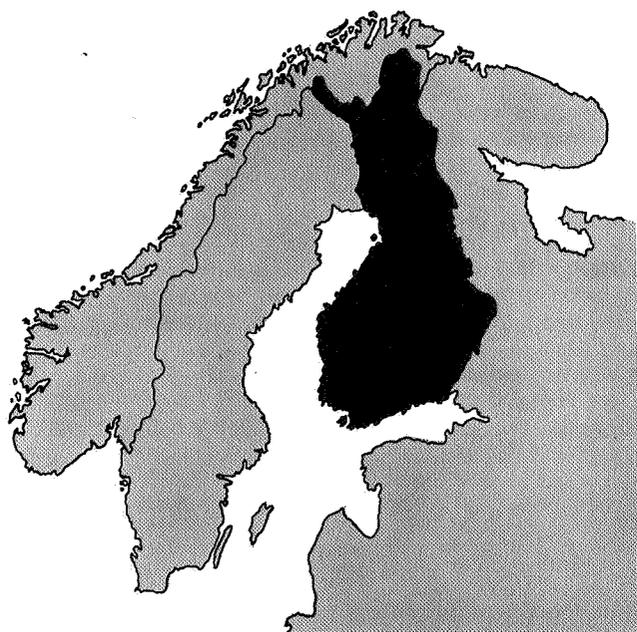


Air Infiltration Review

a quarterly newsletter from the IEA Air Infiltration Centre

Vol. 5, No. 4, August 1984

Welcome Finland



We are delighted to welcome Finland as an additional participant of the Air Infiltration Centre from June 1984.

Finland is much involved in air infiltration research and has regularly provided us with reports of their research activities.

We look forward both to consolidating our links with those involved in air infiltration studies in Finland and to providing the full bibliographic and technical services offered by the Centre.

We hope to feature an article on Finnish research in the November 1984 issue of Air Infiltration Review.

Inside this issue:

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Better Use of AIC Information – Swiss Seminar Report

Dr Peter Hartmann
Building Physics Section, EMPA, Dübendorf, Switzerland

Introduction

This article describes a means of keeping designers up-to-date with current research results in the field of air infiltration. Two years ago the author (Swiss representative on the executive committee of the International Energy Agency – Energy Conservation in Buildings and Community Systems) started to organise specific national meetings in parallel with the different IEA projects. Sometimes the seminars were arranged to announce new projects, and in this particular case the meeting presented the ongoing work in the field of air infiltration (Annexes V, VIII and IX).

Arising from these projects, a large amount of information is now available on the basic problems connected with air infiltration and on its measurement and calculation. However, it is felt that the translation of research results into design tools for architects and building services engineers is lacking in many areas. By way of illustration, there exists a test standard for building pressurization used by many organisations in Switzerland but the recommendations on ventilation and airconditioning plants are not up-to-date; a working group has recently started to develop technical standards in an effort to remedy the situation.

This seminar was organised to bridge this gap between knowledge acquired by researchers (usually published in English) and information required by Swiss designers and those responsible for building regulations (whose mother languages are German, French or Italian). It was held in Berne in April 1984.

Seminar Structure

Most of the seminar participants were aware of the activities of the Air Infiltration Centre or the IEA in general, but very few were familiar with the project plans and available publications. Accordingly the following information was prepared:

- a document giving details of the AIC, summaries in French and German of AIC publications and a complete translation of AIC Technical Note No. 1
- seminar proceedings.
- a display of all AIC publications.
- a display of intended translations/adaptations of AIC documents.

The seminar was divided into three sessions:

1. Problems of infiltration in connection with comfort, condensation and energy.
2. Measurement techniques and design tools; summary of presentations made at the 4th AIC Conference.
3. Forthcoming design tools and building regulations in Switzerland.

In the opening session Dr Peter Hartmann (Swiss representative for Annex V – the AIC) and Professor Wanner (Swiss representative for Annex IX – minimum ventilation rates) presented the up-to-date position and future intentions of these two annexes.



Peter Hartmann and Hans Wanner answering questions

In Session 2, practising engineers and energy consultants attempted to relate the information on measurement techniques and design tools (presented at the 4th AIC Conference) to their own practical work. B. Wenger (Balzari and Schudel, Berne, Switzerland) described the Swedish Handbook and announced his intention to produce an abbreviated Swiss version (in French and German). H. Mühlebach (EMPA, Dübendorf, Switzerland) and Chr. Zürcher (ETH, Zurich, Switzerland) reviewed various measurement techniques and introduced draft Swiss measurement standards. Finally, U. Steinemann (Schindler and Haerter, Zurich, Switzerland) gave a comprehensive presentation on available data for air leakage and air change rates for Swiss buildings; this document will form the basis for preparation of future design tools and regulations.



Urs Steinemann giving his paper

Session 3, with contributions from S. Schuppisser (Swiss Association of Engineers and Architects) and R. Krebs (representing the bodies concerned with building regulations) showed how far the regulations are behind in respect of all three main aspects of infiltration. It also revealed the strength of the demand by designers for valid design tools.

Comments

It is evident that the early collaboration of researchers and/or AIC contacts in the drafting of national regulations and recommendations is very important. Transmitting information from AIC/foreign countries to designers and through them to standards organisations is too time consuming. Many countries have to bear the cost of translating important information into their own language and producing the publications in an appropriate format and at a level appropriate to designers. Most European countries are in the process of producing standards related to infiltration and ventilation, so the international exchange of information and experience on the development and implementation of standards as planned at the forthcoming 5th AIC Conference was therefore welcomed by the state officials who attended the seminar.

Swiss funding bodies were encouraged to extend the translation of AIC documents into French and German (see below) and it was hoped that this activity could be further expanded if other German-speaking countries became participants in the AIC in the future. The seminar was not only well attended but it also gained the attention of the technical press. Summaries have been published in three journals and one, *Blätter für Heizung und Lüftung* (a heating and ventilating journal) will publish almost the full text of the proceedings.

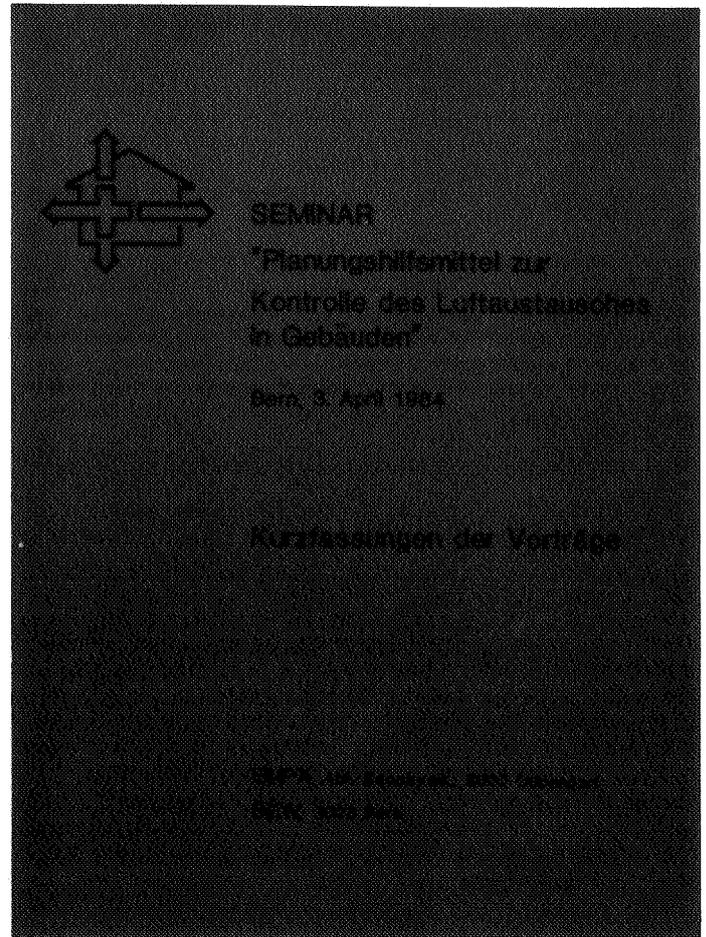
Proposed translations of AIC publications

There are three main reasons for the enthusiasm in Switzerland for the translation and adaptation of AIC material:

- most Swiss building designers are unable – or unwilling – to read English handbooks.
- many of the documents contain information which is not only of interest to researchers, but could also be used to great effect by designers if it were to be presented in the right form.
- information on building regulations is not issued by one body in Switzerland but by many local or provincial authorities (Cantons). Their staff are not able to read all the relevant information from *AIRBASE*, AIC technical notes and conference proceedings so they need an overall guide on this important subject.

For these reasons, Switzerland is considering the issue of:

- an adapted version of the AIC Handbook with clear indications of the original and adapted sections.
- a translation of additional AIC technical notes.
- translated versions of some of the contributions for the 5th AIC Conference.
- regular translations of the AIC's quarterly newsletter *Air Infiltration Review*.
- a translation/adaptation of the planned Design Guide (see also page 6).



It is hoped that this presentation of Swiss proposals will encourage other AIC participating countries to make information more widely available. It would be preferable if this work could be co-ordinated among those countries with similar languages.

Air Infiltration Review

Air Infiltration Review has a quarterly circulation approaching 3000 copies and is currently distributed to organisations in 34 countries. Short articles or correspondence of a general technical nature related to the subject of air infiltration are welcome for possible inclusion in *AIR*. Articles intended for publication must be written in English and should not exceed 1000 words in length. They should also contain two or three diagrams or photographs highlighting the main theme of the text. If you wish to submit a contribution, please contact Jenny Elmer at the Air Infiltration Centre for further details.

5th AIC Conference –

'The implementation and effectiveness of air infiltration standards in buildings'
1 – 4 October 1984 at Harrah's Hotel, Reno, Nevada, USA.

Final Announcement..... page 5

Seminar on Ventilation and Indoor Air Quality Field Measurements at ASHRAE Annual Meeting in Kansas City, USA. June 17-20

Although no formal papers are presented at ASHRAE seminars, they provide an opportunity for the presentation of information of current interest. This seminar proved to be particularly interesting and dealt with the important area of air quality measurements in buildings.

The first contribution was by Jim Quackenboss from the Harvard School of Public Health, Boston, USA. The theme of his presentation was based on the measurement of nitrogen dioxide in dwellings and the relationship of this pollutant to both the use of gas appliances and building airtightness. Passive NO_2 samplers are currently being used to measure the nitrogen dioxide concentration in a total of 137 homes, while airtightness measurements have been made using the pressurization technique. To date, annual average concentrations of $56 \mu\text{g}/\text{m}^3$ (26 ppb) have been monitored in gas homes and $8.9 \mu\text{g}/\text{m}^3$ (4 ppb) in all-electric homes. The corresponding standard deviations are $24.8 \mu\text{g}/\text{m}^3$ (12 ppb) and $3.9 \mu\text{g}/\text{m}^3$ (2 ppb) respectively. Correlations between air infiltration rates and nitrogen dioxide concentrations are currently in progress.

The second contributor was Joseph Rizzuto of the New York State Energy Research and Development Authority who presented a progress report on indoor air quality measurements and control techniques in dwellings. The objectives of this study are to:

- investigate the relationship between indoor air quality, air exchange rates, sources of pollution and construction practices.
- evaluate the effectiveness of inexpensive control techniques.
- disseminate research results.

Approximately 60 houses were selected for airtightness and radon concentration measurements and approximately 40 houses were chosen for combustion pollution monitoring. Following this initial investigation, six houses with high levels of combustion pollution and four houses with high radon concentrations were studied in detail. In addition permanent control measures were installed for evaluation purposes, to reduce indoor air quality problems in several of the remaining dwellings. Approximately half the homes included in the study were regarded as 'energy efficient' while the remainder were classified as being of 'typical' construction. The houses selected for radon analysis were distributed over a wide geological area within the State of New York. Time-averaged indoor concentrations of the gas varied between 4 and 48 pCi/litre as compared with an ASHRAE recommended standard of approximately 2 pCi/litre. A number of methods to reduce the radon concentrations in these dwellings were attempted; one such method - which proved particularly effective - was to introduce mechanical extract ventilation beneath the basement slab using a low powered (20 watt) fan.

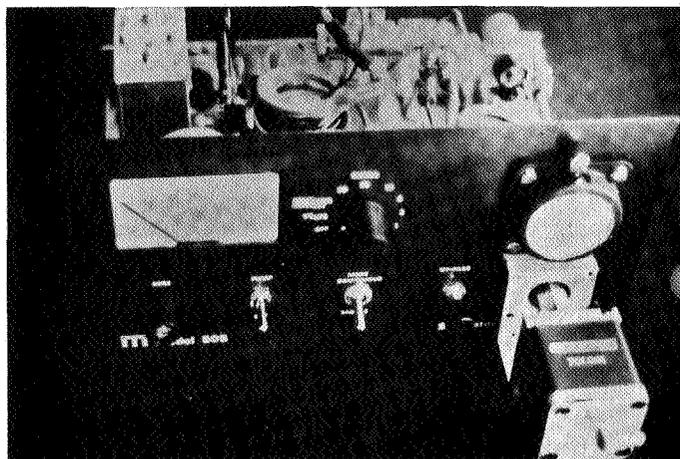
Combustion pollutants under investigation included nitrogen dioxide and respirable suspended particles (RSP). Nitrogen dioxide concentrations were found to vary between 10 and 110 ppb compared with ASHRAE standards of 50 ppb. It was interesting to note that all concentrations in excess of the ASHRAE standard could be associated with the use of

kerosene heaters. The particulate survey revealed RSP concentrations between 12 and $144 \mu\text{g}/\text{m}^3$. High concentrations tended to correlate with tobacco smoking and to the use of wood stoves.

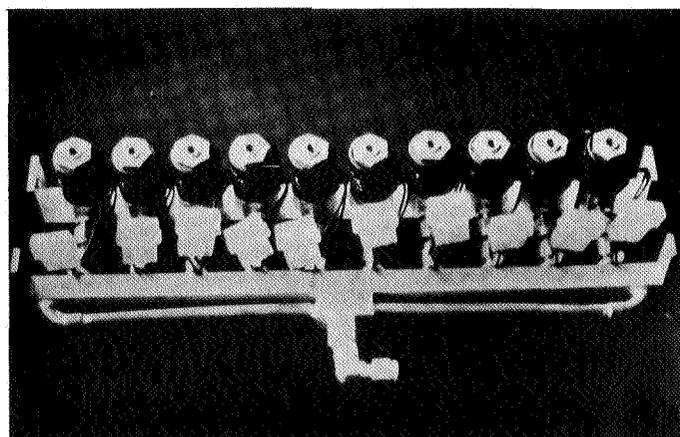
The theme of radon control in dwellings was continued in the third presentation given by Brian Krafthefer from Honeywell Inc, Minneapolis, USA. This study concentrated on the real time measurement of radon decay products and on the use of electronic air cleaners as a method of control. Both modern and older homes were studied and average air infiltration rates for each category were determined using the tracer gas method. Air change rates typically averaged between 0.8 and 1.0 ach in the older homes and were somewhat lower in the more modern houses. In the less-tight dwellings, low levels of radon decay products tended to be measured whereas, in the more modern buildings, large excursions in radon concentrations were typical. The operation of electrostatic air cleaners located in the furnace ductwork of the high radon houses resulted in a dramatic drop in decay products with concentrations being reduced by as much as 60-70%.

The final presentation was given by Andy Persily of the National Bureau of Standards in Washington DC, USA. His contribution focussed on the measurement of air exchange rates in large, occupied, mechanically ventilated office buildings. The results of measurements made in a total of nine modern buildings ranging in floor area between 2000

The tracer gas instrumentation used by NBS to measure air infiltration rates in office buildings.



1. SF_6 detector using an electron capture gas chromatograph and rotary valve actuator.



2. The 10-port manifold used for zone sampling.

and 64,000 m² were reported. The locations of the offices were as diverse as Anchorage in Alaska, Newark in New Jersey and Columbia in South Carolina. In each case the measurement strategy was the same – sulphur hexafluoride was injected every few hours in up to six locations and sampling using an electron capture detector took place at regular intervals during the intervening period. The corresponding decay rate in each zone indicates the total

fresh air change rate due to both the HVAC and the infiltration components. In each case the rates measured were compared with the recommended fresh air supply necessary to minimise the effects of pollution (especially due to smoking). Very often local variations in air change rates resulted in some parts of the buildings investigated being insufficiently ventilated even though average rates appeared to satisfy air quality needs.

CITATION TO
Martin W. Liddament
Building Services Research and Information Association
by the
AMERICAN SOCIETY OF
HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC.

in recognition of authoring "The Air Infiltration
Center's Program of Model Validation," a symposium
paper presented at a 1983 Society meeting, published
in ASHRAE Transactions, and selected for a

ASHRAE Symposium Paper Award of 1983
June 18, 1984




 Secretary


 President

ASHRAE Award for AIC Scientist

At the recent ASHRAE Annual Meeting in Kansas, Martin Liddament, the senior scientist at the AIC, was presented with an ASHRAE Symposium Paper 1983 Award. This Award was given for Martin's paper 'The Air Infiltration Centre's Programme of Model Validation' presented at a symposium during last summer's ASHRAE Meeting. Congratulations Martin! It is surely well deserved recognition for a valuable contribution to the progress of air infiltration research.

5th AIC Conference – Final Announcement

'The implementation and effectiveness of air infiltration standards in buildings'
1 – 4 October 1984 at Harrah's Hotel, Reno, Nevada, USA.

Arrangements for the Air Infiltration Centre's 5th annual conference are well advanced and it promises to be an important event. As previously announced, a total of 26 papers will be presented by authors from ten countries. The emphasis will be both the effectiveness of air infiltration/airtightness standards as a means of achieving energy conservation, and the importance of satisfying indoor air quality requirements. The keynote address will be given by John Millhone, Director of the Office of Building Energy Research and Development at the Department of Energy, Washington.

Subject to availability of accommodation, conference bookings (participating countries only) will continue to be accepted up to 10th September. The registration fee is \$365 (£255 sterling) inclusive of three nights accommodation, all lunches and the conference dinner.

More details and a registration form may be obtained from Jenny Elmer at the Air Infiltration Centre; from Max Sherman, Energy and Environment Division, Building 90, Room 3074, Lawrence Berkeley Laboratory, Berkeley, CA 94720, USA, or from your Steering Group Representative.

Air Infiltration Centre



The participating countries of the AIC welcome you to the

5th AIC Conference

The implementation and effectiveness of air infiltration standards in buildings

1–4 October 1984
Harrah's Hotel, Reno, Nevada, USA

Considerable energy savings in buildings are possible by reducing fresh air exchange rates. Consequently, airtightness regulations have been incorporated in the building codes of a number of countries. In other countries, the implementation of such measures is currently under consideration. However, before such standards are universally introduced, it is necessary to assess the full implications of airtightness measures, particularly in relation to indoor air quality.

The purpose of this conference is to focus attention on the implementation and effectiveness of airtightness standards as a method of conserving energy. The means to achieve these standards and the opportunities for heat recovery and air quality controlled ventilation strategies will also be assessed.

Design Approaches in Air Infiltration

Martin Liddament describes the Air Infiltration Centre's plans for the production of a design guide.

Tracer gas techniques are widely used to determine the rate of air infiltration in buildings. However, these methods suffer from a number of drawbacks. In particular, many discrete measurements over an extended period of time are necessary to determine the long-term weather-dependent infiltration behaviour of a building. Furthermore the technique is of little value as a design tool since it can only be used to assess the performance of existing structures. It is for this latter reason that mathematical models have such an important role to play in assessing the performance of energy efficient ventilation strategies. By combining the design leakage characteristics of a building with local weather and terrain data, a mathematical model provides an alternative route to the estimation of air infiltration rates (see Figure 1).

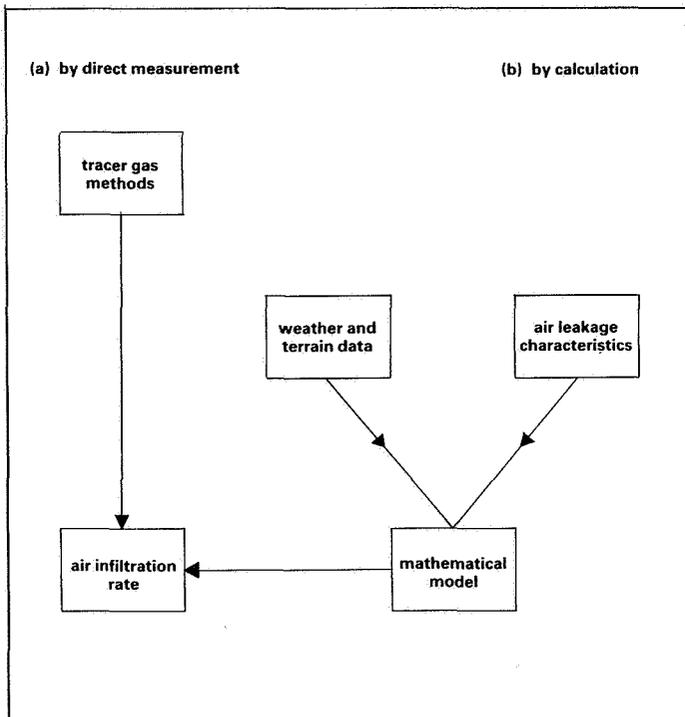


Figure 1. Determining air infiltration.

The reliability of models has hitherto been uncertain and the conditions for which they are applicable have not been clearly defined. Much of the early technical programme of the Air Infiltration Centre concentrated on these problems with the result that a clearer understanding of the performance of models has been obtained.¹ The Centre is now further developing this work and producing a handbook of design calculations and applications.

The objectives of this guide are to:

- provide technical guidance for calculating optimum levels of building airtightness, taking into account climate, ventilation strategy and ventilation needs.
- assess the corresponding energy implications on air change rates and building heat loss.
- provide information on the influence on air change rates and building heat loss of window opening, the introduction of purpose provided openings, furnace stacks, chimneys, etc., mechanical ventilation.
- provide sample air flow patterns for alternative ventilation strategies and building designs.

Calculations and design information are being based on the results of appropriate air infiltration models and, wherever possible, the information provided is also being verified using additional experimental data.

The outcome of this handbook is to provide designers with ready-to-use information to enable:

- cost benefit studies of various ventilation strategies to be performed.
- optimum retrofit approaches for existing buildings to be determined.
- distribution of air flow in buildings to be assessed.
- the interaction of weather conditions, adventitious openings and purpose provided ventilation on air change rates, internal air movement and building heat loss to be calculated.

It is also intended to indicate the algorithms appropriate to particular types of application and specify the minimum input data requirements for each. An analysis of representative building types and climatic data for each of the participating countries is to be included. The distribution of air infiltration rate throughout the heating season will be determined for each condition, taking into account fixed levels in both building leakage and local shielding. The influence of purpose provided ventilation options will be superimposed on these results.

This handbook is being produced in two sections. Part 1 is being devoted to algorithms and applications with an emphasis on the availability of appropriate models and on the application for which each is suitable. Worked examples and, wherever possible, the results of actual studies are being included. Part 2 will contain basic data including statistical climatic data for key locations, wind pressure data and air leakage data.

The appropriate input (design data) and range of predictions being included in this investigation are listed in Figure 2. By selection of the appropriate model, or models, it is hoped that this guide will act as an aide to decision-making. Most importantly, it is envisaged that users will be able to optimise building parameters and ventilation approaches in order to achieve cost effective ventilation.

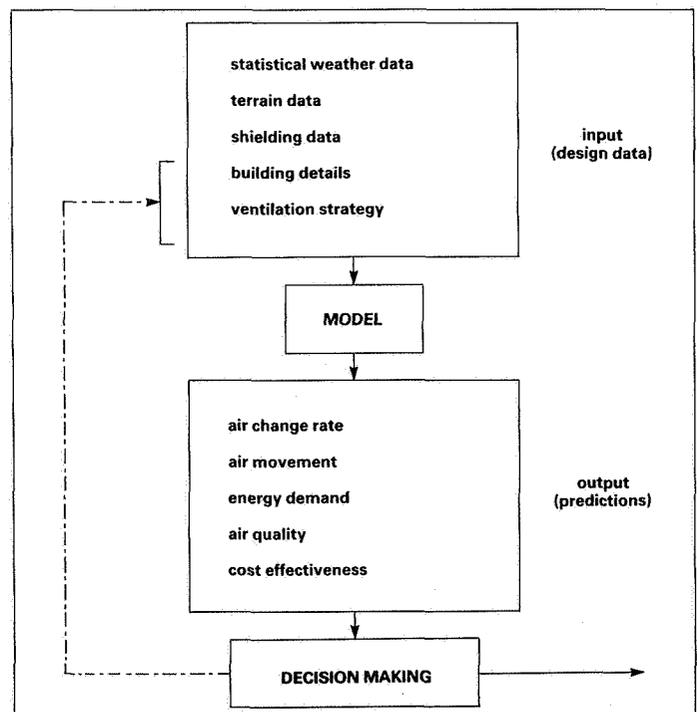


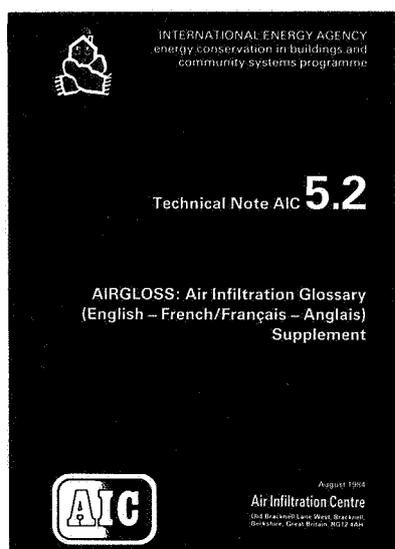
Figure 2. Mathematical models for decision-making.

Current emphasis is being placed on preparing the basic data and/or assessing the availability of individual models. Following the completion of this task, examples of applications will be prepared. It is intended that the results of this work should be published by May 1986.

References

1. Liddament, M. and Allen, C.
The validation and comparison of mathematical models of air infiltration. The Air Infiltration Centre, UK, AIC-TN-11-83, 114pp, September 1983.

New Publication from the AIC



AIC-TN-5.2-84 AIRGLOSS (English/French – Français/Anglais) Supplement

This document is intended as a supplement to AIRGLOSS (AIC-TN-5-81). It contains translations of all the terms which appeared in AIRGLOSS together with some useful additional terms of a more general nature. The definitions themselves have not been translated.

This supplement is available free-of-charge to organisations in participating countries* and at a cost of £7.50 sterling (including post and packing) to non-participating countries).

Book Review

This Swedish report describes the results of studies in 1981 of the control of the ventilation system in the energy-efficient EKONO office building in Finland. Three systems were studied:

1. Constant rate of fresh air supply (equivalent to 4.5 l/s per person).
2. Fresh air supply regulated to maintain constant CO₂ concentration in the main return air duct.
3. Timer control of fresh air supply damper.

Measurements were made to determine the variation of CO₂ concentration in the return air and to study other effects including the special variation of CO₂ concentration within an office, and in different offices the variation of other pollutant concentrations and the energy saving potential. The results of a subjective survey are also presented.

For the CO₂ concentration control system, the report concludes that:

- although there are variations in local concentrations of CO₂, no dangerous levels have been discovered.
- as a fixed CO₂ level is maintained, the level of other pollutants is also regulated.
- office employees have noticed no significant difference in air quality under normal circumstances and during CO₂ controlled air flow.
- as a result of energy saving, the equipment would pay for itself within a year.

The overall conclusion is that the method works satisfactorily and is especially useful for buildings with fluctuating populations during the working day.

| | |
|---|----------------|
| Document | D7:1983 |
| A CO₂-controlled ventilation system | |
| Pilot Study | |
| David Södergren Antero Punttila | |
| Swedish Council for Building Research | |

Copies of this report (No. D7:1983, ISBN No. 91-540-3911-8) may be obtained from Svensk Byggtjänst, Box 7853, S-103 99, Stockholm, Sweden. Approximate price: SEK 25.

AIC Publications List

PERIODICALS

Air Infiltration Review

Quarterly newsletter containing topical and informative articles on air infiltration research and application. Also gives details of forthcoming conferences, recent acquisitions to AIRBASE and new AIC publications.

Unrestricted availability, free-of-charge.

Recent Additions to AIRBASE

Bi-monthly bulletin of abstracts added to AIRBASE, AIC's bibliographic database. Provides an effective means of keeping up-to-date with published material on air infiltration and associated subjects. Copies of papers abstracted in 'Recent Additions to AIRBASE' can be obtained from AIC library.

Bulletin and copies of papers available free-of-charge to participating countries only.*

TECHNICAL NOTES

AIC-TN-1-80 – Manning, S.

'The distribution of air leakage in a dwelling – a brief review', 4pps. Contains a review of 15 papers describing measurements of the distribution of air leakage in a dwelling. The results of leakage measurements made in 81 buildings are summarized.

Available free-of-charge to participating countries only.*

AIC-TN-2-80 – Superseded by AIC-TN-7-81.

AIC-TN-3-81 – Superseded by AIC-TN-8-82.

AIC-TN-4-81 – Superseded by AIC-TN-10-83.

AIC-TN-5-81 – Allen, C.

'AIRGLOSS: Air infiltration glossary (English edition), 124pps.

Contains approximately 750 terms and their definitions. They are related to air infiltration, its description, detection, measurement, modelling and prevention as well as to the environment and relevant physical processes. Translations of the glossary from English into languages of participating countries will appear in due course.

Available free-of-charge to participating countries. Price: £10 to non-participating countries.*

AIC-TN-5.1-83 – Allen, C.

'AIRGLOSS: Air Infiltration Glossary (English-German/Deutsch-Englisch) Supplement' 58pps.

A supplement containing translations of the terms published in AIRGLOSS.

Available free of charge to participating countries. Price £7.50 to non-participating countries.*

AIC-TN-5.2-84 – Allen, C.

'AIRGLOSS: Air Infiltration Glossary (English – French/Français – Anglais) Supplement'

A supplement containing translations of the terms published in AIRGLOSS.

Available free-of-charge to participating countries. Price £7.50 to non-participating countries.*

AIC-TN-6-81 – Allen, C.

'Reporting format for the measurement of air infiltration in buildings', 56pps.

Produced to provide a common method for research workers to set out experimental data, so assisting abstraction for subsequent analysis or mathematical model development. May be used directly for entering results and as a useful checklist for those initiating projects. Example of use of format is included as an appendix.

Available free-of-charge to participating countries. Price: £6 to non-participants.*

AIC-TN-7-81 – Superseded by AIC-TN-12-83.

AIC-TN-8-82 – Superseded by AIC-TN-15-84.

AIC-TN-9-82 – Superseded by AIC-TN-11-83.

AIC-TN-10-83 – Liddament, M., Thompson, C.

'Techniques and instrumentation for the measurement of air infiltration in buildings – a brief review and annotated bibliography', 60pps.

Four-section bibliography contains review papers, information on tracer gas techniques, pressurization methods and miscellaneous approaches. In addition the report contains list of manufacturers of instrumentation currently being used in air infiltration investigations.

Available free-of-charge to participating countries only.*

AIC-TN-11-83 – Liddament, M., Allen, C.

'The validation and comparison of mathematical models of air infiltration', 124pps.

Contains analysis of ten models developed in five participating countries. These range in complexity from 'single-cell' to 'multi-cell' approaches. Also contains numerical and climatic data for fourteen dwellings compiled to produce three key datasets which were used in model validation study.

Available free-of-charge to participating countries only.*

AIC-TN-12-83 – Liddament, M.

'1983 Survey of current research into air infiltration and related air quality problems in buildings'

3rd worldwide survey by AIC, containing over 170 replies from 22 countries. Produced in two sections: an analysis in tabular form of survey results, followed by reproduction in full of research summaries, and appendix containing names and addresses of principal researchers.

Available free-of-charge to participating countries only.*

AIC-TN-13-84 – Allen, C.

'Wind Pressure Data Requirements for Air Infiltration Calculations'

An up-to-date review of the problems associated with satisfying the wind pressure data requirements of air infiltration models.

Available free-of-charge to participating countries only.*

AIC-TN-14-84 – Thompson, C.

'A Review of Building Airtightness and Ventilation Standards', 74pps

Lists and summarises airtightness and related standards to achieve energy efficient ventilation.

Available free-of-charge to participating countries only.*

AIC-TN-15-84 – Thompson, C.

'A subject analysis of the AIC's bibliographic database – AIRBASE.' 3rd Edition, 104 pps.

Comprehensive register of published information on air infiltration and associated subjects. The articles are indexed by subject and full bibliographic details of the 1276 papers are given. A list of principal authors is also included.

Available free-of-charge to participating countries only.*

LITERATURE LISTS – Listing of abstracts in AIRBASE on particular topics related to air infiltration.

- No. 1 Pressurization – Infiltration Correlation: 1. Models (17 references).
- No. 2 Pressurization – Infiltration Correlation: 2. Measurements (26 references).
- No. 3 Weatherstripping windows and doors (24 references).
- No. 4 Caulks and sealants (24 references).
- No. 5 Domestic air-to-air heat exchangers (25 references).
- No. 6 Air infiltration in industrial buildings (14 references).
- No. 7 Air flow through building entrances (22 references).
- No. 8 Air infiltration in commercial buildings (28 references).
- No. 9 Air infiltration in public buildings (10 references).
- No. 10 CO₂ controlled ventilation (13 references).
- No. 11 Occupancy effects on air infiltration (15 references).

CONFERENCE PROCEEDINGS

- No. 1 'Instrumentation and measuring techniques'. 1st AIC Conference, 6–8 October, Windsor, Berkshire, UK, 372pps, £35.00 sterling.
- No. 2 'Building design for minimum air infiltration'. 2nd AIC Conference, 21–23 September 1981, Stockholm, Sweden, 216pps, £15.00 sterling.
- No. 3 'Energy efficient domestic ventilation systems for achieving acceptable indoor air quality'. 3rd AIC Conference, 20–23 September 1982, London, UK, 432pps.
Supplement to 3rd AIC Conference Proceedings (contains five additional papers, one amended paper, discussion), 160pps. Total cost £23.50 sterling.
- No. 4 'Air infiltration reduction in existing buildings'. 4th AIC Conference, 26–28 September 1983, Elm, Switzerland, 342pps.
Supplement to 4th AIC Conference Proceedings (contains one additional paper plus discussion) 52pps. Total cost £16.00 sterling.

HANDBOOK – Elmroth, A., Levin, P.

'Air infiltration control in housing. A guide to international practice', 410pps.

An international guide to airtightness design solutions of great practical value to all those concerned with the design of pollution-free dwellings with low energy demands.

**The participating countries are: Belgium, Canada, Denmark, Finland, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom and the United States of America.*

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Organisation

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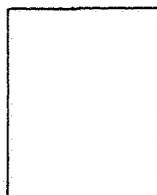
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Forthcoming Conferences

1. 5th AIC Conference
The implementation and effectiveness of air infiltration standards in buildings
Reno, Nevada, USA
1 - 4 October 1984

Further information from:

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Air Infiltration Centre
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2. Swiss National Conference on Energy Conservation in Buildings
ETH-Zentrum, Zurich, Switzerland
4 - 5 October 1984

Topics cover:

- the building envelope
- HVAC systems
- design tools
- monitored buildings

Further information from:

S.R. Hastings
EMPA
Überlandstrasse 129
CH-8600 Dübendorf
Switzerland

3. International Conference on the Indoor Environment of Buildings
Singapore
24 - 26 January 1985

Further information from:

Hon. Secretary
International Conference on the Indoor Environment of Buildings
c/o Secretariat
Applied Research Corporation
303 Tanglin Road
Singapore 1024
Republic of Singapore

4. International Symposium on Moisture and Humidity
Washington DC, USA
15 - 19 April 1985

Further information from:

Charles J. Glazer
Instrument Society of America
67 Alexander Drive
Research Triangle Park
NC 27709
USA

5. Symposium on Multi-cell Infiltration
ASHRAE Conference, Honolulu, Hawaii
June 1985

Papers dealing with numerical models, development of measurement equipment and/or measurement data are requested.

Further information from:

Helmut Feustel
Building 90, Room 3074
Lawrence Berkeley Laboratory
Berkeley
California 94720
USA
Telex: 910 366 2037

6. International Ventilation '85
1st International Symposium on Ventilation for Contaminant Control
Toronto, Canada
1 - 3 October 1985

Please address all enquires for further information on the symposium and for the submission of abstracts to the symposium Chairman:

Dr H.D. Goodfellow
International Ventilation '85
c/o Hatch Associates Ltd
21 St Clair Avenue East
Toronto
Ontario
M4T 1L9
Canada
Tel: (416) 962 6350

7. CLIMA 2000 - Copenhagen '85
World Congress on Heating, Ventilating and Air Conditioning
Bella Center, Copenhagen, Denmark
25 - 30 August 1985

For further information on congress registration and booking of rooms:

DIS Congress Service, Copenhagen
Linde Alle 48
DK 2720 Vanløse
Denmark
Tel: 01 71 22 44
Telex: 15476 DISDK
Cable address: DISCONGRESS

CLIMA EX - Copenhagen '85
International Exhibition on Heating, Ventilating and Air Conditioning
Bella Center, Copenhagen, Denmark
26 - 29 August 1985

For further information on the exhibition and congress secretariat:

VVS Congress - VVS Messe ApS
Ordrup Jagtvej 42 B
DK 2920 Charlottenlund
Denmark
Tel: 01 63 32 30
Telex: 16600

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