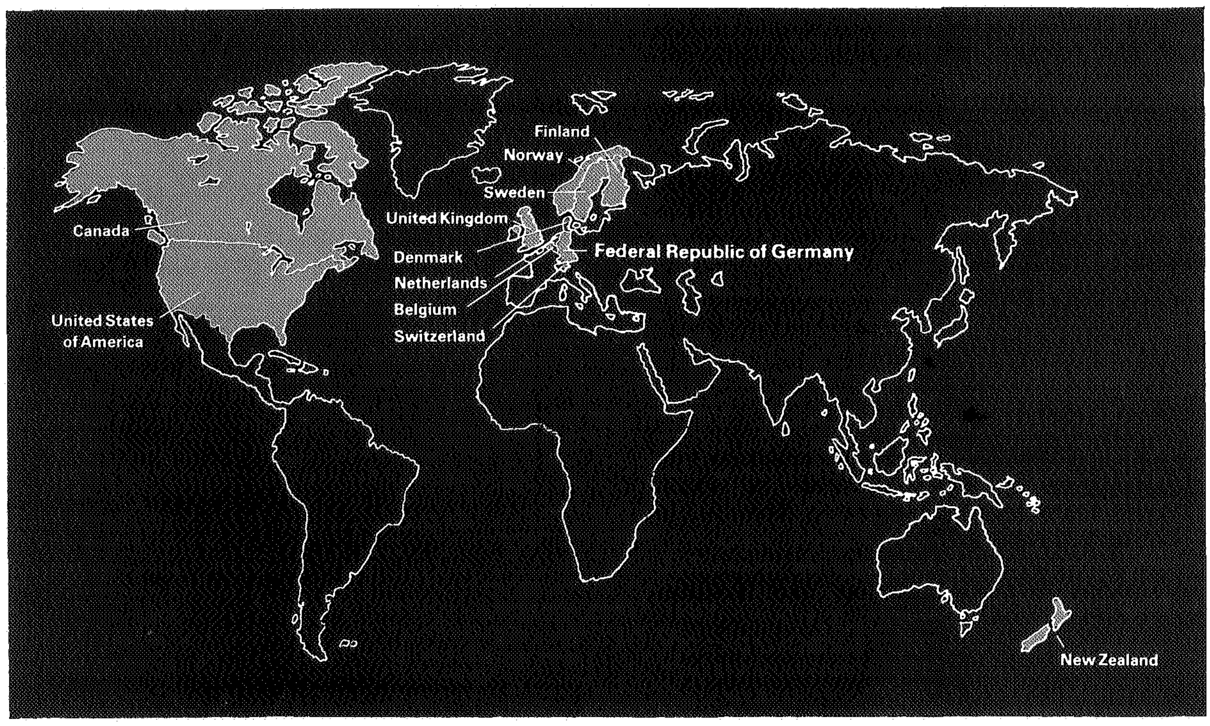
Air Infiltration Review

a quarterly newsletter from the IEA Air Infiltration Centre

Vol. 6, No. 2, February 1985

Germany – Twelfth Participant!



We are most pleased to welcome the Federal Republic of Germany as a new participant of the Air Infiltration Centre, bringing our total to 12. Germany is undertaking an extensive programme of air infiltration research and is also much involved in related IEA projects including participation in Annex IX on 'Minimum Ventilation Rates'. In addition, German standards for ventilation and component airtightness have been developed.

The full participation of Germany can therefore only be of positive benefit and will reinforce the strength of the Air Infiltration Centre as it enters its seventh year of activities.

A full analysis of the German research programme is being prepared for publication as an AIC report. It is also hoped to publish a resume of these activities in the May 1985 issue of Air Infiltration Review.

Inside this issue:

Building Airtightness Standards

P.J. Jackman, M.W. Liddament, Air Infiltration Centre

Introduction

Heat loss from buildings continues to represent a substantial proportion of the prime energy consumed in many countries. As measures to upgrade the thermal performance of buildings proceed, air infiltration and ventilation account for an increasing segment of the space heating (or cooling) load. It is primarily for this reason that airtightness controls are beginning to form part of the building codes and recommendations in a number of countries.

In addition to increasing the potential for energy conservation, more airtight construction or retrofit techniques can also contribute to a comfortable, draught-free environment. On the debit side, however, excessive airtightness may result in a serious deterioration in indoor air quality. Consequently, it is of paramount importance that these measures are introduced with the utmost caution.

The lead in the introduction of airtightness standards has been taken by those countries which have the more severe climates and have been particularly vulnerable to the effects of increase in the price of oil. In others, airtightness standards have recently been, or are currently being, developed.

This article reviews the existing standards of the AIC participating countries and comments on the factors that should be taken into acocunt in the application and future development of airtightness requirements. It is based on papers presented by the authors at the 5th AIC Conference, 1–3 October 1984, Reno, Nevada, USA.[1,2]

Current Airtightness Requirements

Whole Building

Currently Norway and Sweden are the only countries that have recommendations for the airtightness of whole buildings, although there are proposals being discussed in Canada and USA on this subject.[3,4]

Tabulated summaries of the Norwegian and Swedish requirements are given below:

Norwegian Building Regulations*

Building type	Airchange rate/hr at 50 Pa
Single family dwellings	4
Buildings up to two floors	3
Buildings exceeding two floors	1.5

Swedish Building Code

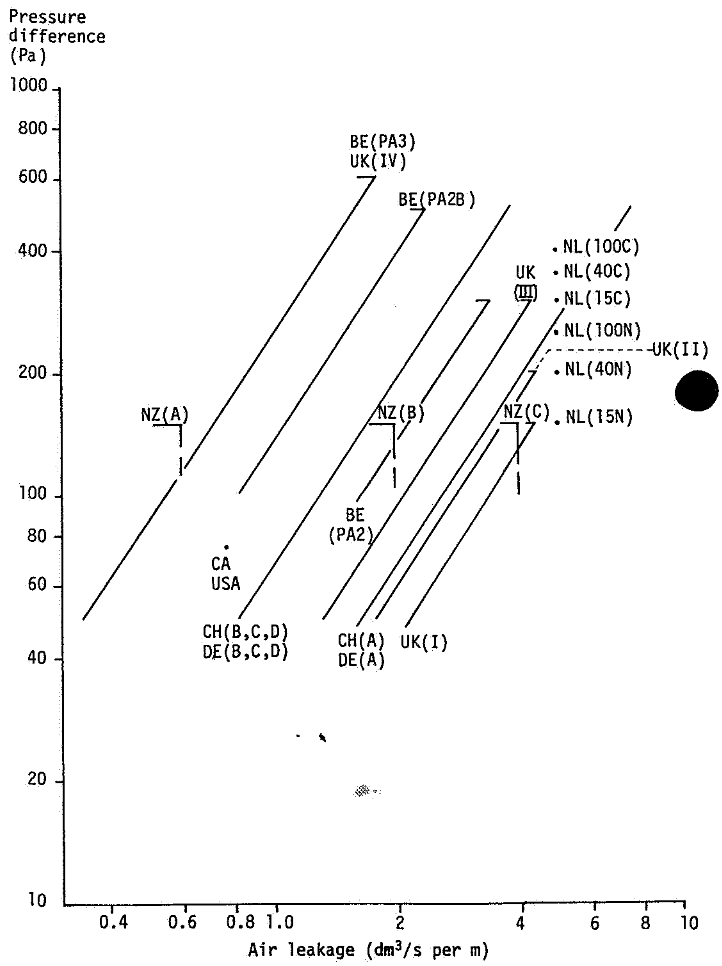
Building type	Airchange rate/hr at 50 Pa
Freestanding single-family houses and linked houses	3
Other residential buildings of not more than two storeys	2
Residential buildings of three or more storeys	1

The Swedish specifications are the more stringent.

*A list of standards to which reference is made is given at the end of this article.

Windows

The standards of several countries specify the maximum allowable leakage of windows with some grading according to application. In others, a leakage classification system is detailed but with no reference to acceptability for particular uses.



KEY

BE = Belgium
CA = Canada
CH = Switzerland
DE = Germany
NL = Netherlands
NZ = New Zealand
UK = United Kingdom
USA= United States of America

Figure 1: Window air leakage rates – per m joint length

Most standards specify the leakages in relation to unit length of the opening joint while a few specify them in terms of unit window area. Thus direct comparison of all the standards is not possible. However, comparison has been made in each of the two forms by plotting the allowable leakage values in Figures 1 and 2. The plot of leakages expressed per metre of joint length show, surprisingly, that the highest classifications are to be found in countries having relatively mild climates, i.e. Belgium, New Zealand and UK. The high Scandinavian standards are evident in the other figure where they are compared with the New Zealand classifications which are expressed in both forms.

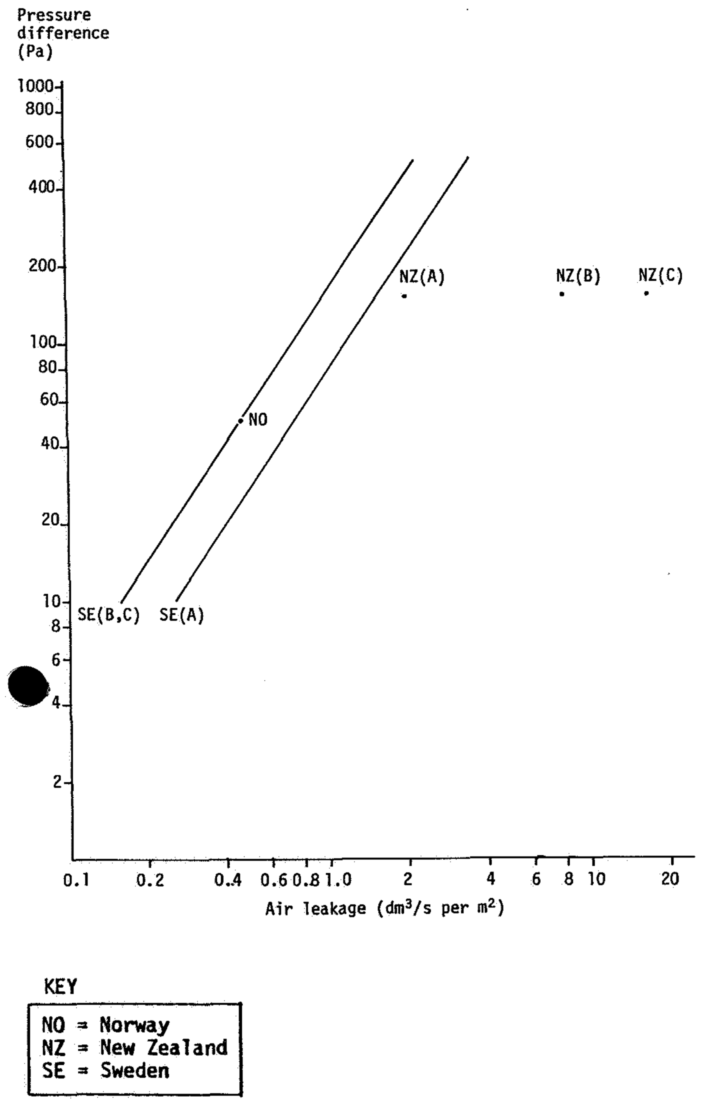


Figure 2: Window air leakage rates – per m^2 window area

Doors

Canada: 'Measures for energy conservation in new buildings'

The following maximum air leakage rates at a pressure differential of 75 Pa are specified for doors separating heated spaces from unheated spaces or the exterior.

Manually operated sliding doors	2.5 dm^3/s per m^2 of door area
Swing doors (residential)	6.35 dm^3/s per m^2 of door area
Other types	17.0 dm^3/s per m^2 of door crack

Norway: Norwegian Building Regulations

External doors are required to comply with the same requirements for airtightness as windows, i.e. 1.7 $m^3/h\ m^2$ (0.47 $dm^3/s\ m^2$).

Sweden: Swedish Building Code SBN 1980

Same classification is given for external doors and windows.

USA: ASHRAE Standard 90–80

Maximum air leakage rates at a pressure differential of 75 Pa are specified as follows:

Sliding glass doors (residential)	2.5 dm^3/s per m^2 of door area
Entrance swinging doors (residential)	6.35 dm^3/s per m^2 of door area
Swinging, revolving, sliding doors for other than residential use	17.0 dm^3/s per linear metre of door crack

These criteria are similar to those of Canada.

Building Sections

Leakage criteria for sections of buildings exposed to outdoors are only found in the following Scandinavian standards.

Norway: Norwegian Building Regulations

The maximum air leakage at a pressure difference of 50 Pa is specified as 0.4 $m^3/h\ m^2$ (0.11 $dm^3/s\ m^2$) for individual external building sections, i.e. external walls, ceilings and floors.

Sweden: Swedish Building Code SBN 1980

The maximum air leakage for various building sections is specified as follows:

	Pressure difference Pa	Maximum air leakage $m^3/h\ m^2$ ($dm^3/s\ m^2$) in building height (number of floors)		
		1–2	3–8	>8
Exposed walls	50	0.4 (0.11)	0.2 (0.056)	0.2 (0.056)
Roof and joist structures exposed to outdoors next to ventilated space	50	0.2 (0.056)	0.1 (0.028)	0.1 (0.028)

Factors Influencing Airtightness Requirements

In formulating airtightness standards many factors need to be considered. These include climate, the sources and severity of indoor pollution, ventilation requirements, existing practices, cost and the overall impact of such controls on energy conservation. Requirements also vary according to building use. Airtightness and ventilation needs are therefore extremely diverse and hence solutions appropriate to one particular building or climatic region may not necessarily be satisfactory elsewhere. It is therefore essential that the concepts and implications of building airtightness are thoroughly explored before the introduction of such standards. Most importantly, airtightness and ventilation should not be approached in isolation but need, instead, to be considered in context with other energy conservation measures. The durability of components used to achieve the desired standard also needs to be verified, since any deterioration in the product will result in a long-term failure to achieve the desired level of energy conservation.

There are essentially two approaches to building airtightness. The first is to follow an almost total airtightness policy in which separate provision is made to satisfy ventilation needs by mechanical means. The second method is to introduce limited airtightness measures such that passive ventilation is sufficient to meet most needs. The former technique offers good control over air change rates, so providing an opportunity to benefit from the full value of air infiltration reduction techniques. Its main disadvantage is that system expense and additional construction costs are high. Furthermore it is essential that the design airtightness is maintained throughout the life of the building. By comparison, the partial airtightness approach, incorporating natural ventilation involves a much smaller increase in expenditure. In addition, a margin of natural leakage ensures a certain degree of safety, while at the same time excessive rates of air infiltration are minimised. However, the latter technique does not offer the same degree of energy conservation as the former.

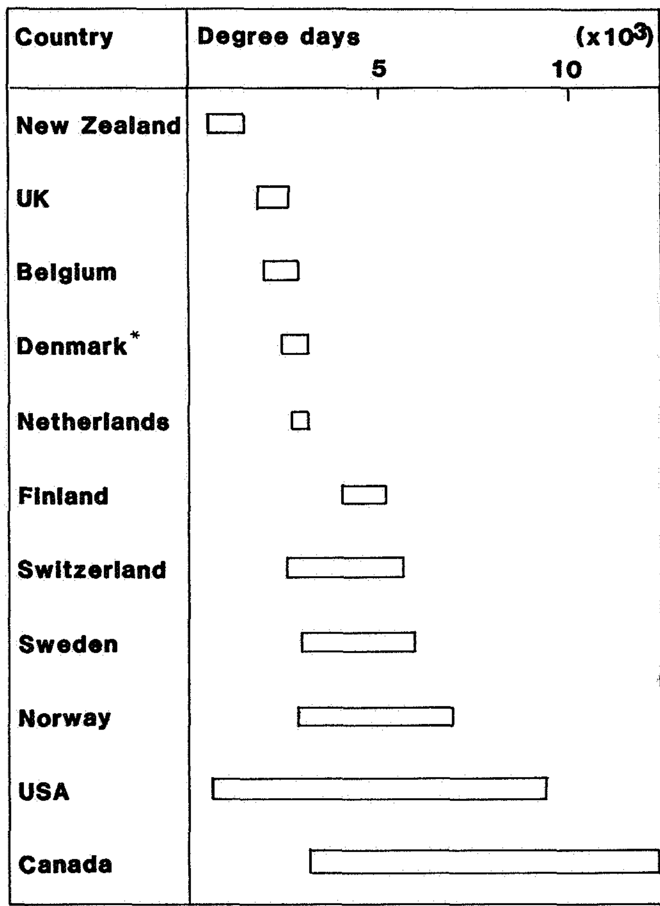
For energy investigations, the severity of climate is frequently quantified in terms of degree days, where a degree day is the number of degrees of temperature difference on any one day between a given base temperature and the corresponding daily mean outside air temperature. Unfortunately there is no international agreement on base temperature, although it is normally regarded as the external temperature below which space heating is required. Typical values of both base temperature and design indoor temperature for dwellings, taken from the AIC Handbook[5] and other sources, are summarised in Table 1. Differences between design room temperature and the temperature at which heating is needed are assumed to be satisfied by incidental gains from solar radiation, building occupants and powered appliances, etc. In the United States the concept of degree days is also used for cooling load calculations where the cooling degree day is given by the number of degrees above a base temperature of 25.5°C. The heating and cooling load degree days are combined to give an 'infiltration' degree day (IDD) for use in air infiltration calculations.[4]

Table 1: Variations in degree day definition

Country	Indoor design temperature (living areas) °C	Base temperature °C
Belgium	20.0	15.0
Canada	21.1	18.0
Denmark	20–21.0	17.0
Finland	20.0	17.0
Netherlands	20.0	18.0
New Zealand	20.0	18.0
Norway	20.0	17.0
Sweden	20.0	17.0
Switzerland	20.0	20.0
United Kingdom	18.3	15.5
USA	20.0	18.3

Typical degree day ranges for several countries are reproduced in Figure 3. This shows values ranging from below 1,000 in parts of New Zealand to above 12,000 in the North of Canada. Despite the lack of uniformity regarding the definition of degree days, this concept nevertheless provides a convenient method for defining an approximate 'climatic threshold' at which specific airtightness and ventilation approaches become effective options.

Such an approach is recommended in proposed United States ASHRAE standards.[4] In the severest climatic areas of the country a high degree of airtightness is proposed with a consequential need for mechanical ventilation. Elsewhere, progressively less stringent requirements are envisaged according to the value of infiltration degree days.



*Approximate range

Figure 3: Degree day ranges for AIC participating countries

Conclusions

Energy conservation cannot be achieved simply by reducing air change rates. Airtightness and ventilation standards must be introduced in conjunction with good building design to ensure that indoor air quality problems are avoided. Actual ventilation needs are dependent on building use, the source and strength of pollutants and local climate. Where stringent airtightness measures have been introduced, purpose provided ventilation is essential. Conversely if mechanical ventilation is installed, airtight construction is essential, otherwise the potential for energy conservation will not be achieved.

It is unlikely that mechanical ventilation alone will offer an energy advantage over a comparable natural ventilation system. Only by combining mechanical ventilation with heat recovery will a reduction in energy usage be possible. However, while heat recovery can be shown to be energy effective, i.e. can offer a considerable reduction in energy demand on a national scale, it is often difficult to justify this approach in terms of cost effectiveness to the consumer. It is possible to make an assessment of the viability of heat recovery by consideration of degree days. Typical installation and operating costs indicate that such a system is viable for single family dwellings over a 20 year payback period for degree days in exceess of about 3K – 5K. More precise figures can be readily calculated given details of energy costs, ventilation needs, etc. For larger buildings where the relative cost of the ventilation system is lower in relation to the volume of air handled, this approach is more likely to be a cost effective proposition.

Unless the relative cost of mechanical ventilation can be considerably reduced, natural ventilation will continue to have a dominant role to play in mild climatic areas. By careful design and control over airtightness, a satisfactory balance between costs and energy conservation is possible.

Airtightness Standards

Belgium:
STS 52.0
External joinery – general principles
INL Draft 1983

Canada:
Measures for energy conservation in new buildings
Associate Committee on the National Building Code
National Research Council of Canada, No. 16574, Ottawa, 1978

Federal Republic of Germany:
DIN 18055
Windows: Air permeability of joints and driving rain (water tightness) protection. Requirements and testing
German Standards Institute (DIN), 1981.

Netherlands:
NEN 3661
Windows: Air permeability, water tightness, rigidity and strength. Requirements
Netherlands Standards Institute (NNI), 1975

New Zealand:
NZS 4211:1979
Specification for performance of windows
Standards Association of New Zealand, 1979

Norway:
Chapter 54. Thermal insulation and airtightness (revised 1980)
Building Regulations of 1 August 1969
Royal Ministry of Local Government and Labour

Sweden:
Chapter 33. SBN 1980. Thermal insulation and airtightness
Swedish Building Code with Comments
National Swedish Board of Physical Planning and Building (1981)

SIS 81 81 03
Windows. Classification with regard to function
Swedish Standards Commission, 1977

Switzerland:
SIA 180/1
Thermal insulation of buildings in winter
Swiss Engineering and Architectural Association, 1980

United Kingdom:
BS 6375: Part 1:1983
Performance of windows. Part 1: Classification for weather-tightness
British Standards Institution, 1983

United States of America:
ASHRAE Standard 90–80
Energy conservation in new building design
The American Society of Heating, Refrigerating and Air-conditioning Engineers Inc., 1980

References

1. Jackman, P.
   Review of building airtightness and ventilation standards
   Proceedings 5th AIC Conference, Reno, Nevada, USA, 1–3 October 1984.

2. Liddament, M.
   Implications and analysis of airtightness and ventilation standards
   Proceedings 5th AIC Conference, Reno, Nevada, USA, 1–3 October 1984.

3. Sherman, M.
   Description of ASHRAE's proposed airtightness standard
   Proceedings 5th AIC Confernence, Reno, Nevada, USA, 1–3 October 1984.

4. Haysom, J.
   Airtightness standards for buildings – the Canadian experience
   Proceedings 5th AIC Conference, Reno, Nevada, USA, 1–3 October 1984.

5. Elmroth, A., Levin, P.
   Air infiltration control in housing – a guide to international practice
   Air Infiltration Centre, UK and Swedish Council for Building Research, Document D2:1983.

New AIC Librarian

Yvette Parfitt has been appointed Librarian of the Air Infiltration Centre to replace Catriona (Katy) Thompson.

Yvette has recently returned from Paris where she was Librarian of the Atlantic Institute for International Affairs. She holds a B.Sc. degree in mathematics from University College London and a Postgraduate Diploma in librarianship.

She is already busy responding to literature requests and has taken over responsibility for operating *AIRBASE,* the bibliographic database of the AIC, about which there will be an article in a later issue of Air Infiltration Review.

Current Research at Lawrence Berkeley Laboratory on Multizone Infiltration

H.E. Feustel, Lawrence Berkeley Laboratory, California, USA

Introduction

Many computer programs have been developed in order to calculate infiltration. Those, which treat the true complexity of flows in a multizone building, and therefore recognise the effects of internal flow resistance, require extensive information about flow characteristics and pressure distribution. Therefore, simplified models have been developed to simulate weather-driven air infiltration of single cell structures, such as single-family houses (see for example the LBL model[1]). Many of the existing buildings, however, have floor plans that characterize them more accurately as multizone structures, which cannot be treated by single cell models. Most multizone models presently in use are either not available to the public or are written as research tools, rather than for the use of professional engineers or architects.[2] Therefore, a simplified multizone infiltration model capable of providing the same accuracy as the established single cell models is being developed at LBL. Figure 1 shows a comparison between the different modelling strategies.

	Advantage	Disadvantage
single-cell	easy to handle few input data reasonable accuracy	only single cell no internal partitions no internal flows
detailed multi-cell	large buildings internal flows good accuracy	extensive input mainframe computer
simplified multi-cell	large buildings internal flows micro computer reduced input	reduced accuracy

Figure 1: Comparison of model strategies

Multizone Models

The air flow distribution for a given building is caused by pressure differences, whether evoked by wind, thermal bouyancy, mechanical ventilation systems or a combination of these forces. The distribution of openings in the building shell and the inner paths also influences the air flow. The openings can be varied by the occupants, which can cause significant differences in the pressure distribution inside the building.

In terms of air flow, buildings are complicated, interlaced systems of flow paths.[3] In this grid system, the joints are the rooms of the buildings and the connections between the joints simulate the flow paths and include the flow resistances caused by open or closed doors and windows or air leakage through the walls. The boundary conditions for the pressure can be described by the grid points outside the building. Differences in density of air, due to differences between outside and inside air temperatures, cause further pressures in the vertical direction, again influencing the air flow.

The duct system for mechanical ventilation systems can be treated like the other flow paths in the building. In the case of mechanical ventilation systems, the fan can be described as a source of pressure differences, lifting the pressure level between two joints according to the characteristic curve of the fan.

Multizone Infiltration Studies at LBL

In order to validate a simplified multizone infiltration model, we have developed a multigas tracer measurement system using Freons as tracer gases. Air from different zones is sampled for a ten minute period in sampling bags and then immediately analyzed using a gas chromatograph with an electron capture detector. The tracer gases are injected in the different zones using the constant flow method for each sampling period. Weather data is recorded during infiltration measurements. For the recorded wind data, surface pressure coefficients are measured on scale models in a boundary layer wind tunnel. These pressure coefficients, together with the weather data and the house leakage data obtained by blower door measurements, are used as input for a detailed multizone model. Whereas the measured infiltration data will mainly be used as a validation of the model, the predicted infiltration data will be used to learn about the mechanisms that cause infiltration (see Figure 2).

To simplify the description of the complex air flow distribution in buildings, similarity parameters – like those used to describe other physical phenomena – have to be found. With these parameters, the infiltration for a given building can be predicted. These parameters will be obtained by using a detailed computer model for simulating a large number of different floor plans. The variation of the flow resistance distribution inside a building will show a few significant combinations which determine the flow.

A study by Krischer and Beck[4] gave the first indication that such similarity parameters may exist. In order to calculate the maximum infiltration heat loss for a building (at design conditions for the heating system) they distinguished between terraced and detached houses. The differences are expressed by the ratio of the permeabilities of the leeward and windward sides of the building envelope. In the latest issue of the German standard DIN 4701[5] a further distinction was made between shaft type and storey type houses, that differ in their vertical inside permeability between floors.

While existing parameters are used to calculate the maximum air flow for the whole building, an investigation has been started into the parameters which describe the different zones of a building and the effect of its location.[6] This preliminary study shows a strong relationship between the air flow distribution in a building and the ratio of the permeabilities of the envelope and the interior partitions. Depending on the permeability distribution, a zone might be stack dominated, wind dominated, or unaffected by the weather at all. Further studies will give more detailed information on the ventilation behaviour of different zones.

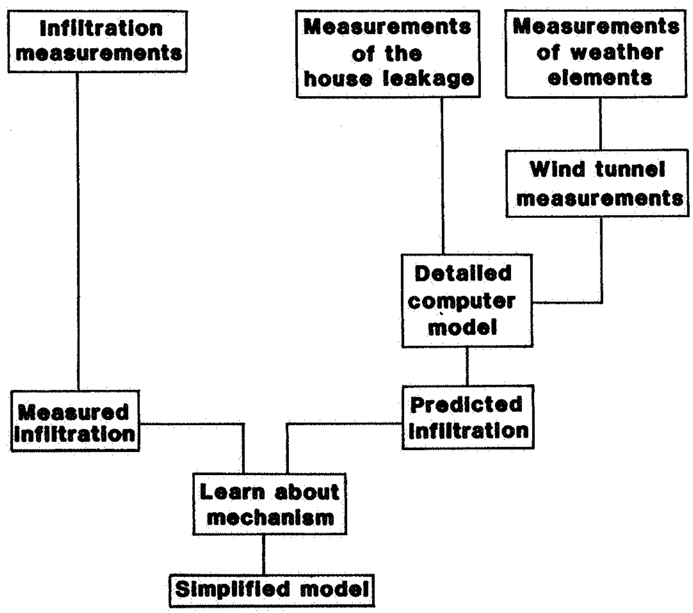


Figure 2: Multi-cell infiltration studies

Acknowledgments

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

References

1. Sherman, M.H. and Grimsrud, D.T.
   Measurement of Infiltration using Fan Pressurization and Weather Data
   Proc. of the 1st AIC Conference, Windsor, England (1980).

2. Feustel, H.E. and Kendon, V.M.
   Infiltration Models for Multicellular Structures – A Literature Survey
   Submitted to Energy and Buildings.

3. Feustel, H.E.
   Zur theoretischen Beschreibung der Druck- und Duftmassenstromverteilung in natuerlich und maschinell geluefteten Gebaeuden
   Heizung, Lueftung/Klimatechnik, Haustechnik, HLH 35 (1980), Nr. 10, pp. 449/502.

4. Krischer, O. and Beck, H.
   Die Durchlueftung von Raeumen durch Windangriff und der Waermebedarf fuer die Lueftung
   VDI-Berichte, Vol. 18 (1957), pp. 29/59.

5. DIN 4701: Regeln fuer die Berechnung des Waermebedarfs von Gebaeuden.
   DIN Deutsches Institut fuer Normung e.V., Berlin, (1983).

6. Feustel, H.E. and Lenz, Th.P.
   Patterns of Infiltration in Multifamily Buildings
   Lawrence Berkeley Laboratory, LBL 17584, (1985).

6th AIC Conference

Advance Notice

'Ventilation strategies and measurement techniques'

Het Meerdal, Netherlands, 16–19 September 1985

The need to reduce energy consumption in buildings produces a strong motivation to reduce infiltration and ventilation rates. This is countered by the requirement to maintain a sufficient rate of air exchange to provide adequate indoor air quality. Thus, to achieve optimum conditions it is necessary to consider not just the overall rates of air flow but the effectiveness of the ventilation process in providing fresh air and removing contaminants.

Increasing attention is being paid to defining ventilation performance and determining the most appropriate ventilation strategies to suit specific applications. At the Conference these subjects will be considered under the following provisional range of headings:

- Design options for ventilation and adequate indoor air quality.
- Parameters of ventilation efficiency.
- Methods of achieving energy efficient ventilation performance.
- Effect of infiltration on ventilation effectiveness.
- Air exchange between spaces.
- Variable ventilation rate systems.
- Ventilation performance in occupied buildings.

The Conference will also be giving attention to infiltration and ventilation measurement techniques – another major subject in which rapid development is taking place.

Discussions are expected to cover:

- New measurement techniques.
- Developments in instrumentation.
- Calibration procedures.
- Methods of monitoring ventilation performance of buildings in use.

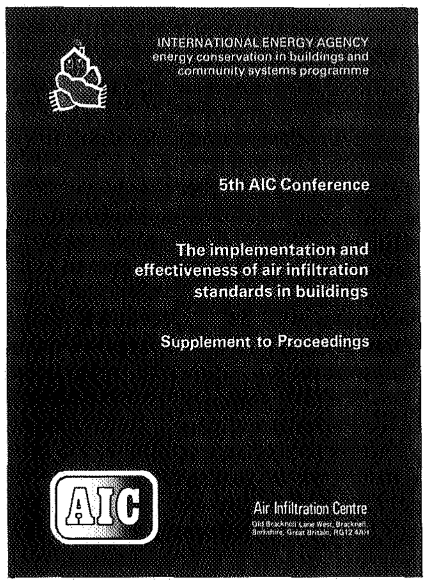
Programme and registration details will be published in the next edition of AIR. Booking forms will be obtainable from your Steering Group representative in May. Meanwhile please reserve the Conference dates 16–19 September 1985 in your diary.

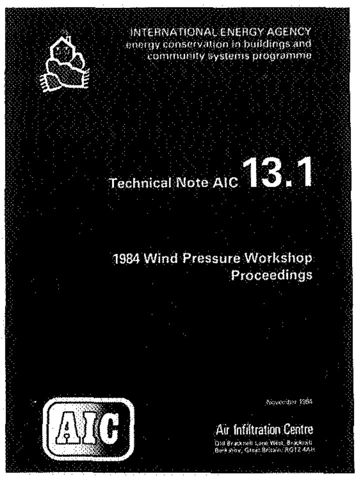
New Publications from the AIC

AIC-PROC-5-S-84
5th AIC Conference, October 1984 The Implementation and Effectiveness of Air Infiltration Standards in Buildings – Supplement to Proceedings

This document is a supplement to the AIC's 5th Conference Proceedings. It contains two additional papers presented at the Conference, together with a discussion record based on written questions and answers prepared by Conference participants and authors, and a report on the final discussion period. Amendments to papers published in the original Conference Proceedings (AIC-PROC-5-84) are also included in this Supplement.

Available to organisations in both participating and non-participating countries at a total cost of £16 sterling for both volumes.*





AIC-TN-13.1-84
1984 Wind Pressure Workshop – Proceedings

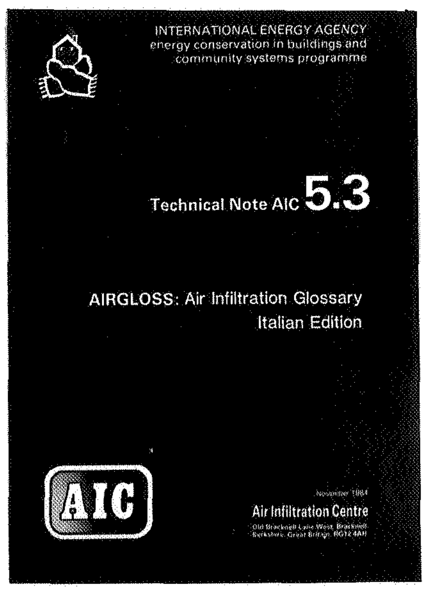
Report of AIC Workshop held in Brussels in March 1984 at which those concerned with the study of wind and its impact on buildings joined others involved in air infiltration studies to discuss techniques for improving the prediction of wind-induced air infiltration. Topics covered include the development of wind pressures, turbulent fluctuations, measurement methods, wind tunnel studies and data requirements for air infiltration calculations. This publication contains the written contributions and edited notes of the discussion.

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

AIC-TN-5.3-84
Airgloss: Air Infiltration Glossary (Italian Edition)

This document is the Italian translation of Technical Note AIC-TN-5-81 Airgloss: Air Infiltration Glossary (English Edition). The translation of about 750 terms and their definitions was edited by Marco Masoero and Daniela Gobetti.

Available free-of-charge to organisations in participating countries and at a cost of £10 sterling (incl. post and packing) to non-participating countries.*



Literature List No. 12
Windbreaks and Shelter Belts

This is the latest in the AIC's series of literature lists. It contains abstracts and bibliographic details of 19 articles describing the effects of windbreaks and shelter belts on air infiltration and energy reduction in buildings.

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

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

Book Review

Theoretical description of pressure and air mass flow distribution in buildings with natural and mechanical ventilation

Dipl.-Ing. Helmut Feustel, Federal Republic of Germany.

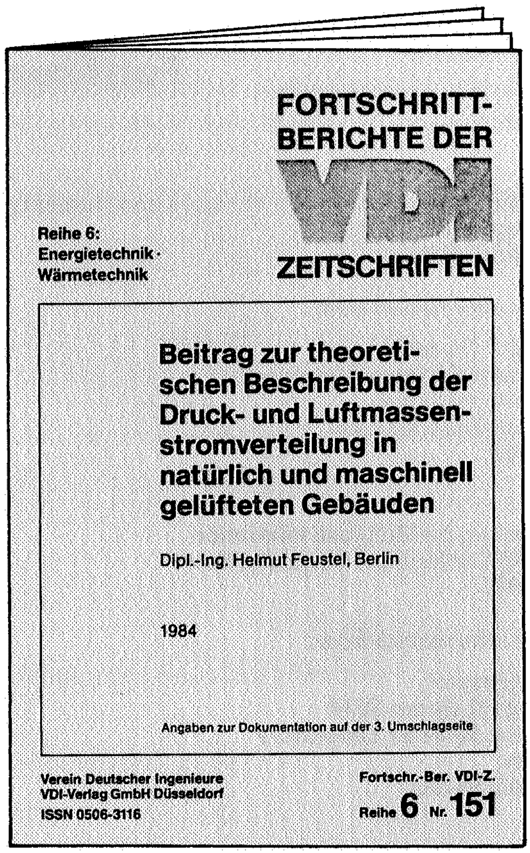
This doctoral dissertation describes the production of a model to simulate pressure and air mass flow distribution in buildings. The model is based on the method of non-linear networks. Meteorological data on wind pressure and profile, and thermal pressure difference is taken into consideration, as are the physical properties of the building such as the resistance characteristics of the building components and air infiltration through the door and window joints in the building envelope. Pressure, flow and other physical details of the mechanical ventilation system are also included. The model is used to study wind and buoyancy effects on mechanically ventilated buildings.

Calculations are made for a naturally ventilated high-rise building for varying permeability distributions and air flow resistances of the building envelope, using data from real buildings and from boundary cases described in the literature.

For mechanically ventilated high-rise buildings, the model considers the effects of the ventilation system and calculates air mass flow distribution as a function of the external air pressure on the ventilation system. This is influenced by the physical characteristics of the air supply duct network, and by the permeability of the doors between the storeys and the windows.

An eight-storey hospital is used as an exmaple of a multi-storey building with a mechanical ventilation system. In this case, the system is designed to control the flow of germ-laden air. It demonstrates that an optimum solution can only be found by a combination of structural and air-handling measures.

Particular attention is paid to the further development of the calculation method to determine annual heat consumption.



For selected building plans, weather data is used to estimate the annual heat load necessary to cover heat loss caused by air infiltration. Using the heating period given in German Standard VDI 2067, the model did not give good results for the calculation of annual heat load for ventilation heat loss on the basis of crack ventilation, due to the small average air infiltration over the time period. The author therefore recommends that a fresh air supply rate based on minimum ventilation rate per person be used to estimate the lower value of annual ventilation heat loss.

Copies of this book in German may be obtained from Verein Deutscher Ingenieure GmbH, Postfach 1139, 4000 Düsseldorf 1, West Germany. ISBN 3-18-145106-1. Price: DM 161.

Correspondence . . .

Comment from C.L. Genge, Retrotec Energy Innovations Ltd., Canada, delegate at 5th AIC Conference held in USA in October 1984.

Pressurization *vs.* depressurisation tests

After attending the last AIC conference in Reno, I got the distinct impression many countries were choosing pressurization testing *vs.* depressurization.

We wish to relate our experience on the matter to all members.

1. The building is subject to:

   (a) More negative pressures on the inside due to

   Stacks exhausting inside air and raising the neutral pressure plane.

   Exhaust fans.

   (b) More positive pressures on the outside since the positive magnitude of wind forces is usually greater than their negative magnitude. This means depressurization more accurately reflects the direction of pressure-created forces on the structure *vis-a-vis* damper and components, etc. which may close under pressurization but open under pressurization (or *vice-versa).*

2. During pressurization, incoming cold air has been known to kill pets and plants as well as make life uncomfortable for occupants. This is less likely to happen with depressurization.

3. A venturi nozzle during pressurization must have its flow pressure pickup and reference pressure hose both taken outside through the door panel (since gauge is generally read inside). This is a minor but still existent irritant.

4. We have not seen more than a few percent difference in both methods over a large number of tests so accuracy of measurement is no issue.

Forthcoming Conferences

1. 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

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

Further information from:

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

3. Building Energy Simulation Conference '85
Seattle, Washington, USA
21 and 22 August 1985

Further information from:

Pamela Garland
P.L. Garland Associates
721 N.W. 30th Street
Corvallis
Oregon 97330
USA
Tel: 503 754 9080

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

For further information on congress registration and booking of rooms:

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

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

Further information from:

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1st International Symposium on Ventilation for Contaminant Control
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6. Thermal Performance of the Exterior Envelopes of Buildings III
ASHRAE/DOE/BTECC Conference
Clearwater Beach, Florida, USA
2–5 December 1985

Papers are invited on the following topics:

- *Thermal analysis of the building envelope*
- *Air infiltration*
- *Test procedure development and building diagnostics*
- *Fenestration and daylighting*
- *Economic optimization*
- *Guidelines, standards and codes*
- *Innovative construction practices*
- *The in-situ measurement of energy use*
- *Impacts of moisture*
- *Retrofitting techniques and performance*
- *Microclimate and design weather data*
- *Design of buildings in extreme hot and cold climates*
- *Thermal mass and transient effects in buildings and building envelopes*
- *Integration of architecture and engineering in energy conservation*
- *Design of energy efficient envelopes*

Abstracts of less than 350 words and titles of proposed papers to be submitted by 1 April 1985 to:

David T. Harrje
Center for Energy and Environmental Studies
The Engineering Quadrangle
Princeton University
Princeton
NJ 08544
USA
Tel: 609 452 5190

7. International Symposium on 'Energy and Building Envelope'
Thessaloniki, Greece
22–25 April 1986

Further information from;

International Symposium: Energy and Building
Laboratory for Building and Construction Physics
Dept. of Civil Engineering Secretariat
Aristotle University
546 36 Thessaloniki
Greece

8. Advanced Building Technology
10th CIB Congress
Washington DC, USA
21–26 September 1986

Further information from:

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