# Air Infiltration Review

a quarterly newsletter from the IEA Air Infiltration Centre


C.S.T.C./W.T.C.B.
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Ter attentie van de Heer
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# Energy Conservation Progress

## IEA Infiltration, Ventilation and Indoor Air Quality Projects

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**The Oscar Faber Partnership**
**Chairman, Executive Committee**
**IEA Energy Conservation in Buildings and Community Systems Programme**

### Introduction

The Air Infiltration Centre is but one of many projects inaugurated by the International Energy Agency. This article presents some general information on the IEA and its energy conservation programme and gives details of three projects relating to air infiltration and ventilation in buildings.

### International Energy Agency

Effective cooperation amongst nations and development of new technologies to reduce dependence on fossil fuels are critically important elements of a sound energy future. Agreement by 21 countries to cooperate on energy policy is embodied in an International Energy Program, developed in the wake of the 1973/74 energy crisis and administered by the International Energy Agency, an autonomous body within OECD.

### Energy Conservation in Buildings and Community Systems

As one element of the Energy Programme, the IEA sponsors research and development in a number of areas related to energy. In one of these areas, energy conservation in buildings, the IEA is sponsoring various exercises to predict more accurately the energy use of buildings, including comparison of existing computer programmes, building monitoring, comparison of calculation methods, as well as air quality and inhabitant behaviour studies. The differences and similarities among these comparisons have told us much about the state of the art in building analysis and have led to further IEA sponsored research.

16 countries have elected to participate in this area and have designated contracting parties to the Implementing Agreement covering collaborative research in this area. The designation by governments of a number of private organisations, as well as universities and government laboratories, as contracting parties have provided a broader range of expertise to tackle the projects in the different technology areas than would have been the case if participation was restricted to governments. The importance of associating industry with government sponsored energy RD & D is recognised in the IEA, and every effort is made to encourage this trend.

## Inside this issue:

## The Executive Committee

Overall control of the programme is maintained by an Executive Committee, which not only monitors existing projects but identifies new areas where collaborative effort may be beneficial. The Executive ensures all projects fit into a predetermined strategy, without unnecessary overlap or duplication but with effective liaison and communication.

The Executive Committee has initiated the following projects to date:

I. Building Energy Use Analysis*
II. Community Energy Systems Analysis*
III. Conservation in Residential Buildings*
IV. Commercial Building Monitoring*
V. Air Infiltration Centre
VI. Energy Systems in the Design of Communities*
VI. Local Government Energy Projects
VIII. Inhabitant Behaviour with regard to Ventilation
IX. Minimum Ventilation Rates based on Air Quality
X. HEVAC Systems Simulation
XI. Energy Auditing
XII. Windows and Fenestration
XIII. Conservation Retrofit in Hospitals†

*Already completed.
†Under discussion.

Each project is administered through an Annex to the Implementing Agreement as not all countries participate in all projects.

## Financing

There is no central IEA fund, and financial support for the projects is the sole responsibility of the participants. This approach is intended to assure that only activities of high mutual interest and value will be undertaken. Projects are typically either task-sharing, with each participant bearing its own costs, or, particularly in the case of the larger projects, jointly-funded, with all project members contributing to a common fund. Technical information exchange constitutes a third form of project where either the task sharing or jointly funded formula may be applicable.

## Infiltration, Ventilation and Air Quality

This area was identified by the Executive Committee as being of increasing importance as other conservation measures began to take effect. Currently three projects have been initiated.

## Annex V

Annex V is a jointly funded project annex in which, at present, 10 countries share the costs of operating the Air Infiltration Centre. The AIC provides specialised technical support for building research and industry to assist in:

- improving the understanding of the complex air infiltration processes

- improving the accuracy of techniques for predicting air infiltration and its relationship to energy consumption, indoor air quality and airborne moisture migration

- promoting the proper application of infiltration reducing measures to both new and existing buildings.

The services provided by the Centre are described under three headings:

### Information

AIC provides a specialised technical information service based on its library and bibliographic database *AIRBASE*.

The library houses a comprehensive stock of publications on air infiltration, ventilation aspects of indoor air quality and related subjects. Also included is commercial information on products relevant to air infiltration, its measurement and reduction. *AIRBASE* is a computer-based data storage and retrieval system consisting of abstracts of all known technical papers in this subject area. This enables rapid response to enquiries for literature on specific topics. In addition, bibliographical and analytical reviews of available information on selected topics are published.

### Technical Projects

AIC's scientific staff undertake an on-going programme of project work on specific aspects of infiltration and ventilation technology. Having completed a major validation exercise on mathematical models for predicting air infiltration, the AIC is now considering the more practical aspects of applying such models in design. This will lead to the publication of a handbook on design strategy and calculation methods for providing adequate and energy efficient ventilation.

Attention will also be given to to extending AIC's collection of experimental information to include numerical data on commercial and industrial buildings. This will provide a basis for widening the scope of model validation. Additionally in this context, an effort is being made to improve the availability of appropriate wind-pressure data for use in predicting air infiltration rates.

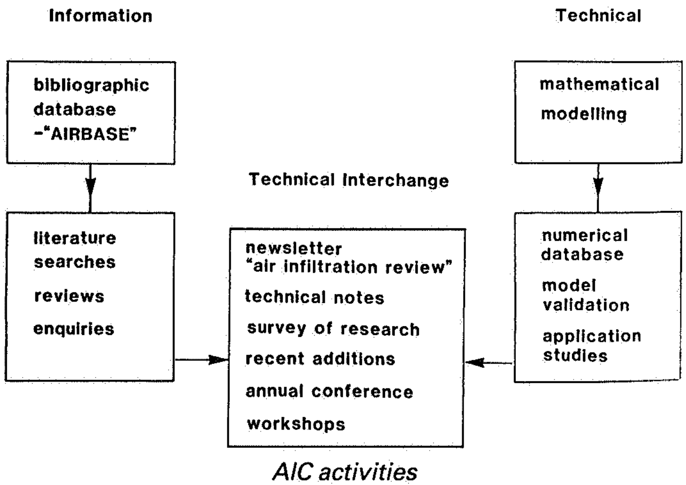
The rapid development of instrumentation and measuring techniques continues to be monitored and regular information reviews are published by AIC to keep those concerned with the measurement of air infiltration, air leakage and associated parameters aware of the progress being made.

### Collaboration

Technical interchange between those concerned with research, design, construction and building use is promoted in several ways. For example, the AIC Conference has become established as a notable annual event providing a splendid opportunity for the mutual exchange of ideas and information.

The survey of current research has also become a regular AIC publication. The report recently issued (AIC Technical Note 12) contains indexed details of 187 projects in 22 countries. This biennial survey provides readily accessible information on the scope of current research and on the potential sources of data on specific developments. A repeat survey is planned for 1985.

This quarterly Newsletter also plays an important role in publicising new developments and in promoting a general awareness of the progress being made in the understanding and application of air infiltration technology.



*AIC activities*

## Annex VIII

The energy balance in buildings is influenced by interaction with the environment via radiation, heat conduction and convection. Of these three phenomena, convection and, in particular, infiltration, is least understood and most affected by the individual behaviour of the inhabitants. This new project is designed to study in far greater depth than hitherto the behaviour of inhabitants with regard to ventilation.

The specific objectives of the project are:

- to determine the actual behaviour of inhabitants regarding ventilation and to correlate it to outdoor and indoor climate; and facing problems of minimum ventilation;
- to estimate that amount of energy which is lost due to this behaviour;
- to study inhabitants' relevant behaviour motivation;
- to study whether such behaviour can be modified and to estimate the amount of energy savings which might result therefrom.

The work of this annex is due to start in March 1984 and take 2½ years to complete, several countries have already agreed to participate but others may still join before the March deadline.

The work will be 'task-shared', each Participant preparing and executing measurements on ventilation patterns and corresponding energy consumption under different influence factors in at least four dwellings. Participants will also undertake observations or measurements on the operation of windows and doors in at least 40 dwellings and perform additional enquiries to develop comparable results from a statistically chosen sample of at least 500 dwellings.

The data collected from the activities as well as from extensive background studies, will be analysed to produce a report on actual behaviour of inhabitants regarding ventilation in dwellings in different countries, and a report on the possibilities for reducing energy consumption by change or modification of the inhabitants behaviour whilst maintaining minimum ventilation requirements.

## Annex IX

Whereas Annex V is concerned with air infiltration and its effects on ventilation, Annex IX is investigating the pollutants which affect indoor air quality with the aim of establishing acceptable concentration levels and defining corresponding minimum ventilation rates.

As reported in the August 1983 edition of AIR, nine countries cooperated on a task sharing bases to complete the first phase involving a review of existing knowledge, national standards and current and required research for a number of specified pollutants. A detailed report of this work is due to be published shortly.

The objectives of the second phase are:

- to quantify more closely the factors which determine the concentrations of the pollutants identified in the first phase and to determine the inter-relationships between these factors
- to establish minimum ventilation rates and all other suitable methods for ensuring that these pollutants are kept at acceptable levels
- to summarize the information that is available about various techniques and their merits for controlling air quality and conserving energy
- to catalogue and assess pollutant measurement and sampling techniques that may be useful in solving the problems connected with maintaining acceptable air quality in buildings.

Over the next two years, the participating countries will each be conducting research to meet these objectives in relation to specific pollutants or to some more general aspect of pollution control. The pollutants under consideration include formaldehyde, tobacco smoke products, radon, moisture, body odour and $CO_2$, and combustion products.

A breakdown of the overall scope of the study is as follows:

Emission rates and time dependence for different materials and sources and their dependence on:

- composition and processing
- installation and handling
- human behaviour
- indoor climate.

Indoor transfer and interactions:

- ad-, ab-, and de-sorption
- dilution
- chemical reactions and other interactions.

Control

- pollution measurement, sampling and identification
- ventilation
- air cleaning and dehumification
- separation and recovery
- reduction of emission rates.

Modelling indoor pollution including economic and social factors.

Strategies for indoor air pollution control under the restraints of energy conservation.

Annex IX is a highly suitable means for coordinating the research in these wide-ranging topics and for stimulating the necessary cooperation from participating countries.

The results of this international programme will be pooled to produce a report which should enable the magnitude of indoor pollution problems to be identified, and alternative solutions, including ventilation, to be considered on a sound basis and with the energy implications properly taken into account.

It will be noted that, while there is no overlap, there are some aspects in which the work of Annex IX and Annex V are closely related. To ensure a suitable level of liaison is maintained, Peter Jackman the Head of the AIC attends the Annex IX Working Party meetings.

# An Improved Multiple Tracer Gas Technique for the Calculation of Air Movement in Buildings

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**Department of Building, Sheffield City Polytechnic, UK**

## Introduction

This paper describes a series of tests carried out in two interconnected environmental chambers, to determine the accuracy of airflows calculated from tracer gas measurements using a new rapid sampling system.

## Sampling System

The schematic layout of the tracer gas sampling system is shown in Figure 1. Using two chromatographic separation columns in parallel and a portable gas chromatograph (Analytical Instruments Ltd., Model 505), it was possible to measure the concentration of Freon 12 (dichlorodifluoromethane) and Freon 114 (1,2 dichlorotetrofluoromethane) in air. The two 4-port valves were switched sequentially such that the column not in use was continuously flushed with argon. For the two tracer gases tested, a sampling interval of 30 seconds was used. This system was capable of measuring three tracer gases simultaneously, the third tracer gas being BCF (bromochlorodifluoromethane); this would extend the sampling interval to 45 seconds.

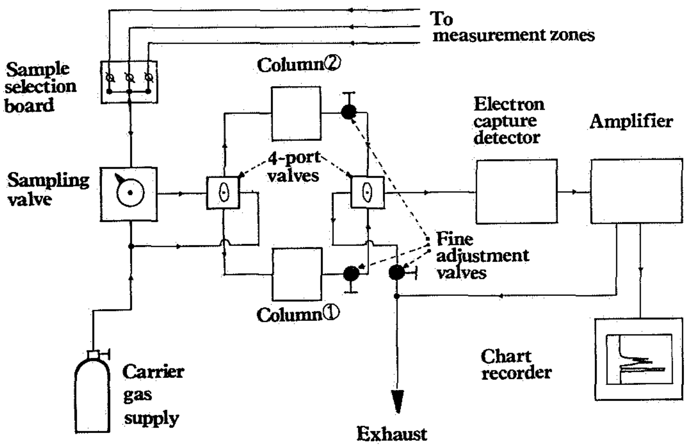


*Figure 1. Sampling system*

## Test Procedure

The two environmental chambers used were 30m$^3$ in volume, each having a separate ducted supply and extract ventilation system. Air/tracer gas in both chambers was sampled at three levels, i.e. floor level, 1.5 m high and 2.4 m high (50 mm below ceiling).

Air movement between the two chambers took place through two 100 mm diameter holes in the partition wall, one 150 mm above floor level and the second 1 m above floor level. The supply air flow rate to both chambers was set to provide a steady airflow through the low level opening from chamber 2 to chamber 1. A ducted low speed fan on the other opening induced air movement from chamber 1 to chamber 2. Air velocites in the supply ductwork were measured using a pitot tube and inclined-tube manometer. The air velocities through both openings in the partition wall were measured using a hot wire anemometer. The tracer gases were injected manually and mixed using desk fans.

## Test Results and Analysis

Initially, a single chamber ventilation rate measurement was taken to observe any significant differences between measured gas concentration for the two columns used (Test 1). Figure 2 shows the exponential decay of tracer gas concentration.

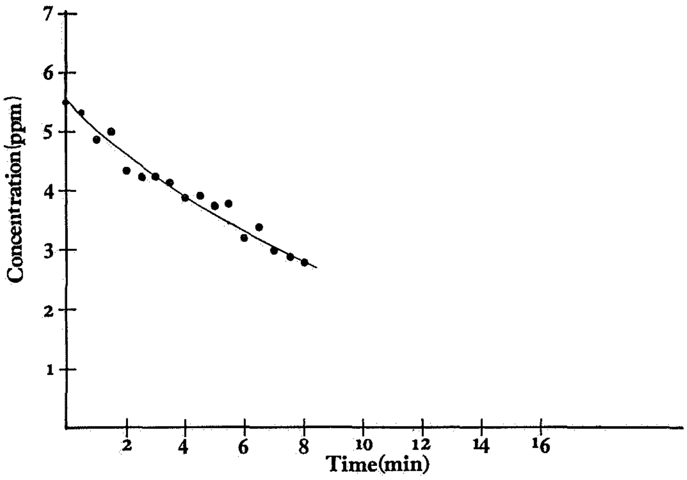


*Figure 2. Tracer gas concentration decay in single space*

The time taken for Freon 12 to mix with air in a single chamber without the aid of mechanical mixing (Test 2) is shown in Figure 3. A pulse of tracer gas was released at floor level and allowed to disperse. The tracer gas concentration tended to equilibrium after approximately 10 minutes

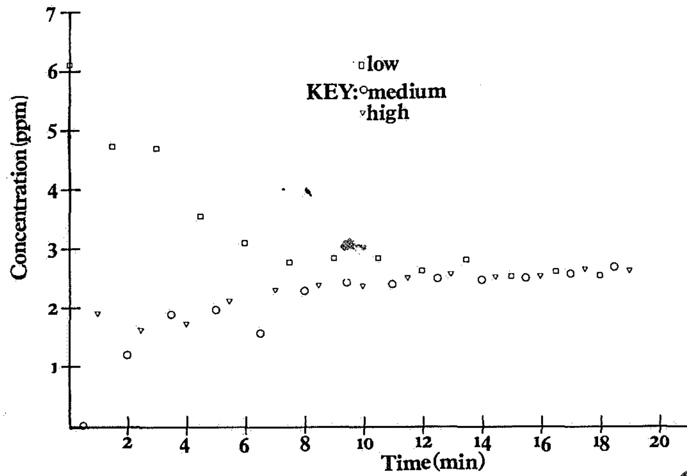


*Figure 3. Tracer gas (R12) concentration in chamber 1 – no mixing.*

A one-directional airflow was induced from chamber 2 to 1 by switching off the supply air system to chamber 1 (Test 3). Freon 12 was released in chamber 2, mixed, and the growth

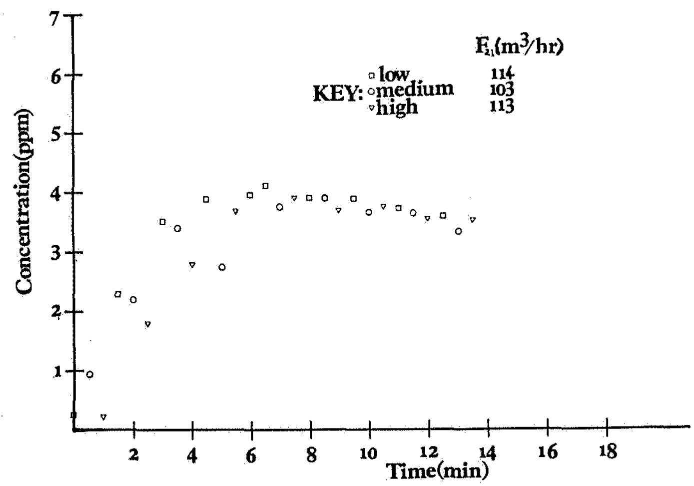


*Figure 4. Growth of tracer gas (R12) concentration in chamber 1*

of tracer concentration monitored at the three different levels in chamber 1. Figure 4 shows the three growth curves obtained; the three estimates of air movement suggest non-uniform mixing errors of approximately ±7%.

Table 1 summarises the air movement data obtained in subsequent tests using two tracer gases. Tests 4 to 5 are the result of a one-directional airflow from chamber 2 to chamber 1. The errors found between calculated and measured airflows were 2.3% and 5.5% respectively. Supply air inputs measured using a pitot tube and those calculated from tracer gas measurement show reasonable agreement; the error lies between 5% and 10%.

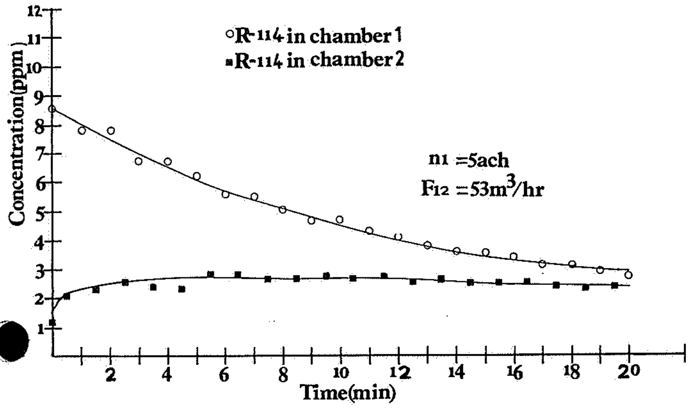


*Figure 5. Concentration of tracer gas (R114) in both chambers with a two-directional airflow*

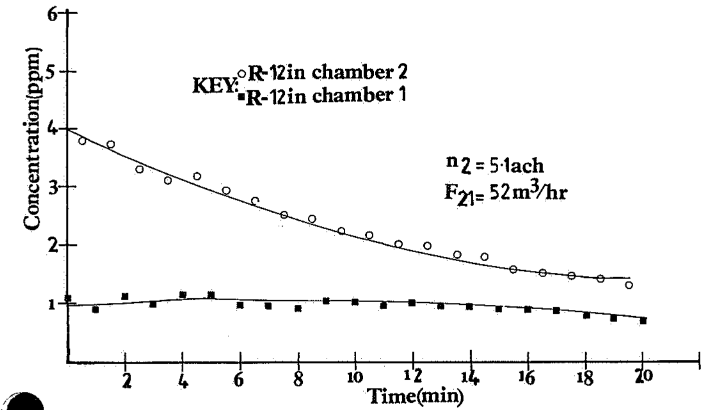


*Figure 6. Concentration of tracer gas (R12) in both chambers with a two-directional airflow*

Tests 6 to 8 inclusive were with two-directional air movement between the chambers. Figure 5 and 6 show the tracer gas concentration time points obtained during Test 6. The error found between calculated and measured airflows lies between 0% and 8%. Supply air inputs to both chambers measured directly and from tracer measurements again show reasonable agreement, with an error of between 4% and 10%.

## Discussion

The magnitude of the two-directional airflows was calculated using a one-directional approximation to give 'first order' estimates.[1]

Where two-directional air movement exists between two connected spaces, recirculation of tracer gas will occur. Consequently the shape of the tracer decay curve in the source room will not be a simple exponential function. The error associated with ignoring recirculation of tracer gas is a complex function of time, air change rate and intercell air movement.[2]

Generally the slope of the tracer decay curve in the source room for time from 0–10 minutes closely approximates to a single exponential function. After this period, the fact that the decay curves represent the sum of two exponential functions becomes increasingly significant.

Provided a sufficient number of concentration and time points are available i.e. at least ten, then a good estimate of the source room air change rate is obtained using the 'first order' estimations. The growths of tracer concentration in the receiving rooms are less strongly dependent on time, so that sufficiently accurate estimations of air flow can be obtained using this method over a period of up to 30 minutes.

## References


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   Air flow measurement using three tracer gases.
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   The measurement of airflows using a rapid response multiple tracer gas technique
   To be published



This research, sponsored by UK Science and Engineering and Research Council (SERC), is based in the Department of Building, UMIST, under the joint supervision of Professor P.J. Burberry and Dr A.T. Howarth.

The authors thank Mr Alan Taylor-Firth of the Department of Building, Sheffield City Polytechnic for his kind cooperation in making available the double environmental chamber.


*Table 1. Summary of Results*

| Test No. | Calc. Supply Rate (1) m³/hr | Calc. Supply Rate (2) m³/hr | Measured Supply Rate (1) m³/hr | Measured Supply Rate (2) m³/hr | Calc. Airflow (1)–(2) m³/hr | Calc. Airflow (2)–(1) m³/hr | Measured Airflow (2)–(1) m³/hr | Measured Airflow (2)–(1) m³/hr | % Error Measured (1)–(2) Calc. | % Error Measured (2)–(1) Calc. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | See Figure 2 | | | | | | | | |
| 2 | | See Figure 3 | | | | | | | | |
| 3 | | See Figure 4 | | | | | | | | |
| 4 | 110 | 116 | 105 | 127 | – | 43 | – | 44 | – | 2.3 |
| 5 | 50 | 180 | 55 | 170 | – | 127 | – | 134 | – | 5.5 |
| 6 | 98 | 100 | 90 | 110 | 53 | 52 | 52 | 54 | 2.0 | 3.9 |
| 7 | 111 | 119 | 120 | 108 | 31 | 49 | 31 | 47 | 0 | 4.1 |
| 8 | 57 | 53 | 60 | 55 | 51 | 26 | 53 | 24 | 3.9 | 7.6 |

# The Present NRC Indoor Air Quality Research Programme

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**National Research Council,**
**Ottawa, Canada**

Indoor air quality research at the Division of Building Research (DBR) consists of a Urea Formaldehyde Foam Insulation (UFFI) research subprogramme of the highest priority, scheduled for completion in 1986–87, and a number of non-UFFI activities spread across several sections. At present there are some eight research and technical officer person years (PY) in DBR being applied to UFFI research plus 1.5 in the National Aeronautical Establishment (NAE) and 0.5 in the Division of Chemistry.

The UFFI research subprogramme has been underway for two years now. This is led by DBR, with the active participation of the NAE and Chemistry Divisions. In the main, the work is contracted out and a small cadre of contractors with useful expertise and facilities to carry out research is beginning to get established across the country. A core of in-house research activities is also in place and this needs to be maintained and expanded for the total programme to be most effective.

Objectives of the UFFI research subprogramme are:

- to develop methods and equipment that can be used to determine if a building has an unacceptably high level of formaldehyde or other contaminants associated with UFFI
- to develop economical ways to reduce the concentration of pollutants emanating from UFFI to acceptable levels
- to provide technical advice.

The major activities of the UFFI research programme to achieve these objectives can be summarized as follows:

- to study and characterize the UFFI materials in chemical and physical terms
- to determine if gases other than formaldehyde are being emitted by UFFI into houses in sufficient quantities to be of concern to health authorities
- to determine the extent to which particles of UFFI material are transmitted into the living space as respirable suspended particulates (RSP)
- to develop UFFI emissions control measures to virtually eliminate their entry to the living space of the building
- to develop Canadian UFFI gas measurement technology
- to provide technical advice to other government departments and agencies, and the public at large.

Major achievements to date include:

- the publication of a technical note entitled 'Urea Formaldehyde Foam Insulation: Problems Identification and Remedial Measures for Wood-Frame Construction, BN P 23. 1981', describing UFFI emission control measures. Two further documents, based on two years of UFFI research and expanding further on the Division's building practice expertise, will be issued later this fiscal year
- the advice of the DBR UFFI Unit continues to be solicited by the UFFI Information and Coordination Centre which was established by the federal government to coordinate the activities of all government agencies in regard to the UFFI problem
- a Canadian Formaldehyde Assay Kit has been developed and is now being marketed. Canadian designed room air and wall cavity dosimeters are completing the initial full scale field testing stage.
- state-of-the-art equipment is being used to assist in the identification and quantification of UFFI RSP and trace gases.

In addition to the UFFI research programme, there are another eight research and technical officer person years (PY) in DBR being applied to other air quality research. This programme is only beginning to get underway. Air contaminant measurement equipment for field and laboratory use is in place in the Energy and Services Section. This section has expertise in smoke movement, which is useful in air quality and ventilation studies, and has two controlled ventilation offices in place and ready for experiments.

The Energy and Services Section contracted with a Consulting Engineering firm to study formaldehyde and radon levels in some electrically heated houses in Toronto. The Thermal Performance, and Energy and Services Sections are conducting tests to measure contaminant levels from kerosene heaters and gas stoves, to determine the effectiveness of using a mechanical ventilation system with an exhaust air heat-recovery heat pump or an air to air heat exchanger in a low energy house in Orleans. The Prairie Regional Laboratory is conducting studies on formaldehyde and radon levels in 46 energy efficient tight enclosures houses in Saskatoon.

While most of the Divisional reports on air quality research to date are still in preparation, some preliminary observations are worth noting:

- many of the energy efficient, tight enclosure houses have higher formaldehyde levels than UFFI houses, and several have relatively high radon daughter levels
- formaldehyde and radon levels in air conditioned electrically heated houses are higher in summer than winter.

# One Million Person Hours Devoted to Air Infiltration Research

The Air Infiltration Centre's latest survey (AIC-TN-12-83) reports an estimated one million person hours of current research effort into air infiltration and related air quality investigations in buildings. This worldwide survey contains information on 187 projects received from researchers in 22 countries.

The significance of this area of research cannot be over emphasised. On the one hand air infiltration can easily account for more than 25% of the heat loss from a building, while on the other hand, excessive levels of airtightness can result in a serious deterioration in indoor air quality. It is this latter aspect that has become a key issue, with over a third of the respondents to the survey citing indoor air quality investigations as a specific objective. Despite the necessity to satisfy indoor air quality needs, the potential for energy conservation is enormous. This is indicated by the many projects in which measurement methods and calculation techniques are being used to determine the impact of both airtightness measures and alternative ventilation strategies on building heat loss.

The survey report, containing an analysis of the results followed by the reproduction in full of the research information provided by contributors, is available free-of-charge to organisations in participating countries direct from the Air Infiltration Centre (see page 12 for ordering details).

# Air Leakage Characteristics of Buildings

**Carolyn Allen**
**Air Infiltration Centre, Bracknell, UK**

During the course of the Air Infiltration Centre's model validation study, as reported in AIC Technical Note 11, it became apparent that, for good prediction of air infiltration rates, there is a need for both a proper representation of wind pressures, and an accurate estimation of the building's air leakage characteristics. The former requirement is being considered in a separate project in relation to which a technical workshop is due to take place in March (see below). This note concerns the second requirement for which more information on the air leakage through structures and building components is needed.

Current leakage values such as published by ASHRAE[1] and CIBS[2] and BSI[3] may be adequate for sizing heating systems, but they are generally not suitable for hour-by-hour energy analysis of buildings (Tamura[4]). In practice, the level of detail of leakage information required is a function of the complexity of the model being used, ranging from single cell models using whole house leakages, to the most complex multi-cell network models which require a knowledge of the leakages between the various nodes. Most models require as input, a relationship between the pressure difference across a leakage path and the flow through it. This relationship is usually expressed in terms of a steady state mean flow, although, in reality, fluctuating pressures are the norm. There are several forms of steady state flow equation in current use, and the debate concerning the suitability of these continues. In reality leakage flows are rarely steady because of the fluctuating nature of wind generated pressures. These fluctuations have been shown to be significant[5] and, although attempts have been made to allow for this effect in calculation models[6], much more information is required before non-steady flows can be adequately predicted.

The geometry of the leakage path is also an important factor. This may be well defined as, for example, in components such as windows, doors, grilles and vents. However a high proportion of air leakage occurs through ill-defined routes within the structural fabric and at wall/floor/ceiling joints. It may be necessary to treat this in general terms as 'background' leakage, but again more data are required to enable representative estimates to be made.

In view of these needs, the Air Infiltration Centre is establishing a database of numerical information on air leakage characteristics. Building on the material derived from the model validation study, the aim is to include results of laboratory and site measurements, as well as leakage specifications and standards. All organisations that have such data or that are currently involved in air leakage measurements are invited to contact us. Any contribution of data would be welcomed because AIC wishes to make the fund of information as comprehensive as possible.

**References**

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3. British Standards Institution 'B.S.I. Code of Practice for design of buildings: ventilation principles and designing for natural ventilation'. British Standard BS5925: 1980.

4. Tamura G.T. 'The calculation of house infiltration rates', ASHRAE Trans. Vol. 85, Pt. 1 (1979), pps58–71, #AIC=3.

5. Potter I.N. 'Effect of fluctuating wind pressures on natural ventilation'. ASHRAE Symposium: Air infiltration and flow around buildings. ASHRAE Trans. Vol. 85, No. 2 (1979), pps445–457.

6. Etheridge D.W., Alexander D.K. 'The British Gas multi-cell model for calculating ventilation', ASHRAE Trans. Vol. 86, Pt. 2 (1980).

## Wind Pressure Workshop

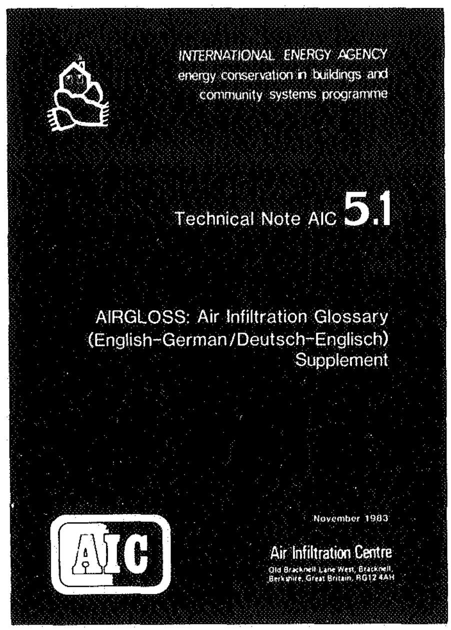
The AIC two-day specialist wind pressure workshop to be held in Brussels, Belgium on 21st and 22nd March 1984 promises to be a well supported event.

The aim is to pool available information and ideas on building wind pressure data suitable for use in air infiltration models. The workshop will open with a presentation outlining the problem, followed by sessions on measurement data (both full-scale and wind tunnel models) and the application of data to air infiltration models. Further research needs will also be considered.

Applications to attend will be accepted up to 29th February 1984. Therefore, if you would like to contribute to this workshop, or receive full information regarding the content, please contact Carolyn Allen or Jenny Elmer at the Air Infiltration Centre.

The registration fee is £35.00.

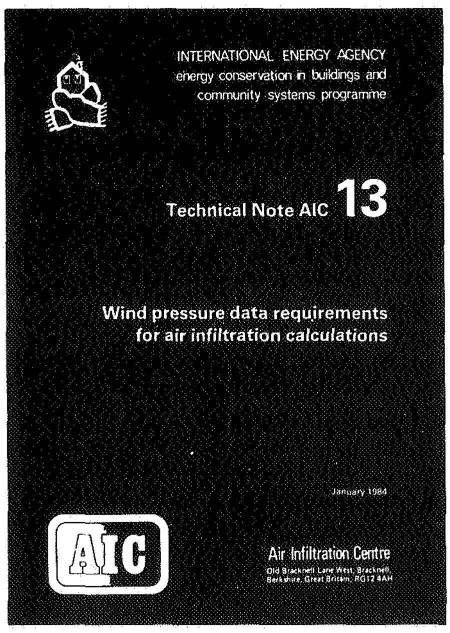
# New Publications from the AIC




## AIC-TN-5.1-83 AIRGLOSS (English/German – Deutsch/Englisch 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).

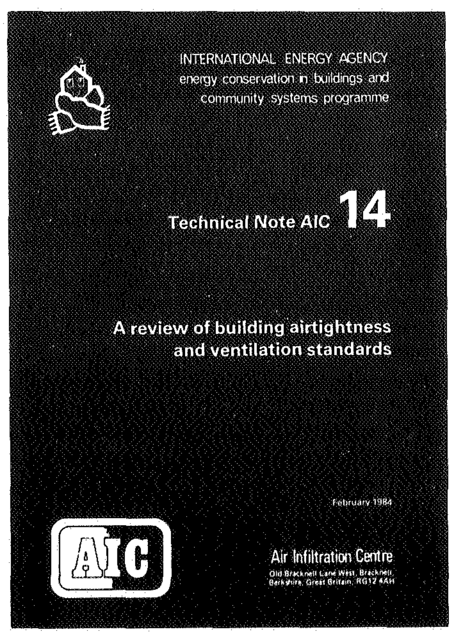



## AIC-TN-13-84 Wind Pressure Data Requirements for Air Infiltration Calculations

This document describes the wind pressure data requirements for calculating air infiltration and highlights the inadequacies of the currently available wind pressure coefficient information. The published results of wind pressure distribution research are reviewed and a novel method of presenting pressure coefficients in a numerical form is developed. A selected bibliography of full-scale, wind tunnel and theoretical studies is included.

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

## AIC-TN-14-84 A Review of Building Airtightness and Ventilation Standards




Since the oil crisis of 1973, many countries have developed policies reducing energy consumption in the national building stock. This has included a trend towards making buildings more airtight. To satisfy the need to both conserve energy and maintain an acceptable level of indoor air quality, standards are being introduced in many countries detailing airtightness requirements and ventilation rates.

The aim of this technical note was to list and analyse such standards in the ten countries participating in the Air Infiltration Centre. One additional country, West Germany, has also been incuded since the German standards are often used as models in other European countries. Relevant standards produced by the European Committee for Standardisation and the International Standards Organisation are also listed.

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

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

# Review

## Proceedings of the Workshop on Indoor Air Quality and Energy Conservation

**Helsinki University of Technology, Finland**

This recently received report contains the text of 14 papers presented at an International CIB W67 Workshop on indoor air quality and energy conservation, held at the Laboratory of Heating, Ventilating and Air Conditioning, University of Helsinki, Finland, on 15th June 1983. The papers cover all aspects of building energy conservation including air infiltration, airtightness, ventilation and heat recovery. Eight of the contributions are by Finnish authors, with the result that this report provides an extensive guide to energy conservation in Finland. The remaining authors are from Germany, the Netherlands, Sweden, the United States and the United Kingdom.

A general review of air infiltration, air quality and ventilation research in Finnish buildings is presented by Jorma Railio of the Technical Research Centre of Finland. He summarises the results of four years of research. Typical ventilation strategies are described and the performance of each is assessed. Air quality problems investigated include high concentrations of formaldehyde in new airtight dwellings, localised radon problems and condensation caused by uncontrolled pressure conditions. Future research needs identified in the paper include:

- studies into the desirability of airtight buildings and structural joints
- research into the relationship between airtightness, air infiltration and total air change rates

investigations into the control of supply air intake through the building envelope.

Many of the points summarised in Dr. Railio's paper are amplified in some of the other Finnish contributions.

Carbon dioxide controlled ventilation systems are attracting much interest in Finland. The value of this strategy is described in a paper by Leena Kuusela of EKONO. Schools, offices, theatres, warehouses and other public buildings are cited as examples of premises in which occupation varies considerably throughout the day. Because the fresh air exchange rate is generally set for maximum occupation, ventilation rates for a substantial part of the day are far too high. Using a $CO_2$ sensor to monitor the metabolic concentration of carbon dioxide, it is possible to continuously adjust the mechanical ventilation rate to suit the number of occupants. Results of a 12 month field study have shown that savings in ventilation heat loss between 35 and 45% are possible using this technique.

Contributions to the proceedings from outside Finland include papers on the monitoring and modelling of low-energy houses (UK), timber frame construction and interstitial condensation (UK), indoor air quality research in the United States, a review of air leakage in dwellings (Netherlands), the Swedish plan for research and energy conservation 1984–1987, and trends in thermal and sound insulation (Germany).

Copies of these proceedings are available direct from:

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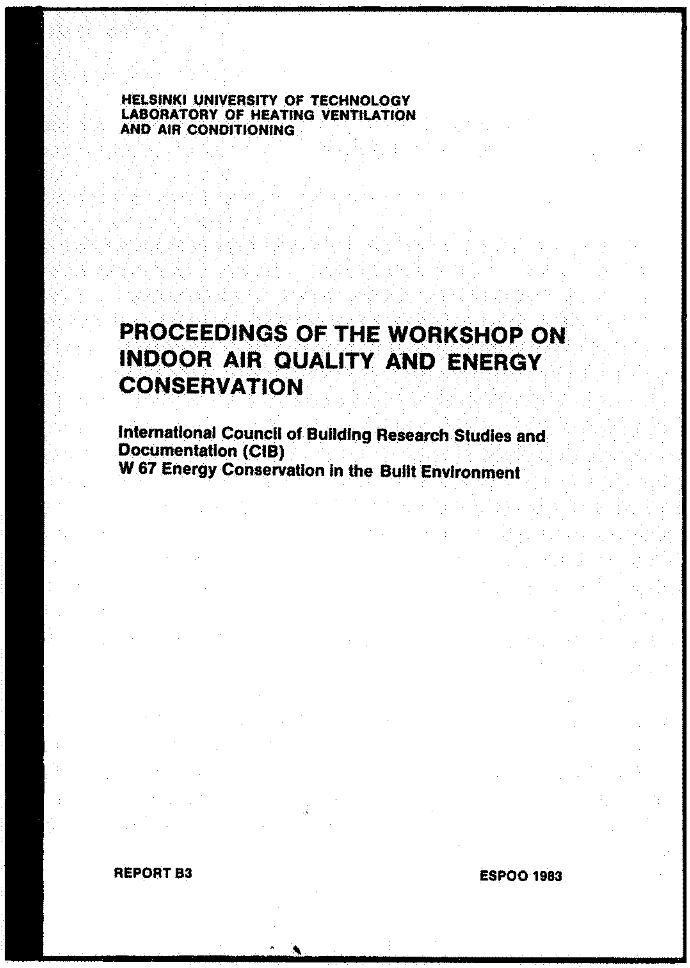
HELSINKI UNIVERSITY OF TECHNOLOGY
LABORATORY OF HEATING VENTILATION
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PROCEEDINGS OF THE WORKSHOP ON
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CONSERVATION

International Council of Building Research Studies and
Documentation (CIB)
W 67 Energy Conservation in the Built Environment

REPORT B3

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# Recent Acquisitions

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

1. Tamura, G.T., Evans, R.G.
   Evaluation of evacuated glass tubes for sampling of SF6/air mixture for air exchange measurement.
   ASHRAE Jnl., Vol. 25, No. 10, 1983, p40–43.

   *Describes a technique for grab sampling a tracer gas/air mixture.*

2. Klems, J.H.
   Methods of estimating air infiltration through windows.
   Energy & Buildings, No. 5, 1983, p243–252.

   *Describes a procedure that claims to yield more reliable estimates of infiltration rates through a window than methods which are currently being employed.*

3. De Walle, D.R., Heisler, G.M.
   Windbreak effects on air infiltration and space heating in a mobile home.
   Energy & Buildings, No. 5, 1983, p279–288.

   *Measures reduction in air infiltration when using a windbreak of pine trees.*

# 5th AIC Conference

## Advance Notice

**Title: 'The implementation and effectiveness of air infiltration standards in buildings'**

**Venue: Reno, Nevada, USA**
**Dates: 1–4 October 1984**

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 such measures. For example, some standards stipulate stringent levels of airtightness. To avoid indoor air quality problems, these must be introduced with caution and generally demand the incorporation of purpose provided ventilation systems. This approach is common in severe climates and provides the opportunity for additional energy savings both by means of heat recovery and by incorporating control strategies to react to deterioration in indoor air quality. In less severe climates, however, the cost effectiveness of such an approach is less certain.

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.

The provisional range of subjects to be covered includes:

- the setting of optimum ventilation rate standards and their enforcement
- review of existing and proposed airtightness standards for buildings
- review of existing and proposed building tightness measurement standards
- experience of building designers/contractors on the practical application of airtightness testing and standards
- impact of current standards in terms of both energy conservation and indoor air quality
- the influence of climate on airtightness requirements
- techniques used to assess the effectiveness of airtightness standards
- air quality controlled ventilation strategies
- occupant reaction to well-sealed buildings.

This conference, therefore, should be of significant importance to those involved in assessing the needs and effectiveness of airtightness approaches in buildings. Full programme and registration details will be published in the May 1984 edition of AIR, or can be obtained from your Steering Group representative. Please reserve the conference dates, 1–4 October 1984, in your diary.

## Other Conferences

1. Wind Pressure Workshop
   Brussels, Belgium
   21 and 22 March 1984

   *Further information from:*
   *The Air Infiltration Centre*

   *Or from your local Representative (see pack page of this newsletter)*

2. ASTM Symposium on Measured Air Leakage Performance in Buildings
   Philadelphia, USA
   April 1984

   *Further information from:*

   *Ms K. Greene*
   *ASTM Publications Division*
   *1916 Race Street*
   *Philadelphia*
   *Pennsylavia 19103*
   *USA*

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

   *Covers energy conservation in residential, commerical and industrial buildings.*

   *Further information from:*
   *Professor F. Curtis*
   *Chairman – Technical Program & Publications*
   *University of Regina*
   *Regina*
   *Saskatchewan*
   *S4S 0A2*
   *Canada*

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

   *Further information from:*

   *RESO Congress Service*
   *S-10524 Stockholm*
   *Sweden*

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*

*3rd fold (insert in Flap A)*

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