Air Infiltration Review

a quarterly newsletter from the IEA Air Infiltration Centre

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Wind Pressure and Air Infiltration

AIC Report on Wind Pressure Workshop in Belgium

During the course of the Air Infiltration Centre's model validation exercise it became apparent that one of the major areas of weakness was the characterisation of wind pressure on the surface of the building. Although existing wind loading codes and specialised wind tunnel results were used with varying degrees of success in this exercise,[1] it was thought that some discussion should be devoted to this topic. Consequently, it was proposed that the Centre should hold an International Workshop on the subject and prepare a state-of-the-art review document on wind pressure coefficients[2] for presentation at this meeting. The workshop was held in Brussels, Belgium on 21 and 22 March 1984 and attracted a total of 30 participants representing eight countries, with interests ranging from wind engineering to air infiltration modelling.

The meeting was divided into five sessions, with Session 1 being devoted to an outline of the problem followed by the presentation of the review document by Carolyn Allen of the Air Infiltration Centre.

Session 2 concentrated on further discussion of the review with particular reference to the wind pressure distribution. Much of the discussion was concerned with the suitability of wind loading data for air infiltration calculations. This session also covered discussions on fluctuating pressures and the influence of pressures generated by both stack action and mechanical ventilation systems.

The third session was devoted to full scale measurements of wind pressure. In particular, Jan Gusten from Chalmers University of Technology, Sweden described pressure measurements made on three low-rise buildings combined with simultaneous measurements of air infiltration using tracer gas. It was noted that calculated infiltration rates based on wind loading codes were much higher than those observed, particularly at higher wind speeds. They were, however, comparable when the calculations were based on measured pressures (see Figure 1). The role of cladding in damping pressure variations was also discussed. Continuing this session, Hiroshi Tanaka from University of Ottawa, presented some results of measurements of internal pressures being made at the University of Ontario, Canada.

This was followed by a presentation by Roger Hoxey from the National Institute of Agricultural Engineering, UK, who described some full scale measurements on agricultural buildings. He noted that pressure fluctuations at the surface of a building reflect not only variations in magnitude but also wind direction. It was further observed that large openings, such as open ridge vents, give rise to an altered pressure distribution on the outside of a building. The session was concluded with a discussion by Max Sherman from the Lawrence Berkeley Laboratory, USA, on direct pressure measurements made on a Mobile Infiltration Test Unit subject to various levels of wind exposure.

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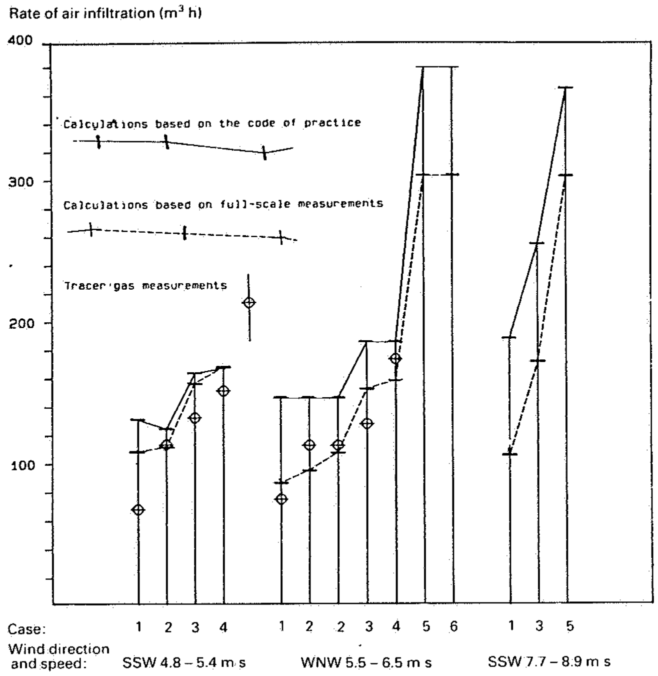

KEY

Ventilation system	Position of supply air terminal devices: Closed	Open
Ventilation system switched off	1	2
Normal ventilation	3	4
Forced ventialtion	5	6

Figure 1. Air infiltration calculations based on different types of C_p-factor.

In Session 4 attention was turned to wind tunnel studies. This session was introduced by Bengt Wiren from the National Swedish Institute for Building Research who discussed how the pressure distribution on a model house is affected by surrounding buildings in regular arrays using the test structure illustrated in Figure 2. It was observed that as long as the array left no unobstructed path for the wind to the test house, the wind pressures were largely independent of array form. A single row of sheltered buildings, however, showed a pattern with strong directional dependence.

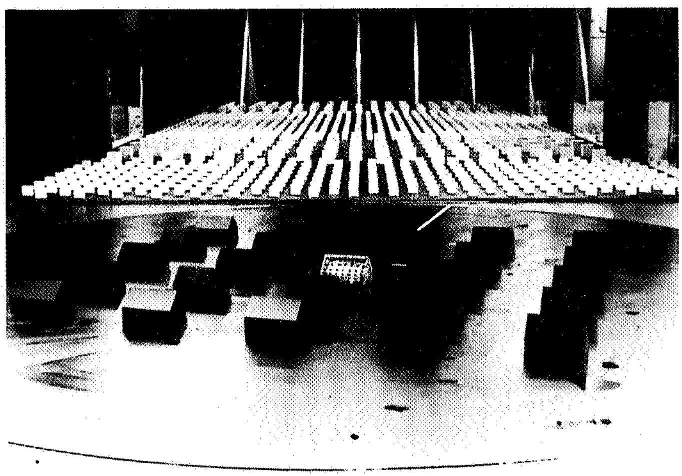

Figure 2. Wind tunnel arrangement showing test house and surrounding obstructions.

This theme was continued by Hans Phaff from IMG-TNO, Netherlands, who described a study which investigated the effect of a neighbouring building on the surface pressure of a test building as a function of their relative sizes and the separation between them for winds along their line of centre. It was observed that, for positions on the side and rear faces of the test building, the effect of the upstream building had faded for separations greater than approximately five times its height, but that for the windward face, effects were still detectable at fifty times the height. Willem de Gids, also from IMG-TNO, Netherlands, described wind tunnel studies into the effects of roof shape and position on the pressures experienced at the mouths of protruding vent pipes. In particular, he discussed the conditions necessary to avoid reversed flow. This was followed by a presentation by Sophia Ashley from the Naval Construction Battalion Center, USA, who described a wind tunnel study of the natural ventilation of houses in Hawaii for the purposes of cooling. The model study considered the mean pressure coefficients as a function of wind angle for buildings of various side ratios in the presence of shelter and with the windows open or closed. Of particular interest was the pressure coefficient difference between opposite pairs of facades which was compared with full scale measurements. The aim was to present a simple design guide whereby the effects of architectural characteristics could be described by a percentage increase in pressure coefficient difference relative to the simplest case of a one-storey rectangular building. This session was closed with a short contribution from Sandor Palffry, Switzerland, who spoke briefly on the mutual effect of a pair of buildings in close proximity on their pressure distributions.

The final session was devoted to the consideration of the introduction of pressure coefficients into calculation models. Martin Liddament from the Air Infiltration Centre, and David Etheridge from British Gas, both described the requirements for the adequate description of wind pressure in computer models. This was followed by a description from Carolyn Allen of a way of representing the dependence of surface pressure coefficients on wind angle by Fourier series. Other contributions were made by Earle Perera from the Building Research Establishment, UK, who described the development of a new pressure coefficient database and Max Sherman, USA, who described the data requirements for the Lawrence Berkeley Laboratory air infiltration model.

Many sources of information representing a wide range of both full scale and wind tunnel data were brought to the attention of those attending the workshop. It was clear, however, that much more effort is necessary in order to overcome the problems associated with specifying the wind pressure distribution for air infiltration calculations. Nevertheless, the meeting provided a valuable opportunity for wind engineers and air infiltration experts to focus attention on this problem.

The material presented at this workshop is currently being compiled, with the intention of publishing a full technical record of the proceedings in the near future.

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Overview of Air Infiltration Research in Japan

Dr Hiroshi Yoshino
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Energy consumption in residential buildings

Recent statistics[1] show that the annual primary energy consumption per person in Japan is 31.0 Gcals (129.8 GJ). Almost 25% of this energy demand is divided equally among the commercial and residential sectors, with secondary energy usage per dwelling amounting to 8.3 Gcals (34.8 GJ). This value is a quarter of that of the United States and one half of that of European developed countries.

Another survey of energy consumption[2] in 1979 of houses throughout Japan, including Hokkaido, shows the energy distribution for various purposes (see Figure 1). Only 30% of the total energy consumed was for heating. However, the percentage of energy used for heating houses in Hokkaido, the northern island of Japan, was 61%. This value is almost equal to that of heating energy consumption for houses in developed countries in Europe and America. The reason why the rate of heating energy consumption in Japan is so small is not because the winter climate is mild or the houses well insulated, but because rooms are not well heated. In Japanese houses, with the exception of those in Hokkaido, unvented portable oil heaters and a type of electric heater mounted under a low table are the most popular means of heating and are used only in the living room. Other rooms are unheated, and the envelopes of houses are not well insulated.

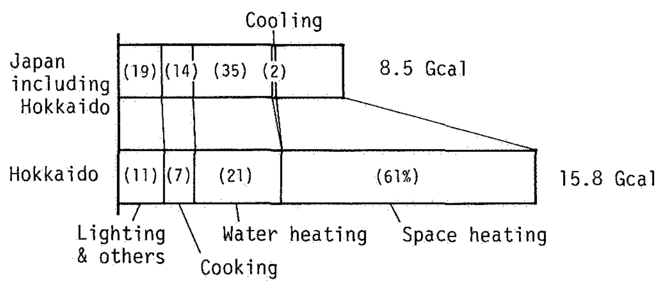

Figure 1. Distribution of annual energy consumption in a house.

The room temperature profiles of a house in Sendai are shown in Figure 2[3]. It can be seen that the temperature in the heated living room rises to about 20°C during the heating period but, after the heating device is turned off, the temperature falls to a point near the outdoor temperature by daybreak. Secondly, the unheated spaces, i.e. bedrooms and corridors, have a temperature as low as 5°C all day, showing a very large temperature difference between the heated and unheated rooms. Thirdly, the vertical temperature difference in the living room is also large due to infiltration of cold air from adjacent rooms and corridors, as well as from outdoors.

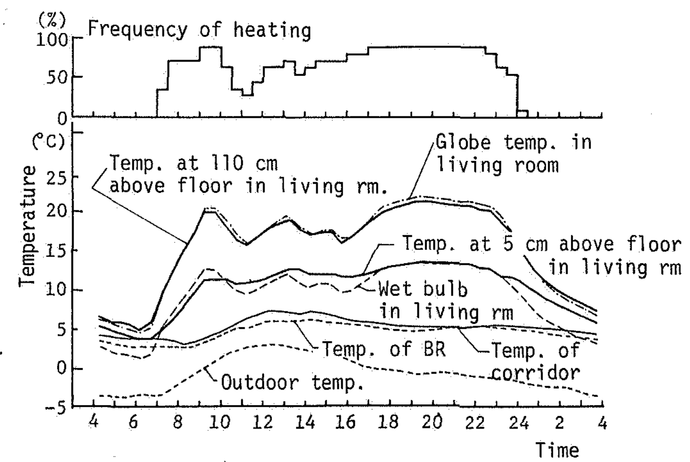

Figure 2. Room temperature profiles in a house (Sendai in winter).

Recently, envelopes of newly constructed houses are often insulated to some degree. A survey of housing construction in the Tohoku area[4] in 1982 shows that the envelopes of 45% of the houses were thermally insulated. Only 20% of houses had insulated walls, floors and ceilings. The insulation used is thin, only 2–3 cm, and almost all the houses have single glazed windows. However, following the oil crisis of 1978, more attention has been paid to energy conservation and, since national laws for rational utilization of energy were enacted in 1979, Japanese houses (except in Hokkaido) have become better insulated. The guideline prepared according to this law recommends, for example, that houses in Tokyo should have 4.5 cm glass fibre insulation. It further recommends that houses in the north of Japan should have doubled glazed windows. However, in Hokkaido, a local law entitled 'Acceleration of housing construction aimed at protection from the cold climate' has been in force since 1953. This law has been revised several times and at present prescribes a standard value of heat transmission factor corresponding to 4 cm glass fibre insulation and double glazed windows. However, the national guideline for rational utilization of energy recommends 10 cm glass fibre wall insulation, and this is now common for newly constructed houses. Some houses also now have triple glazed windows.

History of research in air infiltration and ventilation

Sixty years ago, Nomura in 1924[5] and Ohtani in 1928[6] measured, for the first time, the amount of crackage in room envelopes by means of a scale and investigated the effect such an amount of crackage would have on air infiltration. By 1950 a theorem, representing the air infiltration mechanism and taking into account both wind pressure and buoyancy, was formulated by Watanabe[7] and Shoda[8]. A circuit network calculation method of air infiltration in a multi-cell house was devised by Maeda[9] in 1961.

Since about 1960, unvented portable oil heaters have become popular for heating houses. In 1964, Yoshizawa[10] began research on the air quality and ventilation requirements of rooms heated by such means. After uninsulated multi-family houses began to be constructed of concrete, problems with condensation became prevalent. Maeda, Ishihara, et al[11] therefore conducted a detailed investigation of the thermal environment and air quality of such apartments in 1957. Initially, they measured the airtightness of building components using the fan pressurization technique. Subsequently, in 1969 Shoda, Murakami, et al[12] proposed construction methods for prevention of condensation based on the results of a detailed investigation of room temperature, humidity and life-style of occupants in concrete apartments. However, air infiltration research for the purposes of energy conservation has only been carried out in the last ten years and the airtightness of various types of houses has been measured by many researchers since 1982.

In Hokkaido, newly constructed houses are so well insulated and airtight that the infiltration rate of some of them was found to be 0.3 per hour[13]. Some older houses have been retrofitted recently and dwellings built near the airport or superexpress train line are made airtight for the purposes of acoustical insulation. Research on air quality and suitable ventilation systems in such acoustically insulated houses began in 1973[14].

Current research into air infiltration

Investigation of airtightness in houses

The airtightness of various types of dwellings was measured by Narasaki et al[15], Murakami, Yoshino et al[16], Asano[17], Aranti et al[13], and Kamata et al[18]. Figure 3 shows the level of specific leakage area for various houses in different countries[19]. It has been found that Japanese houses fall into Rank 4 – Rank 6, except for airtight houses in Hokkaido. Almost all these buildings are of recent construction. Older dwellings, built several decades ago, are assumed to be less airtight than those in Rank 6. Multi-family apartments fall into Rank 2 – Rank 4, with the exception of two buildings. Apartments equipped with acoustically insulated windows in housing estate A are very airtight and fall into Rank 2. One apartment in Rank 5 was built in 1956, the other is a terrace house built with concrete panels.

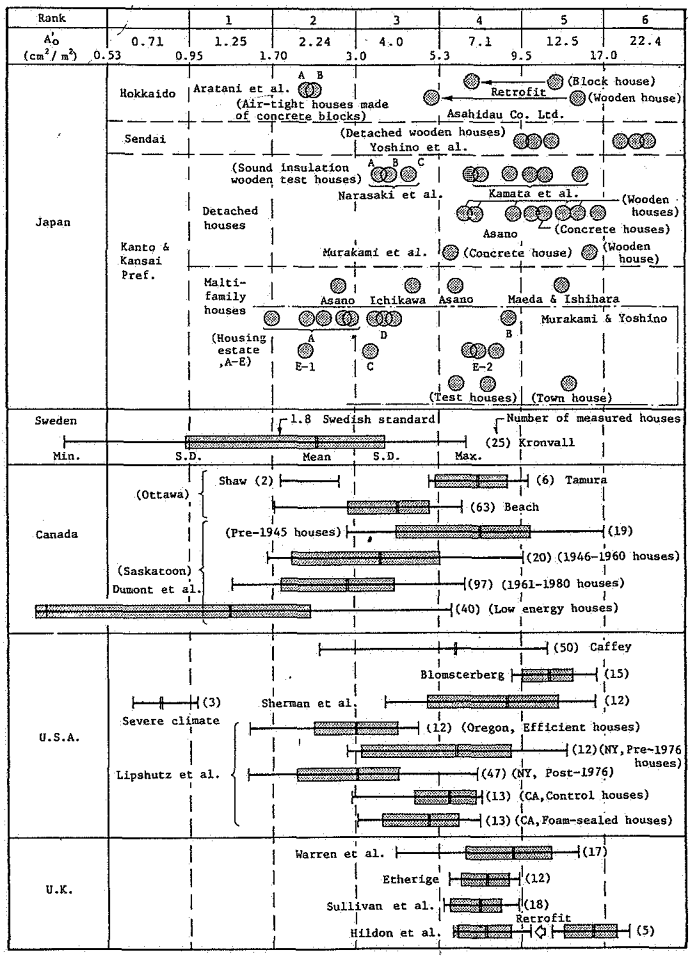

Figure 3. International comparison of airtightness in houses (airtightness is indicated by the ratio of effective leakage area to unit floor area for $\triangle p = 10Pa$).

A draft of the Japanese Industrial Standard entitled 'Methods for measuring equivalent areas of test rooms' is being prepared by a sub-committee concerned with the measurement of airtightness in houses, and chaired by Professor Murakami at the Japanese Testing Center for Construction Materials and responsible to the Ministry of International Trade and Industry. This draft prescribes in detail a fan pressurization method for measuring the airtightness of a whole house as well as the components.

Air infiltration calculation method

Air infiltration in a steady state can be calculated easily if the characteristics of all leakages and their distribution, surface pressure distribution and the difference in indoor and outdoor temperatures are known. However, it is difficult to clarify the characteristics of leakages and their distribution and also to predict the external pressure coefficient of houses. For the purpose of resolving these problems, some simplified calculation methods•assuming certain factors have been proposed by Grimsrud, et al[20], Warren, et al[21], Shaw[22] and other researchers. Yoshino, et al[23] and Kamata, et al[24] are also carrying out validation studies of such calculation methods in Japan.

Recently, Yoshino, et al[25] have measured the air infiltration, pressure distribution and indoor-outdoor temperature difference of three single test houses (floor area 23.7 m2) which have different leakage distributions. The air infiltration of three houses was also calculated on the basis of the external pressure distribution, the indoor-outdoor temperature difference and leakage characteristics measured by the fan pressurization method. The volume of air flow, Q, through the leaks is indicated by the equation: $Q = a(\triangle p)^n$. The constant, a, and the exponent, n, show the leakage characteristics. The pressure difference, $\triangle p$, is yielded by a combination of the wind force and buoyancy. The relation between the measured values of the air infiltration rate found by means of the CO_2 concentration decay method and the calculated value found by means of circuit network method is shown in Figure 4. It can be said that the calculated values are generally overestimated, compared to the measured values.

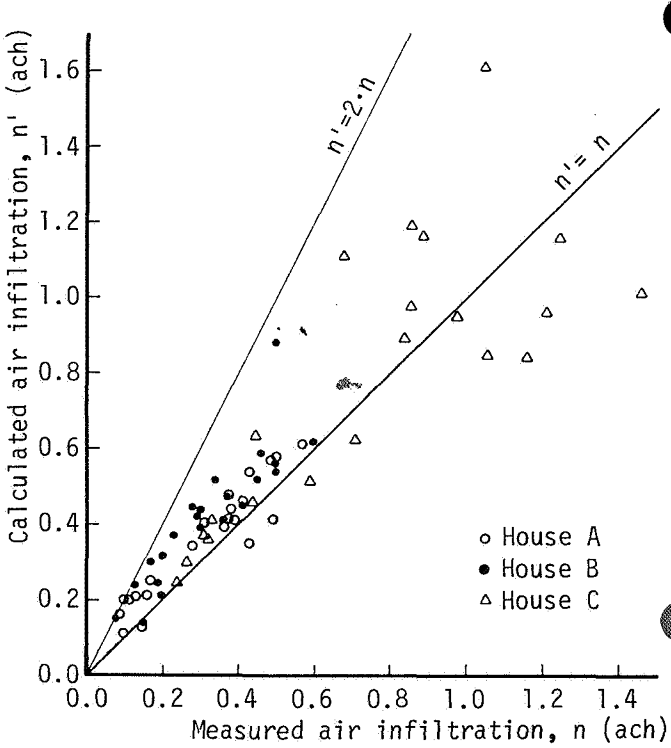

Figure 4. Relationship of infiltration ratio between measurement and calculation.

Udagawa, et al[26] and Sakamoto[29] have developed a method of calculating the heating load in houses taking into consideration the interaction of infiltration between rooms.

Measurement of air infiltration in a multi-cell house

It is easy to measure air infiltration in a single room by using tracer gas, but it is difficult to measure the interaction of air infiltration between rooms. A measurement method using several different types of tracer gas was proposed by Arantani et al[28] and Narasaki et al[29] in 1972. Asano et al[30] made detailed measurements of the infiltration in a detached house in 1978 and clarified the amount of airflow exchanged between rooms. Recently, Sasaki and Arantani[31] proposed a method for estimating the air exchange rate in which a single tracer gas released in one room is subsequently measured in the other room.

Ventilation requirements for occupied rooms

It has already been mentioned that Yoshizawa started research on ventilation requirements of rooms heated by unvented portable oil heaters in 1965. Recently, Minamino and Fujii, et al[32,33] have been conducting research on ventilation requirements for offices for the purpose of reducing body odours and tobacco smoke odours. A sub-committee for formulating standards of heating and air-conditioning systems, organized by the Society of Heating, Air-Conditioning and Sanitary Engineers of Japan and chaired by Prof. Yoshizawa, has drafted a proposed Standard of Ventilation for Residential and Commercial Buildings. This draft prescribes a ventilation requirement of 30 m^3/h per person for an occupied room.

Air infiltration mechanism in high rise buildings

Hayakawa and Togari have been studying the mechanism of airflow resulting from the stack effect in high rise buildings since 1978[34]. They have investigated the pressure distribution at various points in a building including those on the wall surface, and have also developed a circuit network method for calculating the airflow rate. The pressure distribution obtained by computer simulation is well correlated with the results obtained by direct measurement. They have also proposed[35] a simple technique for measuring airtightness of external walls of high rise buildings: the pressures are measured at several points in a building influenced by the stack effect under conditions of a calm outdoor environment. Pressures must be measured several times under different neutral levels which are effected by a fan or open door.

A sub-committee chaired by Prof. Murakami, which is studying the stack effect and air infiltration in office buildings has been organized at the Architectural Institute of Japan. An important report is being prepared concerning the design and construction methods for office buildings for saving the heating and cooling loads resulting from air infiltration. This report will also show that the results regarding infiltration rates calculated by several methods already described in authorized handbooks have unexpected distributions.

Other research studies

– The effect of wind turbulence on infiltration

Narasaki, et al[36] and Nitta, et al[37] have recently started an experimental study on the effect of wind turbulence on infiltration using a small box.

– The effect on the decrease of infiltration of retrofitting houses

In Hokkaido, some old houses have been retrofitted with 10 cm insulation and made airtight with polyethylene sheets. Aratani et al[33] investigated the effect of such retrofitting on the decrease of infiltration and air quality in rooms.

– The measurement of the external pressure coefficient on houses

Murakami et al[39,40] measured in detail the pressure distribution on the envelopes of a solar test house. They also measured the external pressure coefficient of a 1/40 scale model by means of a wind tunnel test and obtained satisfactory results corresponding to the value of actual measurements.

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ASTM Symposium on Measured Air Leakage Performance of Buildings

2–3 April 1984
Philadelphia, USA

This American Society for Testing and Materials symposium provided an opportunity for approximately 120 participants to exchange information on recent advances in air infiltration research. A total of 23 papers were presented by authors from the United States, Canada, Sweden and the United Kingdom. Subject areas encompassed air infiltration and airtightness measurements in dwellings, commercial premises and industrial buildings. In particular, large single cell enclosures attracted much interest with contributors describing measurements in warehouses, factories and giant aircraft hangars. Advances in passive tracer gas measurement techniques, multi zone monitoring and air movement measurements were also described. There was extensive discussion on the relationship between air leakage (pressurization testing) and air infiltration measurements (tracer gas testing). It was argued that, while individual buildings exhibited a range of infiltration rates dependent on ambient climatic conditions, the underlying air infiltration rate is a function of building airtightness as determined by leakage testing. Thus both measurement techniques have important roles in air infiltration studies. The problem of indoor air quality was also addressed with discussion focussing on the maximum desirable tightness of buildings and on the transport of pollution within buildings.

Away from the conference venue, hotel rooms were found to be the ideal location for impromptu demonstrations illustrating the versatility of the "blower door"! On the ninth floor of the conference centre hotel, the American Infiltec System (see Figure 1) was demonstrated. Positioned in the doorway within minutes, final fitting is achieved by inflating a rubber seal around the blower door to achieve perfect mating with the existing door frame. Eleven floors further up, the Canadian Ener-Corp 'Infiltrometer' was under test (see Figure 2). This is supplied in four main sections which clamp to an adjustable plate fitted around the door frame. As can be seen from the photographs, the existing door remains in place during the test for both systems.

Figure 2. Peter Giesbrecht from Ener-Corp demonstrating the 'Infiltrometer'

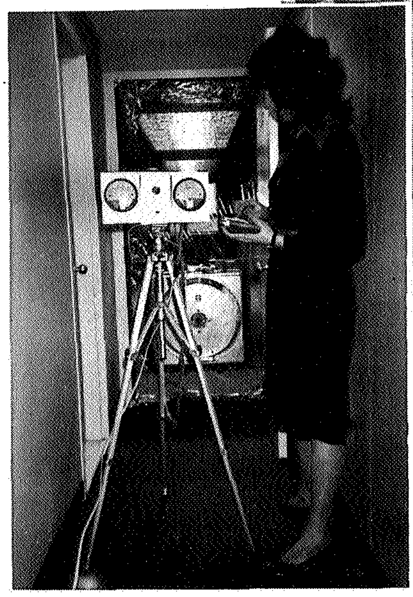


Figure 1. Cynthia Messina from Saum Enterprises demonstrates the Infiltec 'blower door'.

The proceedings of this symposium are currently being compiled and will be reviewed in AIR when published.

Overseas Enquiries – Telex/Telephone Service

Overseas enquiries and requests for literature now account for more than half of those received by the AIC. New arrangements have been made at the Centre to ensure that such requests receive prompt attention. To ensure the speediest of attention, enquiries may be made any time of day via the AIC telex or 24-hour telephone answering service.

Please telephone your enquiry on **+44 344 53123** or telex us on **848288 BSRIAC G.**

5th AIC Conference

'The Implementation and Effectiveness of Air Infiltration Standards in Buildings'

1–4 October at Harrah's Hotel, Reno, Nevada

The programme for this conference has now been finalised. A total of 26 papers will be presented by authors from ten countries focussing attention on the implementation and effectiveness of airtightness measures 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. The conference will be relevant to all who are concerned with the need to conserve energy yet maintain good indoor air quality. An outline programme is reproduced below.

The registration fee is $365 (£255 sterling) inclusive of three nights accommodation, all lunches and the conference dinner. Early booking is recommended as it is anticipated that the demand for accommodation will be high. Final date for registration is 10 September 1984.

Registration forms and complete programme details are available from your Steering Group representative (see back cover of newsletter) or direct from the Air Infiltration Centre. For those unable to attend, full conference proceedings will be available directly following the conference.

Programme

Monday 1 October 1984

Registration
Reception

Tuesday 2 October 1984

Keynote Address	
Review of building airtightness and ventilation standards	P.J. Jackman (UK)
IEA-Annex IX 'Minimum ventilation rates' – survey and outlook	L. Trepte (W. Germany)
Air quality issues in ventilation standards	A.V. Nero, D.T. Grimsrud (USA)
Airtightness standards for buildings – the Canadian experience and future plans	J.C. Haysom (Canada)
Better airtightness: Better or worse ventilation?	J. Railio (Finland)
Energy performance standards with regard to air infiltration for buildings in Switzerland	C.U. Brunner (Switzerland)
Description of ASHRAE's proposed airtightness standard	M. Sherman (USA)
A standard for minimum ventilation	D.T. Harrje, J.E. Janssen (USA)
Air leakage or controlled ventilation?	M. Herrlin, T-G Malmström (Sweden)
Development of occupancy-related ventilation control in Brunel University library	B.E. Smith et al (UK)
The performance of passive ventilation systems in a two-storey house	C.Y. Shaw, A. Kim (Canada)

Wednesday 3 October 1984

Implications and analysis of airtightness measures	M.W. Liddament (UK)
The influence of climate and ventilation system on airtightness requirements	A. Blomsterberg, L. Lundin (Sweden)
The implementation and effectiveness of air infiltration standards in buildings	S. Uvsløkk, B. Vik (Norway)
Measured and building code values of air change rates in residential buildings	C.A. Boman, M.D. Lyberg (Sweden)
Airtightness and wall construction in pre-fabricated Swedish one-family houses, 1984	L-G Mansson (Sweden)
Constancy of airtightness in buildings	A. Carlsson, J. Kronvall (Sweden)
Baseline data: health and comfort in modern office buildings	E.M. Sterling, T.D. Sterling (Canada)
First-phase occupant reaction to well-sealed indoor environments	G.R. Lundqvist (Denmark)
Indoor air quality implications of air infiltration standards	J.W. Bradstreet et al (Canada)
Contaminant build-up in houses	P.J. Manley et al (Canada)
Indoor relative humidity decay as a potential indicator of air exchange in houses	G.B. Parker et al (USA)

Thursday 4 October 1984

Verification of calculation model of air infiltration using three types of test houses	H. Yoshino et al (Japan)
Scandinavian pressurization test methods	L. Lundin (Sweden)
Air flow calibration of building pressurization devices.	A.K. Persily (USA)
Philosophy and background of the Dutch standards for airtightness of dwellings	W.F. de Gids (Netherlands)
Concluding discussion	

New Publications from the AIC

AIC-TN-15-84
A Subject Analysis of the AIC's Bibliographic Database – *AIRBASE* (3rd Edition)

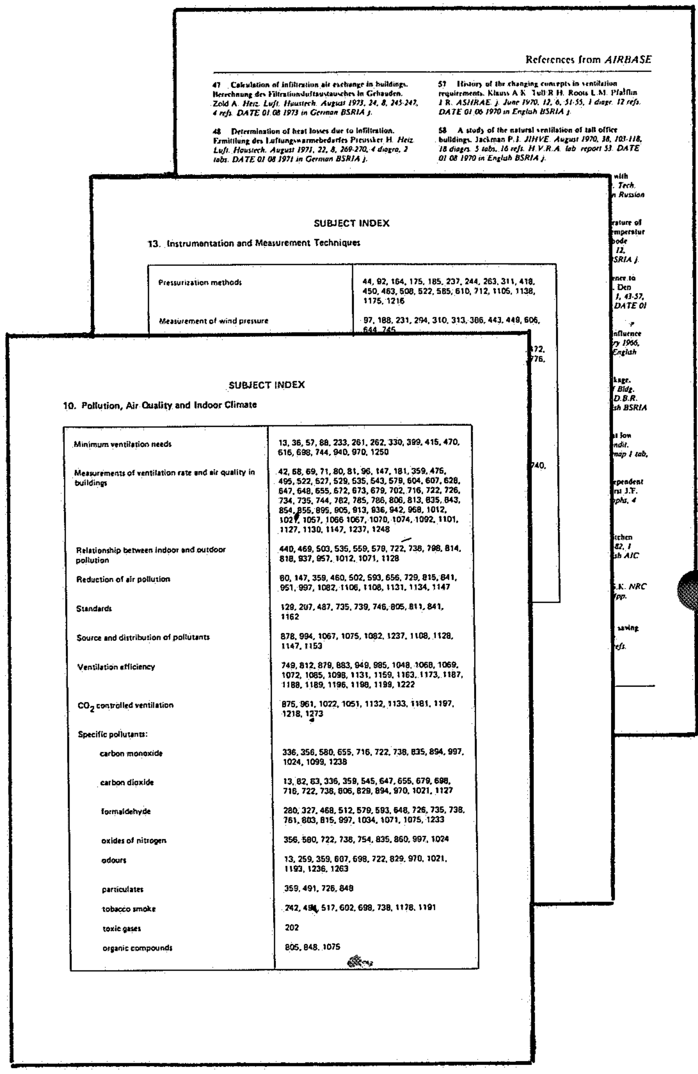
The Air Infiltration Centre's third subject analysis of *AIRBASE* is now available. Compared to the two previous editions, it is much enlarged and contains a full subject index to almost 1300 scientific and technical papers on air infiltration research. Related topics include

- indoor air quality
- the influence of occupants
- thermal comfort
- ventilation efficiency
- ventilation strategies
- wind effects
- energy conservation

The report is presented in two sections with Section 1 containing the analysis itself, in which articles are listed by reference number under one or more of 14 major subject headings. Each heading is further subdivided to give a total of 175 subject areas. Full bibliographic details are listed in reference number order in Section 2, thereby enabling the rapid identification of articles. To complete this publication, an index of principal authors is included as an appendix. Examples of the report layout are illustrated.

This report thus provides one of the most up-to-date and comprehensive guides to air infiltration publications and will undoubtedly be a valuable reference manual for all those concerned with this area of research. To further assist users, copies of all the articles referenced are available direct from the AIC library.

Users are also reminded that references are continually being added to *AIRBASE* as new material is published and the subject coverage of the database is broadened. Details of these new additions are published in a bi-monthly bulletin entitled 'Recent Additions to *AIRBASE*'.



SUBJECT INDEX

10. Pollution, Air Quality and Indoor Climate

Minimum ventilation needs	13, 36, 57, 88, 233, 261, 262, 330, 399, 415, 470, 616, 698, 744, 940, 970, 1250
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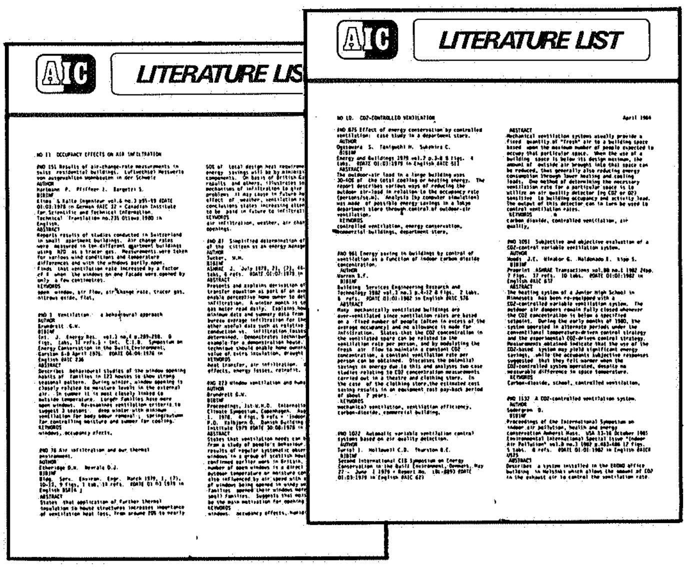
Copies of the subject analysis and 'Recent Additions' are available free-of-charge to organisations in participating countries and may be obtained by completing the order form printed on page 12 of this newsletter.



New Literature Lists

As part of its information service, the Air Infiltration Centre publishes literature lists based on *AIRBASE* searches of topical subjects. Each list contains abstracts and full bibliographic details of key papers.

Two new lists have recently been published. These are:

No. 10 CO_2 controlled ventilation (13 references)

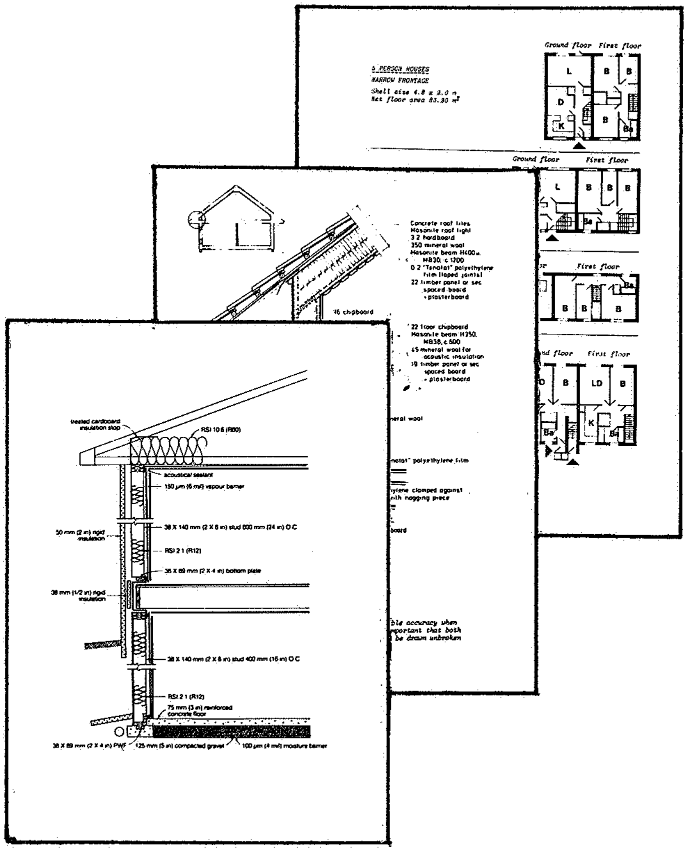
No. 11 Occupancy effects on air infiltration (15 references)

Literature lists are available free-of-charge to all participants direct from the AIC.

AIC Handbook

'Air Infiltration Control in Housing – A Guide to International Practice'

Arne Elmroth and Per Levin
Royal Institute of Technology, Stockholm, Sweden



Copies of the above handbook are still available from the Air Infiltration Centre. This is one of the Centre's major publications and is filled with useful information on airtightness design and retrofit principles. Also included are guidelines on minimum ventilation and details of regulations and requirements. Other sections cover climatic data, degree day definitions, calculation methods and domestic energy balances. Renowned authors from Canada, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States of America were commissioned to write on the construction practices and airtightness needs of each of these countries. These contributions are vividly illustrated to provide pictorial guidance on good construction practices. The sample pages illustrated indicate the level of detail of the design information.

This international guide offers practical design solutions for all those concerned with the construction and operation of energy efficient dwellings. Copies of the handbook are available direct from the Air Infiltration Centre, price £12 sterling inclusive of post and packing or from Svensk Byggtjänst. Box 7853 S-103 99 Stockholm, Sweden, price Skr 95.

Book Review

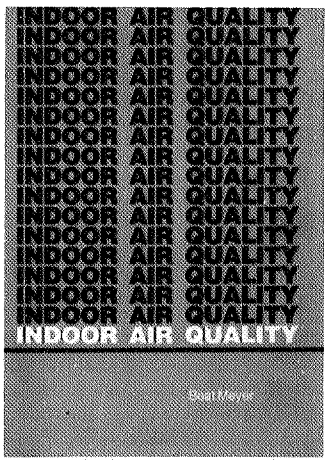
'Indoor Air Quality'

Beat Meyer
University of Washington, USA

This publication aims to provide the reader with an understanding of some of the many factors which cause indoor air pollution. The introductory chapter provides an overview of the indoor air problem and is followed in Chapter 2 by an historical outline of air quality problems and their health effects. Following chapters include

- parameters that define the health of building occupants
- building factors that form the framework for indoor air control, including effects of air infiltration and natural ventilation
- lists of prevailing air pollutants and their sources
- current air monitoring and analysis methods
- current knowledge of indoor pollutant concentrations and exposure levels
- health effects
- air quality control
- current regulatory trends in the USA.

This is supplemented by summaries of data in the form of tables and figures, a bibliography which covers literature up to 1982 and comprehensive author and subject indices. The book concentrates on air quality problems in the most common building types in North America, with the argument that such buildings present a general model that can be applied to other countries. Likewise, the regulatory system of the USA is used as a model for current regulatory trends in other countries.



This book is published by Addison-Wesley Publishing Co., ISBN 0-201-05094-3, approximate price $20, and can be ordered through most local book agents.

Forthcoming Conferences

1. International Congress of Thermography
Lucerne, Switzerland
7–11 May 1984

Further information from:

Alpenstrasse 39
Postfach 108
CH-6010 Kriens
Switzerland

2. Energex '84
Regina, Saskatchewan, Canada
14–19 May 1984

Covers energy conservation in residential, commercial and industrial buildings.

Further information from:

Professor F. Curtis
Chairman – Technical Program & Publications
University of Regina
Regina
Saskatchewan
S4S 0A2
Canada

3. Windows in building design and maintenance
Gothenburg, Sweden
13–15 June 1984

Includes influence of windows on energy consumption, indoor climate, thermal performance, air leakage and ventilation.

Further information from:

RESO Congress Service
S-105 24 Stockholm
Sweden

4. ASHRAE 1984 Annual Meeting
Kansas City, Missouri, USA
17–20 June 1984

Symposium will be held on energy analysis in buildings and comparison of predicted and measured energy use in buildings.

Futher information from:

ASHRAE
1791 Tullie Circle NE
Atlanta
Georgia 30329
USA

5. Indoor Air '84
The 3rd International Conference on Indoor Air Quality and Climate
Stockholm, Sweden
20–24 August 1984

Further information from:

Conference Secretariat
Indoor Air '84
c/o RESCO Congress Service
S-105 24 Stockholm
Sweden

6. 5th AIC Conference
The implementation and effectiveness of air infiltration standards in buildings
Reno, Nevada, USA
1–4 October 1984

Further information from:
Mrs J. Elmer
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Old Bracknell Lane West
Bracknell
Berkshire
RG12 4AH
Great Britain

7. ASTM Symposium on Thermal Insulation, Materials and Systems
Dallas, Texas, USA
2–6 December 1984

Specific topics include:
- *materials research*
- *retrofit*
- *codes and standards*
- *application techniques*

Further information from:

Frank Powell
National Bureau of Standards
Building 226, Room B114
Washington DC 20234
USA

8. 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

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

The 1st International Symposium on ventilation for contaminant control is being held in Toronto, Canada on 1–3 October 1985. The symposium is being sponsored by Industrial Hygiene and Hazard Control Engineering of the University of Toronto and the Air Pollution Control Association – Ontario Section.

The theme of the conference is new technological development on a worldwide basis in the contaminant control field. The organizing committee requests technical papers of high quality for this symposium. A 400-500 word abstract ***is required by August 1984.***

Please address all enquiries 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*

3rd fold (insert in Flap A)

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