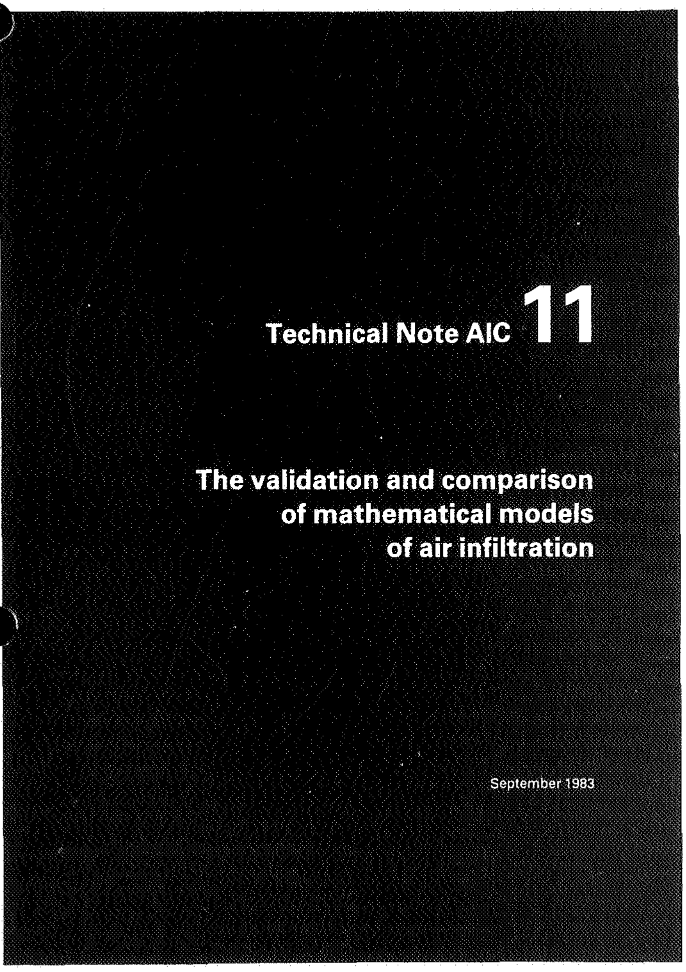
Air Infiltration Review

a quarterly newsletter from the IEA Air Infiltration Centre

Vol. 4 No. 4 August 1983

Model Validation Results



Martin Liddament and Carolyn Allen,
Air Infiltration Centre, UK

One of the fundamental tasks of the Air Infiltration Centre has been to undertake an extensive programme of air infiltration model validation. The principal objectives of this study were to use experimentally-derived data to assess the reliability and full range of applicability of air infiltration models and to identify the key parameters which must be accurately specified to achieve valid calculations of air infiltration. The results of this task will shortly be published as AIC Technical Note 11.

A total of ten models developed in five participating countries were selected for analysis and are described in the report. These models range in complexity from 'single cell' approaches in which the interior of the building is assumed to be at a single uniform pressure, to 'multi-cell' techniques in which the interior is subdividied into zones of differing pressure interconnected by leakage paths.

Numerical data, based on air infiltration measurements and associated climatic data, for 14 dwellings were also compiled. From these data, three key datasets were prepared for use in each of the selected models. To enable future comparison exercises, each of these key datasets is reproduced in full in the appendices.

The performance of each model is described in turn followed by a sensitivity analysis of model parameters. Finally, the accuracy, strengths and weaknesses of each model are compared.

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

Other subjects in this issue:

Symposium on Air Infiltration Model Validation

ASHRAE Semi-Annual Meeting, Washington DC, USA, 26–29 June 1983

Report by Martin W. Liddament, Senior Scientist, Air Infiltration Centre, Bracknell, UK

Air infiltration model validation was the theme of a symposium held at the recent ASHRAE Semi-Annual Meeting in Washington DC. This symposium provided an opportunity to outline details of the Air Infiltration Centre's programme of model validation and to present a selection of results. Other contributions included:

- a detailed examination of the Lawrence Berkeley Laboratory air infiltration model by Mark Modera of LBL, USA.
- a comparison of measured and predicted infiltration rates by Andrew Persily of the US National Bureau of Standards.
- the development of an air infiltration model for an energy performance design system by Chris Crall of Owens-Corning Fiberglas, USA.
- correlating measured infiltration for wind from a single direction by David Wilson of the University of Alberta, Canada.

The presentations encompassed the entire range of modelling techniques from basic regression studies to numerical solutions of flow equations. It was interesting to note that data are now widely available for use in the verification of models, thus enabling a full assessment of the performance of predictive air infiltration models to be made. In all instances, acceptable correlations between calculated results and measured air infiltration rates were achieved and it was apparent that much progress has been made in understanding the performance of air infiltration models. The need for a critical analysis of the influence of leakage openings and weather parameters on infiltration calculations was emphasised by all contributors. Also discussed was the accuracy of tracer gas measurements, against which the results of air infiltration calculations are invariably compared.

As a cautionary note, the point was stressed during the course of the symposium that, by using previous knowledge of the measured rates of air infiltration, it is possible to adjust model parameters to achieve good results. This cannot, of course, be accomplished when using a model to make predictions. It is essential, therefore, to have a thorough understanding of the input needs of models and to ensure that there are sufficient data to satisfy these needs. This provides the key to reliable model performance and has been a fundamental objective of the AIC's validation study.

Several other technical sessions, symposia and seminars proved relevant to air infiltration investigations. In particular, a symposium on ventilation efficiency provided the opportunity to review the several definitions, interpretations and calculation methods that are used to describe the performance of ventilation systems. A seminar cryptically entitled 'Unresolved issues in Fundamentals Chapter 21' was devoted entirely to moisture problems in buildings. In all instances, such problems could be traced to poor air distribution and badly designed ventilation systems. A unique method to overcome moisture problems was not thought to be possible; much depended on building design, climate, ventilation strategy and method of space heating.

Preprints of the papers presented at ASHRAE technical sessions and symposia are available, price $3 each (inclusive of postage), direct from:

ASHRAE Publications Sales Dept.,
1791 Tullie Circle N.E.,
Atlanta,
GA 30329,
USA.
Tel: (404) 636 8400

Unfortunately, papers or proceedings of seminars are not published and therefore much of the discussion on moisture problems in buildings will be lost. However, it is hoped to devote a special issue of Air Infiltration Review to ventilation and air infiltration aspects of moisture problems in the near future.

AIC Welcomes Belgium

We are pleased to announce that Belgium has accepted the invitation of the IEA Executive Committee on Energy Conservation in Buildings and Community Systems to become a participating member of Annex V (Air Infiltration Centre) from 1 June 1983.

It is good to welcome a new participant and we look forward to a fruitful exchange of information with Belgian organisations and to providing them with AIC's full range of technical services.

We hope to feature an article on air infiltration research in Belgium in a future issue of AIR.

4th International Symposium on 'The Use of Computers for Environmental Engineering Related to Buildings' – In Japan

A report by Peter J. Jackman
Head of Air Infiltration Centre, UK

This four day conference reflected both the high efficiency and dedicated application usually associated with the Japanese. It was superbly organised and the intensity of the programme was such that, on one of the days, 32 papers were presented consecutively. Of the 101 papers in all, 59 were by Japanese authors.

Sessions were devoted to calculation procedures for building heating and cooling loads, for design and simulation of HVAC systems and for solar, lighting, water supply and drainage systems. There was a notable trend towards simplified numerical procedures suitable for use on modern micro-computers. The use of computers for research and for the control and monitoring of buildings also featured prominently.

There were several papers which included various aspects of infiltration and indoor air quality. One entilted 'Calculation of unsteady room temperature in a dwelling house including effect of natural ventilation' by Y. Sakamoto was a report of a project undertaken by the Japanese Building Research Institute. The paper emphasises the need to treat infiltration/natural ventilation as an unsteady phenomena and a procedure for calculating air flows generated by wind and buoyancy effects is presented. Although based on exponential flow equations, the calculation procedure has been simplified by treating the flow/pressure difference relationships as a composite of linear relationships. Indoor air temperatures were used for the comparison of predictions and site measurements for two test houses. There was reasonable agreement but, regrettably, no air infiltration rate measurements were made and so an opportunity to verify that part of the calculation procedure was missed.

Another Japanese paper including details of procedures for calculating infiltration and natural ventilation was 'Development of a simulation program for heat loads and room temperatures of a residential building' by M. Udagawa and K. Ishida of Kagahuin University, Tokyo. Again, an exponential flow equation was used. A simulation example is presented giving information on the flow coefficients used for the various windows and doors but the derivation of the corresponding wind pressure differences is not indicated.

A paper describing CIRA, Lawrence Berkeley Laboratory's energy analysis program was presented by R. Sonderegger with the title 'CIRA – a microcomputer based energy analysis and auditing tool for residential applications'. In it air infiltration is calculated on a monthly basis using the method developed by Sherman and Grimsrud. The method is based on the leakage area of the house, the type of terrain on which it is located and the degree of local shielding. The program provides an economic analysis of potential energy saving measures. However, in the example given not one of the retrofit measures listed in order of merit was directly related to air leakage. It was stated during discussion that this was not necessarily typical.

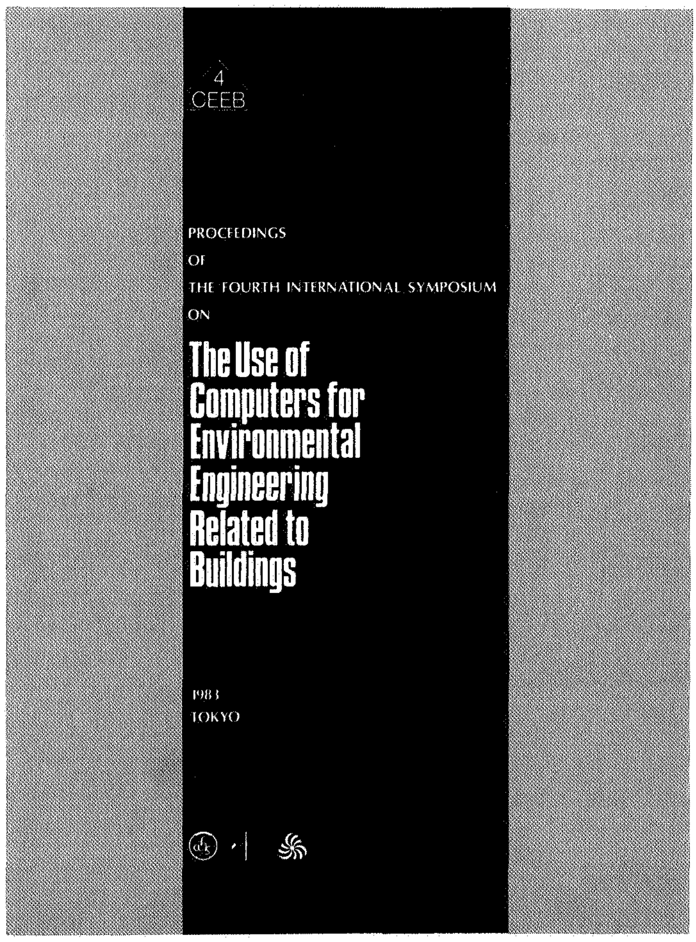
The next paper described a set of programs developed in Sweden for architects. It was 'MEPA Description and verification of a microcomputer building energy analysis program' by B. Andersson, M. Lokmanhekim and A. Wadek. The program calculates monthly heating and cooling loads of residential and small commercial buildings by performing a 24-hour prediction for each of two typical days of weather constructed to represent that month. It is stated that the air leakage change rates used can be either constant at a preselected value, or variable related to wind speed and temperature differentials. Verification of the simplified procedures has been conducted not by comparison with measured data, but by comparisons with a more complex and comprehensive building energy analysis program (BLAST).

There were two papers both by Japanese authors on the numerical modelling of internal flows. One by S. Murakami et al 'Numerical simulation of air flow and gas-diffusion in room model' compares predictions and measured values at a number of steady state conditions. The other, concerned with non-steady flow was 'Numerical solutions and visual experiments for two-dimensional unsteady-state flow' by M. Nishida et al.

A simple equation for the estimation of the concentration of indoor airborne contamination was proposed by Y. Ishizu et al (Japan) in a paper entitled 'Validity of the application of mixing factor and position factor to the expression of indoor air pollution'. The values of these two factors are given for different room shapes and location of contaminant sources.

A second paper on indoor air pollution 'Ventilation strategies for the control of body odour' was presented by P.O. Fanger (Denmark) who described studies undertaken in two auditoria. It was concluded that CO_2 may be used as an index of body odour intensity in a space occupied by a group of people at a given activity and temperature. This confirms the results of others, e.g. Wanner, who conducted experiments under rather more controlled conditions. Unlike the results of Yaglou, no significant influence of space volume per occupant on body odour intensity or steady-state ventilation requirement was found.

A bound volume of the conference proceedings is held in the AIC library.



Air Infiltration Research at the Lawrence Berkeley Laboratory

M.H. Sherman,
Energy Performance of Buildings Group,
Lawrence Berkeley Laboratory, University of California, USA.

Introduction

Because air infiltration can account for one-third to one-half of annual space-heating and space-cooling energy use, it has been the focus of the largest ongoing project in the Energy Performance of Buildings Group, which is a part of the Energy Efficient Buildings project at the Lawrence Berkeley Laboratory. Our work in this area concerns measuring, modelling, and reducing air infiltration in buildings; objectives are to develop the theoretical and experimental expertise needed by researchers, architects, and engineers, to provide design guidelines, and to develop construction quality standards for optimal air leakage and infiltration. A major achievement of this programme has been the development of a model that predicts infiltration from weather data and a single leakage parameter – the effective leakage area. The magnitude of leakage area can serve as an important criterion for designers and builders and is a useful diagnostic aid for auditors or house doctors.

AC Pressurization

One of the most interesting experimental techniques we have developed is called AC pressurization. This is a method for determining the leakage of the envelope of a building at low pressures. It has several advantages over conventional (DC) fan pressurization, which uses a blower door. AC pressurization has a much higher signal-to-noise ratio (i.e. it is more precise), is capable of working in the low pressures typical of natural infiltration (i.e. one to ten pascal), and combines both pressurization and depressurization results simultaneously. The physical process of AC pressurization changes the effective volume of the test space periodically and monitors the resultant internal pressure change; knowing the size of the volume change and the pressure response as a function of time allows the direct (on-line) calculation of leakage.

The first version of AC pressurization was built to investigate the low-pressure leakage behaviour of a structure and to validate the technique. It was successful and led to the concept of effective leakage area. The second version was a stand-alone system that did not pierce the building envelope; it was designed to calculate the leakage area in real time. Measurements taken in 1982 included a study on a single structure at frequencies in the (sub-audible) range of 0.1–3.0 Hz; they showed that the apparatus could respond in real time to changes in the leakage area of the envelope at driving pressures of the order of one pascal. A sample output is shown in Figure 1. The traces show, from bottom to top: the absolute pressure in the sealed back volume behind the piston; the changes in pressure in the test space caused by the changes in volume; the changes in volume in the test space (called the 'volume drive', calculated in real time from the absolute pressure), and finally the leakage area, which is calculated in real time from the volume drive and the test-space pressure. The second version has laid the groundwork for a useful field instrument that could replace conventional fan pressurization; the final instrument may operate with acoustic techniques in the 10-Hz range.

Modelling

The concept of effective leakage area combined with that of weather-induced pressures led to the development of the LBL infiltration model. It expresses natural ventilation as a function of total leakage area, wind speed, temperature, and building configuration and can be used to predict infiltration from weather and blower-door measurements for both short-term and long-term purposes. For short-term measurements, the model has an accuracy of approximately 20%; for longer-term averages, the accuracy is as good as 5%. The model is used in the computer programs Computerized Instrumented Residential Audit (CIRA), DOE-2.1, and BLAST and is included in the 1981 ASHRAE Handbook of Fundamentals. Other institutions that have used the model include the Naval Civil Engineering Laboratory, Retrospectors, and the Bonneville Power Administration.

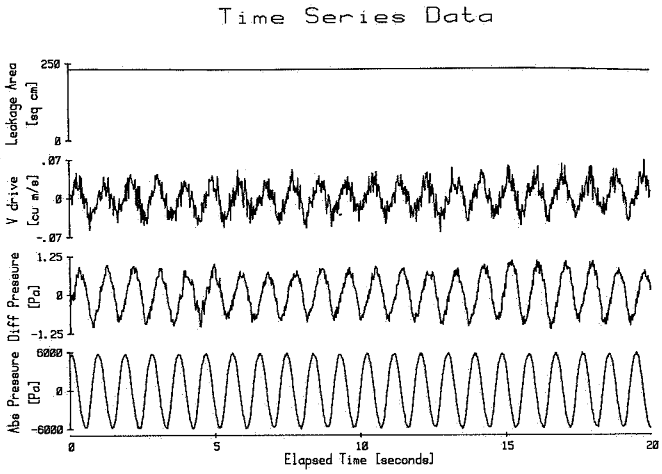


Figure 1. Output from the AC-pressurization equipment, which measures effective leakage area in real time without penetrating the envelope of the building. For an explanation of the trace, see the text.

Field Measurements

We have made several sets of field measurements of infiltration and leakage. Our Mobile Infiltration Test Unit (MITU), a portable, full-size structure, makes simultaneous measurements of infiltration, pressure, wind, and temperature and records them for future analysis. Air infiltration is measured by the Continuous Infiltration Monitoring System (CIMS), which continuously injects a tracer gas. The mobile unit is shown in Figure 2. Because of the value of MITU for understanding and verifying infiltration models, we have continued to make field measurements with it on the grounds of

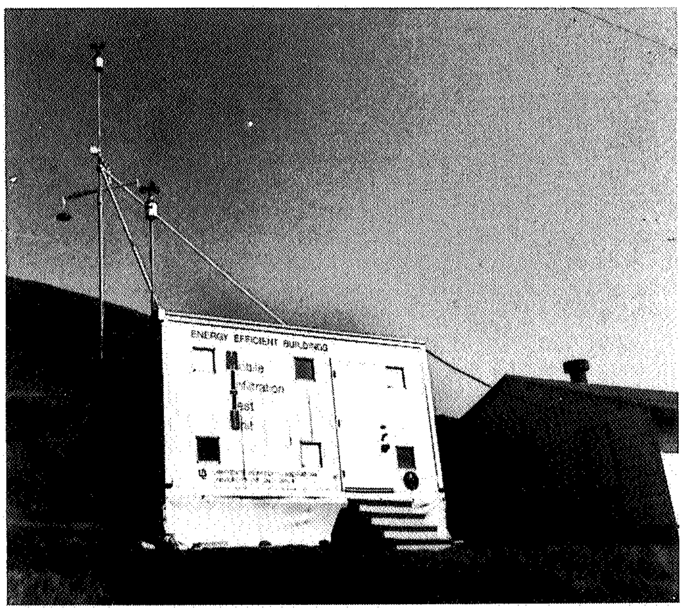


Figure 2. The Mobile Infiltration Test Unit at a site near Fort Cronkhite, CA.

the Reno, Nevada, airport. Most of our work using MITU has been concentrated on the relationship between measured and predicted infiltration, but we have also used it to monitor independently the interior and exterior pressures on MITU. Figure 3 shows the dependence of the exterior pressure coefficient on angle for one of the faces of MITU. A pressure coefficient is a dimensionless factor giving the increase in pressure caused by the wind. It should be positive for windward orientations and negative for leeward ones.

Recently, we began a project to study the effect of wind on natural ventilation for its usefulness in mitigating cooling loads in hot, humid climates. Three dissimilar buildings at the Kaneohe Marine Corps Air Station (KMCAS), Hawaii, were instrumented with surface-pressure, temperature, humidity, and air-velocity probes; on-site weather parameters (air temperature, humidity, wind speed, and wind direction) were also monitored. Other field work has included an investigation into component leakage in a small sample of houses and several sets of long-term average infiltration measurements using our low-cost Average Infiltration Monitor (AIM).

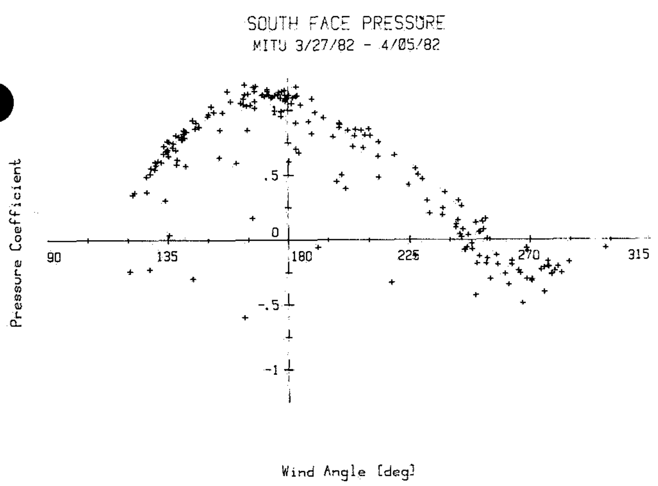


Figure 3. Instantaneous pressure coefficients measured by the Mobile Infiltration Test Unit (MITU) at Reno, NV.

International Research Exchange

Much important work has been contributed by international researchers visiting our group; many governmental and academic institutions have sent scientists to work with us in the pursuit of our research goals. In the past we have had visits of up to one year from distinguished researchers from throughout the world: Ake Blomsterberg from the Royal Institute of Technology, Stockholm, Sweden; Prof. Masaya Narasaki from the University of Osaka, Japan; Dr Jean-Yves Garnier from the Paul Sabatier University, Toulouse, France; Prof. David Wilson from the University of Alberta, Edmonton, Canada; Pierre Ninane and Paul Blaude from the University of Liege, Belgium; Dr Chistoph Zuercher from the Federal Institute of Technology, Zurich, Switzerland; Helmut Feustel from the Hermann Rietschel Institute, Berlin, Federal Republic of Germany; and Pierfrancesco Brunello from the Unviersity of Padua, Italy. We currently have three distinguished visiting scientists from Scandinavian countries: Per Levin, Claus Reinhold, and Eimund Skaaret.

Per Levin graduated from the Royal Institute of Technology, Stockholm, Sweden, in Civil Engineering 1978 and since then has been involved in research regarding airtightness and the consequences thereof for energy-efficient houses at the RIT, Division of Building Technology. Together with Arne Elmroth, he has produced 'Air Infiltration control in Housing: A Guide to International practice' for the Air Infiltration Centre. At LBL, his work is concerned with infiltration modelling and with developing air tightness standards and building technology for new housing in the US.

Claus Reinhold works at the Danish Building Research Institute with the Indoor Climate and Energy Division. This division runs two mobile laboratories: Indoor Climate Measurements; and Energy Measurements; these mobile laboratories use tracer gas measurements in the investigation of infiltration and ventilation efficiency. The mobile Energy Measurement Laboratory, of which Claus is the project leader, analyses the effect of infiltration on energy consumption by analysing weather data and records of the energy consumption. While at the Lawrence Berkeley Laboratory, Claus is participating in several ongoing projects: developing instrumentation for measuring the low pressure function of a building (AC pressurization); developing mobile Air Infiltration Monitors (AIM); and describing a method to calculate building leakage areas based on component information.

Eimund Skaaret is an associate professor in the fields of heating and ventilating at the Norwegian Institute of Technology, Division of Heating and Ventilating. He received his Ph.D. in Heating and Ventilating in 1975: Modelling of Indoor Environment – Physical Small-Scale Flow Models of Ventilated Rooms. Since 1970 he has worked on engineering calculations of air flow in ventilated rooms, which led in 1979 to the study of the efficiency of ventilation. The basis for this work was formed working with industrial ventilation, where it became obvious that ventilation systems aiming at complete mixing were not the best ones. In addition to the definition of various concepts of ventilation efficiency, which have led to new methods for studying air infiltration, guidelines for efficient ventilation are being developed. In short, ventilation systems should be designed to create displacement flow patterns (preferably with air supply direct to the zone of occupation) and not to create complete mixing. The scope of his work at LBL is to study in more detail the local ventilation efficiency specifically related to pollutant transport. This is highly influenced by the characteristics of the contaminant sources and thermal conditions of the rooms and the ventilating system. To study this effect, a project, entitled single-room infiltration and ventilation efficiency, will be carried out in a 27-m^3 test chamber, using tracer gas to simulate the sources of contamination. Tracer-gas concentrations will be monitored at 33 points in the room. Various types of ventilation arrangements will be used ranging from infiltration to balanced mechanical ventilation.

Future Work

We will continue our research efforts into natural ventilation by analysing full-scale measurements of wind-induced infiltration, and we will continue to analyse the data from KMCAS. If the information is to be useful in hot, humid climates, it will be important to consider comfort levels, rather than just air temperature, in the analysis of the data. As the full-scale work progresses, we will begin to make scaled measurements in a wind tunnel. We plan to develop the AC pressurization equipment into a device that can easily be used to measure leakage area and that would replace the current fan-pressurization apparatus.

We will extend our investigations into new areas: multichamber infiltration, HVAC interactions with infiltration, and occupancy effects. We plan to use MITU to make full-scale measurements on the interaction between HVAC systems and total ventilation, including flues and chimneys for combustion appliances and vents and stacks (powered or unpowered) for ventialtion; we will also consider the effect of duct leakage and total ventilation. We also intend to survey a large number of occupied dwellings to extract the occupant contribution to infiltration.

This work was supported by the Assistant Secretary for Conservation and Renewable Energy, Office of Building Energy Research and Development, Building Systems Division of US Department of Energy under Contract No. DE-AC03-76SF00098.

Watson House 'Autovent' – A System for Measuring Air Infiltration Rates

Dr D. Etheridge
British Gas Corporation,
Research and Development Division, London

BRITISH GAS

Introduction

The Watson House 'Autovent' system is designed to monitor ventilation rates in dwellings. It basically consists of two parts – a computer controller and an electromechanical sample and injection system. This note briefly describes the sample and injection system, which could be supplied to interested organisations at a current cost of about £4,500.

The system consists of three units – one sample unit and two injection units (A and B). It allows tracer gases to be injected in controlled amounts at up to fourteen points in the dwelling. Gas samples can be taken from twelve points, independently of the injection units. The sample unit also monitors temperatures at the twelve points, plus one external temperature.

Operation Modes

The system may be operated in one of two modes, Manual or Auto. In manual mode the various functions are selected by front panel switches. In Auto mode the system is controlled by an external, user supplied, computer/data logger. The required mode is selected by a front panel keyswitch. When one mode is selected the other is inhibited. In either mode the system's status is indicated by lamps and an analogue voltage proportional to the temperature of the selected thermistor is provided.

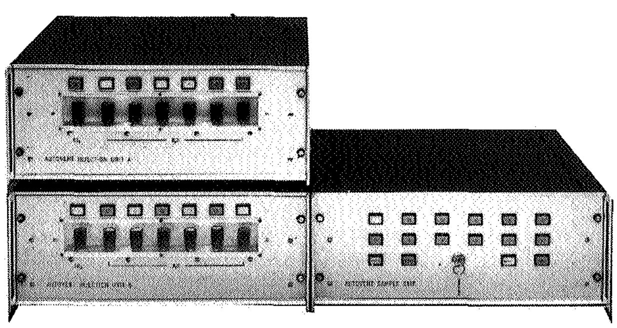


Figure 1. Sample and injection units.

Injection Units

Both injection units A and B are identical except for their labels. Each unit has two tracer gas inputs and seven injection gas outputs. Six outputs are connected to the primary tracer gas and the seventh to a secondary tracer gas. Any of the seven outputs may be switched on and off at random by solenoids as required, either by front panel switches when in manual mode, or by the external computer/data logger when in auto mode. The flow rates of each of the seven outputs are controlled by precision needle valves. In current systems, the valves for channels 7 to 12 of unit B have a smaller operating range than the other channels.

Sample Unit

The sample unit allows sample gas and temperature to be monitored, by external user supplied instrumentation, from one of twelve channels. This is achieved by the use of an electrically stepped rotary valve/switch unit (Samplivalve). Temperature is sensed by linear thermistor networks. In manual mode, operation of the 'step' button causes the next sample channel to be selected. Sequence is: 1, 2, 3, 4,5, 6, 7, 8, 9, 10, 11, 12, 1, 2, 3 etc. The channel selected is indicated by lamps on the front panel. Sample gas inlets and outlets are via bulkhead fittings on the unit's back panel. Temperature sensors are connected via three pin DIN sockets also on the back panel.

The sample unit also contains the various system power supplies.

Mechanical data

The units are mounted in separate cases, approximately 210mm x 400mm x 520mm. Connections between units and external computer/data logger are by plug/sockets.

The needle valves are housed behind the front panel in illuminated boxes. Access to them is via removable clear perspex panels.

The system is designed to run from a 240 volt a.c. 50 Hz single phase mains supply connected to the unit by an IEC mains connector.

For further details, please contact:
Dr D. Etheridge,
British Gas Corporation,
Research and Development Division,
Watson House,
Peterborough Road,
London, SW6 3HN,
UK.
Tel: 01-736 1212, Ext. 3043
Telex: 919082

Let Others Know ......

Air Infiltration Review offers the opportunity for brief, informative articles relating to air infiltration research and its application. Contributions of general interest on, for example, new projects, developments in instrumentation, novel applications of energy saving, natural or mechanical ventilation systems, or behavioural effects on infiltration would be most welcome.

Why not prepare an item for the next issue? Last date for receipt of copy is 3rd October 1983.

Annex IX 'Minimum Ventilation Rates'

IEA – Energy Conservation in Buildings and Community Systems

Dr L. Trepte,
Dornier System GmbH, d-799o Friedrichshafen/Germany

From the viewpoint of energy conservation, air infiltration and ventilation have to be minimized. A certain amount of fresh air, however, has to be supplied to a building in order to maintain healthy, safe and comfortable conditions for the occupants and to avoid damage to the building fabric. The optimization of these conflicting requirements will result in guidelines for minimum ventilation rates which are sufficiently large to meet the demand for fresh air without unnecessarily wasting energy.

In the first phase of the work of ANNEX IX the participants have reviewed existing knowledge, national standards and current and required research. The participants have incorporated these two summary reports. A comprehensive final report is in preparation and will be published in July, 1983. In the course of this review it has become clear that the existing basis for specifying ventilation requirements is weak and that a substantial effort is needed to improve the position.

The work that will be required covers a wide range of disciplines, from hygiene and medicine on one hand to engineering and building science on the other.

Much research is being planned and initiated. The IEA-ANNEX IX provides a highly suitable mechanism for co-ordinating the research in these diverse fields and for encouraging the necesssary contributions from participating countries.

In the first phase nine countries co-operated: Canada, Denmark, Germany, Italy, Netherlands, Sweden, Switzerland, United Kingdom and the United States of America. Germany is the Operating Agent.

The following topics have been investigated:

Carbon Dioxide in Buildings
G.T. Tamura, Canada

Tobacco Smoke
H.U. Wanner, Switzerland

Formaldehyde
J. Wegner, Germany

Biocides
M. Fischer, Germany

Ionizing Radiation
L.-G. Mansson and Th. Lindvall, Sweden

Microorganisms
H.U. Wanner, Switzerland

Hydrocarbons and Other Organic Substances
B. Seifert, Germany

Combustion Products
P.R. Warren, United Kingdom

Humidity
P.R. Warren, United Kingdom

Body Odour
P.O. Fanger, Denmark

Minimum Ventilation Rates Necessary to Prevent Odour Annoyance – A Field Investigation
H.B. Bouwman and W. de Gids, Netherlands

Particulates and Fibres
G.V. Fracastoro and A. Mazza, Italy

Air Treatment in Buildings
G.T. Tamura, Canada

Relationship Between Outdoor and Indoor Air Pollution
G.W. Traynor and A.V. Nero, USA

Some substances can be used as an indicator for acceptable air quality to determine desirable ventilation rates. For example:

CO – as an indicator for tobacco smoke.

CO_2 – if generated by occupants, can be an indicator for body odour and, to a lesser extent, radon.

The determination of concentration limits for minimum ventilation rates are largely correlated with risk analysis and risk strategies. Setting an acceptability limit with respect to comfort or health risk is a question which should be discussed in more detail during the next working phase.

This situation can be illustrated by today's only existing guidelines with respect to radiation in dwellings. Swedish guidelines demand that, in new construction, the long-time-average of radiation must not exceed 70 Bq/m^3. However, the limit of 70 Bq/m^3 is based on the assumption that, of a group of people being exposed to this level for 60 years, 1% will develop lung cancer because of radon.

For the purposes of determining ventilation rates, other substances either are of minor importance in the majority of the building stock, e.g. micro-organisms and most of the particulate fibres, or should not, or in some cases cannot, be used, primarily because the knowledge concerning them is still meagre.

Substances that cause a background pollution and that may even lead to severe health risks, e.g. formaldehyde, biocides, other organic substances and radon, should be treated in the following way:

– identify problem buildings.

– identify pollution sources.

– eliminate pollution sources.

– reduce pollution sources by retrofit measures.

– prevent pollution sources by product control.

– eventually apply air treatment or higher ventilation rates.

The general decrease of ventilation rates that is desirable for energy saving will lead to an increase in the percentage of the buildings with an air-quality problem if appropriate measures are not taken at the same time.

The participants concluded that there are still many areas requiring further research. Therefore, they proposed that ANNEX IX should continue and that the objective for the next phase should be to define more closely the ventilation requirements for those indoor pollutants identified in the first phase of ANNEX IX as being of most importance, and for which research is likely to yield results within a reasonable time scale.

Pollutants which have been so identified are:

– formaldehyde.

- tobacco smoke products.
- radon.
- moisture and humidity.
- body odour and carbon dioxide.
- organic vapours and gases.

The proposed continuation of ANNEX IX covers the two-year period July 1983 until June 1985.

The German contribution is a part of the German research and development programme 'Air Infiltration and Ventilation in Buildings' and relates to a research grant by the Programme Management for Energy in co-ordination with the Federal Ministry for Research and Technology and the Federal Ministry for Regional Planning, Architecture and Town Planning.

Forthcoming Conferences

1. **4th AIC Conference**
   'Air infiltration reduction in existing buildings'
   Elm, Switzerland
   September 26 – 28 1983

   For further information please contact your Steering Group Representative (see back of this newsletter)

2. Infra-red Scanning Course
   Burlington, Canada
   23–26 August and 15–18 November 1983

   Four day certification course in the application of infra-red scanning devices to detect building energy losses, roof moisture and to inspect electrical and mechanical systems.

   Further information from:

   Paul Grover, Director
   The Infraspection Institute
   Hullcrest Drive
   Shelburne
   Vermont 05482
   Canada

3. Energy Saving in Buildings – International Seminar
   The Hague, Netherlands
   14–16 November 1983

   Further information from:

   Dr J. Isings
   c/o Congress Bureau
   TNO Corporate Communication Dept
   PO Box 297
   2501 BD The Hague
   Netherlands

4. 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
   Pennsylvania 19103
   USA

5. Third Annual Symposium on Building Economics
   Ottawa, Canada
   18–20 July 1984

   Subject areas include:

   - New concepts for assessing and measuring economic performance of buildings.
   - Economic optimization of building design.
   - Computer-aided cost modelling.

   Further information from:

   Mr A.A. Wilson
   Division of Building Research
   National Research Council
   Ottawa
   K1A 0R6
   Canada

6. 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

   Call for papers has been announced. Abstracts should be sent to above address by 31 October 1983.

7. Clima 2000.
   World Congress on Heating, Ventilating and Air Conditioning.
   Copenhagen, Denmark.
   August 25 – 30 1985.

   Further details from:

   Clima 2000,
   Copenhagen '85,
   Ordrup Jagtvej 42B,
   DK 2920 Charlottenlund,
   Denmark.

Recent Acquisitions

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

1. Wadden, R.A., Scheff, P.A.
Indoor air pollution: characterization, prediction and control.
A Wiley-Interscience Publication, ISSN 0194-0287, 1983, 212pp, ISBN 0 471 87673 9

Explores the health implications, the measurement of and prediction techniques for indoor air pollution.

*2. Grimsrud, D.T., Sonderegger, R.C., Sherman, M.H.
Infiltration measurements in audit and retrofit programs.
Energy Audit Workshop, 13–15 April 1981, Swedish Council for Building Research Document, D21:1982, 115–139pp

Describes a model that relates fan pressurization results to infiltration values.

*3. Brayshaw, C.J., Dewsbury, J.
The measurement of air infiltration in large enclosures.
Proceedings Contractors Meeting 'Energy conservation in buildings – heating, ventilation and insulation', Brussels, 1982, 306–320pp

Describes a project aimed at developing a method of measuring air infiltration rate in large single cell enclosures and buildings.

*4. Thellier, F., Grossin, R.
CO_2 based ventilation in dwellings.
Proceedings Contractors Meeting 'Energy conservation in buildings – heating, ventilation and insulation', Brussels, 1982, 364–368pp

Discusses a new energy conservation technique based on the control of the 'fresh air intake' through measurement of CO_2 content in extracted air.

*5. Pham, Q.T., Oliver, D.W.
Tracer techniques and data interpretation for infiltration measurements.
Preprint, Meat Industry Research Institute of New Zealand, 1983, 6pp

Describes a simple, inexpensive sampling technique for infiltration measurement using SF_6 tracer gas.

*6. Goodfellow, H.P., Smith, J.W.
Industrial ventilation – a review and update.
American Industrial Hygiene Association Jn1, Vol. 43 No. 3, 1982, 175–184pp

Reviews technical progress being made in the industrial ventilation field, including natural ventilation and specialized ventilation techniques.

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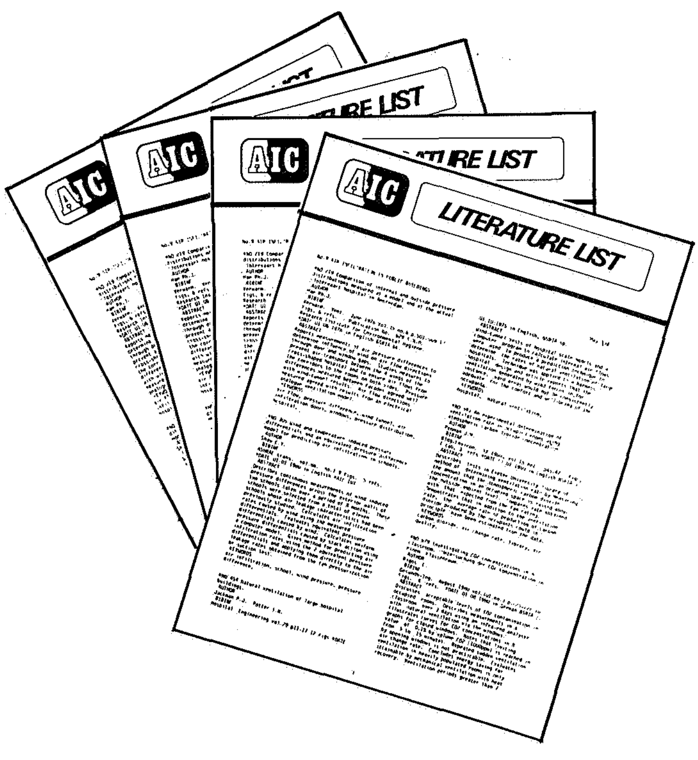

AIC Literature Lists have now been updated to include many more useful references on selected subjects from the AIC bibliographic database *AIRBASE*. To date, there are nine literature lists on particular topics related to air infiltration.

Topics covered are:

- Pressurization – infiltration correlation: 1 models
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- Domestic air-to-air heat exchangers
- Air infiltration in industrial buildings
- Air flow through building entrances
- Air infiltration in commercial buildings
- Air infiltration in public buildings.

Organisations in participating countries may obtain copies by applying to the AIC Library using the AIC Publications Order Form on page 12.

New Instrumentation Report

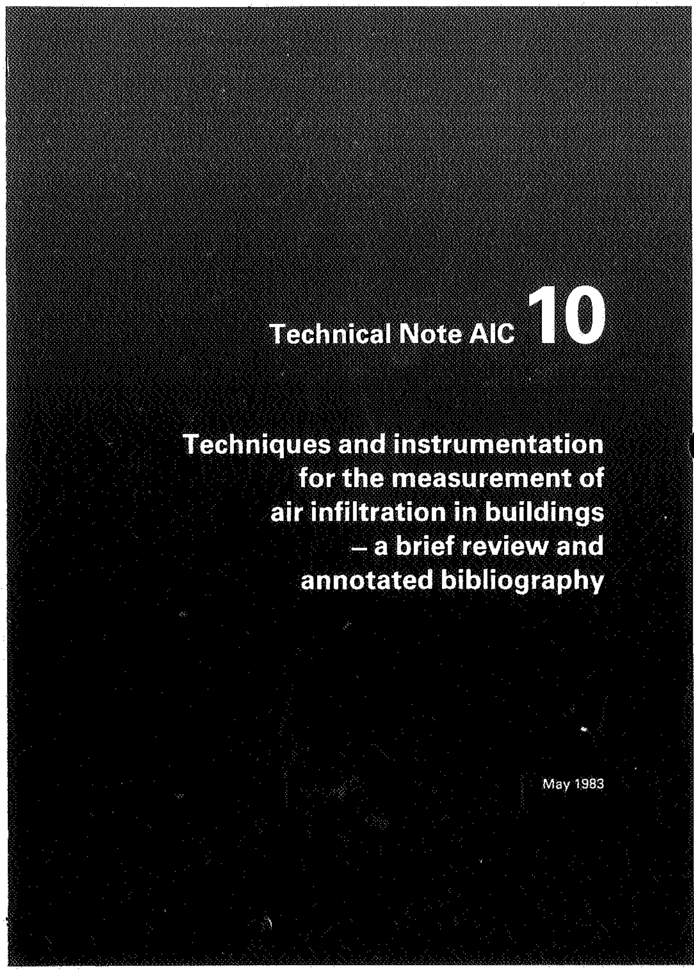
AIC-TN-10-83
Techniques and Instrumentation for the Measurement of Air Infiltration in Buildings – A Brief Review and Annotated Bibliography

Martin Liddament and Catriona Thompson,
Air Infiltration Centre, UK

In recent years, considerable progress has been made in the development of air infiltration measurement techniques; the aim of this report is to highlight these recent developments in a brief review and selective bibliography of measurement methods. In addition, the report contains details of manufacturers of instrumentation currently being used in air infiltration investigations.

The first section of the bibliography contains review papers selected to provide a comprehensive background to the theory behind air infiltration measurement techniques. The remaining three sections concentrate on tracer gas techniques, pressurization methods and miscellaneous approaches respectively. All references are taken from the AIC's bibliographic database *AIRBASE* and have been selected on the basis that they provide sufficient information to allow the techniques described to be readily used and adapted. Detailed listings of instrument manufacturers are contained in three appendices. These cover tracer gas analysers, pressurization test equipment and surface pressure measuring instumentation respectively.

This report is available free-of-charge direct from the AIC to organisations in participating countries only. It supersedes AIC-TN-4-81 'Instrumentation for the measurement of air infiltration – an annotated bibliography'.


Technical Note AIC 10

Techniques and instrumentation for the measurement of air infiltration in buildings – a brief review and annotated bibliography

May 1983

THE AIR INFILTRATION CENTRE was inaugurated through the International Energy Agency and is funded by ten of the member countries:

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

The primary role of the Air Infiltration Centre is the technical support of active research in air infiltration in buildings. Its main aim is to bring the prediction of air infiltration rates and the associated energy implications up to a level comparable with that developed for other energy transfer processes in buildings.

3rd fold (insert in Flap A)

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