
Compare by experiments different measurement techniques and prediction techniques on case studies (tracer gas, pressurization and their relation). Collect statistical information on users' habits on ventilation and infiltration (open doors and windows). Relate them to prediction figures of air infiltration rates.
PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Wind speed direction, indoor temperature, outdoor temperature, air leakage area, pressure difference on facades and for some practical publications, humidity.
START DATE 01:09:1982
END DATE 31:08:1986
BIBLIOGRAPHY
Nusgens, P. (University of Liege), Caluwaerts, P. (BBRI) Determination of the ventilation rate in a series of social houses CIB-S-17 (Holzkirchen partly out-of-date) 7 July 1977

CANADA

#REF CA1 Environment survey of 1106 office, professional and clerical workers
PRINCIPAL RESEARCHER(S) E. M. Sterling
ADDRESS Theodor D. Sterling Limited
70 - 1507 W. 12th Avenue
Vancouver
B.C. V6J 2E2
Canada
Telephone: (604) 733 2701
Telex: SPECIFIC OBJECTIVES
To determine the effect of indoor environment and air quality on health and comfort of office workers.
PROJECT DETAILS
A Work Environment Survey questionnaire was constructed and administered to 1106 office and professional clerical workers in 20 buildings in the New York City area. The survey questionnaire was self-administered and machine readable. Responses were evaluated to determine potential building, life style or occupational factors related to wide-spread incidence of building illness symptoms including eye irritation, headaches and fatigue. Of particular concern are effects of air quality and use of new office equipment such as video display terminals and photocopiers.
PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
An architectural inventory of building characteristics including environment control systems, configurations, interior layout and furnishings, equipment and energy, and reported
health and comfort complaints of building occupants.

START DATE 01:01:1981
END DATE 01:12:1983

BIBLIOGRAPHY


#REF CA2 Building information system
PRINCIPAL RESEARCHER(S) E.M. Sterling
ADDRESS Theodor D. Sterling Limited
70 - 1507 W. 12th Avenue
Vancouver BC V6J 2E2
Canada
Telephone: (604) 733 2701

SPECIFIC OBJECTIVES
Development of a building diagnostic information system and software. A computer based archive to catalogue results of the growing number of epidemiological, hygiene, architectural, engineering, air quality and energy studies.

PROJECT DETAILS
The Building Information System is a collection of programs and files organised with the primary objective of exploring the information contained in existing investigation reports. The system is designed to accommodate:

1. different types of study situations.
2. different originating and dominating problems to which studies respond.
3. different levels of detail and study parameters between and within studies.
4. different enquiry purposes, i.e. epidemiological, industrial hygiene, engineering, etc.

Special search routines will allow the collating of symptoms with architectural, engineering or industrial hygiene information. The database is being constantly enlarged to include additional studies as they become available. The final system will be made available for research purposes to qualified investigators.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
All parameters which are contained in existing investigations will be included.

START DATE 01:05:1982
END DATE 01:10:1983

BIBLIOGRAPHY


#REF CA3 Building modification study
PRINCIPAL RESEARCHER(S) E.D. McIntyre and E.M. Sterling
ADDRESS
Theodor D. Sterling Limited
70 - 1507 W. 12th Avenue
Vancouver BC V6J 2E2
Canada
Telephone: (604) 733 2701

SPECIFIC OBJECTIVES
Development of performance criteria for energy and environment retrofits of modern buildings and design of new energy conserving buildings.

PROJECT DETAILS
Methods are being explored of evaluating environmental performance of buildings from plans and field studies. Criteria are being developed to integrate design, ventilation and lighting solutions for modern energy conserving buildings responding to case studies of environmental performance of problem buildings.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Performance of building components, behaviour of occupants, indoor and outdoor sources of pollution, indoor and outdoor thermal environment.

START DATE 01:04:1982
END DATE 01:09:1983

BIBLIOGRAPHY

#REF CA4 Evaluation of major residential energy conservation retrofits
PRINCIPAL RESEARCHER(S) G. Proskiw, P.Eng.
ADDRESS
UNIES Ltd.
1666 Dublin Avenue
Winnipeg Manitoba R3H 0H1
Canada
Telephone: (204) 633 6363

SPECIFIC OBJECTIVES
Evaluation of reduction of the air leakage rates in houses retrofitted with a variety of conservation options.

PROJECT DETAILS
As part of a much larger project investigating major residential energy conservation retrofits, the air leakage rates of 120 houses will be determined before and after the retrofits. Retrofit options include air leakage sealing, single and double wall retrofits, basement and attic insulation upgrading, furnace replacement, etc.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Energy and economic benefits, comfort levels.

START DATE 01:03:1983
END DATE 01:12:1983

#REF CA5 The effect of indoor relative humidity on survival of airborne micro-organisms and the related absenteeism in schools and hospitals.
PRINCIPAL RESEARCHER(S) G.H. Green
ADDRESS
Department of Mechanical Engineering
University of Saskatchewan
Saskatoon
Saskatchewan S7N 0WO
Canada
Telephone: (306) 343 3101

SPECIFIC OBJECTIVES
To determine the effect of ventilation and indoor
humidity upon the airborne micro-organism levels and relate them to school absenteeism.

PROJECT DETAILS
Laboratory studies have shown that indoor relative humidity has a great effect on the survival of airborne micro-organism. Two studies, one in a school and the other in an office building, have shown that the survival decreases several magnitudes as the indoor humidity is increased towards 50%. Study is being extended to include ventilation as a parameter.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Ventilation (outdoor air) plus infiltration measured with tracer gas.

START DATE 01:04:1983
END DATE 01:07:1984
APPROX NO MAN HOURS 2400
BIBLIOGRAPHY

#REF CA6 Air infiltration in greenhouses
PRINCIPAL RESEARCHER(S)
G.H. Green
ADDRESS
Department of Mechanical Engineering
University of Saskatchewan
Saskatoon
Saskatchewan S7N 0W0
Canada
Telephone: (306) 343 3101

SPECIFIC OBJECTIVES
This is a part of the study of energy conserving measures in greenhouses.

PROJECT DETAILS
A mobile blanket inside and outside the structure has been operated and the measurement of infiltration is a part of that study.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Comparison between types of greenhouse structure, glass and polyethylene covered.

START DATE 01:01:1980
END DATE 01:01:1984

#REF CA7 Weatherization
PRINCIPAL RESEARCHER(S)
A. Idanowicz
ADDRESS
Ministry of Municipal Affairs and Housing
101 Bloor St. W.
Toronto
Ontario MSS 1P8
Canada
Telephone: (416) 965 9108

SPECIFIC OBJECTIVES
To evaluate energy savings achieved by tightening existing (65) houses in four communities. Also to monitor results in case problems occurred.

PROJECT DETAILS
65 houses of varied construction, type and age. Houses tightened under depressurization methods. Test carried out at each tightening package, fuel bills collected and analysed, re-inspection of each house undertaken after one year and air quality test carried out on 20 houses.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Other tightening of envelope.

START DATE 01:10:1981
END DATE 01:09:1983
APPROX NO MAN HOURS 3000
BIBLIOGRAPHY
Report to be finalised by September 1983.


Broder, I. et al Changes in respiratory variables of pulmonary abnormalities in rheumatoid arthritis.

#REF CAIO An infiltration model for a one-storey house based on the Encore-Canada simulation

W.G. Colborne and N.W. Wilson
Department of Mechanical Engineering
University of Windsor
Windsor
Ontario
N9B 3P4
Canada

Telephone: (519) 253 4232 ex 548

SPECIFIC OBJECTIVES
To develop an infiltration model to predict infiltration rates for various wind velocities and indoor-outdoor temperature differences.

PROJECT DETAILS
Encore-Canada was used to establish the basic relationships between the variables and to establish the empirical model. Since Encore-Canada uses a house leakage number in its determination of infiltration, the first empirical model developed was a relationship between the results of a blower door test and the house leakage number. The infiltration model was then developed relating infiltration to wind velocity, indoor-outdoor temperature difference and the leakage number. By determining the leakage number from results of a blower door test, the infiltration equation can more closely predict leakage in a specific house.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Wind velocity, temperature difference vs air flow from a blower door test.

START DATE 01:11:1980
END DATE 01:06:1983

BIBLIOGRAPHY

#REF CA12 Buildability as a factor in the design of building details for airtightness

S.G. Mattar, PhD., P.Eng.,
ADDRESS
Alberta Public Works, Supply and Services
5048 Dalgetty Dr. N.W.
Calgary
Alberta
T3A 1J3
Canada

Telephone: (403) 286 9770

SPECIFIC OBJECTIVES
To ensure that the design of details for airtightness can be met by ensuring that they are practical and simple.

PROJECT DETAILS
Evaluating design details with respect to buildability while ensuring that the objectives, i.e. airtightness, etc., are achieved. It is hoped that, as a result of this exercise, we will be able to derive guidelines, an evaluation of failures and recommendations in practice. Case studies will be published regularly. Note: This project is practical and makes use of actual design details.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Buildability, construction practice, methodology

START DATE 01:06:1982
END DATE on-going

BIBLIOGRAPHY
Mattar, S.G., Morstead, H. Construction methods and the design of building envelope details. Third Canadian Masonry Symposium, Edmonton, Canada, 6-8 June 1983

Mattar, S.G. "Buildability" and the design of building enclosures (paper in preparation)

#REF CA13 Seasonal influence and comparison of measurement techniques for radon and radon daughter concentrations in energy efficient homes.

R.G. McGregor

Six unoccupied test house modules with full basements, simultaneously continuously monitored by computer controlled SF6 tracer gas injection. Identical (6.7 x 7.3 m in plan) wood frame houses (one brick clad) have varying insulation and sealing with factor of 3 variation in both infiltration and overall heat loss. Occupancy effects simulated only during short intervals by manual opening of doors and windows. One house has computer controlled exhaust fan.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, simulated occupancy, mechanical ventilation, individual component leakages. (Note: no air quality measurements)

START DATE 31:12:1980
END DATE 31:12:1985

APPROX NO MAN HOURS 4000/year

BIBLIOGRAPHY
Wilson, D.J., Pittman, W. Air infiltration with wind from a single direction (To appear in ASHRAE Trans. 1983)

Dale, J.D., Wilson, D.J., Ackerman, M. Adaptable modules for air infiltration studies in home heating. Seminar on Air Infiltration and Ventilation, Building Research Establishment, Watford, UK, 14-16 April 1980

#REF CA12 Buildability as a factor in the design of building details for airtightness

S.G. Mattar, PhD., P.Eng.,
ADDRESS
Alberta Public Works, Supply and Services
5048 Dalgetty Dr. N.W.
Calgary
Alberta
T3A 1J3
Canada

Telephone: (403) 286 9770

SPECIFIC OBJECTIVES
To ensure that the design of details for airtightness can be met by ensuring that they are practical and simple.

PROJECT DETAILS
Evaluating design details with respect to buildability while ensuring that the objectives, i.e. airtightness, etc., are achieved. It is hoped that, as a result of this exercise, we will be able to derive guidelines, an evaluation of failures and recommendations in practice. Case studies will be published regularly. Note: This project is practical and makes use of actual design details.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Buildability, construction practice, methodology

START DATE 01:06:1982
END DATE on-going

BIBLIOGRAPHY
Mattar, S.G., Morstead, H. Construction methods and the design of building envelope details. Third Canadian Masonry Symposium, Edmonton, Canada, 6-8 June 1983

Mattar, S.G. "Buildability" and the design of building enclosures (paper in preparation)

R.G. McGregor
A study of seasonal variation and stratification of radon and radon daughter concentrations between levels of 35 multi-level energy efficient homes.

**PROJECT DETAILS**

Various grab sample techniques will be used to measure radon and radon daughter concentrations. Solid state nuclear track detectors will be used to obtain quarterly average radon concentrations. Both active and passive integrating measurement techniques will be used for determination of average radon and radon daughter concentrations in selected homes. Results will be evaluated with respect to air change rates and airtightness measurements conducted on the homes.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

Air change rate, airtightness.

**START DATE 01:03:1982**

**END DATE 31:03:1984**

**BIBLIOGRAPHY**


Letourneau, E.G., et al The design and interpretation of large surveys for indoor exposure to radon daughters. To be presented at International Seminar on Indoor Exposure to Natural Radiation and Related Risk Assessment, Capri, Italy, 3-5 October 1983.

---

**Ref CA16 Low energy housing studies: “Taped Glasclad System”**

**PRINCIPAL RESEARCHER(S)**

J.M. Dewi

**ADDRESS**

Research Division

Ontario Hydro

800 Kipling Avenue

Toronto

Ontario

M8Z 5A

Canada

Telephone: (416) 231 4111 ex 6253

Telex: 06 984 952

**SPECIFIC OBJECTIVES**

To determine the heating demand reductions and energy savings that are possible by upgrading the thermal envelopes of existing homes and to identify any resulting problems, in support of customer information programs.

**PROJECT DETAILS**

Sixteen occupied frame-construction houses were thermally upgraded (3 homeowner airseal, 4 contractor airseal, 4 basement insulation, 4 airseal and basement insulation, 1 attic insulation) and monitored with digital demand recorders (15 min electric space heating demand) for one heating season. The previous heating season was similarly monitored in a dual fuel (oil/electric) experiment. Air exfiltration tests using fan depressurization were conducted before and after upgrading. Analysis will compare before and after load lines (best fit of space heating demand vs outdoor temperature).

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

Extent of retrofit airsealing.

**START DATE 01:05:1983**

**END DATE 31:12:1983** (possible extension for another heating season)

**APPROX NO MAN HOURS 2500**

**BIBLIOGRAPHY**


---

**Ref CA14 Pressure pulse infiltration meter**

**PRINCIPAL RESEARCHER(S)**

Dr. G.K. Yuill

**ADDRESS**

Lion Industries Ltd.

35 Trottier Bay

Winnipeg

Manitoba

R3T 3R3

Canada

Telephone: (204) 475 8393

**SPECIFIC OBJECTIVES**

Development of a pressure pulse technique for measuring house airtightness.

**PROJECT DETAILS**

A device was developed which releases a timed pulse of compressed air into a house. A pressure transducer produces an electronic signal which can be correlated to house airtightness. This avoids the need for an installation in a door.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

**START DATE 01:04:1982**

**END DATE on-going**

**APPROX NO MAN HOURS 600**

---

**Ref CA15 The effect of thermal envelope upgrading in residential dwellings.**

**PRINCIPAL RESEARCHER(S)**

W.R. Jones

---
Short-circuiting between fresh air intakes and exhausts of buildings as source of indoor air pollution

PRINCIPAL RESEARCHER(S)
Mr R H Ferahian, ACGI, DIC, M.Sc.(Eng.), M.I.C.E., M.ASCE.

ADDRESS
R.H. Ferahian
Consulting Engineer
4998 Maisonneuve #1416
Westmount
Quebec H3Z 1N2
Canada
Telephone: (514) 484 5492

SPECIFIC OBJECTIVES
Literature survey and report on case studies where such short-circuiting was a cause of indoor air pollution. Identify design defects and code infringements and, if possible, identify code improvements.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 01:00:1981
END DATE on-going

BIBLIOGRAPHY
Ferahian, R.H. Indoor air pollution - some Canadian experiences Presented at the International Symposium on Indoor Air Pollution, Health and Energy Conservation, Amherst, MA, USA, 13-16 October 1981

Air quality measurements in residences

PRINCIPAL RESEARCHER(S)
R.S. Dumont

ADDRESS
Division of Building Research
National Research Council of Canada
Saskatoon
Saskatchewan
S7N 0W9
Canada
Telephone: (306) 665 4200

SPECIFIC OBJECTIVES
1. Determine pollutant levels of major pollutants in Canadian residences. 2. Determine interaction of pollutant levels with (a) building materials and (b) air change rates.

PROJECT DETAILS
1. Survey of house air leakage values has been undertaken for Canadian houses (pressurization technique). 2. Experimental methods for sealing houses have been developed and are being refined. 3. Airtightness measurements of detached houses in the Saskatchewan area. Division of Building Research, National Research Council of Canada, Ottawa, BRN No.178, 1981.


Time averaged measurement of air quality

PRINCIPAL RESEARCHER(S)
Mr. P. Deacon

ADDRESS
Research Division
Canada Mortgage and Housing Corporation
Montreal Road
Ottawa
Ontario
K1A 0P7
Canada
Telephone: (613) 748 2984
Telex: 0533674

SPECIFIC OBJECTIVES
To monitor, comment upon and correlate air quality and air change characteristics of up to 30 energy-efficient homes over a 3-month winter period.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 01:01:1983
END DATE 30:06:1983

Moisture study.

PRINCIPAL RESEARCHER(S)
Mr. A.J. Houston

ADDRESS
Research Division
Canada Mortgage and Housing Corporation
Montreal Road
Ottawa
Ontario
K1A 0P7
Canada
Telephone: (613) 748 2315
Telex: 0533674

SPECIFIC OBJECTIVES
1. Determination of air leakage characteristics of residences and development of means of reducing air leakage.
SPECIFIC OBJECTIVES
To study moisture-troubled National Housing Act (NHA) homes to determine the extent, nature and geographic distribution of moisture problems.

PROJECT DETAILS
Using the study results, a methodology was developed to (a) analyse climatic and construction data and estimate the number of NHA homes affected, (b) assess the physical causes of moisture damage through a review of national and international literature and (c) investigate the possibility of utilizing vent stacks as a practical measure to reduce moisture in Newfoundland.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 01:01:1982
END DATE 31:03:1983

#REF CA22 Indoor air pollution and housing technology

PRINCIPAL RESEARCHER(S)
Mr. P. Russell

ADDRESS
Research Division
Canada Mortgage and Housing Corporation
Montreal Road
Ottawa
Ontario
K1A 0P7
Canada

SPECIFIC OBJECTIVES
To review the scientific literature on indoor air pollution and to document research of pollution in residences.

PROJECT DETAILS
The major pollutants found in Canadian homes were reviewed - carbon monoxide, nitrogen oxide, radon gas, formaldehyde, tobacco smoke, ozone, asbestos, dust and moulds, bacteria and viruses, and a host of organic chemical vapours some of which are known or suspected carcinogens. The study recommends a four-fold approach to the indoor air pollution - (a) short circuit major potential hazards, (b) deal with low pollution, (c) spread and apply present knowledge, (d) foster more research and discussions on regulations.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 01:06:1982
END DATE 31:12:1982

#REF CA23 Updating health standards for residential construction.

PRINCIPAL RESEARCHER(S)
Mr. P. Russell

ADDRESS
Research Division
Canada Mortgage and Housing Corporation
Montreal Road
Ottawa
Ontario
K1A 0P7
Canada

SPECIFIC OBJECTIVES
To review the building codes, especially the National Building Code and to evaluate those sections which relate to atmospheric health risks.

PROJECT DETAILS
The report concludes that there is considerable scope for improvement of the building codes in the realm of atmospheric health risks and suggests specific changes.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 01:09:1982
END DATE 31:10:1982

#REF CA24 Radon gas (Problem Land series of publications)

PRINCIPAL RESEARCHER(S)
Mr P Russell

ADDRESS
Research Division
Canada Mortgage and Housing Corporation
Montreal Road
Ottawa
Ontario
K1A 0P7
Canada

SPECIFIC OBJECTIVES
To publish a layman guide to radon gas problem land.

PROJECT DETAILS
The publication describes the nature of the problem of radon gas. Preventative and remedial measure to reduce the gas is described.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 01:01:1982
END DATE 31:07:1983

#REF CA25 Instrumentation for detection of radon at potential building sites.

PRINCIPAL RESEARCHER(S)
Mr. P. Russell

ADDRESS
Research Division
Canada Mortgage and Housing Corporation
Montreal Road
Ottawa
Ontario
K1A 0P7
Canada

SPECIFIC OBJECTIVES
The project findings indicate that the vulnerability of buildings to entry of radon from the soil is as dependent on soil permeability within 3m of the basement, as it is on the rate of radon emission from the soil. Instrumentation is available but methodology needs to be developed.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE not stated
END DATE 28:02:1983

#REF CA26 Hazardous heating and ventilation conditions in housing.

PRINCIPAL RESEARCHER(S)
Mr. P. Russell
SPECIFIC OBJECTIVES
To document the hazardous heating and ventilation episodes that have occurred in Canadian housing during the past 3 years where products or combustion have been the cause.

PROJECT DETAILS
The incidence of carbon monoxide poisoning in residences from 72:82 has been documented. So far as records have allowed, the causes have been identified with the following predomination - damaged or blocked chimneys, reverse flow in chimneys, appliance failure. Nearly 300 episodes are referred to.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 01:02:1983
END DATE 31:08:1983

BIBLIOGRAPHY
(Report to be available during second half of 1983)
To evaluate the energy efficient operation of 50 furnace rooms.

P. Rowles
Co-generation Associates Ltd.

To study monitors, comment upon and correlate various physical measurements. The measurements include energy consumption, airtightness, air change, air quality and neutral pressure plane position. A commentary on installation and use of separate rooms for combustion equipment is included.

CA31 Upgrading residential forced air filtration

Mr. P. Russell

Ontario

Telex: 0533674

K1A OP7

Canada

Subcontracted to:

4484 West 9th

Vancouver

British Columbia

V6R 2E1

Canada

C.V. Shaw

SPECIFIC OBJECTIVES

To investigate improved methods and materials for filtering air and to identify impediments to their implementation.

PROJECT DETAILS

The report describes the effectiveness of various filtration media which are or could be used in residential forced air ventilation systems. Equipment, operating and marketing factors that impede the improvement of ventilation air filtering are discussed.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

START DATE 01:03:1982

END DATE 31:08:1983

CA32 Airtightness and ventilation of residential buildings

C.V. Shaw

Division of Building Research

National Research Council

Bldg. M-24, DBR, NRC

Montreal Road

Ottawa

K1A OR6

Canada

Telex: (613) 236 7179

Telex: 0534472

SPECIFIC OBJECTIVES

To develop methods for estimating the air change rate and air pressure distribution of a house, as these factors affect the space heating requirement, indoor air condition and potential for moisture problems of a house.

PROJECT DETAILS

1. Residential ventilation - to study the interaction (airchange and pressure distribution) of house airtightness, weather factors, combustion systems (furnaces), mechanical ventilation systems with and without heat recovery apparatus and passive ventilation measures (vent stack, fresh air openings in the basement wall and to the furnace return air duct). 2. Development of airtightness measurement techniques - to develop methods for in-situ measurement of air leakage routes through building envelope elements such as walls, floors and ceilings, and to obtain air leakage data for design purposes. 3. Development of air change prediction methods - to develop computer algorithms for predicting air leakage, air movement and moisture movement in buildings, and to develop a simple air leakage prediction method.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

START DATE 01:03:1982

END DATE 03:04:1982

APPROX NO MAN HOURS 2.5 person years

BIBLIOGRAPHY

Shaw, C.V. A correlation between air infiltration and airtightness for houses in a developed residential area ASHRAE Trans., Vol.87, II, 1981.


Shaw, C.V. The effect of mechanical ventilation on the air leakage characteristic of a two-storey detached house. (To be published)

CA33 Alternative approaches to improving the airtightness of existing and new houses.

R.E. Platts, P.Eng.

Adresse:

Scanada Consultants Ltd (for Canada Mortgage and Housing Corporation)

436 MacLaren Street

Ottawa

K2P OMS

Canada

Telex: (613) 236 7179

Telex: 0534472

SPECIFIC OBJECTIVES

Proof of concept of 'Structural Sealing' (SS) and 'Final Entry Point Sealing' (FEPS) methods as means of improving the airtightness of existing and new houses during reconstruction.

PROJECT DETAILS

1. Existing houses - progressive airtightening of five existing houses using innovative techniques for sealing the major hidden air leaks, e.g. exterior wall/floor intersections, airtightness testing after each sequence of work to determine its contribution, four variations of SS and FEPS were used. 2. New houses - three units of a six-unit-row house project are being structurally sealed to determine the feasibility of such measures and the difficulties of integrating them along with the normal construction sequences. Mechanical ventilation with heat recovery is to be installed and monitored in all houses where significant airtightening may affect the indoor air quality.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

1. Existing houses - the final airtightness of each house can be related to the initial pre-sealing levels. 2. New houses - the airtightness of the three sealed units will be compared to the three conventionally built units of

35
the same project.
START DATE 01:01:1983
END DATE 31:08:1983
APPROX NO MAN HOURS 1875

BIBLIOGRAPHY

First trials of comprehensive airtightening of existing houses. Prepared for Canada Mortgage and Housing Corporation by Scanada Consultants Ltd., Ottawa, August 1983.

#REF CA34 Analytical determination of building internal pressures induced by wind.
PRINCIPAL RESEARCHER(S)
Dr. T. Stathopoulos
ADDRESS
Centre for Building Studies
Concordia University
1455 de Maisonneuve Blvd. W.
Montreal
Quebec
Canada

START DATE 01:01:1983
END DATE 31:08:1983
APPROX NO MAN HOURS 1875

SPECIFIC OBJECTIVES
A computer program will be developed to evaluate the wind-induced internal pressures of buildings with known porosity given the external wind pressure distribution.

PROJECT DETAILS
Based on the wind-induced external pressure distribution for a building and the respective infiltration, the internal pressure can be calculated because of the air balance inside the building. The computer program will be adjusted to be used with a micro-computer for easy use in engineering offices. Internal pressures evaluated analytically will be compared with those measured in various experimental studies. Also comparisons with standards and codes of practice will be carried out.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Exposure, wind speed and direction, building geometry.
START DATE 01:01:1983
END DATE 31:08:1983

BIBLIOGRAPHY
#REF CA35 Wind effects on airtightness measurements
PRINCIPAL RESEARCHER(S)
D. Eyre
ADDRESS
Saskatchewan Research Council
30 Campus Drive
Saskatoon
Saskatchewan
Canada

START DATE 01:04:1982
END DATE 31:08:1983
APPROX NO MAN HOURS 1875

SPECIFIC OBJECTIVES
To conduct airtightness tests in 100 houses in the same sub-division in Windsor where data was collected over a 5-year period on energy use and occupant effects.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Flow constant 'a', exponent 'b' and the mean wind effect 'c'.

START DATE 01:06:1982
END DATE 31:05:1984

BIBLIOGRAPHY

#REF CA36 Airtightness tests on 200 new houses across Canada
PRINCIPAL RESEARCHER(S)
M. Sulatsisky
ADDRESS
Saskatchewan Research Council
30 Campus Drive
Saskatoon
Saskatchewan
Canada

START DATE 01:04:1982
END DATE 31:08:1983
APPROX NO MAN HOURS 1875

SPECIFIC OBJECTIVES
To establish a database on the airtightness performance of houses built according to current building practices across Canada.

PROJECT DETAILS
Fan pressurization was used to test groups of 20 houses in each of 10 locations across Canada. The houses, which were selected by HUDAC, were to be representative of the style, type of construction and size of houses built in a particular locality. The technical commentary includes an error analysis on the equipment used for the tests.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Equivalent leakage area per above grade surface area (ELA/A) at 10 Pa, (V) at 50 Pa and relative velocity (Q/A) at 10 Pa.

START DATE 01:04:1982
END DATE 31:08:1983
APPROX NO MAN HOURS 1875

BIBLIOGRAPHY

#REF CA37 Airtightness tests and occupant effects on energy conservation
PRINCIPAL RESEARCHER(S)
W. Colborne
ADDRESS
Industrial Research Institute
University of Windsor
Windsor
Ontario
Canada

START DATE 01:04:1982
END DATE 31:08:1983
APPROX NO MAN HOURS 1875

SPECIFIC OBJECTIVES
To conduct airtightness tests in 100 houses in the same sub-division in Windsor where data was collected over a 5-year period on energy use and occupant effects.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Flow constant 'a', exponent 'b' and the mean wind effect 'c'.

START DATE 01:06:1982
END DATE 31:05:1984

BIBLIOGRAPHY
DENMARK

forced air exhaustion on the air renewal was radioactive indicator.

BIBLIOGRAPHY

Colbore, W., Wilson, N. Measuring the air renewal using a telephone: 7529419

CZECHOSLOVAKIA

#REF CZI Air infiltration in a school building

Ing. M. Breda

ADDRESS

Building Research Institute
Vyzkumny ustav pozemnich staveb
102 21 Praha 10
Praze 16
Czechoslovakia

Telephone: 752641 9
Telex: 122688 VUPS C

SPECIFIC OBJECTIVES

Check measurement of air renewal in classrooms from the point-of-view of indoor environment hygiene.

PROJECT DETAILS

1. 3-storey building, U-form plan of about 50 x 80m, exterior walls of light-weight panels (PEAL sandwich). 2. Natural air renewal with short-term forced extract, warm-water central heating with a heat exchanger station attached to a district heating network. 3. Tracer gas Kr85 (neither the building pressure conditions nor the air pollution were determined). 4. Scintillation set for determining the specific activity of Kr85 within the range of 1-10 (MBq/m³). Three probes located on various places in the classroom. 5. People (pupils) not present. 6. Calculations of air renewal depending on time (daily regime, 2-year regime).

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Inside/outside air temperature, wind speed and direction. State of using the building's components, such as windows and doors, was not ascertained. Surveying the activities of people living in rooms is not carried out (measuring in the absence of people). The pollution sources were not surveyed. In short periods, the influence of forced air exhaustion on the air renewal was determined.

START DATE 10:01:1982
END DATE 31:12:1983
APPROX. NO MAN HOURS 1500

BIBLIOGRAPHY

Breda, M. Measuring the air renewal using a radioactive indicator.

DENMARK

#REF DK1 Quality of the air and the amount of fresh air in classrooms

O. Nielsen

ADDRESS

Danish Building Research Institute
Postboks 119
2790 Horsholm
Denmark

Telephone: (02) 06 55 33

SPECIFIC OBJECTIVES

Indoor climate measurements are made in eleven different schools, all with big mechanical ventilation plans, in conjunction with a questionnaire asking pupils' reaction to indoor climate.

PROJECT DETAILS

The pupils are from thirteen to sixteen years old. The experiment in each school takes three days. The amount of fresh air is different each day. Measurements were made for (a) the amount of CO2 in the air, (b) the number of pupils in the classrooms, (c) the total amount of fresh air going into the classrooms, (d) the temperature of the air, (e) the content of moisture in the air, (f) the amount of dust in the air. The pupils fill in a questionnaire after each lesson. This asks (1) if the indoor climate during the last lesson been pleasant or unpleasant, (2) is the air fresh, neutral or stuffy, (3) choice of comfortable temperature on a seven-point scale, (4) was the air humid, neutral or dry. The objective is to determine the air change rate necessary to satisfy a specified percentage of pupils that the air is fresh. The results will enable guidelines to be made for running ventilation plans in schools regarding both economical and welfare effects.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

CO2 content in the air.

START DATE 01:03:1982
END DATE 31:12:1983
APPROX. NO MAN HOURS 7000

BIBLIOGRAPHY


37
Suspended particulate matter.

Telephone: 90 4561

The building (built 1897, renovated 1981) is now

The aim of the study has been to measure the health

measures in their flats. Project report, Arhus,

changes in their flats.

G.R. Lundqvist

ADDRESS

Institute of Hygiene

Universitetsparken 180

DK 8000 Arhus C

Denmark

Telephone: (06) 128288

Telex: 12 2972

Technical Research Centre of Finland (VTT)

SF-02150 Espoo 15

Finland

Telephone: 90 4561

Telex: 12 2972

Specific objectives

Monitoring of energy balance, indoor climate and

performance of ventilation and heat distribution in

new experimental multi-storey buildings.

Project details

Various combinations of mechanical supply and

exhaust ventilation and heat distribution have been

investigated in experimental buildings. The

evaluation consisted of (a) micro-computer-based

data collection and analysis (energy and indoor

temperatures), (b) manual measurement of thermal

indoor climate, airtightness, radon concentration,

system performance, (c) interviews with the

inhabitants.

Parameters related to infiltration/air quality

41 questions regarding indoor climate, health and

comfort as reflected by the tenants once a month.

Start date 01:01:1981

End date 30:06:1983

Bibliography

J. Heikkinen, M. Laukkanen, J. Railio

Address

Technical Research Centre of Finland (VTT)

Vuorimiehentie 5

SF-02150 Espoo 15

Finland

Telex: 12 2972

Specific objectives

Practical comparison between various ventilation

systems. Measurements of airtightness, air change

rates, local leakages, pressure conditions, radon

concentration, etc.

Project details

The building (built 1897, renovated 1981) is now

the Finnish Museum of Architecture. For

experimental purposes, the ventilation system was

run in three alternative ways: (a) Mechanical

supply and exhaust (0.7 ach). (b) Mechanical

exhaust (0.7 ach). (c) Exhaust from toilets only

(0.2 ach). The results show that exhaust

ventilation needs special supply air arrangements

in the building envelope to guarantee a sufficient

ventilation in each room.

Parameters related to infiltration/air quality

Ventilation system, leakage distribution.

Start date 01:01:1982

End date 30:10:1982

Approx no man hours 1000

Bibliography

Saarnio, P. Airtightness, pressure differences and

indoor climate in the experimental building

"Kasarmikatu 24". CIB W67 Seminar on Air

Infiltration Control and Indoor Air Quality, 15

June 1983, Vatanemi, Finland. (The complete

research report has been published in Finnish by

the National Board of Building).

#REF DK4 Health and comfort changes among tenants

after draught proofing of their flats.

Principal researcher(s)

G.R. Lundqvist

Address

Institute of Hygiene

Universitetsparken 180

DK 8000 Arhus C

Denmark

Telephone: (06) 128288

Telex: 12 2972

Technical Research Centre of Finland (VTT)

SF-02150 Espoo 15

Finland

Telephone: 90 4561

Telex: 12 2972

Specific objectives

Monitoring of energy balance, indoor climate and

performance of ventilation and heat distribution in

new experimental multi-storey buildings.

Project details

Various combinations of mechanical supply and

exhaust ventilation and heat distribution have been

investigated in experimental buildings. The

evaluation consisted of (a) micro-computer-based

data collection and analysis (energy and indoor

temperatures), (b) manual measurement of thermal

indoor climate, airtightness, radon concentration,

system performance, (c) interviews with the

inhabitants.

Parameters related to infiltration/air quality

41 questions regarding indoor climate, health and

comfort as reflected by the tenants once a month.

Start date 01:01:1981

End date 30:06:1983

Bibliography

Iversen, M., Bach, E., Lundqvist, G.R. A

prospective study of health and comfort changes

among tenants before and after energy conservation

measures in their flats. Project report, Arhus,

Denmark, August 1983 (in Danish) (an English

version will appear).

Finland

#REF FI1 Ventilation systems for building

renovation - the experimental building "Kasarmikatu

24".

Principal researcher(s)

P. Saarnio

Address

Technical Research Centre of Finland (VTT)

Vuorimiehentie 5

SF-02150 Espoo 15

Finland

Telephone: 90 4561

Telex: 12 2972

Specific objectives

Practical comparison between various ventilation

systems. Measurements of airtightness, air change

rates, local leakages, pressure conditions, radon

concentration, etc.

Project details

The building (built 1897, renovated 1981) is now

the Finnish Museum of Architecture. For

experimental purposes, the ventilation system was

run in three alternative ways: (a) Mechanical

supply and exhaust (0.7 ach). (b) Mechanical

exhaust (0.7 ach). (c) Exhaust from toilets only

(0.2 ach). The results show that exhaust

ventilation needs special supply air arrangements

in the building envelope to guarantee a sufficient

ventilation in each room.

Parameters related to infiltration/air quality

Ventilation system, leakage distribution.

Start date 01:01:1982

End date 30:10:1982

Approx no man hours 1000

Bibliography

Saarnio, P. Airtightness, pressure differences and

indoor climate in the experimental building

"Kasarmikatu 24". CIB W67 Seminar on Air

Infiltration Control and Indoor Air Quality, 15

June 1983, Vatanemi, Finland. (The complete

research report has been published in Finnish by

the National Board of Building).

#REF FI2 Ventilation and warm-air heating in blocks

of flats (three experimental projects).

Principal researcher(s)

J. Heikkinen, M. Laukkanen, J. Railio

Address

Technical Research Centre of Finland (VTT)

Vuorimiehentie 5

SF-02150 Espoo 15

Finland

Telephone: 90 4561

Telex: 12 2972

Specific objectives

Monitoring of energy balance, indoor climate and

performance of ventilation and heat distribution in

new experimental multi-storey buildings.

Project details

Various combinations of mechanical supply and

exhaust ventilation and heat distribution have been

investigated in experimental buildings. The

evaluation consisted of (a) micro-computer-based

data collection and analysis (energy and indoor

temperatures), (b) manual measurement of thermal

indoor climate, airtightness, radon concentration,

system performance, (c) interviews with the

inhabitants.

Parameters related to infiltration/air quality

41 questions regarding indoor climate, health and

comfort as reflected by the tenants once a month.

Start date 01:01:1980

End date 31:05:1984

Approx no man hours 9000 (3000 per project)

Bibliography

Heikkinen, J., Laukkanen, M., Ralio, J. Evaluation

of a warm-air heated block of flats with air

recirculation in each room Ministry of Trade and

Industry, Report D21, 63pp, Helsinki 1983 (in

Finnish with English summary).

(Other projects to be reported approximately

October 1983 and August 1984).

#REF FI3 Air infiltration research

Principal researcher(s)

J. Railio

Address

Technical Research Centre of Finland (VTT)

Vuorimiehentie 5

SF-02150 Espoo 15

Finland

Telephone: 90 4561

Telex: 12 2972

Specific objectives

Development of airtightness requirements,

calculation models, measurement methods and

airtight buildings.

Project details

(a) Calculations: multi-cell models, flow

equations for each room. (b) Output: leakages,

mechanical air flows, pressure conditions. (c)

Parts: "Exhaust air model", "Supply air model",

"Leakage model". (d) Measurements: pressure

method for whole small houses or flats, collector

chamber for local leakages, smoke test or infra-red

thermography for localization, pressure differences

38
with multi-manometers. Possibly "cooling method" as preliminary test. Special attention will be paid to appropriate method combinations in large buildings. (e) Constructions: airtight joints. Possibly also supply air intake through building envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.

The research work will be continued in two new residential areas, where the long-time performance of the building envelope will be tested. Measurements for total airtightness and local leakages for some typical construction joints will be carried out once or twice a year until 1986-87. Requirements related to infiltration/air quality, weather, building components, ventilation system, whole buildings, parts of buildings, structures and envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.

The research work will be continued in two new residential areas, where the long-time performance of the building envelope will be tested. Measurements for total airtightness and local leakages for some typical construction joints will be carried out once or twice a year until 1986-87. Requirements related to infiltration/air quality, weather, building components, ventilation system, whole buildings, parts of buildings, structures and envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.

The calculations for the airtightness and ventilation can be carried out once or twice a year until 1986-87. Requirements related to infiltration/air quality, weather, building components, ventilation system, whole buildings, parts of buildings, structures and envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.

The research work will be continued in two new residential areas, where the long-time performance of the building envelope will be tested. Measurements for total airtightness and local leakages for some typical construction joints will be carried out once or twice a year until 1986-87. Requirements related to infiltration/air quality, weather, building components, ventilation system, whole buildings, parts of buildings, structures and envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.

The research work will be continued in two new residential areas, where the long-time performance of the building envelope will be tested. Measurements for total airtightness and local leakages for some typical construction joints will be carried out once or twice a year until 1986-87. Requirements related to infiltration/air quality, weather, building components, ventilation system, whole buildings, parts of buildings, structures and envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.

The research work will be continued in two new residential areas, where the long-time performance of the building envelope will be tested. Measurements for total airtightness and local leakages for some typical construction joints will be carried out once or twice a year until 1986-87. Requirements related to infiltration/air quality, weather, building components, ventilation system, whole buildings, parts of buildings, structures and envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.

The research work will be continued in two new residential areas, where the long-time performance of the building envelope will be tested. Measurements for total airtightness and local leakages for some typical construction joints will be carried out once or twice a year until 1986-87. Requirements related to infiltration/air quality, weather, building components, ventilation system, whole buildings, parts of buildings, structures and envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.

The research work will be continued in two new residential areas, where the long-time performance of the building envelope will be tested. Measurements for total airtightness and local leakages for some typical construction joints will be carried out once or twice a year until 1986-87. Requirements related to infiltration/air quality, weather, building components, ventilation system, whole buildings, parts of buildings, structures and envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.

The research work will be continued in two new residential areas, where the long-time performance of the building envelope will be tested. Measurements for total airtightness and local leakages for some typical construction joints will be carried out once or twice a year until 1986-87. Requirements related to infiltration/air quality, weather, building components, ventilation system, whole buildings, parts of buildings, structures and envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.

The research work will be continued in two new residential areas, where the long-time performance of the building envelope will be tested. Measurements for total airtightness and local leakages for some typical construction joints will be carried out once or twice a year until 1986-87. Requirements related to infiltration/air quality, weather, building components, ventilation system, whole buildings, parts of buildings, structures and envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.

The research work will be continued in two new residential areas, where the long-time performance of the building envelope will be tested. Measurements for total airtightness and local leakages for some typical construction joints will be carried out once or twice a year until 1986-87. Requirements related to infiltration/air quality, weather, building components, ventilation system, whole buildings, parts of buildings, structures and envelope will be developed. (f) Requirements: For whole buildings, parts of buildings, structures and joints.
15 reports concerning "Minimum ventilation rates" (restricted to IEA-Annex IX members)

#REF DE2 Investigation about the annual heat consumption of today's well-insulated buildings
PRINCIPAL RESEARCHER(S)
Prof. Dr.-Ing. H. Esdorn
ADDRESS
Hermann-Rietschel-Institut fur Heizungs- und Klimatechnik
Technische Universität Berlin
Marchstrasse 4
1000 Berlin 10
West Germany

Television: (030) 314 41 70
Telex: 1 84 262 TUBLN D

SPECIFIC OBJECTIVES
The rules for calculating the annual heat consumption as described in the German Standard VDI 2067 should be advanced by taking into account the influence of solar radiation, inside heat sources and user habits. This influence gets more important with the better insulation of the buildings.

PROJECT DETAILS
The measuring results of energy consumption for heating and hot-water supply, as well as the corresponding climatic data, are available for a great number of residential buildings. The heat loss by transmission and the energy produced by solar radiation as well as the inside heat sources will be calculated by a dynamic computer simulation program. From the measured data and the simulation results, the heat loss due to ventilation can be calculated. This result contains the ventilation habits of the tenants.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Meteorological data, tenant data.

START DATE 01:01:1984
END DATE 31:12:1985

#REF DE3 Demonstration project "Landschul":
Energy-saving and the use of solar energy within one and two family houses.
PRINCIPAL RESEARCHER(S)
Dr. D. Oswald
ADDRESS
Fraunhofer-Institut fur Bauphysik
Nobelstrasse 22
D-7000 Stuttgart 80
West Germany

Television: (0711) 6868 321
Telex: 7 255 167

SPECIFIC OBJECTIVES
A study of energy-saving building designs and techniques that incorporate both active and passive solar components.

PROJECT DETAILS
Comparison of the results of energy-balance calculations with measured data for different types of occupied buildings. Quantification of the air change rate component of the overall heat balance for natural and mechanically-driven ventilation systems for different types of heating systems (including warm air heating). Pressurization test and air change rate measurements with a tracer gas.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Temperature inside and outside. Wind direction and velocity. Behaviour of occupants.

START DATE 01:01:1983
END DATE 31:12:1987
APPROX NO MAN HOURS 750

#REF DE4 Comparative measurements of ventilation systems on one-family twinhouses
PRINCIPAL RESEARCHER(S)
Dr. H. Werner
ADDRESS
Fraunhofer-Institut fur Bauphysik
Postfach 1180
D-8150 Holzkirchen
West Germany

Television: 08024 5055

SPECIFIC OBJECTIVES
Air changes and evaluation of air infiltration energy losses caused by central and de-central apparatus under natural climatic conditions

PROJECT DETAILS
Comparative investigations in two identical test houses (twinhouses) about the energy supply in relation to infiltration rates, inside/outside temperature differences, solar radiation and wind. One house was the standard with natural infiltration caused by cracks and gaps. In the other house the systems were tested.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Wind speed and direction, inside/outside temperature difference.

START DATE 01:01:1981
END DATE 31:12:1982
APPROX NO MAN HOURS 2000

BIBLIOGRAPHY
Werner, H. Comparative measurements of different ventilation systems in one-family twinhouses (not yet published)

#REF DE5 Passive solar warm-air heating and ventilating system
PRINCIPAL RESEARCHER(S)
E. Boy
ADDRESS
Fraunhofer-Institut fur Bauphysik
Postfach 800 469
D-7000 Stuttgart 80
West Germany

Television: 0711 6868 374
Telex: 7 255 167

SPECIFIC OBJECTIVES
Development of a device for passive solar warm-air heating and ventilation systems that is both economically viable and marketable.

PROJECT DETAILS
Passive thermosyphoning warm-air heating system combined with energy storage in walls, floors or ceilings in an unoccupied test room.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Temperature inside and outside. Wall temperatures.

START DATE 01:01:1983
END DATE 31:12:1984
APPROX NO MAN HOURS 900

#REF DE6 Draught problems in air conditioned rooms
PRINCIPAL RESEARCHER(S)
E. Meyer
ADDRESS
Fraunhofer-Institut fur Bauphysik
Postfach 1180
D-8150 Holzkirchen
West Germany

Television: 08024 5055

SPECIFIC OBJECTIVES
Investigation of the physical causes of draught problems.

PROJECT DETAILS
Heat transfer measurements at a simulated test person in an air conditioned test room.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Air temperature, air circulation, air humidity, radiation heat flux
**BIBLIOGRAPHY**


**PRINCIPAL RESEARCHER(S)**

Dr. H. Werner

**ADDRESS**

Fraunhofer-Institut für Bauphysik

Aussenstelle Holzkirchen

Postfach 1180

D-8150 Holzkirchen

West Germany

Telephone: 08024 5055

**SPECIFIC OBJECTIVES**

Part project: comparison of different ventilation systems and ventilation equipment in unoccupied test-houses.

**PROJECT DETAILS**

Measurements in buildings - (i) two one-family houses, (ii) each house c. 100m², brick (k=0.6 W/m²K), (iii) natural and mechanical ventilation, electrical heating, (iv) air change measurements with ethane, measurements of pressurization, (v) instrumentation - FID, (vi) unoccupied building.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

(a) weather (temperature, wind, humidity, solar radiation), (b) degree of window, door and air vent opening.

**START DATE** 01:07:1981

**END DATE** 31:12:1983

APPROX NO MAN HOURS 400

Calculation of air circulation and infiltration heat loss by the flow-in-networks method.

**PROJECT DETAILS**

The dissipation work spent by flowing air to overcome resistance is the 'cost function', its minimum corresponds to the equilibrium condition. Algorithm is established by method of dual gradients. The size of building/network can be approximately 1000 vertices/rooms/5000 edges/doors, etc. The program is used in the design praxis of multi-storey up-to-date buildings.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

Temperature, wind, performance, simulated behaviour of occupants, stack effect, auxiliary mechanical ventilation.

**START DATE** 01:01:1973

**END DATE** 31:12:1973

APPROX NO MAN HOURS 4000


Berechnung des Filtrationsluftaustausches in Gebäuden, Heizung, Luftung Haustechnik, No.6 1973, p245-247

**ITALY**

**PRINCIPAL RESEARCHER(S)**

M. Piana

**ADDRESS**

Montepolimeri S.p.A.

C.S.I.

Viale Lombardia 20

20021 Bollate (MI)

Italy

Telephone: 02 3501201 ex 351

Telex: 310679 MONTED I

**SPECIFIC OBJECTIVES**

Realisation of a part of a window able to act as a heat exchanger for heat recovery from vitiated air.

**PROJECT DETAILS**

The project is aimed at the study of energy saving that can be obtained by installing a particular device on windows to act as a heat exchanger of vitiated air. The research will be carried out on an indoor model with simulated weather conditions.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

Weather, performance of windows, simulated behaviour of occupants.

**START DATE** 01:09:1983

**END DATE** 30:09:1984

APPROX NO MAN HOURS 1200

**HUNGARY**

**PRINCIPAL RESEARCHER(S)**

A.M. Grosso

**ADDRESS**

Istituto di Tecnologica dell' Ambiente Costruito

(Dipartimento di Scienze e Tecniche per i Processi d'Insedimento)

Politecnico di Torino

Viale Mattioli 11

10125 Torino

Italy

Telephone: 011 688861

Telex: 22064 POLITO I

**SPECIFIC OBJECTIVES**

Obtainable energy saving in a building valuation by sealing window joints.
Grosso, M., Peretti, G., Gonella, D. Report of the fixed laboratory on window-standard and (b) with a Air infiltration control method: sealing the moving laboratory on building-standard window. 3. sealant packings). 2. External window air permeability measurement before and after the installation of silicone rubber packings (a) in a fixed laboratory on window-standard and (b) with a moving laboratory on building-standard window. 3. Energy evaluation of obtained results and their possible generalization to existing buildings.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
- Pressure coefficient, wind speed, flow coefficient, time constant of thermal loss, neutral plane and building shape.

START DATE 01:09:1982
END DATE 31:03:1983
APPROX NO MAN HOURS 560

BIBLIOGRAPHY
Grosso, M., Peretti, G., Gonella, D. Report of the research December 1982

Grosso, M., Peretti, G., Gonella, D. Interventi sui serramenti esterni per una riduzione della permeabilità all'aria Case Editrice "L'Annuario", 1983/1984

Grosso, M., Peretti, G., Gonella, D., Vicari, L. Energy evaluation of obtained results and their possible generalization to existing buildings (especially the cast-in-situ of joints). 2. External window air permeability measurement before and after the installation of silicone rubber packings (a) in a fixed laboratory on window-standard and (b) with a moving laboratory on building-standard window. 3. Energy evaluation of obtained results and their possible generalization to existing buildings (a) in a fixed laboratory on window-standard and (b) with a moving laboratory on building-standard window.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
- Pressure coefficient, wind speed, flow coefficient, time constant of thermal loss, neutral plane and building shape.

JAPAN

#REF J1 Research on airtightness of various types of houses
PRINCIPAL RESEARCHER(S)
H. Yoshino and S. Murakami
ADDRESS
Department of Architecture
Faculty of Engineering
Tohoku University
Sendai 980
Japan
Telephone: 0222 22 1800 (4651)

SPECIFIC OBJECTIVES
Airtightness of various types of 25 houses was investigated by the pressurization method and this was compared with other data including the houses of US, Canada and Sweden.

PROJECT DETAILS
(1) Measurements in building. (a) Types of building - detached wooden houses containing one room. (b) Size - all houses are 3.6m wide x 6.4m deep x 2.4m high. (c) No ventilation system, no heating system. (d) Measurements being taken - airtightness is measured by the fan pressurization technique. Air infiltration is measured by CO2 concentration decay technique. (e) Instruments - indoor/outdoor pressure difference is measured by capacitance manometer, wind speed by windmill type anemometer, temperature by thermocouples and the electric potentiometer. (f) Unoccupied. (2) Theoretical calculation - infiltration is predicted by the several theoretical calculations which are proposed by Bahnfleth, Sepsy, Tamura and Grimsrud.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
- Pressure coefficient, wind speed, flow coefficient, time constant of thermal loss, neutral plane and building shape.

END DATE 31:03:1983
START DATE 01:09:1982
APPROX NO MAN HOURS 560

BIBLIOGRAPHY

#REF J2 Validation of several predicting methods of air infiltration using three types of test houses, the airtightness of which are different from each other.

#REF J3 Natural ventilation of dwellings
PRINCIPAL RESEARCHER(S)
S. Murakami
ADDRESS
Institute of Industrial Science
University of Tokyo
22-1 7-Chome
Roppongi
Minato-Ku
Tokyo 106
Japan
Telephone: 03 402 6231

SPECIFIC OBJECTIVES
Experimental study of natural ventilation using full-scale test house and wind tunnel modelling.

PROJECT DETAILS
(a) Measuring: wind pressure coefficient, air change rate by tracer gas method. (b) Tracer gas: C2H4, F.I.D. detector. (c) Type of buildings: detached house, apartment house. (d) Parameter: opening of windows and doors, shape of rooms, wind direction, etc.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
- Weather (wind speed, temperature and humidity).

END DATE 31:12:1982
START DATE 01:09:1981
APPROX NO MAN HOURS 1500

BIBLIOGRAPHY

#REF J4 Ventilation design of dwellings concerned with airtightness

PRINCIPAL RESEARCHER(S)
H. Yoshino
ADDRESS
Department of Architecture
Faculty of Engineering
Tohoku University
Sendai 980
Japan
Telephone: 0222 22 1800 (4651)

SPECIFIC OBJECTIVES
To verify the predicting method of air infiltration by measuring the airtightness and air infiltration of three types of houses, the airtightness of which are different from each other.

PROJECT DETAILS
(1) Measurements in building. (a) Types of building - detached wooden houses containing one room. (b) Size - all houses are 3.6m wide x 6.4m deep x 2.4m high. (c) No ventilation system, no heating system. (d) Measurements being taken - airtightness is measured by the fan pressurization technique. Air infiltration is measured by CO2 concentration decay technique. (e) Instruments - indoor/outdoor pressure difference is measured by capacitance manometer, wind speed by windmill type anemometer, temperature by thermocouples and the electric potentiometer. (f) Unoccupied. (2) Theoretical calculation - infiltration is predicted by the several theoretical calculations which are proposed by Bahnfleth, Sepsy, Tamura and Grimsrud.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
- Pressure coefficient, wind speed, flow coefficient, time constant of thermal loss, neutral plane and building shape.

END DATE 31:03:1984
START DATE 01:08:1982
APPROX NO MAN HOURS 560

BIBLIOGRAPHY
PRINCIPAL RESEARCHER(S)
S. Murakami

ADDRESS
Institute of Industrial Science
University of Tokyo
22-1 7-Chome
Roppongi
Minato-Ku
Tokyo 106
Japan
Telephone: 03 402 6231

SPECIFIC OBJECTIVES
Study of diffusion of combustible gas and prevention of explosion from gas leak caused by residents.

PROJECT DETAILS
Concerned with airtightness of house and with scientific gravity of leaked gas.

Building type: house. Construction type: wood. Measurements: pressurization, gas leakage concentration. Tracer gas: C2H4, F.I.D. detector (tracer gas is prepared so that specific gravity is equal to 1.6 or 0.6 by mixing CO or HE).

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather (wind), performance of building components, source of pollution.

START DATE 01:04:1983
END DATE 31:03:1984
APPROX NO MAN HOURS 1000

BIBLIOGRAPHY


#REF J6 Air infiltration calculation method in multi-rooms
PRINCIPAL RESEARCHER(S)
K. Ochifugi

ADDRESS
Sanitary Engineering Department
Faculty of Engineering
Hokkaido University
060 Sapporo
Japan
Telephone: (011) 711 2111

SPECIFIC OBJECTIVES
The development of the practical and simple calculating method regarding the air infiltration caused by temperature difference and wind pressure.

PROJECT DETAILS
1. Modelling the tall multiple building into four types - single model, shaft model, floor model, multiple model. 2. Calculating air infiltration and room air pressure in each model. 3. Comparing and analysing results.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Temperature difference, wind velocity, flow coefficient, window area, opening area, shaft area.

START DATE 01:01:1980
END DATE 31:12:1984

BIBLIOGRAPHY

NETHERLANDS

#REF NL1 The use and energy consumption of small local exhaust fans in Dutch dwellings.
PRINCIPAL RESEARCHER(S)
Ir. J.M. Cauberg

ADDRESS
Adv. Bureau Cauberg Huygen
Gr. Lodiersstraat 24
Postbox 480
6200 AL Maastricht
Netherlands
Telephone: 043 194448

SPECIFIC OBJECTIVES
Energy conservation

PROJECT DETAILS
The necessary information is acquired from suppliers and, by enquiries in some residential quarters, from users. Based on these enquiries, an estimation is made of the energy consumption during a heating season of these exhaust fans.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 11:01:1979
END DATE 31:12:1981

#REF NL2 Characterization of air pollution in Dutch houses
PRINCIPAL RESEARCHER(S)
E. Lebret, B. Brunekreef, J.S.M. Boelej, D. Noij, K. Biersteker

ADDRESS
Department of Air Pollution
Department of Environmental and Tropical Health
Agricultural University Wageningen
PO Box 8129
6700 EV Wageningen
Netherlands
Telephone: 08380 82684

SPECIFIC OBJECTIVES
Characterization of indoor air pollution in the Netherlands in relation to occupant exposure and possible health effects of occupants.

PROJECT DETAILS
Type of houses: common Dutch houses. Number of houses: over 900. Pollutants: carbon monoxide, nitrogen oxide, respirable suspended particulates, hydro carbons. Ventilation: SF6 tracer experiments in kitchens, ventilation habits by
diary and questionnaire. Measurements: weekly average samples and real time measurement.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Outdoor temperature, real occupant behaviour, sources (smoking, gas appliances, building materials, consumer products).

START DATE 01:10:1980
END DATE 01:09:1984 (prolongation on specific items until 1985)

BIBLIOGRAPHY

Lebret, E. et al Indoor air pollution in the Netherlands. VIIIth World Congress on Air Quality, Paris, 16-20 May 1983, Voorraad door E. Lebret


#REF NL3 Ventilation and formaldehyde concentration
PRINCIPAL RESEARCHER(S)
C. Korf
ADDRESS
Centre of Surface Technology (C.O.T.)
340 Zijlweg
2015 CP Haarlem
Netherlands

Telephone: (023) 319 544
Telex: 41714 NL

SPECIFIC OBJECTIVES
Determination of the formaldehyde concentration in houses, buildings and schools.

PROJECT DETAILS
Separate reports for an approximate total of 500 determinations up to 1.5B3, of the formaldehyde concentration in houses and schools from particle flow in an integrated environment school. (b) The calculation method for the natural ventilation rate in houses and schoolrooms.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Formaldehyde concentration in relation to ventilation rate.

START DATE 01:01:1978
END DATE on-going
APPROX NO MAN HOURS 8 hours per determination

#REF NL4 Patterns in heating and ventilation behaviour of occupants of newly-built terraced houses.
PRINCIPAL RESEARCHER(S)
J.E.F. van Dongen and M. Dubbeld
ADDRESS
TNO Research Institute for Environmental Hygiene
Postbox 214
2600 AE Delft
Netherlands

Telephone: 15 569330
Telex: 38071 ZPTNO NL

SPECIFIC OBJECTIVES
To obtain information on the ventilation behaviour and motives of occupants in relation to weather conditions and internal heat distribution of houses.

PROJECT DETAILS
In newly-built terrace houses (brick, mechanical ventilation, gas heated) and together with measuring technical parameters, extensive verbal interviews were taken with about 55 of the occupants to gain an accurate insight into the energy- related household behaviour and motives. In addition, during a period of 14 days (26 January - 10 February 1983) under very variable weather conditions, logbooks were completed by about 35 occupants concerning (per hour) the people at home, the position of the room thermostat, the periods with open windows and the opening of trickle ventilators in the different rooms, the use of the radiator values and the positions of the doors inside the house.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather conditions, heat distribution, behaviour of occupants, use of ventilation provisions, use of windows.

START DATE 01:01:1983
END DATE 31:07:1984
APPROX NO MAN HOURS 500

#REF NL5 Natural ventilation in schools
PRINCIPAL RESEARCHER(S)
Ir. A M van de Beek
ADDRESS
Technical University of Eindhoven (FAGO, Bouwkunde)
Den Dolech 2
5600 MB Eindhoven
Netherlands

Telephone: 040 479111

SPECIFIC OBJECTIVES
(a) A mathematical model for the calculation of air flow in an integrated environment school. (b) The simulation of opening and closing a window in a classroom in relation to radiator-heating.

PROJECT DETAILS
(a) Wind (velocity, direction), temperature difference, surroundings (roughness), pressure differences, openings, air flows, CO2 concentrations (occupants). (b) The air flow through a window, the radiator capacity, number of occupants, air temperature, CO2 concentration, to open or close the window, energy, air quality.

Projects (a) and (b) are both computer models.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
For both models - (a) temperature, wind velocity, wind direction, (b) windows, doors, form of the building, (c) simulated behaviour, (d) odour

START DATE 01:02:1981
END DATE 31:12:1982
APPROX NO MAN HOURS 30,000 (during my study at university)

BIBLIOGRAPHY
Phaff, J.C. et al Onderzoek naar de gevolgen van het openen van een raam op het binnenklimaat van een kamer. MG-TNO Rapport, Nr C448, 1980

#REF NL6 Minimum fresh air supply per person
PRINCIPAL RESEARCHER(S)
Dr Ir H.B. Bouwman
ADDRESS
ISSO
Postbus 20740
3001 JA Rotterdam
Netherlands

Telephone: 010 146116

SPECIFIC OBJECTIVES
To determine the minimum fresh-air supply per person to avoid complaints about odour.

PROJECT DETAILS
This investigation is carried out as a field study in office rooms. The odour-concentration was determined by the olfacto meter method. The persons who worked in the investigation office rooms and the persons who visited these rooms were questioned. The investigation was carried out under normal working conditions. The office workers involved were informed about the purpose of the research project.
The effective fresh air (outside air) supply (m3/h) was measured by the HE tracer gas method. The CO2 concentration was continuously measured by infra-red absorption method. The number of people present in the rooms was continuously counted. In some cases smoking was allowed and the number of cigarettes counted. The CO2 concentration was also calculated, based on the number of persons, their average height, weight, etc. and the fresh air supply. There was a good correlation between the calculated CO2 concentration and the measured value.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Number and activity of occupants, CO2 concentration.

START DATE not stated
END DATE not stated
APPROX NO MAN HOURS
BIBLIOGRAPHY

Bouwman, H.B. Onderzoek naar minimum verluchting ISSO Research Report No. 1, August 1981 (in Dutch)

#REF NL7 Short reference year for weatherdata (SRY)
PRINCIPAL RESEARCHER(S)
Ir A.M. v. Weele
ADDRESS
ISSO
Postbus 20740
3001 JA Rotterdam
Netherlands
Telephone: 010 146116
SPECIFIC OBJECTIVES
Dutch standard for weatherdata for energy calculations for buildings and solar systems existing of only 1344 hourly weatherdata.

PROJECT DETAILS
Analysis of Dutch weatherdata (period 1960-80) (a) developing statistical model to generate a SRY (b) generating a Dutch SRY (c) computer calculations to check and compare with calculations with 10 year hourly weatherdata.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
A simple model is used to check the wind data of SRY
START DATE 01:01:1980
END DATE 31:12:1983
APPROX NO MAN HOURS
BIBLIOGRAPHY

Verkort Referentie Jaar voor buitencondities (Short Reference Year for weather conditions) ISSO
Publication 12, July 1983 (in Dutch) (This publication contains the Dutch draft standard NEN 5060 with the same title)

#REF NL8 Dutch standard for heatloss calculations for buildings
PRINCIPAL RESEARCHER(S)
Ir G.G. Franke
ADDRESS
ISSO
Postbus 20740
3001 JA Rotterdam
Netherlands
Telephone: 010 146116
SPECIFIC OBJECTIVES

PROJECT DETAILS
A method to estimate and calculate the infiltration and ventilation through building leakage, for different types of ventilation system.

Measurement of the air flow through the building envelope by pressurization of the building (several rooms). Type of building - house and apartment made of brick and concrete with/without mechanical ventilation system that was closed during the pressurization. Flow measurement by rotation anemometer. Pressure measurement by a watergauge manometer. Furnished but unoccupied buildings.


PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Dutch weather data, building construction and ventilation system.
START DATE 01:01:1979
END DATE 31:12:1984
APPROX NO MAN HOURS

#REF NL9 Infiltration rates in dwellings and their effect on radon
PRINCIPAL RESEARCHER(S)
W.F. de Gids and J.C. Phaff
ADDRESS
Institute of Environmental Hygiene-TNO
PD Box 214
Delft
Netherlands
Telephone: (15) 579330
Telex: 38071 ZPTNO
SPECIFIC OBJECTIVES
To study the continuous air infiltration in dwellings, inclusive of behaviour effects. To develop equipment for continuous measurement.

PROJECT DETAILS
A calculation study will be carried out for about 5 different group plans. Measurement equipment for continuous measurement will be developed. In one dwelling, extensive ventilation measurements will be carried out. This study is part of the national research programme on radon in dwellings.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, behaviour, radon levels
START DATE 01:06:1982
END DATE 21:12:1984
APPROX NO MAN HOURS 4800

#REF NL10 Analysis of factors influencing pressure differences on houses in relation to natural ventilation and energy consumption.
PRINCIPAL RESEARCHER(S)
J.C. Phaff and W.F. de Gids
ADDRESS
Institute for Environmental Hygiene-TNO
PD Box 214
Delft
Netherlands
Telephone: (15) 569330
Telex: 38071 ZPTNO NL
SPECIFIC OBJECTIVES
To quantify the effects of nearby obstacles on the pressure distribution.

PROJECT DETAILS
The aim of the study can be seen as a continuation of the completed study 'Natural ventilation and energy consumption'. Measurements were made in dwellings and apartments of infiltration, pressure differences, temperatures, position of windows and doors, airtightness of building and building components. Infiltration measurements were made using katharometers with He as tracer, pressure differences using electronic pressure transducers (VALYDINE), temperatures with copper-constantan thermocouples and the positions of windows and doors with microswitches. All buildings are low-rise and have volumes of approximately 200 to 300 cubic metres. Analysis of already gathered pressure data will be made.
PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, obstacles such as trees, hedges, fences, etc.
START DATE 01:10:1983
END DATE 31:05:1984
APPROX NO MAN HOURS 800

BIBLIOGRAPHY
de Gids, W.F. Investigation of the relationship between the natural ventilation of a flat and meteorological conditions. Institute for Environmental Hygiene-TNO, Delft, 1977

de Gids, W.F. Natural ventilation and energy consumption. EC-Brussels, October 1979


de Gids, W.F. Natural ventilation and energy consumption. Institute for Environmental Hygiene-TNO, Delft, 1981

#REF NL11 Ventilation in welding halls
PRINCIPAL RESEARCHER(S)
B. Knoll
ADDRESS
Institute for Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands
Telephone: (15) 569330
Telex: 38071 ZPTNO NL

SPECIFIC OBJECTIVES
To collect data for ventilation and air movement in halls with welding processes.

PROJECT DETAILS
The study is part of a large survey on health conditions in factories. Measurements will be carried out in about 7 factories. The measurements consist of air flow rates, air flow patterns, air velocity, etc.

#REF NL12 Ventilation in dwellings with sound attenuated ventilation provisions
PRINCIPAL RESEARCHER(S)
W.F. de Gids and J.C. Phaff
ADDRESS
Institute for Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands
Telephone: (15) 569330
Telex: 38071 ZPTNO NL

SPECIFIC OBJECTIVES
To establish ventilation rates in dwellings with respect to these systems and energy consequences

PROJECT DETAILS
A parametric calculation study will be carried out. The performance of the system and system components such as fans, duct, grids, will be studied. Also different levels of airtightness and airtightness distribution will be investigated.

#REF NL13 Heat recovery and warm air heating systems in relation to infiltration
PRINCIPAL RESEARCHER(S)
W.F. de Gids and M. Dubbeld
ADDRESS
Institute for Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands
Telephone: (15) 569330
Telex: 38071 ZPTNO NL

SPECIFIC OBJECTIVES
To study the air tightness of the shell and the interior with respect to these systems and energy consequences

PROJECT DETAILS
To obtain information about the behaviour, motivation and changes in motivation due to an educational program

#REF NL14 Occupants' behaviour and motivation in relation to natural ventilation
PRINCIPAL RESEARCHER(S)
J.E.F. van Dongen and W.F. de Gids
ADDRESS
Institute for Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands
Telephone: (15) 569330
Telex: 38071 ZPTNO NL

SPECIFIC OBJECTIVES
To establish the benefits of educating inhabitants of dwellings in relation to natural ventilation

PROJECT DETAILS
Measurements and enquiries will be made in approximately 150 apartments of position of windows, temperature and energy consumption, during two subsequent heating seasons. After the first heating season, half of the occupants will get information on how to use their windows in an energy-efficient way. The effects in changing the motivation will be studied. Position of windows will be recorded with microswitches, temperatures with thermocouples, energy consumption with yearly gas-meter readings.

#REF NL15 Pressurization tests in dwellings in relation to natural ventilation
PRINCIPAL RESEARCHER(S)
W.F. de Gids
ADDRESS
Institute for Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands
Telephone: (15) 569330
Telex: 38071 ZPTNO NL

SPECIFIC OBJECTIVES
To establish the benefits of educating inhabitants of dwellings with respect to the use of ventilation provisions.
PROJECT DETAILS
Measurements will be carried out in 100 representative dwellings. The distribution of the air leakage will be measured in at least 25 dwellings. With this information a parametric calculation study will be carried out to find out the effects of known behaviour and 'educated' behaviour. The results will also be used for the Dutch standard on airtightness.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, building practice, behaviour

START DATE 01:06:1983
END DATE 31:12:1984
APPROX NO MAN HOURS 2500

BIBLIOGRAPHY
de Gids, W.F. Investigation of the relationship between the natural ventilation of a flat and meteorological conditions. Institute for Environmental Hygiene-TNO, Delft, 1977

de Gids, W.F. Natural ventilation and energy consumption. EC-Brussels 382-78-EEN

de Gids, W.F. Wind-tunnel and on-site pressure distribution measurements on a house and its effect on infiltration. ASHRAE, Detroit, 1979


NEW ZEALAND

#REF NL16 Air leakage of houses
PRINCIPAL RESEARCHER(S)
W.F. de Gids

ADDRESS
Institute for Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands

Phone: (15) 569330
Telex: 30071 ZPTNO NL

SPECIFIC OBJECTIVES
To study air leakage of houses in order to establish a standard.

PROJECT DETAILS
This study includes measurement of a representative sample of houses on air leakage, gathering information about the distribution of air leakage over the building envelope, calculations for different air leakages and pressure distributions of infiltration and heat loss due to infiltration, methods to improve air leakage paths in building construction. The study will be carried out in different steps.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, performance of building components

START DATE 01:01:1982
END DATE 30:06:1985
APPROX NO MAN HOURS 800

BIBLIOGRAPHY


de Gids, W.F. An overview of the air leakage in dwellings. C525, Delft, May 1983

#REF NL17 Air flow and indoor climate of various ventilation openings.
PRINCIPAL RESEARCHER(S)
R.D. Crommelin

ADDRESS
Institute for Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands

Phone: (15) 569330
Telex: 30071 ZPTNO NL

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

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

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, obstacles as houses, trees, etc.

START DATE 01:08:1982
END DATE 31:12:1984
APPROX NO MAN HOURS 800

BIBLIOGRAPHY

#REF NL18 Analysis of ventilation through one opening only.
PRINCIPAL RESEARCHER(S)
R.D. Crommelin

ADDRESS
Institute for Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands

Phone: (15) 569330
Telex: 30071 ZPTNO NL

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

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

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, obstacles as houses, trees, etc.

START DATE 01:08:1982
END DATE 31:12:1984
APPROX NO MAN HOURS 800

BIBLIOGRAPHY

NEW ZEALAND

#REF NZ1 Study of air leakage in houses
PRINCIPAL RESEARCHER(S)
M.R. Bassett

ADDRESS
Building Research Association of New Zealand
BRANZ Private Bag
Porirua
New Zealand

Phone: 357 600
Telex: 30256 BRANZ NZ

SPECIFIC OBJECTIVES
Investigation of the part that air infiltration plays in moisture control and winter space heat loss.
A survey of the airtightness of houses, components and building materials is nearing completion. Air infiltration rate measurements using SF6 as a tracer gas are being made in houses to confirm predictive models based on weather, site and airtightness data. Multi-gas tracing methods are being investigated to measure airflows between living spaces and building cavities.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind pressures and performance of wind barriers</td>
<td>(no special investigation into types of air pollutants is included).</td>
</tr>
<tr>
<td>START DATE</td>
<td>01:01:1983</td>
</tr>
<tr>
<td>END DATE</td>
<td>31:12:1983</td>
</tr>
</tbody>
</table>

BIBLIOGRAPHY

Usvlokk, S. Air infiltration model validation, the ENCORE computer program. The Norwegian Building Research Institute, Report to AIC, 20 January 1983

PAPUA NEW GUINEA

#REF PNG Correlation of wind tunnel and full scale natural ventilation

PRINCIPAL RESEARCHER(S)

Dr. R. Aynsley

ADDRESS

Department of Architecture and Building

Papua New Guinea University of Technology

PO Box 793

LAE

Papua New Guinea

Telephone: 45 7054

Telex: 42428 NE

SPECIFIC OBJECTIVES

To determine the order of accuracy that can be expected when estimating airflow rates through naturally ventilated buildings in humid, tropic climate using wind tunnel wind speed co-efficient approach.

PROJECT DETAILS

(1) Type of building: Office and classrooms, building housing Dept. of Fisheries and Forestry.

(2) Size and type of construction: 2-storey, 23mx53m timber framed with glass louvred walls without insect screening, timber shingle roof.

(3) Ventilation: Natural, through louvred internal and external walls. Ceiling fans fitted in most rooms.

(4) Measurements: Miniature cup anemometers recording wind are being used for measuring mean airflow at specific points inside the building and at 10 metre high reference point clear of the building where wind direction shall also be recorded. A hot wire 2-channel anemometer will be used for obtaining mean velocity coefficients from the wind tunnel model.

(5) Instruments: RIMCO miniature 1.25" cup anemometers impulse light chopper type with digital counters supplied by Rauchfus Instruments P/L, Mitcham, Victoria, Australia. 10 metre reference recordings anemometer is a BILL CUP TYPE meteorological instrument 'Stellma' 2-channel constant temperature hot-wire anemometer supplied by Leonard Electronics, Ashbury, New South Wales, Australia.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Thermal comfort

START DATE 01:01:1981

END DATE 31:12:1983

APPROX NO MAN HOURS 500

BIBLIOGRAPHY

Aynsley, R.M. Natural ventilation model studies. Proceedings of International Workshop on Wind Tunnel Modelling Criteria and Techniques in Civil Engineering Applications, National Bureau of Standards, Gaithersburg, Maryland, April 1982

Aynsley, R.M. Wind tunnel modelling for civil engineering applications. Proceedings of International Workshop on Wind Tunnel Modelling Criteria and Techniques in Civil Engineering Applications, National Bureau of Standards, Gaithersburg, Maryland, April 1982
Poland

M.B. Nantka

Institute of Heating, Ventilating and Air Protection

Silesian Technical University

ul. Pstrowskiego 5/25

44 100 Gliwice

Poland

Telephone: 31 75 11 ext 52

Specific Objectives

(a) Comparison of infiltration between 20 buildings with good and bad thermal insulation. To study effects of heat losses, real energy consumption, and conservation.

(b) Comparison of measurement results with existing infiltration models.

Numerical investigation about pressure distribution and air flow.

Project Details

(1) Apartment buildings (5-18 storey).

(2) Concrete and mineral wool.

(3) Natural and mechanical ventilation, and water heating system.

(4) Surface pressures, pressurization, thermography, experimental set-up for measuring air leakage rate through building components.

(5) Fluid multimanometers, thermal sensor, pressure transducer recorder, etc.

(6) Occupied and unoccupied buildings.

Parameters Related to Infiltration/Air Quality

Inside/outside temperature differences, wind velocity and direction, size/shape/siting/orientation of buildings, distribution and position of leakage.

Bibliography


South Africa

National Building Research Institute

Council for Scientific and Industrial Research (CSIR)

National Building Research Institute

PO Box 395

Pretoria 0001

Republic of South Africa

Telephone: (021) 86 9211 ex 3859 or 2576

Telex: 3 630 S.A

Specific Objectives

The current project is aimed at assessing the viability of five passive solar heating technologies in low cost housing in the Western Cape winter rainfall climatic area.

Project Details

The test houses are typical low cost units of 85 m² floor area that are being built in large numbers. Construction is double leaf masonry with facing brick and concrete block with truss roof and cement tile roof. Natural ventilation with optional air vents is used and heating is solar with radiant electrical backup. A locally made automated SF6 tracer gas system is being used in concert with an Autodata 10/10 logger which provides weather and building data. The buildings are at present not occupied but an occupied phase of one year is planned to commence in late 1984. No theoretical models are currently being developed.

Parameters Related to Infiltration/Air Quality

Infiltration vs air velocity, wind direction, temperature difference and later, if time permits, building pressure gradient.

Bibliography

Two local reports were issued, written for a
non-technical audience, concentrating on the passive solar design of the houses.

SWEDEN

#REF SE1 A wind tunnel study of effects of surrounding buildings on wind pressure distributions and ventilation losses for a single family house, detached 1.5 storey houses and 2 storey terrace houses.

PRINCIPAL RESEARCHER(S)

B.G. Wiren

The National Swedish Institute for Building Research
Box 785
S-801 29 Gavle
Sweden

Telex: 026 100220
Telex: 47396 BYGGFO S

SPECIFIC OBJECTIVES

Use of scale models to provide input data for calculation of heat losses due to uncontrolled ventilation of buildings.

PROJECT DETAILS

Model scale 1:100. Measurement of time-mean pressures at 122 locations on walls and roof of a house surrounded by identical houses in regular arrays. Calculations of air change rates and corresponding ventilation losses. Presentation of a dimentionless heat loss reduction factor as a function of a Froude Number based on free-stream wind speed and internal/external temperature difference.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Relative leakage area, wind speed (u between 0 and 8 m/s), temperature difference (between 5 and 35 K)

START DATE 01:05:1982
END DATE 01:10:1983
APPROX NO MAN HOURS 1500

BIBLIOGRAPHY

Wiren, B.G. Effects of surrounding buildings on wind pressure distributions and ventilation heat losses for a single family house. Paper presented at Sixth International Conference in Wind Engineering, Gold Coast, Australia, 21-25 March 1983.

#REF SE2 Heat recovery from exhaust air

PRINCIPAL RESEARCHER(S)

A. Svensson

National Swedish Institute for Building Research
Box 785
S-801 29 Gavle
Sweden

Telex: 026 10 02 20
Telex: 47386 BYGGFO S

SPECIFIC OBJECTIVES

To investigate the energy savings for different kinds of heat recovery units in different single family houses.

PROJECT DETAILS

44 single family houses with 130 m2 living area. 14 are provided with mechanical exhaust air system (F). 15 are provided with mechanical exhaust and supply air system with heat recovery (PTX). 15 are provided with mechanical exhaust air system combined with heat pump for recovery of heat from exhaust air to hot water (FV).

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Weather (temperature and wind), installations (pressure difference inside/outside).

START DATE 01:01:1983
END DATE 31:12:1986
APPROX NO MAN HOURS 4000 (incl. development of measuring equipment)

BIBLIOGRAPHY


Good economy of heat recovery installations require well balanced systems and tight houses. 9th CIB Congress, Stockholm, 1983.

#REF SE3 Ventilation (air diffusion) efficiency in dwellings

PRINCIPAL RESEARCHER(S)

M. Sandberg

ADDRESS

National Swedish Institute for Building Research
Box 785
S-801 29 Gavle
Sweden

Telex: 026 10 02 20
Telex: 47386 BYGGFO S

SPECIFIC OBJECTIVES

The principal aim is to develop design guidelines for establishing an efficient ventilation in multi-room applications.

PROJECT DETAILS

Measurements in an indoor full-scale test house with one facade exposed to the outdoor environment. Mechanical extract and combined supply/extract ventilation. Electrical heating. Air movements in door opening are visualized by smoke. Pressure and temperature are measured in each room. Ventilation (air diffusion) efficiency is measured by tracer gas technique.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Lay-out of ventilation, air flow rate, temperature difference, indoor air quality.

START DATE 01:01:1983
END DATE 31:12:1986

BIBLIOGRAPHY


#REF SE4 Low energy houses in Skultorp - performance monitoring and evaluation

PRINCIPAL RESEARCHER(S)

A. Blomsterberg, K-O. Lagerkvist

ADDRESS

Dept. of Building Physics
National Testing Institute
Box 857
S-501 15 Boras
Sweden

Telex: 033 165174
Telex: 36252 TESTING S

SPECIFIC OBJECTIVES

To monitor and evaluate a calculated energy saving and to study space-heating with forced air. The ventilation efficiency and the thermal efficiency will be studied.

PROJECT DETAILS

Two unoccupied identical houses built by Rockwool AB will be monitored. They are identical in every respect except for the level of insulation. One house is very well insulated, and the other is super-insulated. The floor area is 100m2. The
hoses are heated by a heat pump and equipped with a forced air system. Tracer gas measurements will be made on several occasions using the constant concentration technique and the decay technique. Pressurization test will be made on several occasions. A modified version of the Lawrence Berkeley Laboratory air infiltration model will be used. The houses are monitored continuously (hourly averages of temperature, etc.)

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, performance of building components, simulated occupancy.

START DATE 01:07:1982
END DATE 01:12:1984
APPROX NO MAN HOURS 1300

BIBLIOGRAPHY

#REF SE5 Microclimate - the influence of wind pressure distribution on air infiltration through building structures.
PRINCIPAL RESEARCHER(S) K. Handa, J. Gusten
ADDRESS Division of Structural Design
Chalmers University of Technology
S-412 96 Goteborg
Sweden
Telephone: 46 31 810100

SPECIFIC OBJECTIVES
In the field of energy-related problems, the influence of wind pressure distribution on low-rise buildings is studied. Project details: Some single-family houses are instrumented, and mean and fluctuating pressure and permeability characteristics of the houses are investigated. The test houses are selected in order to represent different surface roughness conditions. The study has shown the importance of the wind-related flow studies and the inadequacy of the existing models for calculating the rate of air infiltration.

START DATE 01:01:1981
END DATE on-going

BIBLIOGRAPHY


#REF SE6 Radon from soil - field test of cost effective remedial actions in existing buildings.
PRINCIPAL RESEARCHER(S) S-O Ericson, H Schated

ADDRESS AIB - Consulting Engineers
PO Box 1315
S-171 25 Solna
Sweden
Telephone: 08 630020
Telex: 17195 AIB STH S

SPECIFIC OBJECTIVES
To test and evaluate different technical remedial actions to prevent infiltration of radon with soil gas into buildings.

PROJECT DETAILS
Infiltration of soil gas through cracks and holes in existing buildings, even if the radon-222 concentration of the soil gas is normal, may result in unacceptable indoor radon concentrations. Problems occur when the radon concentration of the soil gas is high. Effective methods can be to seal basement or slab floor with radon-tight materials or achieve a pressure difference to prevent soil gas from infiltrating. We are presently in the beginning of evaluating 30 remedial actions. Some preliminary results are positive.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Pressure difference, occurrence of cracks and holes in basement or slab. Radon concentration of soil gas. Indoor ventilation rate.

START DATE 01:07:1983
END DATE 31:12:1984
APPROX NO MAN HOURS 8,000

BIBLIOGRAPHY


Radonutredningen SOU 1983:6 (in Swedish)

#REF SE7 Air infiltration compared to energy consumption in small houses
PRINCIPAL RESEARCHER(S) CIV. ENG. U. Bergstrom

ADDRESS Swedish Foundation of Research of Woodworking Industries (TTC)
Box 43200
S-100 72 Stockholm
Sweden
Telephone: 08 231525

SPECIFIC OBJECTIVES
To find correlations between tightness of small houses and energy consumption, and to compare with calculation theories.

PROJECT DETAILS
Small houses with wooden structure, insulated according to Swedish Standard SBN 1980. Some groups of occupied single and detached houses with electrical heating will be followed for at least one year (total electrical energy consumption). In each group a number of houses will be pressurized and tests of ventilation-standard will be carried out. The results will be compared to theories of calculation of the importance of airtightness.

START DATE 01:05:1981
END DATE 30:11:1983

BIBLIOGRAPHY
Bergenstjerna, A. Energiforbruken i smahu 1975-77 FB 1970

#REF SE8 SPARSAM - Energy efficient single family houses
PRINCIPAL RESEARCHER(S) A. Elmroth and G. Granberg

ADDRESS Dept of Energy Conservation in Buildings
Royal Institute of Technology
S-100 44 Stockholm
Sweden
Telephone: 46 8 7877000
Telex: 10389 KTHB S

SPECIFIC OBJECTIVES
To build energy efficient houses (total energy consumption for heating, ventilation, hot water and household electricity less than 10,000 kWh/year in Stockholm climate) which can be produced in long series.
PROJECT DETAILS

Well insulated airtight envelope, passive solar design, mechanical ventilation with an exhaust air heat pump for preheating supplied air and for producing hot water, water conserved by using water saving system, comparison between light and heavy structure on energy consumption and installed effect.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Long time measurements of ventilation and air infiltration by using continuous tracer gas technique and a new passive technique. Air distribution in the houses. Indoor and outdoor climate.

START DATE 30:04:1982
END DATE 31:12:1984
APPROX NO MAN HOURS 8,000

BIBLIOGRAPHY

(not yet decided)

#REF SE9 Air pollutants inside dwellings - medical, environmental, hygienic and chemical aspects of air quality.

PRINCIPAL RESEARCHER(S)

Prof. T. Lindvall

ADDRESS

The National Institute of Environmental Medicine
Box 60208
S-104 01 Stockholm
Sweden

Telephone: 08 23 69 00

SPECIFIC OBJECTIVES

This study aims to make precise statements as to the functional demands posed by environmental, hygiene and medical considerations on the air quality inside dwellings. These findings will then be used as a basis for setting up requirements concerning material, building design and ventilation systems.

PROJECT DETAILS

Inside an environmental chamber, a room in a dwelling is simulated. Test persons in the chamber are exposed acutely to low concentrations of simple and complex air pollutants. We will determine sensory effects such as odour sensations, eye irritations and subjective airway resistance as well as document early physiological changes in the airways and in the conjunctiva. The project includes (a) construction of an environmental chamber and related equipment as well as the application of techniques to measure sensory and physiological effects of low concentrations of air pollutants indoors, (b) use of these techniques in the environmental chamber to study the effects of building material, ventilation designs and human activities, (c) study sensitivity in limited risk groups, specifically in persons with allergies, (d) study of chemical processes of importance for indoor air quality, e.g. dependence of indoor air composition of outdoor air as well as the decomposition, accumulation and interaction of substances in the air of a room and (e) precise comments on the medical and environmental hygiene demands when various groups are taken into consideration.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

This evaluation will be based on the results of this project and findings in other laboratories in and outside Sweden.

START DATE 01:01:1978
END DATE 30:09:1983

BIBLIOGRAPHY

Ahlborg, U. et al Medicinska och hygieniska effekter av formaldehyd i omgivningsluft. Litteraturgenomgang och toxikologisk utvardering.


Berglund, B. et al Characterization of indoor air quality and 'sick buildings'. To be published in ASHRAE, 1983


Bylin, G. et al Pulmonella och sensoriska effekter av korttidsexposition för kvavedioxid.

Camm, P. et al Luftfororenings effekter på luftvagana.


Johansson, I. Kemiska kartlagningar av inomhusluft. Skall publiceras VVS Special, September 1983

Lindvall, T. Health effects of nitrogen dioxide and oxidents. A document on health criteria to serve as a basis for the establishment of Swedish air quality standards.


Rondahl, L. Medicinska och hygieniska effekter av tolen och xylan i omgivningsluft. Litteraturgenomgang och toxikologisk utvardering.

Sigtryggsson, P., och Rondahl, L. Disocyanater i omgivningsluften. Riskidentifiering och riskuppskattning.

Sodergren, D. and Punttila, A. A CO2-controlled ventilation system. Pilot study. Swedish Council for Building Research, 07:1983. (Thomas Lindvall has ingatt i arbetsgruppen för projektet och aktiv medverkat vid skrivning av rapporten)

#REF SE10 Influence on the function of a ventilation system according to the leakage of the building.

PRINCIPAL RESEARCHER(S)

G. Ahlander

ADDRESS

Dept. of Heating and Ventilation
Royal Institute of Technology
Brinellvagen 60
S-100 44 Stockholm
Sweden

Telephone: 46 8 7877000

Telex: 10389 KTHB S

SPECIFIC OBJECTIVES

PROJECT DETAILS

A mathematical model for air infiltration in buildings is determined. The model is used for predicting the way different ventilation systems are influenced by inside/outside temperature difference and wind velocity. The influence of retrofitting is also calculated.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Inside/outside temperature difference, wind velocity.

START DATE 01:07:1982
END DATE 01:10:1984

APPROX NO MAN HOURS 8,500

52
SWITZERLAND

#REF CH1 Real airtightness of residential buildings

PRINCIPAL RESEARCHER(S)
U. Steinemann and A. Haerter

ADDRESS
Schindler Haeter AG
Stockerstrasse 12
CH 8002 Zurich
Switzerland

Telephone: (01) 201 29 00

SPECIFIC OBJECTIVES
The measurements shall give a better knowledge of the real airtightness of typical different constructions, which is the base to calculate natural ventilation.

PROJECT DETAILS
During three winters, a number of residential buildings of typical construction will be tested by pressurisation and supplementary measurements to determine the real airtightness of the whole facade. The project is supported by the Swiss Energy Foundation.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Main parameter - performance of building components.

START DATE 01:01:1982
END DATE 31:12:1985

#REF CH2 Compact equipment for survey of air renewal (Project CESAR)

PRINCIPAL RESEARCHER(S)
J.L. Scartezzini

ADDRESS
Solar Energy Research Group (GRES)
Leso Building
Federal Institute of Technology
CH 1015 Lausanne
Switzerland

Telephone: 021 147 4546

SPECIFIC OBJECTIVES
Measurement of mean and instantaneous air renewal in multi-chamber dwellings using N20 as tracer gas.

PROJECT DETAILS
Using continuous flow and decay methods, measurements of instantaneous air renewal rate will be possible. Using constant flow and constant concentration methods, precise measurement of air renewal will also be possible, over period of days or weeks. The apparatus, designed for both field and laboratory survey, is compact and easily movable.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Infiltration value will be correlated with effects of occupation as well as house tightness and meteorological conditions.

START DATE 01:01:1983
END DATE 31:12:1983
APPROX NO MAN HOURS 2000

#REF CH3 Radiation dose and effects from radon and its progeny in indoor air.

PRINCIPAL RESEARCHER(S)
Dr. W. Burkart

ADDRESS
Swiss Federal Institute for Reactor Research Biologie & Umwelt
Abt. B1
EIR
CH-5303 Wurenlingen
Switzerland

Telephone: (056) 99 23 38/99 21 11
Telex: 537 14 EIR CH

SPECIFIC OBJECTIVES
Assessment of weatherstripping/insulation on indoor radioactivity (radon and daughters). Resulting annual dose to general public.

PROJECT DETAILS

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, weatherstripping, ventilation behaviour of occupants.

START DATE 01:09:1982
END DATE ongoing

BIBLIOGRAPHY

Burkart, W., et al Energy conservation: increased health impacts despite source.Proceedings of Annual Congress SFRP 'Comparisons of Risks Resulting from Major Human Activities'.


Internal reports.

#REF CH4 Indoor pollutants emitted by building materials

PRINCIPAL RESEARCHER(S)
H.U. Wanner

ADDRESS
Swiss Federal Institute of Technology Institute for Hygiene and Workphysiology
CH 8092 Zurich
Switzerland

Telephone: 01 256 39 73

SPECIFIC OBJECTIVES
Investigation of pollutants emitted by building materials.

PROJECT DETAILS
(1) Review of relevant literature. (2) Studies in living rooms and in a climatic chamber. (3) Elaboration of standards or guidelines to minimize the emissions of gaseous compounds.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Ventilation, temperature, humidity

START DATE 01:04:1980
END DATE 30:06:1983

BIBLIOGRAPHY


Huber, G., Wanner, H.U. Indoor air quality and minimum ventilation rates. Environment International (accepted for publication).

#REF CH5 Energy auditing: evaluation and development of specific audit procedures.

PRINCIPAL RESEARCHER(S)
Ch. Weinmann

ADDRESS
Weinmann-Energies
Route d'Yverdon
CH-1040 Ecublens
Switzerland

Telephone: 021 81 10 81
SPECIFIC OBJECTIVES

Evaluation of air infiltration rate, evaluation of energy consumption due to air infiltration, quantification of effects of wind velocity and direction.

PROJECT DETAILS

Applied to apartment houses with natural and mechanical exhausts, and heated with oil, gas or electricity. Determination of air infiltration rate by component categories, e.g. windows, walls, doors, etc. Measurement of differential surface pressure. Instrumentation: special device for measuring air infiltration coefficients for differential pressure between 0 and +/- 500 Pa, differential pressure manometers.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Indoor and outdoor temperatures, wind direction and velocity, shape of building.

START DATE 01:06:1982
END DATE 31:12:1984
APPROX NO MAN HOURS 500
BIBLIOGRAPHY

Reports on energy auditing methods (to be published)

#REF CH6 Air leakage measurement methods for the building shell
P. Hartmann and H. Muhlebach

ADDRESS
EMPA
Section 176
Ueberlandstrasse
CH-8600 Dübendorf
Switzerland

Telephone: 01 823 4276
Telex: 53817

SPECIFIC OBJECTIVES

To evaluate advantages of different techniques of static and dynamic measurements of building leakage, for different types of building with the scope of a national standard.

PROJECT DETAILS

To carry out a literature survey on existing methods, especially other than pressurization technique. To develop measurement kits for methods which seem interesting for an application in Swiss buildings. To evaluate these methods by measurements in different buildings. To issue a national standard which should be based on international standards.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

This project is connected with the evaluation of reference values for CH buildings.

START DATE 07:1983
END DATE 30:03:1985
APPROX NO MAN HOURS 1200
BIBLIOGRAPHY

Baumgartner, Hartmann, Muhlebach Luftun sver1uste - wie sind tie messtechnisch erfassbar Heizung und Luftung Nr 2/981

(this publication will be "retrofitted by this new project")

UNITED KINGDOM

#REF UK1 Improvement in the working environment

G.R. Winch

ADDRESS
Dept. of Architecture
University of Manchester
Oxford Road
Manchester
M13 9PL

SPECIFIC OBJECTIVES

Ventilation-based studies of work spaces to secure improvement in air quality and thermal comfort.

PROJECT DETAILS

Instrumented studies of various work spaces where problems have been reported and assessment of causative factors and remedial measures, e.g. airborne particulates, air change rates, air temperature and movement, air humidity, surface temperature, gaseous contaminants, ventilation rates, etc.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Air change rate and thermal comfort (air movement, temperature, radiation, etc.) and energy factors.

START DATE 01:01:1974
END DATE on-going
BIBLIOGRAPHY


#REF UK2 An investigation of the air infiltration characteristics of windows

T.F. Provan

ADDRESS
Dept. of Civil Engineering
Paisley College of Technology
High Street
Paisley
Scotland
PA1 2BE

Telephone: (041 887) 1241
Telex: 778951 PCT LIB G

SPECIFIC OBJECTIVES

To assess the air infiltration characteristics of different types of windows under laboratory conditions.

PROJECT DETAILS

Equipment - pressure chamber test rig (3m x 3m max.) Measurements - air leakage, pressure difference, temperature using standard instrumentation. Calculations - statistical analysis of tests on approximately 600 windows, correlation of results and comparison with existing data, e.g. CIBS Guide.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Air infiltration rate, pressure difference, dimensionless parameters

START DATE 01:05:1983 (data in existence + additional)
END DATE 01:06:1984
APPROX NO MAN HOURS 500
BIBLIOGRAPHY


Provan, T.F. Keeping the elements at bay,Building, June 1979
VENTILATION OF BUILDINGS

PRINCIPAL RESEARCHER(S)
Dr. D.W. Etheridge

ADDRESS
British Gas Corporation
Watson House
Peterborough Road
London
SW6 3HN
United Kingdom

SPECIFIC OBJECTIVES
To develop and use theoretical and experimental methods for determining ventilation

PROJECT DETAILS
(a) (i) Dwellings and small commercial buildings.
(ii) Conventional and new construction types.
(iii) Natural and mechanical systems. Gas heating.
(vi) Unoccupied.
(b) Multi-cell and single-cell versions of “VENT”. Quadratic flow equation. Validation described in reference 5 below.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, leakage, simulated occupancy dwellings, commercial, pressurization, tracer gas, mathematical models

BIBLIOGRAPHY
Build. and Env., 12, pp181-189, 1977
The prediction of ventilation rates in houses. Proc. of CIB S17 Meeting, Holzkirchen, West Germany, September 1977.

#REF UK4 The measurement of air infiltration rates in large enclosures and buildings.

PRINCIPAL RESEARCHER(S)
J. Dewsbury

ADDRESS
Building Services Research and Information Association
Old Bracknell Lane West
Bracknell
Berkshire
RG12 4AH
United Kingdom

SPECIFIC OBJECTIVES
1. Determination of effects of wind on ventilation. (2) Relation between vent design and pressure drop at low Reynolds Numbers.

PROJECT DETAILS
Wind velocity and direction effects will be studied under controlled conditions in a test chamber. Vent design parameters will be related to discharge coefficients, using both theoretical and experimental methods. This project follows previous work which measured overall ventilated container performance.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Wind velocity, temperature difference

START DATE 01:07:1983
END DATE 31:03:1986
APPROX NO MAN HOURS 1120

#REF UK5 Ventilated containers (naturally ventilated freight containers for carriage of perishable cargoes)

PRINCIPAL RESEARCHER(S)
R.D. Heap

ADDRESS
Shipowners’ Refrigerated Cargo Research Association
140 Newmarket Road
Cambridge
CBS 9HE
United Kingdom

SPECIFIC OBJECTIVES
1. Determination of effects of wind on ventilation. (2) Relation between vent design and pressure drop at low Reynolds Numbers.

PROJECT DETAILS
Wind velocity and direction effects will be studied under controlled conditions in a test chamber. Vent design parameters will be related to discharge coefficients, using both theoretical and experimental methods. This project follows previous work which measured overall ventilated container performance.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Wind velocity, temperature difference

START DATE 01:07:1983
END DATE 31:03:1986
APPROX NO MAN HOURS 1120

#REF UK6 Low energy housing: ventilation.

PRINCIPAL RESEARCHER(S)
Dr D.J. Dickson

ADDRESS
Electricity Council Research Centre
Capenhurst
Chester
CH1 6ES
United Kingdom

SPECIFIC OBJECTIVES
To assess the ventilation pattern in low energy houses which contain controlled mechanical ventilation.

PROJECT DETAILS
Four low energy masonry houses have been instrumented to record energy consumption, temperatures and ventilation. The ventilation factors are monitored by continuously recording the operating conditions of the fan and by recording open doors and windows.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Pressurisation tests are used to check the consistency of the houses over time. Decay techniques were used to calibrate the houses.

START DATE 01:01:1981
END DATE 31:12:1984
APPROX NO MAN HOURS 7000

#REF UK7 Multi tracer gas techniques

PRINCIPAL RESEARCHER(S)
J.G.F. Littler

BIBLIOGRAPHY


Littler, J.G.F. Multi tracer gas techniques
SPECIFIC OBJECTIVES
Development and evaluation of a 4+ gas tracer system

PROJECT DETAILS
The prototype system uses four different gases simultaneously. It will be used to examine zone-to-zone air movement in three low energy houses designed by Polytechnic of Central London and built by Peterborough Development Corporation.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Heat movement by zone-to-zone air movement
START DATE 01:10:1980
END DATE 30:06:1984
APPROX NO MAN HOURS 4 person years

BIBLIOGRAPHY

J.M. Penman
PRINCIPAL RESEARCHER(S)

ADDRESS
South-West Energy Group
Physics Department
The University
Exeter
EX4 4QL
United Kingdom
Telephone: (0392) 79111 ex 751

SPECIFIC OBJECTIVES
To investigate the practicality of determining air exchanges in occupied buildings by recording the CO2 concentration in the internal air and relating this to the number and level of activity of the occupants

PROJECT DETAILS
Successful trials of the method have been made in naturally and mechanically ventilated areas at Exeter University. A year's data have been collected from a naturally ventilated school and this information is now being analysed.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Wind speed, outdoor temperature, occupant behaviour

START DATE 01:03:1979
END DATE 01:01:1984

BIBLIOGRAPHY

Penman, J.M., Rashid, A.A.M. Experimental determination of air flow in a naturally ventilated room using metabolic carbon dioxide. Building and Environment, Vol.17 No.4, pp253-256

J.M. Penman
PRINCIPAL RESEARCHER(S)

ADDRESS
South-West Energy Group
Physics Department
The University
Exeter
EX4 4QL
United Kingdom
Telephone: (0392) 79111 ex 751
#REF UK11 Experiments with a passive ventilation system.

**PRINCIPAL RESEARCHER(S)**
K.A. Johnson (in conjunction with T.R.A.D.A.)

**ADDRESS**
Pilkington Bros. plc
R & D Laboratories
Lathom
Ormskirk
Lancs.
L40 5UF
United Kingdom
Telephone: (0695) 73B01 ex 360

**SPECIFIC OBJECTIVES**
Test feasibility of a simple passive ventilation system for domestic property. Continuation of work reported at 3rd AIC Conference (see reference below).

**PROJECT DETAILS**

Timer framed house, 2 storey (but applicable to masonry construction also). Natural system using "chimneys" from ridge to kitchen and bathroom, inlets via window slot vents and door vents or just natural infiltration. Heating (temporary) by fan heaters. Measuring flows in "chimneys", i.e. ducts by thermistor bead, CO2 concentration reduction and CO2 timed release. Correlating flows with inside/ outside temperature difference. Unoccupied building. Also some CO2 decay tests.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

- Wind speed, traffic (rate and pattern), temperature difference and pressure difference were correlated with air change rate. The infiltration component due to the passage of real people through doors was established.

**BIBLIOGRAPHY**


#REF UK12 Design of low air speed and air direction instrument using corona discharge.

**PRINCIPAL RESEARCHER(S)**
A.G. Campbell

**ADDRESS**
Physics Dept.
Napier College
Colinton Road
Edinburgh
Scotland
United Kingdom
Telephone: (031) 447 7070

**SPECIFIC OBJECTIVES**
Characterisation of instrumentation parameters and finally to have dedicated microprocessor system.

**PROJECT DETAILS**

Use of corona discharge to pick up electrodes in quadrature. Pick up voltage directed to multiplexer and to 1502 microprocessor.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**
Air speed, air direction

**START DATE** 01:10:1981

**END DATE** 31:08:1983

**APPROX NO MAN HOURS** 800

#REF UK13 Air infiltration through building entrances.

**PRINCIPAL RESEARCHER(S)**
S. Macloughlin

**ADDRESS**
Dept. of Building Engineering
University of Liverpool
PO Box 147
Liverpool
L69 3BX
United Kingdom
Telephone: (051) 709 6022

**SPECIFIC OBJECTIVES**
Review the mechanisms of infiltration and the results of others who have tried to establish the relationship between infiltration and traffic rate through various forms of building entrance.

**PROJECT DETAILS**
Field tests were carried out in the School of Civil Engineering, University of Liverpool. The measured infiltration rate due to the use of entrance doors was compared with that predicted by theory and the work of others. It is a 7-storey reinforced concrete framed building with brick and glass block infill panels. The foyer, where the tests were carried out, had no mechanical ventilation and was heated by oil-fired central heating system. Measurement of internal and external temperatures, pressure difference across entrance, traffic and wind speed were made. It is an occupied building. The concentration of CO2 was measured and its rate of decay calculated.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

- Wind speed, traffic (rate and pattern), temperature difference and pressure difference were correlated with air change rate. The infiltration component due to the passage of real people through doors was established.

**START DATE** 12:01:1983

**END DATE** 22:04:1983

#REF UK14 Leakage and frictional characteristics of Kleeneze Superseal.

**PRINCIPAL RESEARCHER(S)**
A.F. Railton and R.S. Clough (Supervisor: P.W. Fitt)

**ADDRESS**
Dept. of Mechanical Engineering
University of Bristol
Queen's Building
University Walk
Bristol
BS8 1TR
United Kingdom
Telephone: (0272) 24161
Telex: 444174

**SPECIFIC OBJECTIVES**
To establish the relationship between mechanical resistance to motion and sealing quality of typical brush strip seals.

**PROJECT DETAILS**
A third stage undergraduate project is under way in which a range of straight brush strip seals will be investigated to determine how their sealing quality varies with interference with a range of surface materials. Sealing qualities tested using an airtight box with a metered air supply. Over the same spectrum of interferences and surfaces, the mechanical force required to move the strip linearly, laterally and rotationally will be investigated.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY (as above)**

**START DATE** 01:10:1982

**END DATE** 30:04:1983

#REF UK15 CO2 infiltration control

**PRINCIPAL RESEARCHER(S)**
(not known)

**ADDRESS**
Robert Matthew, Johnson-Marshall and Partners
42-46 Weymouth Street
London
W1A 2BG
United Kingdom
Telephone: (01) 486 4222
Studies of CO₂ infiltration control

7000 m² office building for the National Farmers Union in Stratford-upon-Avon. Building to be completed early in 1984. Monitoring planned, but not yet funded.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 16:06:1978
END DATE on-going
BIBLIOGRAPHY (not known)

#REF UK16 Radon in buildings - assessment of exposure, models and remedy.

A.D. Wrixon

ADDRESS
National Radiological Protection Board
Chilton
Didcot
Oxon
OX11 0QX

United Kingdom

Telephone: (0235) 831600
Telex: 837124

OX11 ORQ

Telex: 779561 PCT LIB

Telephone: (041) 887 1241

To investigate the impact of recently developed energy conservation measures and produce a clear set of rules for their cost effective and safe application.

PROJECT DETAILS

START DATE 01:10:1982
END DATE 30:09:1985

APPROX NO MAN HOURS 2000/year

BIBLIOGRAPHY
(not applicable)

#REF UK17 The factors effecting the control of the environment in houses (with special reference to insulation and condensation)

PRINCIPAL RESEARCHER(S)

W.Mc. Douglas

ADDRESS
Paisley College of Technology
High Street
Paisley
Renfrewshire
PA 1 2BE

Scotland

Telefax: (041) 887 1241

Telex: 779561 PCT LIB

SPECIFIC OBJECTIVES

To investigate the impact of recently developed energy conservation measures and produce a clear set of rules for their cost effective and safe application.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY


START DATE 01:10:1982
END DATE 30:09:1985
APPROX NO MAN HOURS 2000/year

BIBLIOGRAPHY
(not applicable)

#REF UK18 Three-dimensional computations of air flows in buildings.

PRINCIPAL RESEARCHER(S)

Dr. A.S. Green

ADDRESS
Atkins Research and Development
Woodcote Grove
Ashley Road
Epsom
KT18 5BW

Surrey

Telex: 266701

United Kingdom

Telephone: Epsom 26140 ex 2868

Telex: 266701

SPECIFIC OBJECTIVES

To develop and calibrate reliable computer programs for comparison with measurements or intuition.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Heat transfer, turbulence, ventilation and air quality.

START DATE 01:01:1980
END DATE 31:12:1984

APPROX NO MAN HOURS 2000/year

BIBLIOGRAPHY


Cliff, K.O., Wrixon, A.D., Green, B.M.R., Miles, J.C.H. Radon daughter exposures in the UK. Health Physics (in press)

O'Riordan, M.C., James, A.C., Rae, S., Wrixon, A.D. Human exposure to radon decay products inside dwellings in the United Kingdom NRPB R-152 (1983)


Cliff, K.O., Wrixon, A.D., Green, B.M.R., Miles, J.C.H. Radon daughter exposures in the UK. Health Physics (in press)

O'Riordan, M.C., James, A.C., Rae, S., Wrixon, A.D. Human exposure to radon decay products inside dwellings in the United Kingdom NRPB R-152 (1983)

#REF UK16 Radon in buildings - assessment of exposure, models and remedy.

A.D. Wrixon

ADDRESS
National Radiological Protection Board
Chilton
Didcot
Oxon
OX11 ORQ

Telex: 837124

Telephone: (0235) 831600

To investigate the impact of recently developed energy conservation measures and produce a clear set of rules for their cost effective and safe application.

PROJECT DETAILS

START DATE 01:01:1980
END DATE 31:12:1984

APPROX NO MAN HOURS 2000/year

BIBLIOGRAPHY

(not known)
PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Temperature of walls and windows and effect on flow and temperature patterns caused by positions of internal obstacles.
START DATE 01:06:1983
END DATE 01:10:1983
APPROX NO MAN HOURS 200

BIBLIOGRAPHY

#REF UK19 Measurements and computations of air flows in clean rooms
PRINCIPAL RESEARCHER(S)
Dr. D.M. Deaves
ADDRESS
Atkins Research and Development
Woodcote Grove
Ashley Road
Epsom
Surrey
KT18 5BW
United Kingdom
Telephone: Epsom 26140 ex 2869
Telex: 266701

SPECIFIC OBJECTIVES
To gain an insight into the nature of clean room flows and to compare predictions with full scale measurements.

PROJECT DETAILS
Measurements were taken of the air flows within a newly installed vertical flow recirculating clean room facility. Air flow measurements were taken, using both vane and hot-wire anemometry, in various flow configurations affected by the presence of obstacles and heat sources. Temperature and concentrations were also taken, the latter in order to assess the dispersion from a simulated particle source.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Air speed, obstruction size, heat source, concentration source.
START DATE 17:12:1982
END DATE on-going
APPROX NO MAN HOURS 350

BIBLIOGRAPHY


#REF UK20 Air and smoke movement in buildings
PRINCIPAL RESEARCHER(S)
S.J. Irving
ADDRESS
Oscar Faber Partnership
Marlborough House
18 Upper Marlborough Road
St Albans
Herts.
AL1 4JT
United Kingdom
Telephone: (0727) 59111
Telex: BB9072

SPECIFIC OBJECTIVES
Development of computer-based models for predicting smoke movement through buildings.

PROJECT DETAILS
This project is concerned with the detailed simulation of air and smoke movement through buildings. The programs take account of wind, stack, mechanical ventilation, and local effects due to the fire itself. Leakage characteristics of building components are fed in as data. The programs can cater for any building from single family dwellings to large commercial premises. The program uses a nodal representation of the flow network and uses a Newton-Raphson iterative technique to solve the flow rates and pressures. The program has been validated against output from similar programs and against known details of a hospital fire at Wythenshawe, near Manchester.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Wind surface pressures, temperature differences.
START DATE 01:06:1977
END DATE on-going

BIBLIOGRAPHY


#REF UK21 Thermal performance of houses
PRINCIPAL RESEARCHER(S)
Dr D C Spooner
ADDRESS
Cement and Concrete Association
Wexham Springs
Stoug
SL3 6PL
United Kingdom
Telephone: Fulmer 2727
Telex: 848352

SPECIFIC OBJECTIVES
Measurements of heat losses, heat gains and energy balance in an intermittently heated, high thermal capacity house.

PROJECT DETAILS
The house is well insulated and heated twice each day to 20 degrees C (nominal). Instrumentation enables heat losses through walls, floor and roof to be compared with energy input. Originally the house was sealed but recently tests with automatic door and window opening were completed.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Door and window opening regime, temperature difference and local weather records.
START DATE 01:01:1979
END DATE 31:12:1983

BIBLIOGRAPHY
Spooner, D.C. Preliminary measurements of heat losses from an unoccupied house. CIBS Congress, Oslo, June 1980

To measure the air exchange rate within large single-cell buildings, as well as exchange to the outside, and to develop a theory which will enable their exchanges to be expressed in terms of single parameters.

**PROJECT DETAILS**

This project is a continuation of a pilot study with the same titles. Experience gained in the pilot study is being used to design and build a new tracer dilution measurement system which will then be used in a range of buildings up to 10,000 m³ internal volume. Multi-point sampling will allow the determination of internal air movement patterns. A theoretical model will be developed to enable designers to relate air exchange rates to energy conservation and indoor air quality requirements.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

- **Volume of building**, position of major openings, position and type of emitters, position of extract grilles.
- **START DATE**: 01:09:1983
- **END DATE**: 31:02:1986
- **APPROX NO MAN HOURS**: 10,000
- **BIBLIOGRAPHY**

Papers are in preparation for publication in Autumn 1983 and Spring 1984.

#REF UK23 Ventilation of animal houses

**PRINCIPAL RESEARCHER(S)**

Dr. C.M. Wathes

**ADDRESS**

Department of Animal Husbandry
University of Bristol
Langford House
Langford
Bristol
United Kingdom

**Telephone**: CHURCHILL 852581

**SPECIFIC OBJECTIVES**

To measure local ventilation rates in animal houses using N₂O as a tracer gas.

**PROJECT DETAILS**

Measurements of local ventilation rates in a mechanically ventilated animal house will be made using the constant rate of emission method with N₂O as the tracer gas.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

- **START DATE**: 01:10:1983
- **END DATE**: 31:10:1986
- **APPROX NO MAN HOURS**: 3 man years

#REF UK24 Environmental response of flexible structures

**PRINCIPAL RESEARCHER(S)**

Dr. D.J. Croome

**ADDRESS**

School of Architecture and Building Science
University of Bath
Claverton Down
Bath
BA2 7AY
United Kingdom

**Telephone**: (0225) 61244

**SPECIFIC OBJECTIVES**

To measure the temperature and air velocity gradients which have been measured throughout a 1500 m³ airhouse during winter through to summer. The results suggest that low-level air heating with means for recovering heat from high level are important. Solar heating in summer necessitates skin air jets to collect the heat for use with a heat pump.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

- **START DATE**: 01:05:1980
- **END DATE**: 31:01:1984
- **APPROX NO MAN HOURS**: 40
- **BIBLIOGRAPHY**

Articles in preparation

#REF UK25 A study of domestic background leakage paths through the development of a portable pressurization test rig.

**PRINCIPAL RESEARCHER(S)**

I.C. Ward

**ADDRESS**

Dept. of Building Science
Sheffield University
Western Bank
Sheffield
S10 2TN
United Kingdom

**Telephone**: (0742) 78555 ex 4712

**SPECIFIC OBJECTIVES**

The aim of this project is to develop and validate a field testing facility for quantifying background leakage paths in buildings.

**PROJECT DETAILS**

The work will be carried out by firstly undertaking a laboratory study of flow characteristics of non-standard cracks (typified by very low height to length ratios). Once a range of portable testing boxes has been proved in the laboratory, they will be evaluated against cracks found between component joins in Local Authority housing to establish repeatability and spread.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

- **START DATE**: 01:10:1983 (SERC funded)
- **END DATE**: 31:10:1986
- **APPROX NO MAN HOURS**: 6600
- **BIBLIOGRAPHY**

Ward, I.C. Experiences in air infiltration measurements in domestic dwellings. Presented at 4th AIC Conference, Elm, Switzerland, September 1983
PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Wind velocity and direction, inside/outside and vertical temperature difference, measured component infiltration rates.
START DATE 01:01:1981
END DATE 30:06:1984
BIBLIOGRAPHY

#REF UK27 The development of a predictive model for air movement and heat distribution in factories.
PRINCIPAL RESEARCHER(S)
Prof. P. O'Sullivan and Dr. P.J. Jones
ADDRESS
Welsh School of Architecture
20/22 North Road
Cardiff
South Wales
United Kingdom
Telephone: Cardiff 42588 ex 4150

SPECIFIC OBJECTIVES
To develop from existing techniques for modelling fluid flow, a model for predicting air flow patterns in large single-volume spaces. To validate the model with 'real' building data. To this end a number of factories will be monitored.

PROJECT DETAILS
PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Air movement, stratification, system/building designs.
START DATE 01:11:1983
END DATE 31:10:1986
APPROX NO MAN HOURS 54 man months

#REF UK28 Energy conservation within urban renewal of inner city housing.
PRINCIPAL RESEARCHER(S)
Dr. A. Hildon
ADDRESS
Birmingham School of Architecture
City of Birmingham Polytechnic
Perry Barr
Birmingham
B42 2SU
United Kingdom
Telephone: (021 356) 6911 ex 344

SPECIFIC OBJECTIVES
To demonstrate through a monitored field trial the viability of incorporating energy conservation measures within existing housing rehabilitation programmes.

PROJECT DETAILS
Inner city '1890 - 1920' dwellings, solid wall. A sample of 40 dwellings from a programme of improvements to 200 houses are subject to a 'before' vs 'after' monitoring exercise. Energy and temperature monitoring with biannual pressurization testing and occasional tracer gas measurements.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, energy signature.
START DATE 04:01:1982
END DATE 30:06:1984
BIBLIOGRAPHY
(none yet available)

#REF UK29 The development and application of multi-tracer gas analysis of ventilation and internal air movement.
PRINCIPAL RESEARCHER(S)
(a) A.T. Howarth and (b) Professor P. Burberry
ADDRESS
(a) Department of Building
Sheffield City Polytechnic
Pond Street
Sheffield
S1 5EB
United Kingdom
Telephone: (0742) 20911
(b) Department of Building
UMIST
P O Box 88
Manchester
M60 100
United Kingdom
Telephone: (061 236) 3311
Telex: 666094

SPECIFIC OBJECTIVES
To improve a multi-tracer gas technique for application to air flow measurements in buildings and hence develop an understanding of ventilation and air movement in buildings.

PROJECT DETAILS
The use of gas chromatography is employed to detect variations of concentration of up to three tracer gases simultaneously. Following the release of particular tracers in particular zones, the ventilation rates of each zone and the air movements between them can be evaluated. The emphasis is placed on rapid sampling and portability of equipment.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Wind speed and direction, constructional details, internal interconnection.
START DATE 01:01:1983
END DATE 31:10:1986
APPROX NO MAN HOURS 54 man months

#REF UK30 Ventilation in housing.
PRINCIPAL RESEARCHER(S)
P.R. Warren
ADDRESS
Building Research Establishment
Bucknalls Lane
Garston
Watford
WD2 8JR
United Kingdom
Telephone: (09273) 74040
Telex: 923229

SPECIFIC OBJECTIVES
To develop and validate simple techniques for assessing the ventilation performance of existing and new housing. To produce guidance on the means for ensuring adequate air quality in dwellings, whilst minimising energy consumption.

PROJECT DETAILS
Available data on housing ventilation and air flow paths through the fabric will be reviewed and extended by further measurements. In order to investigate the way in which air moves between zones within a dwelling, appropriate techniques
will be developed and tested. Simple methods, developed for predicting the flow of air through the external envelope of dwellings, will be improved and extended. Data on pressure distribution in relation to building shape, surroundings and exposure will be obtained from wind tunnel studies. Methods for reducing radon levels will be investigated and current research on indoor air pollutants reviewed to provide a basis for ventilation requirements and ameliorative measures.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 01:10:1982
END DATE on going

UNITED STATES OF AMERICA

#REF US1 The Brookhaven house
PRINCIPAL RESEARCHER(S)
R.F. Jones, AIA
ADDRESS
Brookhaven National Laboratory
Upton,
New York 11973
USA
Telephone: (516) 282 2052
SPECIFIC OBJECTIVES
To demonstrate the potential of various combined conservation and solar techniques to lower energy requirements.
PROJECT DETAILS
The Brookhaven House is a demonstration project funded by the US DOE. To test the thermal integrity of the building envelope, various infiltration tests were made and compared. These methods were SF6 gas decay, pressurization with blower door and a new PRT tracer gas method being developed currently at Brookhaven. Extensive infra-red tests were also performed.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Temperature, wind, humidity, and with furnace fans on and off. In addition to testing with an air-to-air heat exchanger.
START DATE 01:09:1980
END DATE 31:10:1983
APPROX NO MAN HOURS 200 (on infiltration only)

BIBLIOGRAPHY

#REF US4 Weather Haven indoor air quality analyses
PRINCIPAL RESEARCHER(S)
Dr. L.A. Scott, D. Hoffman, M.G. Scott.
ADDRESS
Superinsulation Ltd., RR3 Box 10
Northfield Minnesota 55057
USA
Telephone: (507) 662 0155
Monitoring of indoor air quality in demonstration superinsulation home (the Weather Haven).

62
air quality analysed for alternative mechanical ventilation levels.

PROJECT DETAILS
Northern States Power and Western Wisconsin Technical Institute are jointly operating in the construction, demonstration and monitoring of a super-insulated home. The 1500 square foot wood frame structure will install and monitor the performance of several HVAC systems and air-to-air heat exchangers. Several potential pollutants, e.g. radon, sulfur and nitrite oxides, formaldehyde, etc. will be measured using grab bag samples and passive detectors.

PARAMETERS RELATED TO INFLATION/AIR QUALITY
Varying alternative rates of mechanical ventilation. Also the impact of different amounts of building materials on air quality will be tested.
START DATE 01:04:1983
END DATE 01:09:1984
APPROX NO MAN HOURS 200

BIBLIOGRAPHY

#REF US5 Indoor moisture effects on structure, comfort, energy consumption and health.
PRINCIPAL RESEARCHER(S)
K.M. Kelly
ADDRESS
Jay-K Independent Lumber Corp.
Box 1376
New Hartford
New York 13413
USA
Telephone: (315) 797 1914

SPECIFIC OBJECTIVES
To discover the sources of moisture in buildings, reasons for moisture retention and the problems resulting from it. To refine and enhance a Moisture Problem Check List. Investigation of problems possibly caused by moisture in buildings, with the purpose of defining and preventing them.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE not stated
END DATE on-going

BIBLIOGRAPHY

#REF US6 Performance of solar classroom at Hamilton College.
PRINCIPAL RESEARCHER(S)
J.W. Ring
ADDRESS
Dept. of Physics
Hamilton College
Clinton
New York 13323
USA
Telephone: (315) 859 7510

SPECIFIC OBJECTIVES
The effect of air infiltration on the performance of the solar classroom
PROJECT DETAILS
(1) Classroom (of 1000 sq.ft.) used for astronomy students and as an experimental building. (ii) Concrete block. (iii) Natural ventilation. (iv) SF6 tracer gas (with pressurization). (v) Miran IR spectrometer. (vi) Occupied only for a few hours each week.
PARAMETERS RELATED TO INFLATION/AIR QUALITY
(a) Weather (temperature, wind and humidity). (b) Performance of passive solar building as a whole.
START DATE 01:01:1983
END DATE 01:04:1984
APPROX NO MAN HOURS 350

BIBLIOGRAPHY


#REF US7 Building ventilation study
PRINCIPAL RESEARCHER(S)
Dr. R.L. Peterson
ADDRESS
Northwest Hydraulic Consultants Inc.
22477 72nd Avenue South
Kent
Washington 98032
USA
Telephone: (206) 872 0218

SPECIFIC OBJECTIVES
(1) Determine the best locations for HVAC air intakes so that self-contamination is minimised. (2) Determine stack height for laboratory fume hood exhaust so that the quality of laboratory supply air is maintained.

PROJECT DETAILS
A 1:192 model of existing and proposed laboratory buildings, nearby terrain and other significant buildings was constructed and positioned in Northwest Hydraulic Consultants' environmental wind tunnel. Gas sampling taps were installed at 70 locations on the buildings and at various ground-level locations. A tracer gas was released from a stack atop the laboratory for various wind directions, wind speeds and stack heights. By measuring dilution factors on the roof, walls and at ground-level, the optimum position for HVAC air intakes and the most suitable stack height were determined.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Exhaust stack height, wind speed, wind direction, air intake location
START DATE 01:02:1982
END DATE 01:04:1982
APPROX NO MAN HOURS 500

#REF US8 Rural biomass fuels and air pollution
PRINCIPAL RESEARCHER(S)
K.R. Smith
ADDRESS
East-West Center
Resource Systems Institute and Environment and Policy Institute
1777 East-West Road
Honolulu
Hawaii 96848
USA
Telephone: (808) 944 7519
Telex: 743 0331 EWCAD

SPECIFIC OBJECTIVES
(1) Determine the extent and cause of air pollution
exposures in village homes of the developing world. (2) Measure their health impacts. (3) Evaluate the 
efficacy of alternative remediation such as improved 
fuels, stoves and ventilation. (4) Explore policy 
options.

PROJECT DETAILS
(a) Ventilation and air quality measurements are 
being made in a simulated village house at the 
East-West Center, and in rural field studies of 
the homes of a number of areas of Asia and the 
Pacific including India, Nepal, Sri Lanka, Fiji and 
Thailand (12-80 m3). Measurements include use of 
CO2 and perfluorocarbon as tracers using both 
battery-operated and passive detectors.
(b) Simple equilibrium box models, 
multiple box models, empirical models.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
(1) Weather and climate (temperature, wind, 
humidity, prevalence of ground-level air 
Inversions. (2) Performance of alternative 
ventilation arrangements. (3) Fuel type and 
quality. (4) Stove design and operation. (5) 
Housing style. (6) Behaviour of cooks and fire 
tender. (7) Location of stove. (8) Cultural and 
socioeconomic parameters.

PROJECT DETAILS
This is a permanent program which will stress 
environmental measurement during the first few 
years. State-wide surveys will be made of various 
pollutants. Epidemiological studies will be 
carried out and an educational outreach programme 
will be developed to assist local health 
departments.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Health effects, building characteristics, outdoor 
air quality and indoor sources.

PROJECT DETAILS
Review of Codes and Standards on ventilation 
requirements. Literature review of air quality in 
hospitals including airborne infection and chemical 
contaminants. Classification of space with respect 

to ventilation requirements using Duke University 
Hospital. Odour-exhaust air rate study using 
college students as panelists in judging odour 
intensity.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Ventilation and exhaust air rates.

PROJECT DETAILS
Continued development of voluntary consensus 
standards.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Start date not stated
End date not stated

BIBLIOGRAPHY

#REF US10 Ventilation and exhaust air requirements 
for hospitals
PRINCIPAL RESEARCHER(S)
Prof. J.B. Chaddock
ADDRESS
Center for the Study of Energy Conservation 
Duke University Durham 
NC 27706 
USA
Telephone: (919) 684 2832

SPECIFIC OBJECTIVES
(1) Characterization of hospital ventilation 
parameters. (2) Experimental evaluation of the 
effect of reduced toilet exhaust.

#REF US11 ASTM Standards and related activities
PRINCIPAL RESEARCHER(S)
R.R. Treschel
ADDRESS
ED0.41 on Infiltration Performances
American Society for Testing and Materials (ASTM) 
1916 Race Street 
Philadelphia 
Pennsylvania 19103 
USA
Telephone: (215) 299 5400 
Telex: 710 670 1037

SPECIFIC OBJECTIVES
Continued development of voluntary consensus 
standards.

PROJECT DETAILS
Parameters related to infiltration/air quality
Start date not stated
End date not stated

BIBLIOGRAPHY
Stroik, J. Building security STP 719, ASTM, 1981
Firstly, a model is being developed to predict ventilation rates due to wind and thermal buoyancy. A computer model to simulate a control system will be tested using the airflow model. The control model will be used to develop a "best" strategy (one which could go into a microprocessor controller).

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

START DATE 07:09:1982
END DATE 15:03:1983
APPROX NO MAN HOURS 450

BIBLIOGRAPHY


A microcomputer-based instrument has been developed to monitor indoor working level (WL) concentrations of radon daughters. It is being used to monitor homes near uranium production areas of the US southwest.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

**Radon daughter working levels.**

- **START DATE:** 01:01:1980
- **END DATE:** 31:12:1983
- **APPROX NO MAN HOURS:** 4000

**BIBLIOGRAPHY**


#REF US16 Latent loads in low humidity rooms due to moisture

**PRINCIPAL RESEARCHER(S)**

B.W. Jones

**ADDRESS**

Department of Mechanical Engineering
Kansas State University
Manhattan
Kansas 66506
USA

**Telephone:** (913) 532 5610

**SPECIFIC OBJECTIVES**

Moisture infiltration through openings of various geometries for different temperature, humidity and airflow conditions.

**PROJECT DETAILS**

Measurements were made in a test chamber (2m wide x 2m high x 4m long) divided by vertical partition in the center in which test openings were placed. One chamber was warm and moist, the other cool and dry. Measurements were made with natural and forced convection at the opening. A theoretical model based on static pressure difference as a function of height was used to correlate the experimental data. The results may be extended to infiltration of substances other than moisture.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

Inside and outside air temperature and absolute humidity, net air outflow, opening geometry.

- **START DATE:** 01:01:1980
- **END DATE:** 30:09:1981 (continuing at low level activity)
- **APPROX NO MAN HOURS:** 2800

**BIBLIOGRAPHY**


#REF US17 Detection of air infiltration leak sites in residential and commercial structures.

**PRINCIPAL RESEARCHER(S)**

S. Ryan

**ADDRESS**

Department of Physics and Astronomy
University of Oklahoma
Norman
Oklahoma 73019
USA

**Telephone:** (405) 325 3961

**SPECIFIC OBJECTIVES**

To develop a simple, inexpensive, portable electronic instrument for use in energy audits to detect air infiltration sites by sensing air flow through leaks in the building envelope.

**PROJECT DETAILS**

An inexpensive, hand-held anemometer has been developed to detect air infiltration sites by sensing air flow through the site induced by a pressure differential created by a small window fan or environmental conditions. The anemometer, which requires no adjustment in normal operation, will detect both influx and efflux of air and used a novel configuration to reject the spurious signals caused by motion of the instrument which render a conventional anemometer useless for air infiltration work. The device is suitable for both the homeowner and professional auditor.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

Infiltration velocities of less than 5cm/sec can be detected.

- **START DATE:** 01:01:1980
- **END DATE:** 31:05:1984
- **APPROX NO MAN HOURS:** 2000

**BIBLIOGRAPHY**

(Patent application pending)

#REF US18 Air pollutants, aero-allergens and airway-obstructive diseases.

**PRINCIPAL RESEARCHER(S)**

Professor M.D. Lebowitz

**ADDRESS**

Division of Lung Diseases
University of Arizona Health Sciences Center
Tucson
Arizona 85724
USA

**Telephone:** (602) 626 6379

**SPECIFIC OBJECTIVES**

To measure micro-indoor and outdoor, and regional air pollutants, aero-allergens and weather, and relate these to daily respiratory symptoms and peak flow.

**PROJECT DETAILS**

Houses: brick, wood-stucco, trailers (metal-wood). Ventilation: natural, central forced air (incl. heat pumps (electric), furnaces (gas/electric), refrigeration (electric), evaporative coolers (electric-water)).

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

Internal and external weather sources (temperature, relative humidity, wind speed/direction, precipitation, barometric pressure).

- **START DATE:** 01:12:1976
- **END DATE:** 30:06:1984
- **APPROX NO MAN HOURS:** 73,500

**BIBLIOGRAPHY**


#REF US19 Exposure to nitrogen dioxide of inner city residents of New York City.

**PRINCIPAL RESEARCHER(S)**

I.F. Goldstein

**ADDRESS**

Division of Lung Diseases
Epidemiology and Biostatistics
University of Arizona Health Sciences Center
Tucson
Arizona 85724
USA

**Telephone:** (602) 626 6379

**SPECIFIC OBJECTIVES**

Detection of air infiltration leak sites by sensing air flow through the site induced by a pressure differential created by a small window fan or environmental conditions. The anemometer, which requires no adjustment in normal operation, will detect both influx and efflux of air and used a novel configuration to reject the spurious signals caused by motion of the instrument which render a conventional anemometer useless for air infiltration work. The device is suitable for both the homeowner and professional auditor.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

Infiltration velocities of less than 5cm/sec can be detected.

- **START DATE:** 01:01:1980
- **END DATE:** 31:05:1984
- **APPROX NO MAN HOURS:** 2000

**BIBLIOGRAPHY**

(Patent application pending)
activities. (3) 2-week samples of NO2, HCHO, SO2 and
Source, use and health symptoms reported every 2
weeks. (4) 2-week samples of NO2 were taken in each home.

Project will use current available technology
To assess exposure to the relevant air contaminants
2-week samples of NO2 were taken in each home.
Measurements will be related to medical and
quality acceptability.

Goldstein, J.F., Cuzick, J. Daily patterns of
chemo, chlordane, carbon monoxide and carbon
dioxide.

F.J. Berlandi, PhD, CIH
Touchstone Environmental Consultants Inc
33 Thompson Street
Winchester
MA 01890
USA

To relate indoor levels of NO2 to combustion and to
personal exposure measured by personal monitors.

PROJECT DETAILS
Inner city apartments using gas stoves for cooking.
Palms tubes used in four locations in apartment,
kitchen, living room and bedrooms. Palms tubes
are also placed outdoors.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Eventually, health parameters.

START DATE 01:09:1982
END DATE 31:12:1984
BIBLIOGRAPHY
Goldstein, I.F., Cuzick, J. Daily patterns of
asthma in New York City and New Orleans: An
epidemiological investigation. Environmental
Research, 30, pp211-223, 1983.

#REF US20 Chemical evaluation of indoor air quality
PRINCIPAL RESEARCHER(S)
F.J. Berlandi, PhD, CIH
ADDRESS
Touchstone Environmental Consultants Inc
33 Thompson Street
Winchester
MA 01890
USA

To measure the variability of common indoor air
contaminants in homes and buildings. On the basis
of chemical measurements, assess the overall air
quality acceptability.

PROJECT DETAILS
The project will use current available technology
to measure typical contaminants such as asbestos,
formaldehyde, chlordane, carbon monoxide and carbon
dioxide.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Measurements will be related to medical and
physical complaints of the occupants.

START DATE 01:01:1983
END DATE 31:07:1985
APPROX NO MAN HOURS 1000

#REF US21 Yale health and heating survey
PRINCIPAL RESEARCHER(S)
J.A.J. Stolwijk and B.P. Leaderer
ADDRESS
John B Pierce Foundation and Yale University of
Medicine
290 Congress Avenue
New Haven
CONN 06519
USA

To measure the variability of common indoor air
contaminants in homes and buildings. On the basis
of chemical measurements, assess the overall air
quality acceptability.

PROJECT DETAILS
The project will use current available technology
to measure typical contaminants such as asbestos,
formaldehyde, chlordane, carbon monoxide and carbon
dioxide.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Measurements will be related to medical and
physical complaints of the occupants.

START DATE 01:01:1983
END DATE 31:07:1985
APPROX NO MAN HOURS 1000

#REF US22 Hospital ventilation requirements
research project
PRINCIPAL RESEARCHER(S)
M. Gough, J. Zang
ADDRESS
American Hospital Association
840 North Lake Shore Drive
Chicago
IL 60611
USA

To improve indoor air quality in health care
facilities while simultaneously increasing their
energy efficiency
PROJECT DETAILS
Phase I: Obtain and review currently available
data and information regarding indoor air quality
in hospitals. Determine research agenda for
conducting air quality tests in hospitals. Develop
protocol and equipment specifications for
air quality sampling in hospitals.

Phase II: Will involve on-site air quality
sampling in hospitals.

Phase III: Will analyse Phase II data to determine
extent to which ventilation requirements can be
relaxed in certain functional areas of the
hospitals.

Phase IV: Will involve the manipulation of
ventilation rates under very close supervision,
monitoring and recording changes in energy use and
indoor air quality, and developing a set of
recommended changes in ventilation rates.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Sources of pollutants, dilution of pollutants,
occupancy levels, pressure relationships and/or
directional air flows for infection control. Air
handler unit equipment performance.

START DATE 01:04:1983
END DATE 30:06:1984 (Phase I)
BIBLIOGRAPHY
Bleckman, J.R. Hospital ventilation requirements
update.American Hospital Association, June 1983
Bleckman, J.R. Frequently-cited ventilation codes
and standards.American Society for Hospital
Engineering, Technical Document 16:5-82, American
Hospital Association, May 1982.

#REF US23 The influence of building design and
other factors on indoor air quality.
PRINCIPAL RESEARCHER(S)
C.I. Davidson and V. Hartkopf
ADDRESS
Carnegie-Mellon University
Dept of Civil Engineering
Pittsburgh
PA 15213
USA

To relate indoor levels of NO2 to combustion and to
personal exposure measured by personal monitors.

PROJECT DETAILS
Inner city apartments using gas stoves for cooking.
Palms tubes used in four locations in apartment,
kitchen, living room and bedrooms. Palms tubes
are also placed outdoors.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Eventually, health parameters.

START DATE 01:09:1982
END DATE 31:12:1984
BIBLIOGRAPHY
Goldstein, I.F., Cuzick, J. Daily patterns of
asthma in New York City and New Orleans: An
epidemiological investigation. Environmental
Research, 30, pp211-223, 1983.
SPECIFIC OBJECTIVES
To determine relationships between factors such as source emissions, air exchange rates and outdoor pollution levels on indoor air quality.

PROJECT DETAILS
Several single family residences in Pittsburgh will be instrumented for measurement of airborne particles, CO, SO2, O3, NOx, formaldehyde and trace organics. Emissions from stoves, furnaces, water heaters and other sources will be measured. Mathematical models relating sources, air exchange rates and indoor airborne concentrations will be developed and tested.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Source emissions, outdoor pollution levels, outdoor weather, opening/closing of windows and doors, ventilation system parameters.

START DATE 01:01:1983
END DATE 30:06:1984
APPROX NO MAN HOURS 5000

BIBLIOGRAPHY
Manuscripts in preparation.

#REF US24 Monitoring of active/passive solar house.
PRINCIPAL RESEARCHER(S)
V. Hartkopf, V. Loftness and C. Davidson
ADDRESS
Institute of Building Sciences
Carnegie Mellon University
Pittsburgh PA 15213
USA
Telephone: (412) 578 3716

SPECIFIC OBJECTIVES
Measure systems performance of inhabited passive/active solar home.

PROJECT DETAILS
An intercity experimental house in Pittsburgh, PA is being monitored to establish: (1) Overall energy performance. (2) Performance of components (active/passive). (3) Inter-relationship to home use. (4) Comparison of actual performance to simulated performance.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
In this case infiltration was due to leakage from a connecting hallway and was not influenced by weather conditions.

START DATE 01:03:1983
END DATE 15:07:1983
APPROX NO MAN HOURS 125

BIBLIOGRAPHY

#REF US26 Study of potential energy savings through CO2 sensing automatic ventilation control in the Minnesota State Capital Building
PRINCIPAL RESEARCHER(S)
J.E. Janssen, P.E.
ADDRESS
Honeywell, Inc
TSC
1700 West Highway 36
St Paul MN 55113
USA
Telephone: (612) 379 4937

SPECIFIC OBJECTIVES
To demonstrate energy saving potential of CO2 controlled ventilation.

PROJECT DETAILS
Measurements of CO2 levels and infiltration rates were made in the Security Department office area of the State Capital Building. A methane tracer was used for infiltration measurements. Results showed that leakage through the outside air dampers provided adequate outside air. Ventilation efficiency was high (approximately 100 'plug flow' which allowed the supply air to sweep contaminated air from the space.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
In this case infiltration was due to leakage from a connecting hallway and was not influenced by weather conditions.

START DATE 01:03:1983
END DATE 30:06:1984
APPROX NO MAN HOURS 125

BIBLIOGRAPHY

#REF US27 Air infiltration in industrial buildings
PRINCIPAL RESEARCHER(S)
C.F. Sepsy
ADDRESS
Dept. of Mechanical Engineering
Ohio State University
206 West 18th Avenue
Columbus Ohio 43210
USA
Telephone: (614) 422 6898

SPECIFIC OBJECTIVES
To measure air infiltration in industrial buildings

PROJECT DETAILS
A tracer gas technique was used to determine infiltration rates in several industrial buildings. A tracer gas was SF6. Studies were made with the building empty and the industrial processes shut down. Data was also collected during normal working periods. A mathematical model was developed and verified by field measurements.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Wind velocity, temperature difference between inside/outside the building as well as exhaust fan operating/non-operating.

START DATE 03:01:1983
END DATE 30:06:1983
APPROX NO MAN HOURS 600

BIBLIOGRAPHY
Air infiltration in residential structures Presented at ASHRAE Semi-Annual Meeting in Philadelphia, USA

#REF US28 Air infiltration modelling.
PRINCIPAL RESEARCHER(S)
M.P. Madera, M. Sherman
ADDRESS
Bldg. 90, Rm. 3074
Lawrence Berkeley Laboratory
measurements in the prediction of infiltration for
This involves the use of simplified comfort
Wind and pressure coefficients/leakage area.
M. Sherman, D. Dickerhoff
Ashley, S., Sherman, M. Natural ventilation in
Sherman, M. A simplified model of thermal comfort
(a) Measure buildings in hot, humid climates that
wind speed and direction, temperature differences, ventilation and heating systems.
START DATE 01:01:1978
END DATE on-going
BIBLIOGRAPHY
Modera, M.P., Sherman, M.H., Levin, P.A. A
detailed examination of the LBL infiltration model
using the Mobile Infiltration Test Unit.Presented
at ASHRAE Meeting, Washington DC, USA, June 1983
Sherman, M.H., Grimsrud, D.T. A comparison of
alternate ventilation strategies.LBL Report
LBL-13678, presented at 3rd AIC Conference,
September 20-23 1982

(see AIRBASE for earlier reports)

#REF US29 Natural ventilation
PRINCIPAL RESEARCHER(S)
M. Sherman, D. Dickerhoff
ADDRESS
Bldg. 90, Rm. 3074
Lawrence Berkeley Laboratory
1 Cyclotron Road
Berkeley
CA 94720
USA
Telephone: (415) 486 4022
SPECIFIC OBJECTIVES
To study air leakage through building envelopes
PROJECT DETAILS
(a) Develop instrumentation for measurement of air
leakage. Currently developing acoustic version of
AC pressurization which will allow simple real-time
monitoring of building leakage. (b) Measurement
and cataloging of leakage sites within structure.
Component leakage measurements and prediction of
total leakage therefrom
PARAMETERS RELATED TO INfiltration/AIR QUALITY
Relating component leakage to total measured
leakage.
START DATE not stated
END DATE on-going
BIBLIOGRAPHY
Sherman, M., Grimsrud, D., Sonderegger, R.C. Low
pressure leakage function of a building.LBL Report
No.9161, 1979
Dickerhoff, D., Grimsrud, D.T. Component leakage
testing in residential buildings.LBL Report No.
14735, July 1982
Reinholt, C., Sonderegger, R. Component leakage
areas in residential buildings.Proceedings of 4th
AIC Conference, Elm, Switzerland, 1983

#REF US31 An indoor air quality study of 40 East
Tennessee homes
PRINCIPAL RESEARCHER(S)
Dr. A. Hawthorne, et al
ADDRESS
Instrumentation and Measurements Group
Health and Safety Research Division
Oak Ridge National Laboratory
Oak Ridge
Tennessee 37830
USA
Telephone: (615) 574 6246
SPECIFIC OBJECTIVES
For one year, measurements of indoor air pollutants
were made in 40 East Tennessee homes. The houses
were of various ages with different types of
insulation and heating. In 30% of the houses, the
annual indoor guideline for radon, 4 pCi/L was
exceeded. The mean radon level in houses built on
the ridgelines was 4.4 pCi/L, while half of the
houses exceeded the indoor ceiling guidelines of
0.1 ppm for formaldehyde on at least one occasion.
Over the duration of the study, older houses
averaged 0.04 ppm of formaldehyde while houses less
than 5 years old averaged 0.08 ppm. The highest
concentration of formaldehyde measured was 0.4 ppm.
Diurnal and seasonal fluctuations in levels of
formaldehyde were usually recorded during summer months. The
concentration in indoor air of other hydrocarbons
was at least tenfold higher than in outdoor air.
Gasoline vapors from automobiles and stored
gasoline/oil were responsible for most of the
persistent, highly volatile hydrocarbons. Carbon
monoxide and nitrogen oxides were usually less than
2 and 0.02ppm respectively, except when gas stoves
or kerosene space heaters were operating, or when a
car was running in the garage. The factor having
the most impact on ventilation was operation of the
central duct fan of the heating, ventilation and
air conditioning system. The mean rate of air

#REF US30 Air leakage in buildings
PRINCIPAL RESEARCHER(S)
M. Sherman, M. Modera

ADDRESS
Bldg. 90, Rm. 3074
Lawrence Berkeley Laboratory
1 Cyclotron Road
Berkeley
CA 94720
USA
Telephone: (415) 486 4022
SPECIFIC OBJECTIVES
To model residential air infiltration. 2. To
verify and refine the assumptions in the LBL
single-zone infiltration model. 3. To extend the
single-zone model to a multi-zone model.
PROJECT DETAILS
Single-zone model - compare predictions with
measurements made in the Mobile Infiltration Test
Unit (MITU) and with predictions made without
various simplifying assumptions. Make measurements
in MITU of combined natural and system-induced
infiltration. Multi-zone model - model problem as
in single-zone but including effect of flow
resistances between zones within the structure.
Make measurements with multiple tracer gases in
test structure and in multi-unit residences.
PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Leakage area (exterior envelope and between zones),
wind speed and direction, temperature differences,
ventilation and heating systems.
START DATE 01:06:1982
END DATE on-going
BIBLIOGRAPHY
Sherman, M., Grimsrud, D., Sonderegger, R.C. Low
pressure leakage function of a building.LBL Report
No.9161, 1979
Dickerhoff, D., Grimsrud, D.T. Component leakage
testing in residential buildings.LBL Report No.
14735, July 1982
Reinholt, C., Sonderegger, R. Component leakage
areas in residential buildings.Proceedings of 4th
AIC Conference, Elm, Switzerland, 1983

#REF US29 Natural ventilation
PRINCIPAL RESEARCHER(S)
M. Sherman, D. Dickerhoff
ADDRESS
Bldg. 90, Rm. 3074
Lawrence Berkeley Laboratory
1 Cyclotron Road
Berkeley
CA 94720
USA
Telephone: (415) 486 4022
SPECIFIC OBJECTIVES
To study effects of natural ventilation in warm
climates and wind-driven infiltration in all
climates
PROJECT DETAILS
(a) Measure buildings in hot, humid climates that
can make use of natural ventilation for cooling.
This involves the use of simplified comfort
algorithms. (b) Study usefulness of wind tunnel
measurements in the prediction of infiltration for
both open and closed window configurations.
PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Wind and pressure coefficients/leakage area.
START DATE 01:06:1982
END DATE on-going
BIBLIOGRAPHY
Ashley, S., Sherman, M. Natural ventilation in
hot, humid climates.Submitted to ASHRAE
Sherman, M. A simplified model of thermal comfort
(draft)

#REF US30 Air leakage in buildings
PRINCIPAL RESEARCHER(S)
M. Sherman, M. Modera
exchange increased from 0.38 to 0.72/h when the duct fan was operated.

**PROJECT DETAILS**

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

START DATE not stated

END DATE not stated

BIBLIOGRAPHY

ORNL/5965 NTIS, Springfield, VA, USA, 1983

#REF US32 Formaldehyde from pressed wood products (PWP)

PRINCIPAL RESEARCHER(S)

F. Brauer

ADDRESS

US Consumer Product Safety Commission

Washington DC 20207

USA

Telephone: (301) 492 6508

SPECIFIC OBJECTIVES

To provide mechanism for predicting effects of PWP leading on indoor formaldehyde levels.

**PROJECT DETAILS**

Development of characterization technology, secure cross-section of currently sold PWP, develop/refine computer model to predict ACR based on temperature, loading of sources/sinks in 2-compartment model including gypsum walls.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

Temperature, PWP loading, sink loading, inter-chamber air change, inside/outside air exchange, emission rate/product.

START DATE 01:01:1980

END DATE 31:12:1985

APPROX NO MAN HOURS 30,000 (direct and under contract)

BIBLIOGRAPHY

Matthews, Formaldehyde measurements from pressed wood products 17th Annual Symposium, Proceedings of International Particleboard/ Composit Materials

#REF US33 Home weatherization project

(a) J. Quackenboss and J. Flickinger (b) J.D. Spengler and W. Turner

ADDRESS

(a) University of Wisconsin

Room 102

Preventative Medicine Department

Madison

WI 53706

USA

Telephone: (608) 263 6928

(b) Havard University

Dept of Environmental Science and Physiology

Boston

MA 02115

USA

Telephone: (617) 732 1255

SPECIFIC OBJECTIVES

Document ventilation rates and pollutant levels in 50 homes before and after energy conservation retrofits.

**PROJECT DETAILS**

This work was sponsored by ASHRAE Technology Dept., 1791 Tullie Circle NE, Atlanta, Georgia 30329, USA.

Telephone: (404) 636 8400

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

Energy consumption, operation habits, sources, before/after retrofits, SF vs perfluorocarbon tracers, LBL model predictions.

START DATE 01:01:1982

END DATE 31:03:1984

APPROX NO MAN HOURS 4 man years

BIBLIOGRAPHY


#REF US34 Properties and dynamics of indoor radon progeny aerosols

PRINCIPAL RESEARCHER(S)

E.A. Martell, PhD

ADDRESS

National Center for Atmospheric Research

PO Box 3000

Boulder

Colorado 80307

USA

Telephone: (303) 494 5151

Telex: 45 694

SPECIFIC OBJECTIVES

To determine the properties of indoor radon progeny aerosols and their synergistic interactions with cigarette smoke.

**PROJECT DETAILS**

Experimental chamber studies are carried out using radon progeny and thoron progeny - tagged smoke particles and other combustion product particles. The size distributions of radon progeny aerosols are determined using multi-stage impactors, low-level beta-counting, etc. Variations of size distribution vs age and other factors are determined.

**PARAMETERS RELATED TO INFILTRATION/AIR QUALITY**

The influence of indoor airborne particle concentration on the attached fraction, the size distribution and other properties.

START DATE 01:07:1980

END DATE on-going

APPROX NO MAN HOURS

BIBLIOGRAPHY

Martell, E.A. Alpha-radiation dose at bronchial bifurcations of smokers from indoor exposure to radon progeny Proc. National Academy of Science, USA, Vol.80, 1285-1289, March 1983


#REF US35 362-RP Predicting energy losses due to infiltration in refrigerated warehouses

PRINCIPAL RESEARCHER(S)

H.Z. Jackson

ADDRESS

Administrative Building

Georgia Institute of Technology

Atlanta

Georgia 30332

USA

Telephone: SPECIFIC OBJECTIVES

Phase I - Conduct literature search into the topic of the research and condense findings into a final report. Identify mathematical models for field test verification.

**PROJECT DETAILS**

This work was sponsored by ASHRAE Technology Dept., 1791 Tullie Circle NE, Atlanta, Georgia 30329, USA.

Telephone: (404) 636 8400

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

START DATE 01:04:1983

END DATE 31:10:1983 (Phase I)

APPROX NO MAN HOURS 600
Analysis of indoor air acceptability data collected in TRC/LBL project on energy conservation.

PRINCIPAL RESEARCHER(S)
Dr. A. Dravnieks

ADDRESS
Institute of Olfactory Science
211 Tampa Street
Park Forest
Illinois 60466
USA

Telephone:

SPECIFIC OBJECTIVES
To correlate and analyse the air acceptability data collected in connection with an energy study carried out earlier.

PROJECT DETAILS
Measured were: overall air acceptability as judged by occupants and visitors, acceptability with respect to odour, odour intensity per butanal scale, odour threshold, concentrations of various pollutants (particulate matter, carbon oxides, nitrogen oxides, etc.), physical factors such as temperature and humidity and actual ventilation rates.

This work was sponsored by ASHRAE Technology Dept., 1791 Tullie Circle NE, Atlanta, Georgia 30329, USA.

Telephone: (404) 636 8400.

BIBLIOGRAPHY
No. 2774. Analysis of indoor air acceptability data from a public buildings ventilation study. ASHRAE Trans., Vol.70, Pt.2

Air leakage properties of insulation

D. Harrje, G. Dutt and D. Jacobson

ADDRESS
Center for Energy and Environmental Studies
Princeton University
Engineering Quadrangle
Princeton
NJ 08544
USA

Telephone: (609) 452 5190

SPECIFIC OBJECTIVES
To assess the air leakage properties of various types of commonly used insulation both in a laboratory situation and in actual buildings.

PROJECT DETAILS
A laboratory set-up involving a simulated ceiling section is used to measure the air flow passing through the insulation at various induced pressure differences. In the field, homes are pressure tested before and after insulation is blown into walls and/or ceilings and the relative flows at specific pressures are noted. The reduction in air leakage due to the addition of insulation is noted.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 01:02:1981
END DATE 30:06:1984
APPROX NO MAN HOURS 2000

Dual infiltration reduction experiment

G.S. Dutt and D. Jacobson

ADDRESS
Center for Energy and Environment Studies
Princeton University
Princeton
NJ 08540
USA

Telephone: (609) 452 4684

SPECIFIC OBJECTIVES
To compare different methods of reduction of pressurization data with tracer gas measurements in order to determine the quickest, most accurate way to assess air infiltration reduction during a specific building tightening activity.

PROJECT DETAILS
Pressurization and tracer gas measurements were obtained before and after retrofit measures for five 900 ft² attached, single story apartment units in Eastern Pennsylvania. Comparisons were made between 50 Pa air change rates, 4 Pa flow rates (converted to equivalent leakage areas (ELA)), and tracer gas decay measurements. Additional detailed data of the same type will be collected in the second half of 1983.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, pressurization measurements.

START DATE 01:11:1982
END DATE 30:04:1984
APPROX NO MAN HOURS 1000

Energy use, infiltration and indoor air quality in tight, well insulated residences.

(a) N. Nagda, (b) O.T. Harrje and (c) B. Karpay

ADDRESS
(a) Geomet
1801 Research Blvd.
Rockville
MD 20850
USA

Telephone: (301) 424 9133

(b) Center for Energy and Environment Studies
Princeton University
Engineering Quadrangle
Princeton
NJ 08544
USA

Telephone: (609) 452 5190

(c) Applied Management Sciences
962 Wayne Avenue
Silver Spring
MD 20910
USA

Telephone: (301) 585 8181

SPECIFIC OBJECTIVES
To evaluate indoor air quality as building tightness is increased, and to evaluate the IAQ benefits of air-to-air heat exchanger use.

PROJECT DETAILS
Two side-by-side houses have been newly built to the tightness typical of houses 10 years old (10 ach at 50 Pa). One has since been retrofitted to 6 ach at 50 Pa. Indoor pollutant levels are being measured in a series of experiments. Envelope tightness over time is checked by pressurization. The two-chamber flow in each building is being monitored by SF6 tracer gas.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Weather, local infiltration rates, pollution sources and movement through the houses, building tightness.

START DATE 01:07:1982
END DATE 31:08:1984
APPROX NO MAN HOURS 12,500

BIBLIOGRAPHY
# REF US40 Indoor air pollution: an annotated bibliography
PRINCIPAL RESEARCHER(S)
E. Kundidzora
ADDRESS
Bendix Environmental Research
1390 Market Street
Suite 902
San Francisco
CA 94102
USA
Telephone: (415) 861 8484

SPECIFIC OBJECTIVES
A current, annotated bibliography useful to both laymen and scientists interested in indoor air pollution.

PROJECT DETAILS
12-page bibliography printed in March 1983 to be updated periodically.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 01:01:1982
END DATE ongoing
BIBLIOGRAPHY
Bendix, S., Kundidzora, E. Indoor air pollution: an annotated bibliography March 1983

# REF US41 Comparison of models for residential air infiltration
PRINCIPAL RESEARCHER(S)
V. Goldschmidt
ADDRESS
Herrick Laboratories
Purdue University
West Lafayette
Indiana 47907
USA
Telephone: (317) 494 2130

SPECIFIC OBJECTIVES
Determine which of the current models for air infiltration provide the best correlation with measured data and are most useful in predicting infiltration of given structures.

PROJECT DETAILS
Data from various projects are being collected and compared on a point-to-point basis in an attempt to isolate which tendances are being modelled with success and which models are successful in general, while noting the applicability of these models to existing structures.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
Varies with model
START DATE 01:05:1983
END DATE 31:01:1984

# REF US42 Expert system for diagnosing air infiltration problems in buildings.
PRINCIPAL RESEARCHER(S)
G. Wolton and J. Barnett
ADDRESS
Thermal Analysis Group
Bldg. 226, Room B114
National Bureau of Standards
Washington DC 20234
USA
Telephone: (301) 921 3501
Telex: 89 8493 GARG

SPECIFIC OBJECTIVES
To use the concepts of artificial intelligence to develop an expert system to diagnose air infiltration problems.

PROJECT DETAILS
This project will use the concept of artificial intelligence to develop an expert system to analyse ventilation system designs and air infiltration problems in buildings. It is intended to develop a simple expert system to demonstrate the feasibility of these concepts to building applications.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
START DATE 01:01:1983
END DATE on-going
APPROX NO MAN HOURS 1 man year
BIBLIOGRAPHY
Grot, R.A. Air infiltration and ventilation in two large office buildings. ASHRAE Publication, 1984

Hunt, C., Treado, S. Air infiltration in large office buildings. ASHRAE Publication


#REF US46 Multi-cell thermal modeling for buildings

PRINCIPAL RESEARCHER(S)

G. Wolton

ADDRESS

Thermal Analysis Group
Building 226, Room B114
National Bureau of Standards
Washington DC 20234
USA

Telephone: (301) 921 3501
Telex: 89 8493 GARG

SPECIFIC OBJECTIVES

To develop research thermal analysis computer models for analyzing multi-cell buildings

PROJECT DETAILS

This project has developed a research computer program (Thermal Analysis Research Program - TARP) to model heat transfer in multi-cell buildings. Part of this program is a multi-cell air flow model based on the simultaneous solution of the pressure-flow equations between the cells. Contaminant propagation of smoke movement has been added to this model. The air flow part of the program has been implemented as a separate program and it has been demonstrated that this program can be run on the new generation of 16-bit microcomputer with math processor.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY

START DATE 01:09:1981
END DATE on-going
APPROX NO MAN HOURS 2 man-years per year

BIBLIOGRAPHY


Fong, J.B., Grot, R.A. Heat loss from thermal bridges. Proceedings of Thermal Sense VI, SPIE, 1984

Grot, R.A., Persily, A.K. Fan pressurization testing of office buildings. ASTM Special publication on air infiltration measurements, April, 1984

YUGOSLAVIA

#REF Y1 Energy saving by improved building characteristics in relation to indoor air quality.
PRINCIPAL RESEARCHER(S)
K. Sega

ADDRESS
Institute for Medical Research and Occupational Health
Mose Pijade 158
POB 297
41000 Zagreb
Yugoslavia
Telephone: (41) 274 911

SPECIFIC OBJECTIVES
Exposure assessment, determination of (a) indoor/outdoor air pollution relationships, (b) air quality in modern office buildings, (c) influence of construction materials in IAQ.

PROJECT DETAILS
(1) Modern office buildings. (2) Concrete, metal, glass, plywood, plastics and textiles. (3) Mechanical ventilation sometimes in combination with natural, district or central heating (gas). (4) TSP, RP, smoke, CO, SO2, NH3, HCHO, phenol. (5) Low volume pumps with fibreglass filters (TSP, smoke) proceeded by cyclone (RP) and determination of mass concentration, wet chemical methods for SO2, NH3, HCHO and phenol, Ecolyzer for CO2. (6) Occupied buildings.

PARAMETERS RELATED TO INFILTRATION/AIR QUALITY
(a) Temperature and humidity outdoors and indoors. (b) Real behaviour of occupants. (c) Sources of pollution.

START DATE 01:09:1982
END DATE 30:06:1984
APPROX NO MAN HOURS 1200

BIBLIOGRAPHY

Sisovic, A., Eugas, M. Exposure to CO of urban population groups. Poster presented at 6th World Congress on Air Quality, Paris, 1983.

Sega, K. Indoor air quality. Accepted for publication in Arh.hig.rada i toks. (review in Croatian)

APPENDIX 1 - CONTRIBUTING COUNTRIES
## APPENDIX 1 - Contributing Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Identification Letters</th>
<th>Number of Replies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>AU</td>
<td>1</td>
</tr>
<tr>
<td>Belgium</td>
<td>BE</td>
<td>2</td>
</tr>
<tr>
<td>Canada</td>
<td>CA</td>
<td>37</td>
</tr>
<tr>
<td>Czechoslovakia</td>
<td>CZ</td>
<td>1</td>
</tr>
<tr>
<td>Denmark</td>
<td>DK</td>
<td>4</td>
</tr>
<tr>
<td>Finland</td>
<td>FI</td>
<td>4</td>
</tr>
<tr>
<td>France</td>
<td>F</td>
<td>1</td>
</tr>
<tr>
<td>Germany</td>
<td>DE</td>
<td>8</td>
</tr>
<tr>
<td>Hungary</td>
<td>H</td>
<td>1</td>
</tr>
<tr>
<td>Italy</td>
<td>IT</td>
<td>2</td>
</tr>
<tr>
<td>Japan</td>
<td>J</td>
<td>6</td>
</tr>
<tr>
<td>Netherlands</td>
<td>NL</td>
<td>18</td>
</tr>
<tr>
<td>New Zealand</td>
<td>NZ</td>
<td>1</td>
</tr>
<tr>
<td>Norway</td>
<td>NO</td>
<td>2</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>PNG</td>
<td>1</td>
</tr>
<tr>
<td>Poland</td>
<td>PL</td>
<td>2</td>
</tr>
<tr>
<td>South Africa</td>
<td>SA</td>
<td>1</td>
</tr>
<tr>
<td>Sweden</td>
<td>SE</td>
<td>10</td>
</tr>
<tr>
<td>Switzerland</td>
<td>CH</td>
<td>6</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>UK</td>
<td>31</td>
</tr>
<tr>
<td>United States of America</td>
<td>US</td>
<td>47</td>
</tr>
<tr>
<td>Yugoslavia</td>
<td>Y</td>
<td>1</td>
</tr>
</tbody>
</table>

Total 187
APPENDIX 2 - SURVEY FORM
Air Infiltration Centre’s Survey Form for
Current Research into Air Infiltration and Related Air Quality Problems in Buildings

For office use only

Title of project

Principal researcher

Organisation

Address

Telephone

Telex

Date survey form completed

Description of Project

Specific objectives

Project details

Parameters with which infiltration and indoor air quality will be related

Date project began

Expected termination date

Estimated number of man hours

Important reports and publications, both past and future, (titles, authors, publishers, dates of publication)

Please return completed form to:
The Air Infiltration Centre, Old Bracknell Lane, Bracknell, Berkshire, RG12 4AH, Great Britain.
APPENDIX 3 - INDEX OF PRINCIPAL RESEARCHERS
AUSTRALIA

K.L. Biggs  
Commonwealth Scientific and Industrial Research Organisation (CSIRO)  
Division of Building Research  
PO Box 56  
Highett  
Victoria 3190  
Australia  
Telephone: (03) 555 0333  
Telex: 33766 AA  
#REF AUl Air infiltration characteristics of buildings

BELGIUM

Ir. P. Caluwaerts  
Belgian Building Research Institute  
Lombardstreet 41  
B-1000 Brussels  
Belgium  
Telephone: (02) 653 88 01  
Telex: 25682 CETEX B  
#REF BE2 Case studies of low energy houses (air infiltration)

Ir. M. Guillaume  
Belgian Building Research Institute  
Lombardstreet 41  
1000 Brussels  
Belgium  
Telephone: (02) 653 88 01  
Telex: 25682 CETEX B  
#REF BEI Integration of energy saving techniques for dwellings

CANADA

Dr. I. Broder  
The Gage Research Institute  
223 College Street  
Toronto  
Ontario  
M5T 1R4  
Canada  
Telephone: (416) 979 2744  
#REF CA9 Study of health status of residents in homes insulated with urea formaldehyde foam (UFF) before and after remedial measures are undertaken.

W.G. Colborne and N.W. Wilson  
Department of Mechanical Engineering  
University of Windsor  
Windsor  
Ontario  
N9B 3P4  
Canada  
Telephone: (519) 253 4232 ex 548  
#REF CA10 An infiltration model for a one-storey house based on the Encore- Canada simulation  
#REF CA37 Airtightness tests and occupant effects on energy conservation  

Mr. P. Deacon  
Research Division  
Canada Mortgage and Housing Corporation  
Montreal Road  
Ottawa  
Ontario  
K1A 0P7  
Canada  
Telephone: (613) 748 2984  
Telex: 0533674  
#REF CA20 Time averaged measurement of air quality  
#REF CA30 Performance evaluation of the Apple Hill energy-efficient homes

J.M. Dewil  
Fiberglas Canada Inc  
Technical Centre  
PO Box 3005  
Sarnia  
Ontario  
N7T 7N6  
Canada  
Telephone: (519) 344 7461  
Telex: 064 76121  
#REF CA16 Low energy housing studies: "Taped Glasclad System"

R.S. Dumont  
Division of Building Research  
National Research Council of Canada  
Saskatoon  
Saskatchewan  
S7K 0W9  
Canada  
Telephone: (306) 665 4200  
#REF CA18 Air quality measurements in residences  
#REF CA19 Determination of air leakage characteristics of residences and development of means of reducing air leakage.

R.S. Eaton  
Low Level Radioactive Waste Management Office  
Atomic Energy of Canada Ltd  
275 Slater Street  
Ottawa  
Ontario  
K1A 1E5  
Canada  
Telephone: (613) 236 6444  
Telex: 053 4867  
#REF CA35 Wind effects on airtightness measurements

D. Eyre  
Saskatchewan Research Council  
30 Campus Drive  
Saskatoon  
Saskatchewan  
S7N 0X1  
Canada  
Telephone: (306) 664 6925  
Telex: 074 2484 SARECO  
#REF CA38 Radon in housing, commercial and public buildings.

R.H. Ferahian  
Consulting Engineer  
4998 Maisonneuve  
#1416 Westmount  
Quebec  
H3Z 1N2  
Canada  
Telephone: (514) 484 5492  
#REF CA17 Short-circuiting between fresh air intakes and exhausts of buildings as source of indoor air pollution

G.H. Green  
Department of Mechanical Engineering  
University of Saskatchewan  
Saskatoon  
Saskatchewan  
S7N 0W0  
Canada  
Telephone: (306) 343 3101  
#REF CA5 The effect of indoor relative humidity on survival of airborne micro-organisms and the related absenteeism in schools and hospitals.  
#REF CA6 Air infiltration in greenhouses

Mr. A.J. Houston  
Research Division  
Canada Mortgage and Housing Corporation  
Montreal Road  
Ottawa
Ontario
K1A 0P7
Canada
Telephone: (613) 748 2315
Telex: 0533674
#REF CA21 Moisture study.

Housing and Urban Development Association of Canada (HUDAC)
10th Floor
15 Toronto St
Toronto
Ontario
MSC 2E3
Canada
Telephone: (416) 364 4135
#REF CA29 Builders' guidelines for controlled ventilation in new houses

W.R. Jones
Research Division
Ontario Hydro
800 Kipling Avenue
Toronto
Ontario
M8Z 554
Canada
Telephone: (416) 231 4111 ex 6253
Telex: 06 984 525
#REF CA15 The effect of thermal envelope upgrading in residential dwellings.

S.G. Mattar, Ph.D., P.Eng.,
Alberta Public Works, Supply and Services
5848 Dalgety Dr. N.W.
Calgary
Alberta
T3A 1J3
Canada
Telephone: (403) 286 9770
#REF CA12 Buildability as a factor in the design of building details for airtightness

R.G. McGregor
Radiation Protection Bureau
National Health and Welfare
Brookfield Road
Ottawa
Ontario
K1A 0C1
Canada
Telephone: (613) 990 0668
#REF CA13 Seasonal influence and comparison of measurement techniques for radon and radon daughter concentrations in energy efficient homes.

E.D. McIntyre and E.M. Sterling
Theodor D. Sterling Limited
70 - 1507 W. 12th Avenue
Vancouver
B.C. V6J 2E2
Canada
Telephone: (604) 733 2701
#REF CA3 Building modification study

R.E. Platts, P.Eng.
Canadat Consultants Ltd. (for Canada Mortgage and Housing Corporation)
436 Maclaren Street
Ottawa
Ontario
K2P 0M8
Canada
Telephone: (613) 236 7179
Telex: 053 4472
#REF CA33 Alternative approaches to improving the airtightness of existing and new houses.

G. Proskiw, P.Eng.
UNIES Ltd.

1666 Dublin Avenue
Winnipeg
Manitoba R3H 0H1
Canada
Telephone: (204) 633 6363
#REF CA4 Evaluation of major residential energy conservation retrofits

Mr. P. Russell
Research Division
Canada Mortgage and Housing Corporation
Montreal Road
Ottawa
Ontario
K1A 0P7
Canada
Telephone: (613) 748 2306
Telex: 0533674
#REF CA22 Indoor air pollution and housing technology
#REF CA23 Updating health standards for residential construction.
#REF CA24 Radon gas (Problem Land series of publications)
#REF CA25 Instrumentation for detection of radon at potential building sites.
#REF CA26 Hazardous heating and ventilation conditions in housing.
#REF CA27 Biomethylation of arsenic in preserved wood foundations
#REF CA28 Strategies for healthy residential environments
#REF CA31 Upgrading residential forced air filtration

C.Y. Shaw
Division of Building Research
National Research Council
Bldg. M-24, OBR, NRC
Montreal Road
Ottawa
K1A 0R6
Canada
Telephone: (613) 993 1421
Telex: 0533145
#REF CA32 Airtightness and ventilation of residential buildings

Dr. T. Stathopoulos
Centre for Building Studies
Concordia University
1455 de Maisonneuve Blvd. W.
Montreal
Quebec
H3G 1M8
Canada
Telephone: 18:07:1983
#REF CA34 Analytical determination of building internal pressures induced by wind.

E.M. Sterling
Theodor D. Sterling Limited
70 - 1507 W. 12th Avenue
Vancouver
B.C. V6J 2E2
Canada
Telephone: (604) 733 2701
#REF CA1 Environment survey of 1106 office, professional and clerical workers
#REF CA1 Building information system

M. Sulatisky
Saskatchewan Research Council
30 Campus Drive
Saskatoon
Saskatchewan
S7N 0X1
Canada
Telephone: (306) 664 5468
Telex: 074 2484 SARECO

86
D.J. Wilson
Department of Mechanical Engineering
University of Alberta
Edmonton
Alberta
Telephone: (403) 432 5467

Dr. G.K. Yuill
Lion Industries Ltd.
35 Trottier Bay
Winnipeg
Manitoba
Telephone: (204) 475 8393

A. Zdanowicz
Ministry of Municipal Affairs and Housing
101 Bloor St. W.
Toronto
Ontario M5S 1P8
Canada
Telephone: (416) 965 91D8

Czechoslovakia
Ing. M. Breda
Building Research Institute
Vyzkumný ústav pozemních staveb
102 21 Praha 10
Pražska 16
Czechoslovakia
Telephone: 752641 9
Telex: 122688 VUPS C

Denmark
G.R. Lundqvist
Institute of Hygiene
Universitetsparken 180
DK 2200 Arhus C
Denmark
Telephone: (06) 128288

Finland
J. Heikkinen, M. Laukkanen, J. Rallio
Technical Research Centre of Finland (VTT)
Vuorimiehentie 5
SF-02150 Espoo 15

France
M. Wolfe, M. Baroux and M. Kilberger
Centre d'Etudes Techniques de l'Equipment de Lyon
1'Isle d'Abeau
38317 Bourgoin Jallieu
France
Telephone: (74) 93 85 50
Telex: 900427 CETIDA F

Germany
E. Boy
Fraunhofer-Institut fur Bauphysik
Postfach 800 469
D-7000 Stuttgart 80
West Germany
Telephone: 0711 6868 374
Telex: 7 255 167

E. Meyer
Fraunhofer-Institut fur Bauphysik
Postfach 1180
D-8150 Holzkirchen
West Germany
Telephone: 08024 5055
Telex: 1 84 262 TUBLN D


data: airtightness tests on 200 new houses across Canada

Full-scale measurement of air infiltration and ventilation in houses. ·

Pressure pulse infiltration meter

Quality of the air and the amount of fresh air in classrooms

Ventilation systems for building renovation - the experimental building "Kasarmikatu 24".

Ventilation and warm-air heating in blocks of flats (three experimental projects).

Ventilation and warm-air heating in blocks of flats.

Heat recovery from exhaust air in existing blocks of flats.

Passive solar warm-air heating and ventilating system.

Investigation about the annual heat consumption of today's well-insulated buildings.

Rules for determining minimum rates of air-change from the standpoint of building physics.

Air permeability in new dwellings.
Telephone: 08024 5055

Dr. D. Oswald
Fraunhofer-Institut fur Bauphysik
Nobelstrasse 12
D-7000 Stuttgart 80
West Germany
Telephone: (0711) 6868 321

Demonstration project "Landstuhl":
Energy-saving and the use of solar energy within
one and two family houses.

Dr. L. Treppe
Dornier System GmbH
Postfach 1360
D-7990 Friedrichshafen 1
West Germany
Telephone: 07545 82244

Telex: 0734209-0 DOD

Air infiltration and ventilation in
buildings.

Dr. H. Werner
Fraunhofer-Institut fur Bauphysik
Aussenstelle Holzkirchen
Postfach 1180
D-8150 Holzkirchen
West Germany
Telephone: 08024 5055

Air ventilation in buildings
Comparative measurements of ventilation
systems on one-family twinhouses

HUNGARY

Prof. Dr. A. Zold
TU Budapest
Muegyetem rkp. 3
Budapest 111
Hungary
Telephone: (01) 664 011
Telex: 225931

Calculation of air circulation by the
flow-in-networks method

ITALY

A.M. Grosso
Istituto di Tecnologica dell'ambiante Costruito
(Dipartimento di Scienze e Tecniche per i Processi
d'Insediamento)
Politecnico di Torino
viale Mattioli 39
10125 Torino
Italy
Telephone: 011 668861
Telex: 220646 POLITO I

Technological and energetic evaluation of
existing building external windows methods to
decrease the heat load rate due to air
infiltration.

M. Piana
Montepolimeri S.p.A.
C.S.I.
viale Lombardia 20
20021 Bollate (MI)
Italy
Telephone: 02 3501201 ex 351
Telex: 310679 MONTECO I

Energy saving in buildings by controlling
ventilation and heat exchanging with vitiated air

JAPAN

S. Murakami
Institute of Industrial Science
University of Tokyo
22-1 7-Chome
Roppongi
Minato-Ku
Tokyo 106
Japan
Telephone: 03 402 6231

Natural ventilation of dwellings
Ventilation design of dwellings concerned
with airtightness

Dr Y Yanagisawa
Department of Chemical Engineering
University of Tokyo
Hongo
Bunkyo-ku
Tokyo 113
Japan
Telephone: (03) 812 2111 ex 7356

Personal exposure to nitrogen dioxide in
ambient air

H. Yoshino and S. Murakami
Department of Architecture
Faculty of Engineering
Tohoku University
Sendai 980
Japan
Telephone: 0222 22 1800 (4651)

Research on airtightness of various types
of houses
Validation of several predicting methods of
air infiltration using three types of test houses,
the airtightness of which are different from each
other.

K. Ochifugi
Sanitary Engineering Department
Faculty of Engineering
Hokkaido University
Sapporo
Japan
Telephone: (011) 711 2111

Air infiltration calculation method in
multi-rooms

NETHERLANDS

Dr Ir H.B. Bouwman
ISSO
Postbus 20740
3001 JA Rotterdam
Netherlands
Telephone: 010 146116

Minimum fresh air supply per person

Ir. J.M. Cauberg
Adv. Bureau Cauberg Huysen
Gr. Looiersstraat 24
Postbox 690
6200 AL Maastricht
Netherlands
Telephone: 043 19448

Use and energy consumption of small
local exhaust fans in Dutch dwellings.

R.D. Crommelin
Institute for Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands
Telephone: (15) 569330
Telex: 38071 ZPTNO NL
Air flow and indoor climate of various ventilation openings.
R.D. Crommelin
Institute for Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands
Telephone: (15) 569330
Telex: 38071 ZPTNO NL

Analysis of ventilation through one opening only.
W.F. de Gids and J.C. Phaff
Institute of Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands
Telephone: (15) 579330
Telex: 38071 ZPTNO NL

Infiltration rates in dwellings and their effect on radon
#REF NL9

Ventilation in dwellings with sound attenuated ventilation provisions.
#REF NL12

Heat recovery and warm air heating systems in relation to infiltration
#REF NL13

Pressurization tests in dwellings in relation to natural ventilation
#REF NL15

Air leakage of houses
Ir G.G. Franke
ISSO
Postbus 20740
3001 JA Rotterdam
Netherlands
Telephone: 010 146116

Dutch standard for heat loss calculations for buildings.
#REF NL8

Ventilation and formaldehyde concentration
J.C. Phaff and W.F. de Gids
Institute for Environmental Hygiene-TNO
PO Box 214
Delft
Netherlands
Telephone: (15) 569330
Telex: 38071 ZPTNO NL

Ventilation in welding halls
C. Korf
Centre of Surface Technology (C.O.T.)
340 Zijlweg
2015 CP Haarlem
Netherlands
Telephone: (023) 319 544
Telex: 41714 NL

Ventilation and formaldehyde concentration
#REF NL3

Analysis of factors influencing pressure differences on houses in relation to natural ventilation and energy consumption.
Ir. A M van de Beek
Technical University of Eindhoven (FAGO. Bouwkunde)
Den Dolech 2
5600 MB Eindhoven
Netherlands
Telephone: 040 479111

Natural ventilation in schools
#REF NL5

Analysis of ventilation in welding halls
#REF NL9

Survey of tracer gas in single family houses
B. Vik, J. Brunsell, S. Uvslokk
Norwegian Building Research Institute
Forskningsveien 3b
PO Box 322
Blindern
Oslo 3
Norway
Telephone: (02) 46 98 80

Thermal insulation and airtightness of buildings
#REF NO2

Correlation of wind tunnel and full scale natural ventilation
Dr. R. Aynsley
Department of Architecture and Building
Papua New Guinea University of Technology
PO Box 793
LAE
Papua New Guinea
Telephone: 45 7054
Telex: 42428 NE
#REF PNG1
# REF UK19 Measurements and computations of air flows in clean rooms

Dr. D.J. Croome
School of Architecture and Building Science
University of Bath
Claverton Down
Bath
BA2 7AY
United Kingdom
Telephone: (0225) 61244
# REF UK24 Environmental response of flexible structures

J. Dewsbury
Building Services Research and Information Association
Old Bracknell Lane West
Bracknell
Berkshire
RG12 4AH
United Kingdom
Telephone: (0344) 426511
Telex: 848288 BSRIAC G
# REF UK4 The measurement of air infiltration rates in large enclosures and buildings

Dr. D.J. Dickson
Electricity Council Research Centre
Capenhurst
Chester
CH1 6ES
United Kingdom
Telephone: (051) 339 4181
Telex: 627124
# REF UK6 Low energy housing: ventilation.

Dr. D.W. Etheridge
British Gas Corporation
Watson House
Peterborough Road
London
SW6 3HN
United Kingdom
Telephone: (0225) 61244
# REF UK3 Ventilation of buildings

Dr. A.S. Green
Atkins Research and Development
Woodcote Grove
Ashley Road
Epsom
Surrey
KT18 5BN
United Kingdom
Telephone: Epsom 26140 ex 2869
Telex: 266701
# REF UK13 Three-dimensional computations of air flows in buildings.

R.D. Heap
Shipowners’ Refrigerated Cargo Research Association
140 Newmarket Road
Cambridge
Cambridge
CBS BNE
United Kingdom
Telephone: (0223) 65101
Telex: 81604
# REF UK5 Ventilated containers (naturally ventilated freight containers for carriage of perishable cargoes)

Dr. A Hildon
Birmingham School of Architecture
City of Birmingham Polytechnic
Perry Barr
Birmingham
B29 2SU
United Kingdom

Telephone: (021) 356 6911
#REF UK9 Energy efficiency in a new traditional school
#REF UK10 Energy improvement kits
#REF UK18 Energy conservation within urban renewal of inner city housing.

(a) A.T. Howarth and (b) Professor P. Burberry
(a) Department of Building Sheffield Polytechnic
(b) Department of Building UMIST Manchester
#REF UK29 The development and application of multi-tracer gas analysis of ventilation and internal air movement.

S.J. Irving
Oscar Faber Partnership
Marlborough House
18 Upper Marlborough Road
St Albans
Herts.
AL1 3UT
United Kingdom
Telephone: (0727) 59111
Telex: 889072
#REF UK20 Air and smoke movement in buildings

K.A. Johnson (in conjunction with T.R.A.D.A.)
Pilkington Bros. plc
R & D Laboratories
Ormskirk
Lancs.
LA4 5UF
United Kingdom
Telephone: (0695) 73801 ex 360
#REF UK31 Experiments with a passive ventilation system

J.G.F. Littler
Building Unit
Polytechnic of Central London
35 Marylebone Road
London
W1N
United Kingdom
Telephone: (01) 486 5811 ex 345
#REF UK7 Multi tracer gas techniques

S. Macloughlin
Dept. of Building Engineering
University of Liverpool
PO Box 147
Liverpool
L69 3BX
United Kingdom
Telephone: (051) 709 6022
#REF UK13 Air infiltration through building entrances

W.McL. Douglas
Paisley College of Technology
High Street
Paisley
Renfrewshire
PAI 2BE
Scotland
United Kingdom
Telephone: (041) 887 1241
Telex: 778951 PCT LIB
#REF UK17 The factors effecting the control of the environment in houses (with special reference to insulation and condensation)

Robert Matthew, Johnson-Marshall and Partners
42-46 Weymouth Street
London
W1A 2BG
United Kingdom
Telephone: (01) 486 4222
#REF UK15 CO2 infiltration control

Prof. P. O'Sullivan and Dr. P.J. Jones
Welsh School of Architecture
20/22 North Road
Cardiff
South Wales
United Kingdom
Telephone: Cardiff 42588 ex 4150
#REF UK27 The development of a predictive model for air movement and heat distribution in factories.

J.M. Pennan
South-West Energy Group
Physics Department
The University
Exeter
EX4 4QL
United Kingdom
Telephone: (0392) 77911 ex 751
#REF UK8 Determination of air-flow in occupied buildings using metabolic carbon dioxide

T.F. Provan
Dept. of Civil Engineering
Paisley College of Technology
High Street
Paisley
Scotland
PAI 2BE
United Kingdom
Telephone: (041) 887 1241
Telex: 778951 PCT LIB G
#REF UK2 An investigation of the air infiltration characteristics of windows

A.F. Railton and R.S. Clough
(Supervisor: P.W. Fitt)
Dept. of Mechanical Engineering
University of Bristol
Queen's Building
University Walk
Bristol
BS8 1TR
United Kingdom
Telephone: (0272) 24161
Telex: 444374
#REF UK14 Leakage and frictional characteristics of Kleeneze Supersseal

Dr D.C. Spooner
Cement and Concrete Association
Wexham Springs
Slough
SL3 6PL
United Kingdom
Telephone: Fulmer 2727
Telex: 848352
#REF UK21 Thermal performance of houses

I.C. Ward
Dept. of Building Science
Sheffield University
Western Bank,
Sheffield
S10 2TN
United Kingdom
Telephone: (0742) 78555 ex 4712
#REF UK25 A study of domestic background leakage paths through the development of a portable pressurization test rig.
#REF UK26 Infiltration evaluation in an 18-storey, naturally ventilated building.

P.R. Warren and M.D.A.E.S. Perera
Building Research Establishment
Bucknalls Lane
Garston
Watford
WD2 7JR
United Kingdom
Telephone: (09273) 74040
Telex: 923220
#REF UK30 Ventilation in housing.
#REF UK31 Ventilation in non-domestic buildings.

Dr J R Waters
Coventry (Lanchester) Polytechnic
Priory Street
Coventry
CV1 8FB
United Kingdom
Telephone: (0203) 24166
#REF UK22 Ventilation in industrial buildings

Dr. C.M. Wathes
Department of Animal Husbandry
University of Bristol
Langford House
Langford
Bristol
United Kingdom
Telephone: CHURCHILL 852581
#REF UK23 Ventilation of animal houses

G.R. Winch
Dept. of Architecture
University of Manchester
Oxford Road
Manchester
M13 9PL
United Kingdom
Telephone: (061) 273 3333
#REF UK1 Improvement in the working environment

A.D. Wrixon
National Radiological Protection Board
Chilton
Didcot
Oxon
OX11 ORQ
United Kingdom
Telephone: (0235) 831600
Telex: 837124
#REF UK16 Radon in buildings - assessment of exposure, models and remedy.

UNITED STATES OF AMERICA

Dept. of Agricultural Engineering
Cornell University
Ithaca
NY 14853
USA
Telephone: (607) 256 4355
#REF US13 Control of natural ventilation for agricultural buildings

F.J. Berlandi, PhD, CIH
Touchstone Environmental Consultants Inc
33 Thompson Street
Winchester
MA 01890
USA
Telephone: (617) 729 8450
#REF US20 Chemical evaluation of indoor air quality

F. Brauer
US Consumer Product Safety Commission
Washington DC 20207
USA
Telephone: (301) 492 6508
#REF US32 Formaldehyde from pressed wood products (PWP)

Prof. J.B. Chadock
Center for the Study of Energy Conservation
Duke University
Durham
NC 27706
USA
Telephone: (919) 684 2832
#REF US10 Ventilation and exhaust air requirements for hospitals

J.L. Coggins
Energy Applications Inc.
Long Reach Village Center
Suite 224
Columbia
Maryland 21045
USA
Telephone: (301) 730 0663
#REF US12 Calculate maximum allowable pollutant emissions from clean-burning diesel engine forklift trucks

C.I. Davidson and V. Hartkopf
Carnegie-Mellon University
Dept of Civil Engineering
Pittsburgh
PA 15213
USA
Telephone: (412) 578 2951
#REF US23 The influence of building design and other factors on indoor air quality.

Dr R.N. Dietz
Dept. of Applied Science
Brookhaven National Laboratory
Building 426
Upton
NY 11973
USA
Telephone: (516) 282 3059
Telex: 96 7703
#REF US14 Brookhaven air infiltration measurement system (BNL/AIMS)

Dr. A. Dravnieks
Institute of Olfactory Science
211 Tampa Street
Park Forest
Illinois 60466
USA
Telephone:
#REF US36 352-RP Analysis of indoor air acceptability data collected in TRC/LBL project on energy conservation.

G.S. Dutt and D. Jacobson
Center for Energy and Environment Studies
Princeton University
Princeton
NJ 08540
USA
Telephone: (609) 452 4684
#REF US38 Dual infiltration reduction experiment

E.L. Geiger
Eberline Instrument Corporation
PO Box 2108
Santa Fe
New Mexico 87501
USA
Telephone: (505) 471 3232
Telex: 66 0438 EIC SFE
#REF US15 Indoor concentration of radon daughters

V. Goldschmidt
School of Mechanical Engineering
Purdue University
West Lafayette
IN 47906
USA
Telephone: (317) 494 2132
Telex: 272 396
#REF US52 Infiltration rates in residential type buildings
M.P. Modera, M. Sherman
Bldg. 90, Rm. 3074
Lawrence Berkeley Laboratory
Berkeley
CA 94720
USA
Telephone: (415) 486 4678
Telex: 910 366 2039
#REF US28 Air infiltration modelling.

(a) N. Nagda, (b) D.T. Harrje and (c) B. Karpay
(a) Geomet
1801 Research Boulevard
Rockville
MD 20850
USA
Telephone: (301) 424 9133
(b) Center for Energy & Environment Studies
Princeton University
Engineering Quadrangle
Princeton
NJ 08544
USA
Telephone: (609) 452 5190
(c) Applied Management Sciences
962 Wayne Avenue
Silver Spring
MD 20910
USA
Telephone: (301) 585 8181
#REF US39 Energy use, infiltration and indoor air quality in tight, well insulated residences.

A.K. Persily
Building Physics Division
Bldg. 226, Rm. Bl14
National Bureau of Standards
Washington DC 20234
USA
Telephone: (301) 921 3501
Telex: 89 8493 GARG
#REF US43 Air infiltration in passive solar buildings
Dr. R.L. Peterson
Northwest Hydraulic Consultants Inc.
22477 72nd Avenue South
Kent
Washington 98032
USA
Telephone: (206) 872 0218
#REF US57 Building ventilation study
(a) J. Quackenboss and J. Flickinger
(b) J.D. Spengler and W. Turner
(a) University of Wisconsin
Room 102
Preventative Medicine Department
Madison
WI 53706
USA
Telephone: (608) 263 6928
(b) Havard University
Dept of Environmental Science & Physiology
Boston
MA 02115
USA
Telephone: (617) 732 1255
#REF US53 Home weatherisation project
J.W. Ring
Dept. of Physics
Hamilton College
Clinton
New York 13323
USA
Telephone: (315) 859 7510
#REF US6 Performance of solar classroom at Hamilton College.

S. Ryan
Department of Physics and Astronomy
University of Oklahoma
Norman
Oklahoma 73019
USA
Telephone: (405) 325 3961
#REF US17 Detection of air infiltration leak sites in residential and commercial structures.

C.F. Sepsy
Dept. of Mechanical Engineering
Ohio State University
206 West 18th Avenue
Columbus
Ohio 43210
USA
Telephone: (614) 422 6898
#REF US27 Air infiltration in industrial buildings

J.A.J. Stolwijk and B.P. Leaderer
John B Pierce Foundation and Yale University of Medicine
290 Congress Avenue
New Haven
CONN 06519
USA
Telephone: (203) 562 9901
#REF US21 Yale health and heating survey

Dr. L.A. Scott, D. Hoffman, M.G. Scott.
Superinsulation Ltd.,
RR3
Box 18
Northfield
Minnesota 55057
USA
Telephone: (507) 662 0155
#REF US4 Weather Haven indoor air quality analyses

K.R. Smith
East-West Center
Resource Systems Institute and Environmental and Policy Institute
1777 East-West Road
Honolulu
Hawaii 96848
USA
Telephone: (808) 944 7519
Telex: 743 0331 TEWCH
#REF US8 Rural biomass fuels and air pollution

H.R. Treschel
E06,41 on Infiltration Performances
American Society for Testing and Materials (ASTM)
1916 Race Street
Philadelphia
Pennsylvania 19103
USA
Telephone: (215) 299 5400
Telex: 710 670 1037
#REF US11 ASTM Standards and related activities

G. Wolton and J. Barnett
Thermal Analysis Group
#REF US42 Expert system for diagnosing air infiltration problems in buildings.
#REF US45 Multi-cell thermal modelling for buildings

J.J. Wesolowski, Ph.D.
Air and Industrial Hygiene Laboratory
California Department of Health Services
2151 Berkeley Way
Berkeley
CA 94704
USA
Telephone: (415) 540 2476

#REF US9 California indoor air pollution program

YUGOSLAVIA

K. Sega
Institute for Medical Research and Occupational Health
Mose Pijade 158
POB 291
41000 Zagreb
Yugoslavia
Telephone: (41) 274 911

#REF Y1 Energy saving by improved building characteristics in relation to indoor air quality.
THE AIR INFILTRATION CENTRE was inaugurated through the International Energy Agency and is funded by ten of the member countries:

Belgium, Canada, Denmark, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom and United States of America.

The Air Infiltration 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.