Air
Infiltration
Review
a quarterly newsletter from the IEA Air Infiltration Centre

Vol. 6, No. 4, August 1985

The User's Influence on Air Infiltration

Bjørn Kvisgaard
Department of Building Technology
Technological Institute, Taastrup, Denmark

Introduction

When calculating energy consumption for space heating and the concentration of pollution in the room air, knowledge of the dwelling's air-change rate is a prerequisite. The air-change rate to be applied in these calculations is the rate for the dwelling during normal occupancy.

Not until 1981, when the first complete sets of air-change measurement equipment capable of continuous registration had been fully developed, was it possible to measure air-change in dwellings during occupancy.

The paper presents the measuring technology, and the results from 23 one-week measurements of air-change in occupied dwellings.

The major part of the paper deals with the occupants' influence on the air-change in dwellings with and without mechanical ventilation systems.

Measuring equipment and measuring technology will be described briefly.

Measuring equipment

The measuring equipment has been designed to be capable of automatic registration of air-changes in occupied houses. The measuring principle applied is the method with 'constant concentration of tracer gas' (figure 1).

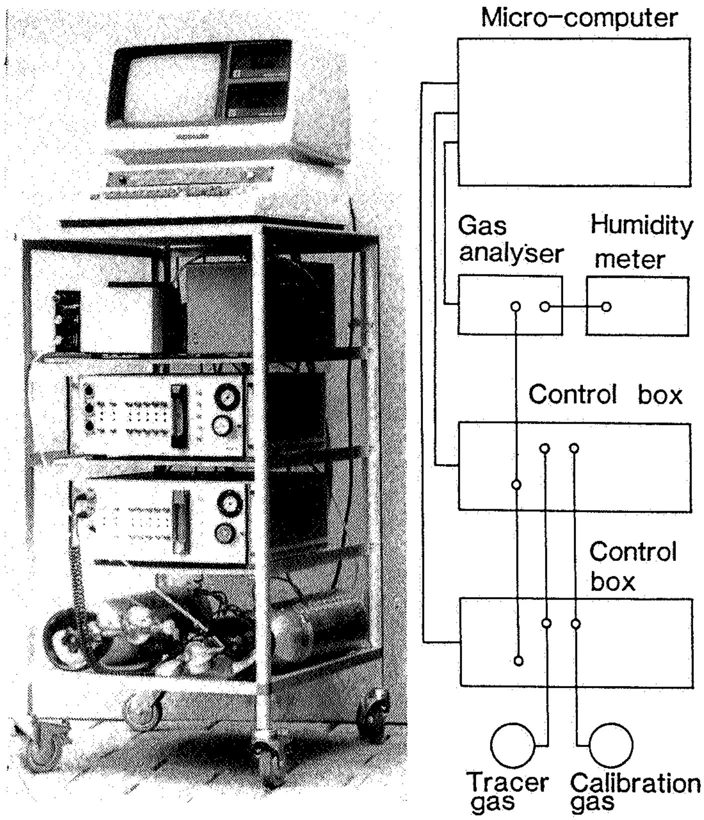


Figure 1: Unit's construction – photo, diagram

Inside this issue:

The principle applied when measuring with 'constant concentration of tracer gas' is that a constant concentration of a tracer gas is maintained in the rooms where the air-change is to be measured. The air-changes are then calculated on the basis of the quantity of tracer gas that it is necessary to dose to the rooms to maintain the concentration. We use the tracer gas SF_6, and the concentration in the rooms is maintained at 5 ppm.

The 'constant concentrations of tracer gas' measuring principle has been selected because it is the only method which can be employed for continuous measurement in several rooms, where the air moves between the rooms.

The system is controlled by a micro-computer and constructed so as to be capable of measuring the air-change and humidity in up to ten separate rooms. The measurement data are continuously gathered and stored on a diskette which can store eight days' measurements.

Each control box has two functions: to collect air samples from the rooms to the gas analyser, and to regulate the dosage of tracer gas to the rooms. The calibration gas is used for a periodic control of the gas analyser.

Results

In the paper the air-change in the occupied dwelling is designated 'total air-change', while the air-change registered in the sealed dwelling (i.e. with air-escape valve, doors, windows and ventilation system closed) is designated 'basic air-change'.

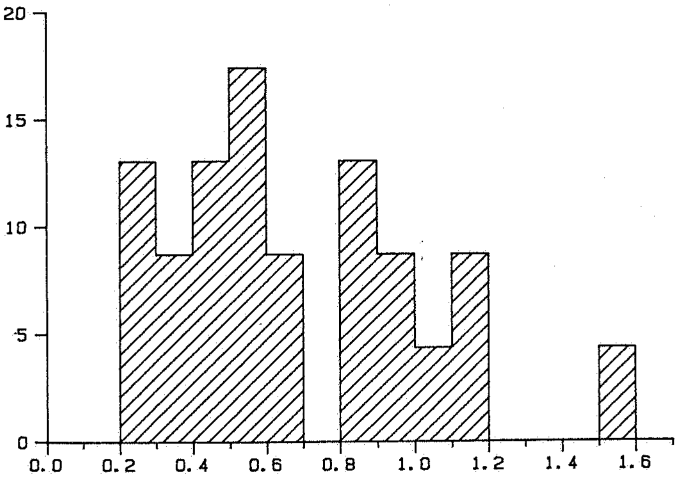


Figure 2: Distribution of the 23 dwellings' total air-change

If the 23 measurements are classified according to the dwelling's ventilation system, it is seen that 14 of the measurements were in dwellings with natural ventilation, six in dwellings with mechanical injection and exhaust units and three measurements in dwellings with mechanical exhaust units only. The average size of dwelling was 106 m^2, while the average number of occupants was 2.7 – roughly corresponding to the national average for Denmark.

The average total air-change rate for the 23 dwellings is 0.68 times per hour, corresponding to 142 m^3 per dwelling per hour.

The difference in total air-change from dwelling to dwelling is shown in figure 2. Figure 3 shows the distribution of the hourly registrations of the total air-change in the individual dwellings. A typical example of the variations in the air-change of a dwelling is shown in figure 4.

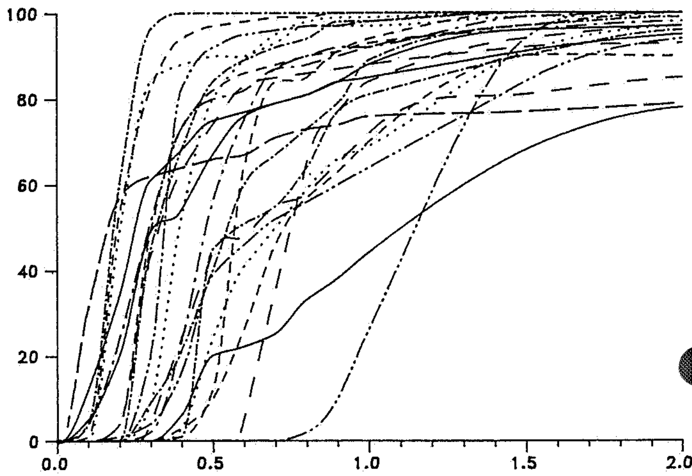


Figure 3: Relative part of hourly registrations of the total air-change which are less than the x-axis value. The curves for all 23 dwellings are shown.

From figure 3 it can be seen that the distribution of the air-change varies greatly from dwelling to dwelling. They include both the steep S-curves which represent a fairly constant air-change over the measuring period, and the flatter curves which represent greater variations over the measuring period. Some curves are initially steep, and then snap and become flatter. These curves usually indicate periodic thorough airing.

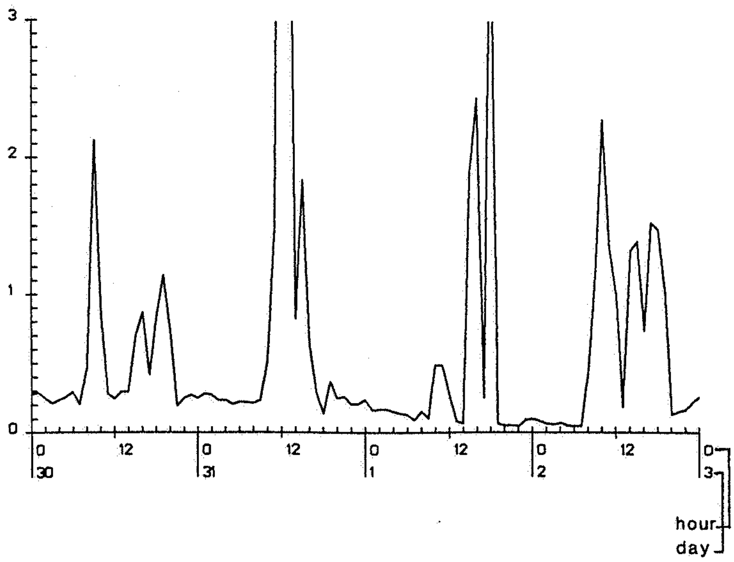


Figure 4: Total air-change in a naturally ventilated dwelling. The air-change is shown as a function of time.

Figure 5 provides a clearer impression of the difference between naturally ventilated dwellings and mechanically ventilated dwellings.

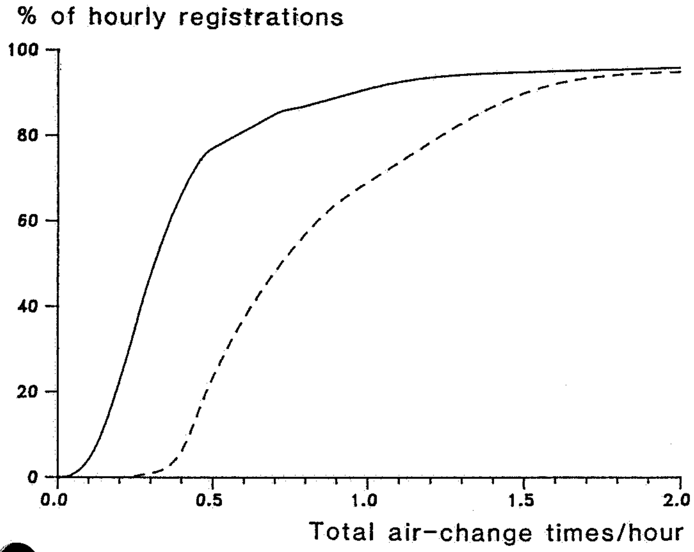


Figure 5: Relative part of hourly registrations of the total air-change which are less than the x-axis value. The continuous (line) curve is the average for the naturally ventilated dwellings, while the dotted curve represents the average for the mechanically ventilated dwellings.

Correlation between total air-change and basic air-change

Figure 6 demonstrates that there is no correlation between a dwelling's basic and total air-change.

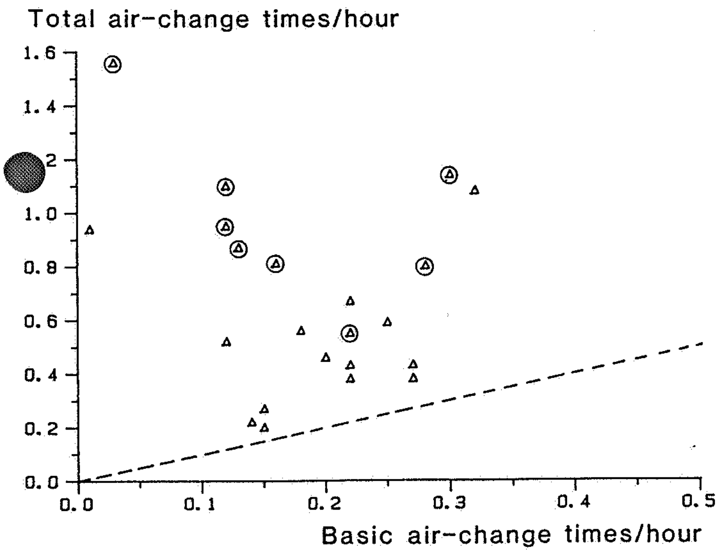


Figure 6: Total air-change as a function of basic air-change for 22 dwellings. Mechanically ventilated dwellings are marked ⓐ.

As regards the mechanically ventilated dwellings, it is interesting to relate the total air-change to the dimensioned performance of the ventilation unit. Calculated on the basis of six dwellings the relationship was:

$$\frac{\text{total air-change}}{\text{performance ventilation unit}} = \frac{0.98}{0.58} = 1.7$$

As the occupants' behaviour exerts a very considerable influence on the air-change, it could be expected that the total air-change depended on the number of occupants.

This is, however, not the case, and the spread of the total air-change expressed in m^3 per occupant per hour is even bigger than the spread of the total air-change expressed in times per hours.

Conclusion

Measurement of air-change rate in occupied dwellings shows that the occupants' behaviour has a very considerable influence on the total air-change rate. On average, the air-change rate in an occupied dwelling is 3–4 times higher than the basic air-change rate.

The average total air-change rate for the dwellings measured is 0.68 times per hour. Even though this rate is higher than the 0.5 times per hour recommended in Denmark, nevertheless 20% of the dwellings measured had a total air-change rate so low that indoor climate problems can easily arise.

The average total air-change rate for the dwellings measured varies from 0.20 to 1.56 times per hour.

Improved control of the total air-changes would achieve both energy savings and better indoor climate for the home.

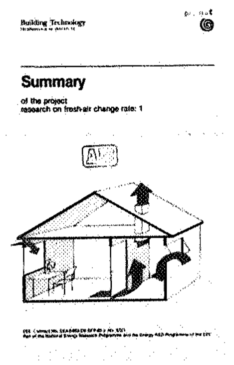
Only a small percentage of the dwellings have ventilation systems that can be adjusted to provide the desired rate of air-change. The mechanical ventilation systems usually give too high a rate of air-change, while the natural ventilation systems usually provide too low a rate.

The occupants' behaviour also exerts a considerable influence in dwellings with mechanical ventilation. The total air-change rate in the mechanically ventilated dwellings is, on average, some 70% higher than the rate which the ventilation system was designed to provide.

As no correlation has been determined between the dwelling's basic air-change rate and its total air-change rate, it is relevant to warn against drawing any conclusions with regard to a dwelling's indoor climate and its humidity balance on the basis of a single set of measurements of its basic air-change rate.

Reference

B. Ksvisgaard, P.F. Collet and J. Kure.
Research on fresh-air change rate: 1.
Technological Institute, Copenhagen, 1985.



This paper is the summary of the project 'Research on fresh-air change rate: 1' carried out by Building Technology, The Technological Institute, Copenhagen under contract to EEC and is reproduced here by their kind permission. The report (reference number EUR 9930 EN) can be ordered from the Office for Official Publications of the European Communities, L-2985 Luxembourg.

Buoyancy Driven Flow Through an Open door

P.F. Linden and J.E. Simpson
Department of Applied Mathematics & Theoretical Physics
University of Cambridge, UK

Introduction

A good understanding of natural ventilation air-flows through open doors and windows can be obtained by using laboratory experiments in water tanks. Such flows are of great importance, since only very few houses in the world have any artificially driven and controlled ventilation systems. Most rely on mixing by convection currents produced by heating from internal sources, and on the use of open windows and doors for external ventilation. These open windows and doors can be responsible for excessive losses of heat in cold countries and invasion of hot air in hot climates, as gravity currents of dense or buoyant air pass through these spaces.

Even at quite small temperature differences (a few degrees) between the exterior and interior air, buoyancy forces are significant and a gravity current flow is established through an open doorway. This flow may cause a loss of heat due to the intrusion of cold air along the floor, or a heat gain in a refrigerated room, when the indoor air flows along the ceiling. These flows account for a significant part of total heat losses in housing, and can also determine the distribution of indoor contaminants within a building.

Laboratory Experiments

Experiments can be set up in small scale laboratory apparatus which serve to demonstrate the kinds of flow which can occur and enable realistic calculations to be made about the full-size flows. In such experiments, rather than use hot and cold air, it is better to use water as the working fluid, with density differences produced by dissolved salt. By this means it is easier to achieve dynamic similarity by maintaining the correct range of the relevant dimensionless numbers concerned with viscosity and diffusion. These are:

		domestic–industrial
Reynolds No.	$Re = (g'H)^{1/2} H/\nu$	range $10^3 - 10^6$
Peclet No.	$Pe = (g'H)^{1/2} H/K$	$10^3 - 10^6$

where $g' = g\Delta\rho/\rho$, where g is the acceleration due to gravity and $\Delta\rho/\rho$ is the fractional density difference, υ is the viscosity and K the diffusivity.

Using air as the working fluid these parameters are smaller by a factor of $[H(model)/H(full\ size)]^{3/2}$ for the same temperature difference ΔT. Full scale values can be readily obtained using water tanks. It is worth noting that a temperature difference of 3K in air corresponds to a density difference of about 1%.

Two-dimensional Flows

The flow which takes place through an open doorway at the end of a passage is illustrated in figure 1. When the door is opened the dyed dense fluid enters the building as a gravity current. This current fills half the depth of the door and advances at a uniform velocity U along the floor. Outside the house at the same time the less dense fluid can be seen rising up the outer wall and mixing with the surroundings.

In this type of exchange flow the orifice (of height H) acts as a hydraulic control, and the speed of the intruding current is

$$U = 0.5\,(g'H)^{1/2}$$

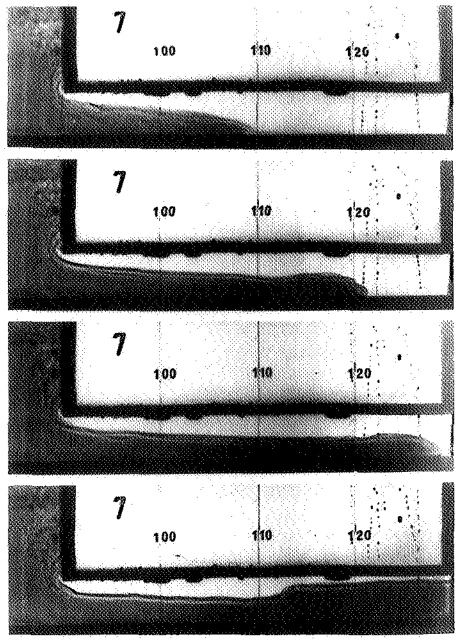


Figure 1: Four views of the advance of a dense flow through an open door in a laboratory experiment. The door height is 10 cm and the density difference $\Delta\rho/\rho$ is 1%. The separation between the vertical lines is 10 cm

When the front of the current reaches the end wall the flow is reflected and can be seen travelling back towards the door. The dense fluid almost fills the space, but there is a small space above filled with lighter fluid which appears to have difficulty in escaping due to frictional effects near the ceiling.

Figure 2 shows some of the experimental results, plotted on a log/log scale in non-dimensional form. The distance X is expressed non-dimensionally by the depth H of the channel, and the time t by the expression $(H/g')^{1/2}$. It can be seen that the results lie close to a straight line with gradient 1, showing that the velocity U is constant. The experimental result for the uniform speed is $U = 0.47\,(g'H)^{1/2}$, close to the theoretical value stated above.

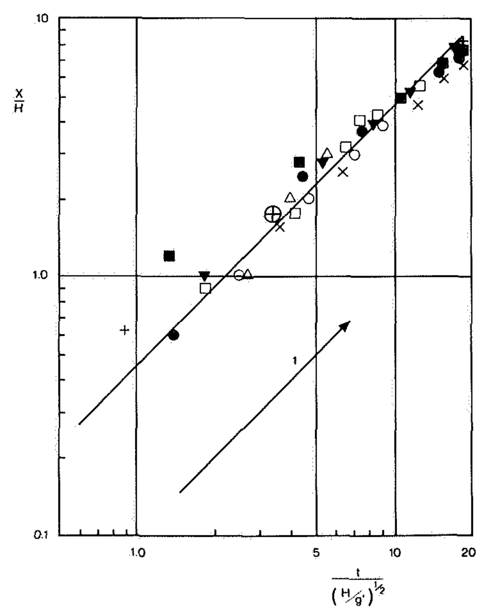


Figure 2 : Measurements from a series of experiments similar to those shown in figure 1. The point ⊕ corresponds to observations made in the house of one of the authors, and it agrees with the laboratory data showing that the experiments accurately represent the full-scale flow

Experiments were also carried out with an open staircase at the end of the passage. At the end of the passage, the gravity current eventually filled up all the space in the ground floor until the dense fluid reached the level of the upper floor but no higher.

Three-dimensional Flows

We have also carried out experiments in which the flow is no longer restricted to a parallel channel such as in a passage. For example in a more general case we may have a door in a much wider wall, so that the flow through it can widen out after passing through the doorway.

To illustrate some of the flows here, a series of experiments was carried out in a simple apparatus consisting of a box of perspex, just under a metre cube, with a vertical partition across it containing a door which could be opened. As before the tank was filled with water and salt dissolved on one side of the door to produce a density difference, corresponding to that produced by a temperature difference in the air.

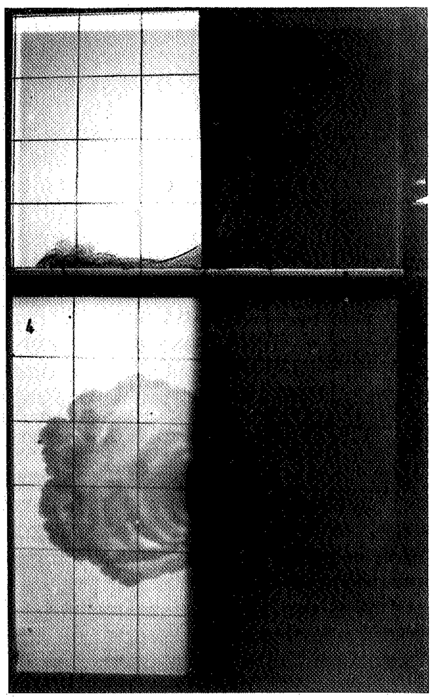


Figure 3: Simultaneous plan and elevation of the exchange flow through a doorway in a wall. Note the marked difference in behaviour between the dense fluid (on the left) and the buoyant fluid (on the right)

When the door was opened the dense flow issued through the door and spread out along the ground, while the less dense fluid rose up the wall as a buoyancy plume on the other side. The radial spread of the dense fluid is clearly visible in figure 3. The exchange flow provides a constant flux Q through the doorway

$$Q = 0.5\,HWU,$$

where H and W are the height and width of the door and U is the velocity of the leading edge of the front moving along the floor.

On the basis of dimensional analysis we expect that the position X of the foremost point of the leading edge be given by

$$X = c(Qg')^{1/4}\, t^{3/4},$$

where c is a constant, and this result is confirmed by the experimental results shown in figure 4.

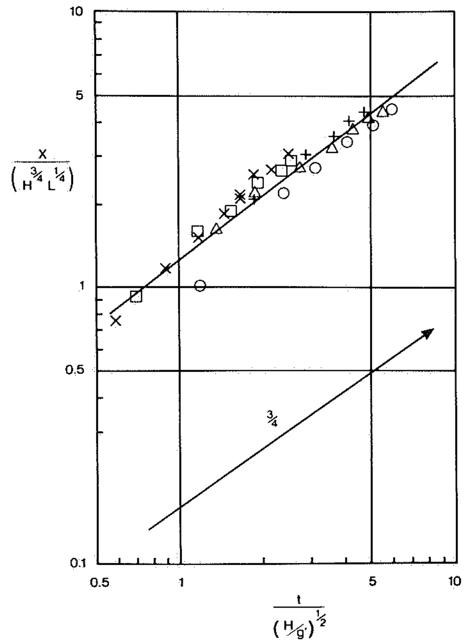


Figure 4: Measurements of the spread of the gravity current with time through a doorway into a large room

Summary of These Effects

a) After an initial acceleration phase ~ $(H/g')^{1/2}$ the flow takes on gravity current behaviour.

b) A doorway acts as a region of hydraulic control.

c) The transient effects – as the room fills with cold or warm air – are significant.

d) During gravity current phases, flow rates and heat losses can be accurately modelled using gravity current dynamics.

The technique described for these investigations has the advantage that it is inexpensive. Complicated patterns of doors and passageways and even separate floors as found in atria can easily be set up. Other effects such as turbulence in the outside air, or the effects of air curtains can readily be incorporated into these laboratory models. Most importantly the experiments give a clear visual picture of the flows concerned, and they are capable of producing realistic numerical results of both the rates of flow and the amounts of heat loss or gain. We believe these features will be of value to those interested in estimating the energy consumption of a building.

References

1. Benjamin, T.B.
   Gravity currents and related phenomena
   J. Fluid Mech, 31, p209-248, 1968.

2. Shaw, B.H. and Whyte, W.
   Air movement through doorways
   J. Inst. Heat. & Vent. Eng., 42, p210–218, 1974.

3. Simpson, J.E.
   Gravity currents in the laboratory, atmosphere and ocean
   Ann. Rev. Fluid Mech., 14, p213–234, 1982.

AIC Plans Its Future

Steve Irving, Chairman of the AIC Steering Group and Operating Agent to the Air Infiltration Centre, discusses the Centre's future plans.

Introduction

The AIC was established in 1979, and has enjoyed an increasing international reputation for its work on infiltration and ventilation of buildings. The agreement between the participating countries currently provides for work to continue until May 1986. The AIC Steering Group (comprising technical experts from all participating countries) have unanimously recommended that the annex be extended for a further three year period beyond May 1986 in order to consolidate the achievements already made, and to move forward to cover aspects of the subject not yet addressed.

The proposed work of the Centre during the annex extension comes under the following three main areas of activity.

1. Information service
2. Technical work plan
3. Technical liaison

Information Service

One of the primary functions of AIC to date has been the collection and dissemination of literature and information relevant to air infiltration and closely associated subjects. This valuable feature of AIC's work will continue in the extension period.

Technical Programme

The information service is complemented by a full technical work programme. In the past, this programme has concentrated on the validation of mathematical models of air infiltration and on the preparation of a model applications user guide. It is proposed that this technical function should continue with the objective of disseminating and expanding the applicability of research results in design. In particular, the Centre will use its expertise to produce user guides covering important aspects of air infiltration related studies. Three key areas have been identified for specific analysis. These are:

- Measurement techniques
- Airborne moisture transfer
- Infiltration and indoor air movement

Measurement Techniques

AIC already has a fund of information on the techniques and instrumentation involved in measuring ventilation, air infiltration, air leakage and associated parameters and so it will be possible to initiate a project on this subject early in the extension period.

A set of standard formats will be prepared to describe the various measurement techniques and associated instrumentation. This will ensure that comparable information is produced from which selection of the most appropriate systems for particular applications can be made. This data will be updated as new techniques and instruments become available.

The dissemination of information on calibration and validation techniques would be of value to users of instrumentation, and so any material on these aspects will also be collected, assessed and made available to enquirers. On the basis of all of the information gathered, AIC will produce a handbook containing detailed descriptions of the current measurement techniques and providing the background information likely to influence the choice of method. Details of the sources of instrumentation and examples of its use will also be included.

This exercise will form a major part of the work programme during the first half of the extension period, with a completion date set for early 1988.

Airborne Moisture Transfer

Several participating countries have highlighted airborne moisture transfer as an important area of future study. There are two main aspects of concern. One is the behaviour of moisture in structural cavities. This has been shown to be closely related to air infiltration and the potential for serious thermal, structural and occupant-related problems has led to an increasing commitment to research. The other aspect relates to the moisture within and between rooms. This is also largely dependent on air movement and can have a considerable influence on ventilation requirements and energy needs.

The present AIC technical staff have expertise in this subject area so it will be possible to make a full technical appraisal of available information.

During the course of the proposed extension period, two major publications on moisture transfer are envisaged. The first will be a brief review and annotated bibliography providing information on the scope of the available information and indicating the aspects being studied or problems encountered in the participating countries. The impact of climate, particularly humidity, will also be identified. Publication is expected early in 1987.

The second report will concentrate on calculation techniques for the prediction of moisture behaviour. A review will be made of the mathematical models that have been developed and the extent to which they have been validated. Comments will be included on the range of applicability of the models as design aids. The alternative ventilation/airtightness strategies for minimising moisture problems will also be highlighted. The target publication date is September 1988.

Infiltration and Indoor Air Movement

In recent years considerable progress has been made in the development of mathematical models for predicting air infiltration in buildings. In the validation study carried out in the current AIC operating period, the scope was restricted to dwellings because insufficient experimental data was available for other building types and conditions. As a wider range of data becomes available, the model validation work can be extended.

Data is becoming available from the parallel IEA annex on inhabitant behaviour with regard to ventilation and this might be used to enable the model validation work to be extended to cover the open window situation. Similarly, AIC will gather numerical data on infiltration measurements in commercial and industrial buildings. These high quality data sets will be made available to model owners for validation purposes, and as resources permit, will be used directly by AIC staff.

Until now air change rate has been used to define both the requirement for and the performance of ventilation systems. This is no longer an adequate parameter, because maximum economy can only be achieved with optimum ventilation efficiency. Hence more research attention is being given to the patterns of air circulation within rooms and through buildings, to ensure that fresh air supply and pollutant removal requirements are effectively attained.

Mathematical models are being applied to these air circulation and mixing processes and information on these and the data to validate them will be of particular interest to researchers and others concerned with the prediction of internal air movement. AIC will seek relevant project details and reports, and disseminate the information accordingly.

This work will enable the Centre to present a full picture of the validation performance of mathematical models for a wide range of building types and operating conditions. This subject area will have the ongoing attention of the AIC staff throughout the extension period with a final report programmed for May 1989.

Technical Liaison

An important part of AIC's work has been the encouraging of communication between technical experts. This role will continue and is promoted through the organisation of regular conferences and workshops, as well as visits by AIC staff to appropriate organisations in the various countries.

Conclusion

The work plan summarised above has now been unanimously accepted by the Executive Committee responsible for the IEA programme of R&D on energy conservation in buildings. Before the extension can finally go ahead, the participants have to confirm their individual contributions to the joint fund which finances the Centre. This final stage is now well in hand, and it is hoped that the 'go-ahead' will be confirmed in the near future. ■

Correspondence

Pressurization vs Depressurization?

Comment from Helmut E. Feustel, Energy Performance of Buildings Group, Lawrence Berkeley Laboratory, University of California, USA

Blower doors are widely used to determine the leakage area of single-family detached houses. Many contractors who perform these tests use nozzle or orifice blower doors and find that changing the fan direction is inconvenient, thus adding to the cost of the test. Other US contractors only perform the depressurization measurement knowing that the test is not in compliance with the ASTM standard.

The reason for prescribing blower door measurements using both positive and negative pressure differences is to overcome weather dependency problems. The average between pressurization and depressurization should be leveled out.

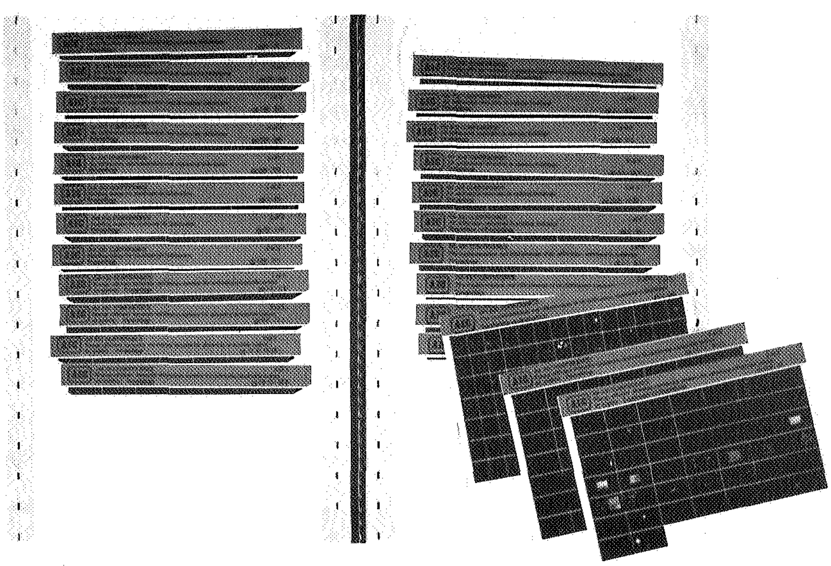
It is common practice not to record the measured wind speed during a blower door test but to give explanations like 'calm' or 'windy'. By reviewing blower door measurement results one discovers an unbelievably large number of calm days throughout the United States.

The differences in flow coefficients and exponents due to changing the flow direction have usually been explained as a change in the flow characteristics of the building (e.g. due to valve-action of windows and doors or exhaust fan systems). However, results of a numerical investigation on the influence of wind on the accuracy of blower door measurements showed that the flow coefficient, the exponent of the pressure difference as well as the effective leakage area at 4 Pa are quite sensitive to increasing wind speed and the air flow direction of the blower door.

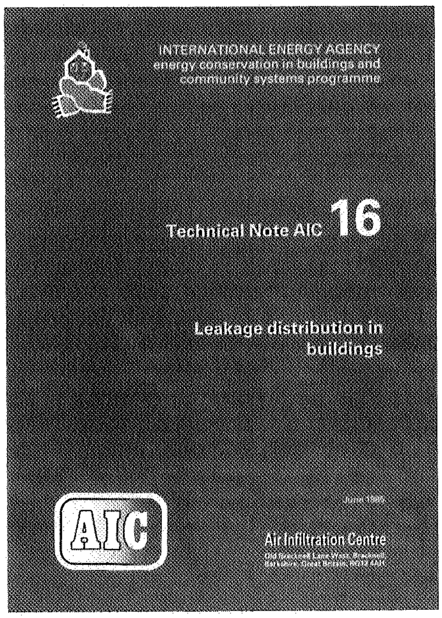
As long as the outside reference pressure is dependent on the weather condition during the test procedure the solution for blower door measurements can only be pressurization *and* depressurization. (Any other measurement technique that is used to account for weather dependency of the reference pressure is not in compliance with the ASTM Standard E779-81.)

New Microfiche Edition of AIC Conference Proceedings

The proceedings of the first five Annual Conferences are now available on high quality 98-frame microfiche. The set of 25 microfiches, covering all conference proceedings and supplements, is contained in a compact hard cover folder and offered for sale at the price of £75.

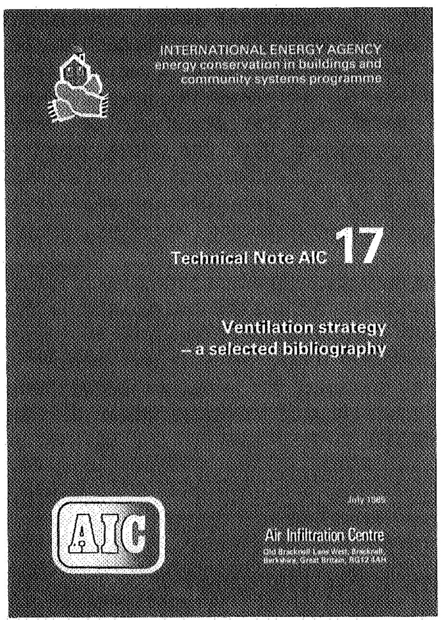


Publications from the AIC



AIC-TN-16-85
Leakage Distribution in Buildings

This document examines those factors which can influence the leakage distribution in a building. The effect of pressure on leakage distribution is considered, as is the possible seasonal effect of variations in humidity. Information on leakage distributions measured *in situ*, taken from papers in the AIC's bibliographic database *AIRBASE*, is summarised in an Appendix.

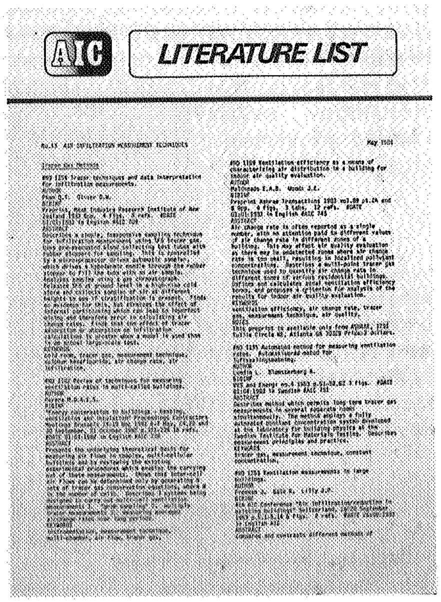


AIC-TN-17-85
Ventilation Strategy – A Selected Bibliography

The literature on choice of ventilation strategy for residential, industrial and other buildings is reviewed. The fundamental characteristics of natural and mechanical ventilation are outlined and the advantages and disadvantages of each option compared. Some suggestions are made for obtaining the best performance from the system chosen.

Literature List No. 13
Air Infiltration Measurement Techniques

This list of 27 abstracts covers articles published in the last four years on tracer gas techniques, pressurization methods applied to whole buildings and to building components, and thermographic (infra-red) scanning. It updates the bibliography contained in AIC-TN-10-83 – Liddament, M.W., Thompson, C. 'Techniques and instrumentation for the measurement of air infiltration in buildings – a brief review and annotated bibliography'.



Book Reviews

Linford Low Energy Houses

R. Everett, A. Horton, J. Doggart with J. Willoughby, Energy Research Group, Open University, Milton Keynes, UK.

The Linford project involved the design, construction and monitoring of eight low energy passive solar houses. When the project started, in 1976, there was very little experience of low energy house design in the UK, and therefore two or three years were taken to evaluate designs, using computer modelling. This initial work led to designs for two estates – eight houses on the Linford estate and 200 on the neighbouring Perryland estate in Milton Keynes. The Linford houses were monitored intensively and one was designated as an unoccupied test house. The 200 Perryland houses were monitored at a lower level in a complementary project. The houses were built in 1980/81 and are detached, south-facing houses, build to Danish requirements for thermal insulation with double glazing. The glazing was concentrated on the south side with only small windows on the north side.

Fairly intensive monitoring, with about 30 sensors being installed in each house, took place over an 18-month period. Temperatures, delivered and useful energy consumptions and window openings were recorded in the occupied houses; in addition heat flux and air infiltration measurements were taken in the test house. Results were recorded on four data loggers in the garage of the test house.

The origins of the project are described plus earlier research in cost-effective low energy passive solar houses in the UK, which led up to the energy brief for the Linford houses. The effects of these energy saving features on the detailed design of the houses are illustrated.

The results of the measurement of fuel consumption and costs are analysed and an example of an energy balance is constructed for one house. The savings that can be attributed to individual energy-saving features are estimated by computer modelling. An infiltration model was developed from extensive infiltration measurements in the test houses and used to investigate the effect of site layout, and to estimate infiltration rates and heat losses in the occupied houses. Estimated savings due to airtightness measures are:

Draughtstripping (doors)	500 kWh/yr
Double glazing (draughtstripping)	246 kWh/yr
Balanced flue boiler	246 kWh/yr
Better design and construction techniques	245 kWh/yr
Total	1,237 kWh/yr

Sheltering effects of other houses were noted, but not included in the savings calculations, as it was felt that any estate layout would probably provide these benefits. Energy saving due to air infiltration reduction is estimated to be 20% of total energy savings.

The occupants were generally pleased with the houses and glad that they had bought them. All were satisfied with the ease with which the houses could be kept warm. The large south-facing windows were appreciated in general, but had they been overviewed from the south this might have affected reaction. While the concept of cheap, sashless double glazing was accepted, the mechanics and cleaning of the actual windows caused some dissatisfaction.

The authors conclude that the package of energy saving measures has worked well, proved very cost effective and caused no notable difficulties in construction. They recommended that the measures described be more widely adopted in the future.

Copies of this report can be obtained from:

Energy Research Group
The Open University
Walton Hall
Milton Keynes
MK7 6AA
Great Britain

Price: £10 sterling (summary £3.50)

Lüftung im Wohnungsbau / Air Infiltration and Ventilation in Residential Buildings

This is a report of the seminar on 'Air Infiltration and Ventilation in Residential Buildings' held in the Bauzentrum, Munich on 4 – 5 April 1984. The meeting was one of a series, held every two years to provide discussion of the results of the research programme on air infiltration and ventilation in residential buildings, sponsored by the Federal Ministries for Research and Technology, and for Regional Planning, Building and Urban Development. It brought together representatives from research, development, industry, administration and housing with experts from both Germany and abroad.

The first section of the book contains papers outlining the philosophy and aims of the research programme with an evaluation of the results to date and further research to be undertaken. International activities in the field are also summarised.

This is followed by a section comparing different ventilation strategies, covering research in unoccupied test houses and in various occupied buildings such as a block of flats, an experimental low-energy house and prefabricated housing.

Reports on several demonstration projects are given in Section 3. The problems encountered in the planning and construction of 24 dwellings in the Duisberg demonstration project, the low-energy building in Hamm, and the use of earth temperature for air conditioning as applied to the Heilbronn Theatre are among the topics covered.

The final section contains papers relating to ventilation needs and requirements. The relationship of humidity and ventilation and the effects of the operation of fireplaces are discussed in two papers. The influence of lifestyle on minimum ventilation rates is another important topic analysed. The final technical paper deals with the use of heat recovery units for ventilation systems.

This report is currently available in German, from:

Verlag TÜV Rheinland GmbH
5 Köln 1
Postfach 101 750
Federal Republic of Germany

Price: Approximately DM38

Forthcoming Conferences

1. 6th AIC Conference
   Ventilation strategies and measurement techniques
   Het Meerdal Park, Southern Netherlands
   16–19 September 1985

   Further information from:

   Mrs J. Elmer
   Air Infiltration Centre
   Old Bracknell Lane West
   Bracknell
   Berkshire
   RG12 4AH
   Great Britain
   Tel: +44 344 53123
   Telex: 828488 BSRIAC G

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

   Further information from:

   Dr H.D. Goodfellow
   Ventilation '85
   1st International Symposium on Ventilation for Contaminant Control
   PO Box 33, Station 9
   Toronto
   Ontario
   M4T 2L7
   Canada
   Tel: (416) 978 4467
   Telex: 065 24315

3. The Washington Energy Extension Service and Oregon State University Extension Energy Program are sponsoring a conference entitled 'Moisture problems in residential construction: separating myth from reality'
   Seattle, WA, USA
   17–18 October 1985

   Further information from:

   C. Eberdt
   Washington Energy Extension Service
   Seattle University
   Seattle
   WA 98122
   USA
   Tel: (206) 626 6225

4. Thermal Performance of the Exterior Envelopes of Buildings III
   ASHRAE/DOE/BTECC Conference
   Clearwater Beach, Florida, USA
   2–5 December 1985

   Further information from:

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

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

   Further information from;

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

6. CIBS/ASHRAE 1986 Conference
   Dublin, Republic of Ireland
   14–17 September 1986

   Topics:

   - *Building design construction and management*
   - *Equipment advances*
   - *Case studies*

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

   Noël J. Raufaste
   Director CIB.86
   Center for Building Technology
   National Bureau of Standards
   Gaithersburg
   MD 20899
   USA

8. ICBEM '87
   Third International Congress on Building Energy Management
   Lausanne, Switzerland
   28 September – 2 October 1987

   Call for papers:

   Building energy management is a fast growing and rapidly changing field of considerable scientific, technical as well as economic and social importance. The aim of ICBEM '87 is to present the state-of-the-art together with ongoing research in selected fields such as

   - *ventilation, air movement in buildings, air quality*
   - *control and regulation of heating and ventilation*
   - *field measurement and auditing*
   - *building planning process and design tools*
   - *energy strategies and the occupants*
   - *solar energy use*
   - *daylighting and artificial lighting*
   - *building concepts for hot climates*
   - *building regulatory process*
   - *case studies on the above listed topics*

   Preliminary abstracts should be about 200 words in length and typed in English. The abstracts must be received by the Program Committee not later than 1 June 1986.

   Persons wishing to submit a paper are invited to indicate a preliminary title to:

   ICBEM '87 Secretariat
   p.a. Prof. Andre P. Faist
   EPFL – LESO Building
   CH 1015 Lausanne
   Switzerland
   Tel: 021 47 11 11
   Telex: 24478

3rd fold (insert in Flap A)

Air Infiltration Centre
Old Bracknell Lane West
Bracknell
Berkshire
RG12 4AH
Great Britain

1st fold

2nd fold (Flap A)

Representatives and Nominated Organisations

Belgium

*P. Caluwaerts,
Belgian Building Research Institute,
Lombard Street 41,
1000 Brussels.
Tel: 02-653-8801/02-511-0683
Telex: 256 82

P. Nusgens,
Université de Liège,
Laboratoire de Physique du Bâtiment,
Avenue des Tilleuls 15-D1,
B-4000 Liège,
Belgium.
Tel: 041-52-01-80
Telex: 41746 Enviro B.

Canada

*R. Dumont,
Division of Building Research,
National Research Council,
Saskatoon,
Saskatchewan,
Canada S7N 0W9.
Tel: 306-665-4200
Telex: 074 2471

J. Shaw,
Division of Building Research,
National Research Council,
Ottawa,
Canada K1A 0R6.
Tel: 613-993-1421
Telex: 0533145

J.H. White,
Research Division,
Canada Mortgage and Housing Corporation,
Montreal Road,
National Office,
Ottawa, Ontario,
Canada K1A 0P7.
Tel: 613-748-2309
Telex: 053/3674

Denmark

*P.F. Collet,
Technological Institute,
Byggeteknik,
Post Box 141,
Gregersensvej,
DK 2630 Tastrup, Denmark.
Tel: 02-996611
Telex: 33416

Finland

*S. Ahvenainen/R. Kohonen,
Technical Research Centre,
Laboratory of Heating and Ventilation,
Lampomiekenkuja 3,
SF-02150 Espoo 15,
Finland.
Tel: 358 04564742
Telex: 122972 VTTHA SF

Federal Republic of Germany

*L.E.H. Trepte,
Dornier System GmbH,
Postfach 1360,
D–7990 Friedrichshafen 1,
Federal Republic of Germany.
Tel: 07545 82244
Telex: 734209-0 DO D

A. Le Marié
Projektleitung Energieforschung in
der KFA Jülich GmbH
Postfach 1913
D–5170 Jülich
Federal Republic of Germany
Tel: 02461 616977
Telex: 833556 KFA D

Netherlands

*W. de Gids,
Institute for Environmental Hygiene – TNO,
P.O. Box 214,
Delft,
Netherlands.
Tel: 015-569330
Telex: 38071

New Zealand

*H.A. Trethowen,
Building Research Association of New Zealand Inc
(BRANZ),
Private Bag,
Porirua,
New Zealand.
Tel: Wellington 04-357600
Telex: 30256

Norway

*J.T. Brunsell,
Norwegian Building Research Institute,
Box 322,
Blindern,
N-0314 Oslo 3,
Norway.
Tel: 02-46-98-80

S. Uvsløkk,
Norwegian Building Research Institute,
Høgskoleringen 7,
N-7034 Trondheim – NTH,
Norway.
Tel: 07-59-33-90

Sweden

*L.G. Månsson,
Swedish Council for Building Research,
St. Göransgatan 66,
S-112 33 Stockholm,
Sweden.
Tel: 08-540640
Telex: 10398

F. Peterson,
Royal Institute of Technology,
Dept. of Heating and Ventilating,
S-100 44 Stockholm,
Sweden.
Tel: 08-7877675
Telex: 10389

Switzerland

*P. Hartmann, EMPA,
Section 176,
Ueberlandstrasse,
CH 8600 Duebendorf,
Switzerland.
Tel: 01-823-4276
Telex: 53817

The Oscar Faber Partnership (UK)

*S. Irving,
The Oscar Faber Partnership,
Marlborough House,
Upper Marlborough Road,
St. Albans,
Herts, AL1 3UT,
Great Britain.
Tel: 0727-59111
Telex: 889072

H. Danskin,
Building Research Energy Conservation
Support Unit (BRECSU),
Building Research Establishment,
Bucknalls Lane, Garston,
Watford,
Herts, WD2 7JR,
Great Britain.
Tel: 0923-674040
Telex: 923220

BSRIA,
Old Bracknell Lane West,
Bracknell,
Berks, RG12 4AH,
Great Britain.
Tel: 0344-426511
Telex: 848288

USA

*M. Sherman,
Energy and Environment Division,
Building 90, Room 3074,
Lawrence Berkeley Laboratory,
Berkeley, California 94720,
USA.
Tel: 415/486-4022
Telex: 910-366-2037

R. Grot,
Building Thermal and Service Systems Division,
Centre for Building Technology,
National Bureau of Standards,
Washington D.C. 20234,
USA.
Tel: 301/921-3470

J. Smith,
Department of Energy,
Buildings Division,
Mail Stop GH-068,
1000 Independence Avenue S.W.,
Washington D.C. 20585,
USA.
Tel: 202/252-9191
Telex: 710 822 0176

D. Harrje,
Centre for Energy and Environmental Studies,
Princeton University,
Princeton, New Jersey 08544,
USA.
Tel: 609-452-5190/5467

*Steering Group Representative.

Published by

Air Infiltration Centre,
Old Bracknell Lane West,
Bracknell,
Berkshire, RG12 4AH,
Great Britain.

ISSN: 0143-6643

Tel: National 0344 53123
International +44 344 53123

Telex: 848288 (BSRIAC G)

Head of AIC: Peter J. Jackman,
BTech CEng FIMechE FCIBSE

Operating Agent: The Oscar Faber Partnership