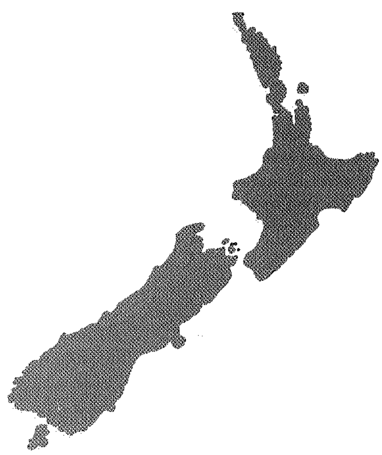
Air Infiltration Review

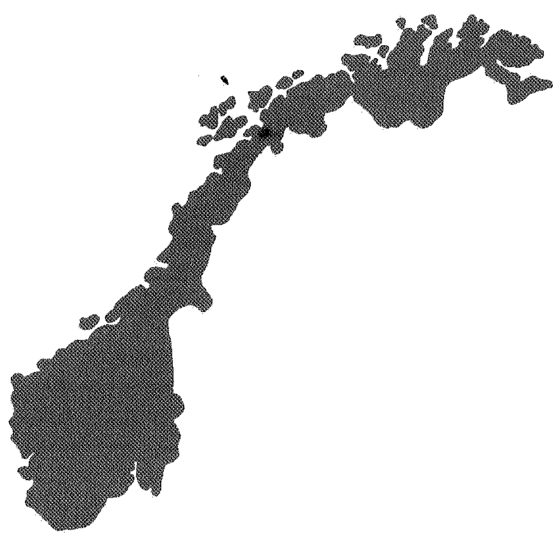
a quarterly newsletter from the IEA Air Infiltration Centre

Vol. 3 No. 3 May 1982

Welcome !

New Zealand and Norway





We are delighted to welcome New Zealand and Norway as additional participating countries from June 1982. These countries, located in opposite hemispheres, are quite similar in size and population but have considerable differences in climate. Both are actively engaged in air infiltration research and there will be positive advantages to them and to the other participants arising from their decisions to share in the support of AIC. We look forward to a long and happy association with them, realising that the supply and exchange of information will help to promote an acceleration in the understanding of the complex air infiltration processes and in the application of infiltration-related energy conserving measures in buildings.

The accompanying article describes the work underway in Norway and we expect to include details of New Zealand's research programme in the August issue of AIR.

Current Work on Air Infiltration in Norway

Trond Ramstad, Research Officer,
The Norwegian Building Research Institute

Research on air infiltration in buildings is mainly carried out at two institutions; The Norwegian Building Research Institute (NBI) in Oslo and The Norwegian Institute of Technology (NTH) at the University of Trondheim. The building industry sponsors research work at these institutes, but does not carry out research projects of any significant size itself. Current work on air infiltration in Norway can be divided into the following five categories:

- Infiltration measurements (field and laboratory)
- Theoretical calculations of ventilation, including air infiltration
- Improved building details
- Experimental building
- Information, mainly to architects and contractors

Infiltration Measurements

The pressurization method, using 50 Pa pressure difference, is now well established and has become a Norwegian Standard (NS 8200). From 1981 the national building code also includes quantified performance requirements on air tightness of buildings. The requirements are based on the pressurization method and the following maximum leakage rates at 50 Pa are specified:

One- and two-family houses	4.0 air changes per hour
Other buildings, max. 2 storeys	3.0 air changes per hour
Buildings more than 2 storeys	1.5 air changes per hour

Standard pressurization tests are now performed in increasing numbers by private companies instead of by research institutes.

Some initial work has been made to develop a standard method for utilizing the building's ordinary ventilation system in air tightness measurements. However, it is considered that larger projects in this field in other countries (e.g. Finland) will produce most of the necessary results.

Tracer gas measurements will now be used more extensively in research at both institutes. This year work is concentrated on a study where calculated ventilation rates are compared with tracer gas and pressurization measurements in a few special selected houses, including some low-energy experimental houses, and on projects dealing with ventilation efficiency in industrial buildings. The decay method of determining ventilation rates will be used, with SF_6 tracer gas.

The air tightness of building components are in Norway tested at the laboratory of NBI's Trondheim Division. Tests on windows, external doors, prefabricated curtain walls, wind barrier products, weather strips and sealants are mainly carried out as contract work for manufacturers. But the institute also include in their work programme research on general building details such as the performance of overlapping joints in vapour and wind barriers, joint geometry and the long-time performance of various sealing techniques.

Theoretical calculations

A project at NBI dealing with rather extensive calculations of the total ventilation rates in low-rise houses was started last year and will hopefully be finally reported this year. The calculations are performed with the computer programme ENCORE where the ventilation based on mass balance is determined hour by hour throughout the heating season. A number of parameters are varied, such as geographical place (meteorological data), house form (number of storeys), ventilation system (natural and mechanical), leakage factor and the position of air leaks in the building envelope. Figures 1 and 2 show examples of calculation results.

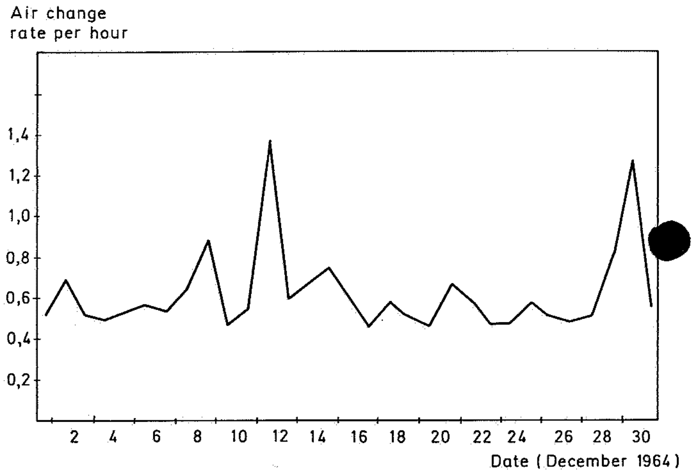


Figure 1

Example of calculation results from the ENCORE computer programme. The diagram shows the daily average ventilation rate in a 100 m^2 one-storey house over a specific (windy) month. The house is located in Trondheim, has a leakage rate of 4.0 air changes per hour at 50 Pa and a natural ventilation system with standard outlet ducts and closed inlet dampers. Leakages are assumed to be positioned only at floor and ceiling level. The hourly variations in computed ventilation rates is of course even larger.

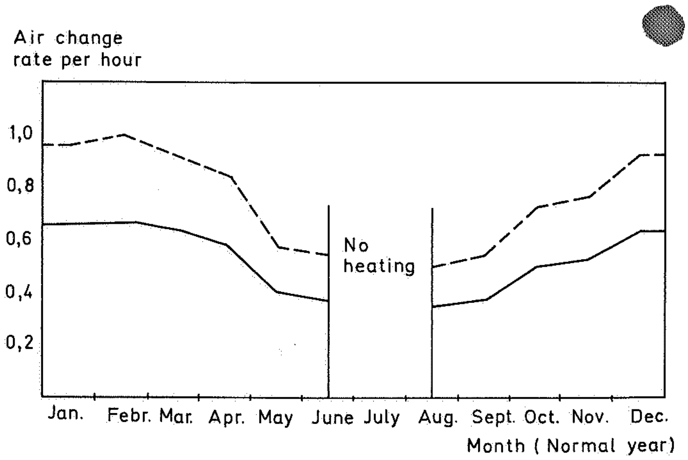


Figure 2

Example of calculated monthly average ventilation rates in 100 m^2 houses located in Tromsö. The dotted line represents a 3-storey house and the continuous line a one-storey house with the same volume. Ventilation system and air tightness are as indicated in Figure 1. The diagram shows clearly how the natural ventilation is at maximum during the coldest winter months, when a reduced ventilation may actually be wanted at this time.

The accuracy of the calculations seems very promising, but a more extensive documentation where the results are compared directly with detailed ventilation and infiltration measurements is still to be done. However, these calculations will hopefully be the necessary tool for a number of purposes, such as appraising future code requirements on air infiltration and energy consumption, determining the efficiency of various ventilation systems relatively to building type and quality, evaluating the efficiency of air-to-air heat exchangers and alternative's for retrofitting existing buildings etc.

Improved Building Details

One of NBIs most important activities is to study the performance of building details in order to present recommendations on good building practice. An earlier study of the air tightness of Norwegian timber-frame houses showed clearly that good workmanship and labourers with a sense of responsibility are necessary if acceptable results are to be achieved by using traditional building methods (see AIC Translation No. 7).

A number of new building techniques and details are now being tried out with the aim of finding methods for reducing air infiltration that are simple to perform and consequently are not too dependent on skilled labour. In addition the new methods must of course also be economically acceptable. Application of PUR polyurethane foam in joints, stronger vapour barrier materials, continuous vapour and wind barrier installations all around the house, air barriers of sheet-type materials are typical current projects. A particularly promising method is hot air welding of polyethylene film on the building site. Successful welding is now achieved with standard equipment originally designed for jointing PVC flooring. With a speed of approximately 3 m per minute, independant of weather conditons, this technique may be the solution to a better and cheaper way to install vapour barriers. The advantages are primarily the elimination of the need for clamped overlapping joints (joints can be made anywhere) and easy repair of accidental holes in the plastic film.

Experimental Building

The overall activity on full-scale experimental building has so far been rather small in Norway. However, the so-called Heimdal project which is run by the division of architecture and building construction at NTH in Trondheim has caught special attention. It consists of 14 low-energy one-family detached houses which were completed last year and are now being monitored for energy consumption, ventilation etc. The houses were built on a fairly low budget, they have above standard thermal insulation and airtightness and the exterior envelope is expected to perform extremely well in relation to the cost of construction. The average recorded infiltration rate for the houses is 0.9 air changes per hour at 50 Pa, ranging from 0.6 – 1.5 air changes per hour. This performance is obtained mainly by the application of simple building details, easy to carry out in practice on site, but consisting of ordinary materials and installation methods. One example is shown in Figure 3.

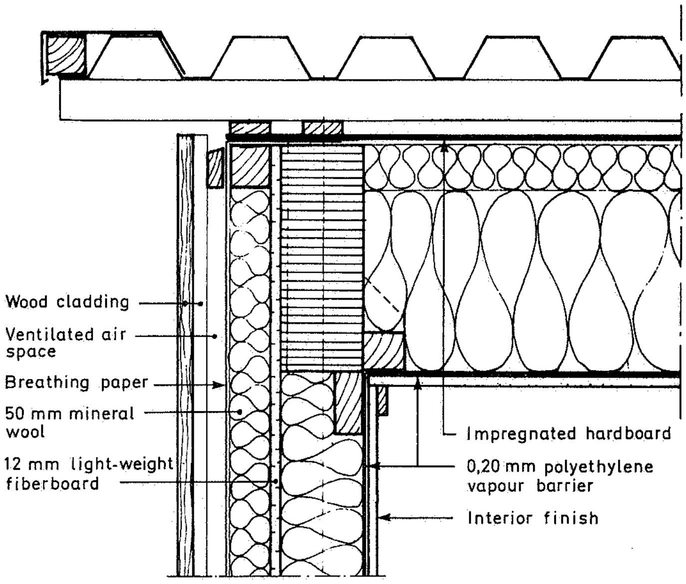


Figure 3

Typical detail from the experimental houses in the Heimdal project, Trondheim, showing a section of the connection between gable wall and roof with a sloping ceiling. The hardboard sheets in the roof runs continuously from the eaves to the ridge and serve both as wind barrier and sheathing. Both the exterior and the interior air barriers overlap between wall and roof continuously at all sides of the houses.

Information

NBI gives high priority to information in the form of recommendations on good building practice, in addition to the ordinary reports from research projects. The main channel of direct information to architects and other planners and to contractors and building firms is a series of data sheets on building details. The series consists of loose sheets, at the moment approximately 270 compiled in 4 covers. New sheets and revisions are sent to over 10,000 subscribers twice a year. Although the data sheets are formally NBIs recommendations on good practice only, the sheets are used very much as an addition to the building code which is entirely based on pure performance requirements. Hence the series is widely used by almost the entire building industry and serves as an efficient way for relatively fast information of the practical consequences of research results.

This year NBI is also working on a special handbook on air infiltration control. The aim is to produce a typical book of reference showing alternatives on how to make all the most typical joints in Norwegian building practice airtight, but otherwise leaving out most of the background information related to air infiltration and energy loss. May be this guide can be available as an addendum to the AIC guide to international practice later on!

New ! Updated AIRBASE Subject Analysis

(see page 5 for details)

3rd AIC Conference

'Energy efficient domestic ventilation systems for achieving acceptable indoor air quality'

20th – 23rd September 1982
at Park Court Hotel, London, UK

With the introduction of low-leakage building design and the upgrading of the thermal performance and airtightness of existing buildings, it is becoming increasingly important to design and install purpose provided ventilation systems. These are necessary to ensure good indoor air quality and air distribution whilst at the same time minimising energy consumption due to ventilation losses.

The International Conference will provide a forum for researchers, designers and housing managers to discuss progress in the design and application of energy efficient domestic ventilation systems. The scope of the conference includes developments in the areas of both controlled natural and mechanical ventilation systems. Particular interest will be focussed on practical experience of the effective use of alternative systems. A total of 27 papers will be presented by authors from 8 countries.

The Park Court Hotel provides first class accommodation and conference facilities. It is pleasantly situated overlooking Kensington Gardens near Hyde Park, easily accessible by public transport and close to the West End – famous for its shops and entertainment.

Registration Fees

Delegate fee per person (if received by 26th July 1982 – £175.00 inclusive of VAT.

Delegate fee per person (if received after 26th July and up to 23rd August 1982) – £200.00 inclusive of VAT.

Booking will only be accepted on receipt of registration fee.

The registration fee includes overnight accommodation on nights of 20th–22nd September, 1982 – inclusive English breakfast, lunch and dinner within conference period – full conference facilities – printed papers.

Further details and booking forms are available from your Steering Group representative.

CIB Conference in Dublin

Natural ventilation and air infiltration

– a special technical session at the CIB W-67 3rd International Symposium 'Energy conservation in the built environment'

An international symposium on energy conservation in the built environment was held in Dublin between 30th March and 1st April 1982. It was divided into five main sessions and two special technical sessions, running parallel to the main ones. Dr. S. Leach of the Building Research Establishment, UK, and joint co-ordinator of the CIB W-67 committee, explained that these technical sessions had been introduced 'with some trepidation' and were primarily intended only for experts in the field. In the event, the technical session on natural ventilation and air infiltration proved to be very popular, with approximately 50 conference participants attending.

The first contribution to this session was by Max Sherman from the Lawrence Berkeley Laboratory in the USA. He reported on the results of a comparison exercise between residential building infiltration predictions using a computer model developed at LBL and direct measurements. Good comparisons between observation and prediction were obtained for a number of buildings. Max said that the critical parameters for accurate prediction were found to be the leakage area of the building and the degree to which the structure is shielded from wind.

The second paper, entitled 'Airtightness vs air infiltration for Swedish homes – measurements and modelling', was presented by Åke Blomsterberg from the National Testing Institute in Sweden. By incorporating data from 45 Swedish dwellings into a mathematical model, he showed that air infiltration in these dwellings was insufficient to meet a recommended minimum ventilation rate of 0.5 air changes per hour (ach). Air infiltration rates average 0.23 ± 0.08 ach for houses built between 1965–1975 and 0.16 ± 0.10 for houses built after 1975. He therefore concluded that, in such houses, it was necessary to augment natural ventilation by mechanical means. The potential for heat recovery in well-sealed housing was also discussed.

The theme of mathematical modelling continued with a presentation by Peter Warren from the Building Research Establishment in the UK, who described a simple method for predicting infiltration rates in housing. An infiltration equation was proposed for use in the prediction of air change rate of houses over a range of meteorological conditions. Initial comparisons with the results of field measurements, made in a range of typical modern UK dwellings, have proved to be encouraging.

Jorma Railio from the Technical Research Centre of Finland presented a paper entitled 'Air infiltration problems in ventilation systems'. In this paper, the latest results of air infiltration research in Finland were described. This research included development of a calculation model for predicting the relationship between airtightness and air change rate, development of air infiltration measurement methods, study of construction techniques and consideration of controlled ventilation systems.

The next contribution was by Andrew Howarth from the University of Manchester Institute of Science and Technology in the UK. His presentation was on the development and use of a multiple tracer gas technique for measuring air flows in houses. Three different tracer gases were released into three distinct zones within the building envelope. By measuring the decay in concentration of each of the gases over a two to three hour period, it is possible to determine the ventilation rate in each zone and the movement of air between zones. Investigations are currently taking place into weather dependence of air flows, condensation prediction for roof spaces, heat loss due to the oversizing of first floor radiators and heat loss due to air flowing through first floor ceilings.

This paper was followed by a presentation by Mats Sandberg from the National Swedish Institute for Building Research entitled 'Ventilation and temperature efficiencies of mechanical ventilation systems'. Ventilation efficiency is a measure of the performance of providing air in an occupied zone and is also an indicator of air quality. The measurement of both ventilation and temperature efficiency of mechanical supply and exhaust systems was decribed. It was found that these efficiencies were very sensitive to the positioning of the supply and exhaust registers, the ventilation flow rate and the relative difference between supply air temperature and room air temperature.

The final presentation was by Mr I. Samuelson of the Swedish National Testing Institute. He described the results of measurements of radon concentration in 12,000 Swedish homes. The 1979 Swedish regulations stipulate a maximum radiation concentration in dwellings of 400 Bq/m^3 in existing houses and 70 Bq/m^3 in new dwellings. In almost 15% of the dwellings investigated, the radon daughter concentrations were in excess of 400 Bq/m^3. The relationship between radon concentration and ventilation rate was interesting. If radon contamination was due to emission from the building fabric, increased rates of ventilation would reduce the radon concentration. On the other hand, if contamination was due to radon in the underlying strata, then a mechanical exhaust ventilation system could cause an increase in radon concentration by creating a radon flux across the basement of the building.

The papers presented in this session will be published in Volume VI of the conference proceedings. Publication details are available from:

Miss F. Curran
Symposium Secretariat
3rd International CIB W-67 Symposium
An Foras Forbartha
St. Martin's House
Waterloo Road
Dublin 4 — Telephone: 01-764211
Republic of Ireland — Telex: 30846

AIC-TN-8-82 A subject analysis of the AIC's bibliographic database – *AIRBASE*

Since the first subject analysis of *AIRBASE* was produced in 1981, the database has grown from 621 to 875 abstracts, at the rate of 20 articles per month. This technical note gives an updated subject analysis of *AIRBASE* with its increased content. The report is divided into two parts: Section 1 consists of 13 tables each with a major subject heading and sub-headings under which the reference number order, of all 875 papers. The report can thus be used as a subject index by looking up a reference number under a relevant heading in Section 1 and turning to Section 2 for full bibliographic details of the paper. In addition, an index of principal authors of papers listed in *AIRBASE* is appended to the report.

This publication is thus a comprehensive register of published information on air infiltration and associated subjects and will be a valuable reference document for all those concerned with this field of knowledge and application.

This technical note is available free-of-charge, direct from the AIC, to organisations in participating countries only.

Forthcoming Conferences

1. XII Nordic Heating and Ventilation Congress and Trade Fair
Bella Centre, Copenhagen, Denmark.
June 2–4, 1982

2. ASHRAE Annual Meeting
Royal York Hotel, Toronto, Ontario, Canada.
June 27–July 1, 1982

3. CIB/CIE Environmental Workshop on 'The effects of interpersonal differences on design criteria'
Chester, Gt. Britain
September 15–17, 1982

Further information from:

Mrs J. Hughes
Electricity Council Research Centre
Capenhurst
Chester
CH1 6ES
Great Britain

4. Second International Congress on Building Energy Management
Ames, Iowa, USA
May 31–June 3, 1983

Further information from:

Office of the Secretariat
c/o Prof. James E. Woods
Iowa State University
102 Scheman Building
Ames
Iowa 50011
USA

5. ASHRAE Professional Development Series 'Air systems design and retrofit for energy cost effectiveness'

a) New York Statler, New York, NY, USA
May 12–13, 1982

b) Sheraton O'Hare, Chicago, IL, USA
May 19–20, 1982

c) Golden Gateway Holiday Inn, San Francisco, CA, USA
May 26–27, 1982

Recent Acquisitions

The following papers have recently been acquired by the Air Infiltration Centre's library:

1. Shurcliff, W.A.
Air-to-air heat exchangers for houses.
Cambridge, MA, USA. November 1981. 190p

Describes more than 35 kinds of small, inexpensive exchangers from various countries.

2. Dumont, R.S., Orr, H.W., Figley, D.A.
Airtightness measurements of detached houses in the Saskatoon area.
Building Research Note No. 178, Division of Building Research, NRCC. November 1981. 18p

Measures the airtightness levels of a group of houses in Saskatoon, Canada, using a pressure test procedure.

*3. Murmann, H.
Domestic ventilation with the emphasis on heat recovery.
(Luftung im wohnungsbau unter besonderer beruck-sichtigung von warmeruckgewinning)
IKZ Sanit. Heiz Klima, Vol. 36, No. 21, November 1981. P96–108

Considers the reasons for advocating mechanical domestic ventilation, and the different ventilation principles involved.

*4. Lundin, L.
Tracer gas measurement
(Spargasmatuing)
In 'Seminar on tracer gas and ventilation efficiency', Swedish National Institute for Building Research Memorandum M81:16, March 1981, p49–51

Describes a variation of the conventional tracer gas measurement technique for measuring air change rates.

*5. Trümper, H. and Hain, K.
Independent or central ventilation in apartment blocks.
(Einzellüftung oder zentrallüfting in wohngebäuden)
TAB No. 12, December 1981, p11–15
= AIC Translation No. 17

Compares independent and central ventilation in apartment blocks and concludes that independent ventilation saves more energy.

*6. Franke, G.G.
Air transfer in residential buildings.
(Luchttransport door woningen)
Klimat beheersing, Vol. 11, No. 11, January 1982, p18–23
= AIC Translation No. 18

Reports on studies made by the Netherlands Standards Commission into air infiltration in residential buildings.

7. Swedish Council for Building Research
Energy saving effects in dwellings where measures have been implemented by governmental energy saving grants.
Report D7:1981 Swedish Council for Building Research, 184p

Investigates the amount of energy saved in Swedish buildings retrofitted with government funds.

Copies of the papers marked with an asterisk are available from the AIC to organisations in participating countries. The remainder are available on loan.

AIC Publications for Sale

Technical Notes (free to participating countries)

AIC-TN-5-81 AIRGLOSS: Air Infiltration Glossary

The AIC's 5th Technical Note is a glossary of terms related to air infiltration, intended to promote a more uniform usage of terms by workers in the subject of air infiltration.

Terms have been assembled concerning air infiltration, its description, detection, measurement, modelling and prevention. Also included are terms associated with the environment and relevant physical processes.

Topics covered include:

- experimental techniques
- instrumentation
- climate
- terrain
- building descriptions and components
- construction techniques
- ventilation requirements

Translations of the terms in the glossary from English into the languages of the participating countries will appear in due course.

Price: £10 sterling

AIC-TN-6-81 Reporting Format for the Measurement of Air Infiltration in Buildings

This standardized reporting format has been produced to provide a common method for research workers to set out their experimental data, so making the information easier to extract for subsquent analysis or mathematical model development.

The format may be used directly for entering results and should also serve as a useful checklist to aid those who are initiating projects.

The format contains sections covering:

- general information
- test site description
- climatic data
- building description
- building function
- measurement procedures and results
- models

The contents of each section are amplified by a set of explanatory notes and an example of the use of the format is included as an appendix.

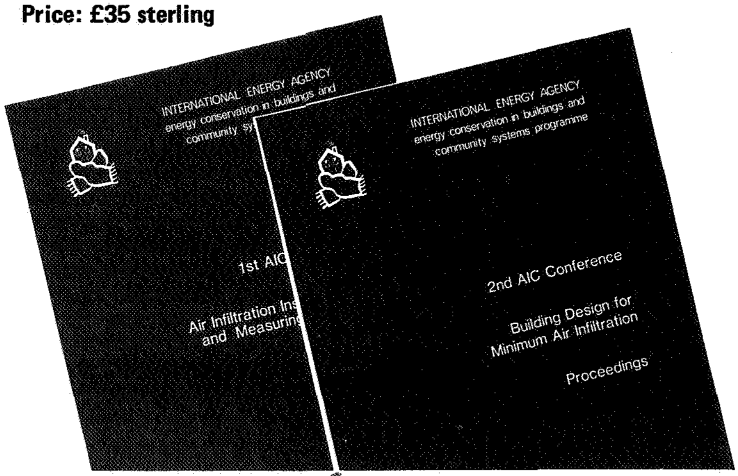
Price: £6 sterling.

Conference Proceedings

1st AIC Conference
'Air Infiltration — Instrumentation and Measuring Techniques'

The proceedings of the first conference, held in the UK in October 1980, are still available from the Air Infiltration Centre. They contain nineteen papers with discussions, presented by fifteen internationally renowned contributors from eight different countries. The most recent developments in the measurement of air infiltration and natural ventilation are fully described and the subjects covered include tracer gas systems, pressurization test methods, the correlation of tracer gas and pressurization tests and the measurement of air flow.

Price: £35 sterling



2nd AIC Conference
'Building Design for Minimum Air Infiltration'

The proceedings of this conference, held at the Royal Institute of Technology, Stockholm, Sweden in September 1981, are now available. This publication contains 15 papers with discussions, presented by internationally respected contributors.

The papers cover a range of topics including:

- Introduction to the AIC Handbook on air infiltration control in housing — a guide to international practice.
- The effects of energy conservation measures in existing buildings (retrofitting).
- The effects of the structure and installations of a building on energy consumption.
- Tracer gas tests on occupied and unoccupied buildings.
- Pressurization tests on buildings and building components.

Price: £15 sterling

Orders for these publications should be sent direct to the AIC using the attached form.

Representatives and Nominated Organisations

Participant	Steering Group Representative	Other Nominated Organisations		
Canada	R. Dumont, Division of Building Research, National Research Council, Saskatoon, Saskatchewan, Canada S7N 0W9. (Tel: 306.665.4200)	J. Shaw, Division of Building Research, National Research Council, Ottawa, Canada, K1A 0R6. (Tel: 613.993.1421) (Telex: 0533145)	P. Favot, Technical Research Division, Canada Mortgage and Housing Corporation, Ottawa, Canada, K1A 0P7. (Tel: 614.748.2326) (Telex: 053/3674)	
Denmark	P.F. Collet, Technological Institute, Byggeteknik, Post Box 141, Gregersensvej, DK 2630 Tastrup, Denmark. (Tel: 02-996611) (Telex: 33416)			
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Switzerland	P. Hartmann, EMPA, Section 151, Ueberlandstrasse, CH 8600 Duebendorf, Switzerland. (Tel: 01-8234251) (Telex: 53817)			
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