AIC

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A survey of current research into air infiltration in buildings

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A survey of current research into air infiltration in buildings

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Survey of Current Research in Air Infiltration

Introduction

An important objective of the Air Infiltration Centre is to keep organisations in participating countries informed of current research into air infiltration. To meet this requirement a questionnaire (Appendix 1) requesting information on research into this topic was widely circulated. This report describes the results of this survey and is based on a total of 65 replies received from 14 countries (Appendix 2). To facilitate access and regular updating of this work, the research summaries are stored on computer in a database which can be searched by the AIC's free text retrieval system.

This report is presented in two parts. In the first, the results are summarised in terms of specific objectives, project details and parameters with which air infiltration is related. These results are presented in tabular form in which the various aspects of research are cross-referenced against the organisations concerned. In the second part, the research summaries are reproduced in full. Thus the first part of this report may be used as an index to the summaries.

SECTION 1 Summary of Results

1.1 Specific Objectives

The specific objectives are divided into 10 categories (Table 1). In many instances organisations specified more than one objective and therefore appear under more than one subject heading.

The most common objectives are to:

- Determine the effects of construction methods and retrofitting on air infiltration (21 replies).
- Develop mathematical models (17 replies).
- Determine energy losses associated with air infiltration (15 replies).
- Develop or use methods to measure or locate sources of air infiltration (15 replies).

The remaining objectives are to:

- Measure air leakage through building components and specific openings (8 replies).
- Determine minimum ventilation requirements (8 replies).
- Determine the effects of occupancy on air infiltration (7 replies).
- Determine representative values of air infiltration (7 replies).
- Determine the pressure distribution in buildings (6 replies).
- Study the effects of air infiltration on the performance of heating, ventilation and heat recovery systems (6 replies).

In some instances objectives overlap. For example the effects of construction techniques and retrofitting are often considered in terms of both air infiltration and energy consumption (AT1, CA1, CA7, GB3, IE1, SE4, US4). Similarly, in many cases, the effects of occupancy are related to these two parameters (CA1, GB8, GB10, US4).

The development of air infiltration models includes air infiltration in buildings (CA1, CA4, IE1, US5, US7, US8), the effects of wind on air infiltration (CA3) and air flow through building components (DE3, SE1). Other models are of ventilation (FI1, GB5, NL4), internal pressure distribution (DE1, DE2), heat flow (CA2, GB6) and smoke movement (GB1).

Work on the development and evaluation of methods to measure air infiltration and leakage is mainly based on tracer gas and pressure testing techniques. There is also interest in the development of instrumentation for the continuous monitoring of air infiltration (CA8, DK1, GB5). Other measurement methods under development are thermography (FI1), AC pressure testing, (US6, US7), gas sampling using sealed bottles (US1), and relating ventilation rate to atmospheric carbon dioxide concentration (GB9).

The individual components through which air leakage is being measured are underfloor areas and attic spaces (AU1), wall cavities (AU1, CA2), general leakage paths through facades (BE1, SE1, US5), porous insulation materials (CA2), windows (GB7, US5), doors (US5) and structural slits (DE3, SE5).

Minimum ventilation rates are being assessed in terms of general ventilation requirements (DE1, FI1, NL1, NL4, SE4), air quality (CH5, US3), concentration of pollutants (CH4) and moisture damage (SE6).

The determination of pressure distribution in buildings is being primarily undertaken in large buildings with many rooms and flow paths. Typical buildings are high rise dwellings (DE1, DE4, GB1), high rise offices (DE4, GB1) and hospitals (DE2).

Representative rates of air infiltration are generally being related to such factors as climatic conditions and season.

1.2 Project Details

The project details are divided into two categories. The first deals with the type of building under investigation (Table 2) and the second gives details of measurements and tests (Table 3).

Approximately 75% of the measurements are being made in dwellings. The remainder are in climatic chambers, individual rooms, commercial buildings, educational establishments, hospitals, a laboratory, a supermarket and a greenhouse. About half of these premises are occupied.

The most common air infiltration and air leakage measurements are based on tracer gas methods and pressure tests. Thermography is also being used by some organisations.

In a number of cases the facade pressure distribution and pressure difference across building components are being measured directly and, to a lesser extent, wind tunnel tests are being used. Other measurements include energy consumption, air quality, radon concentration and smoke movement. Mathematical models are being widely used to interpret results.

1.3 Parameters with which Air Infiltration is Related

The parameters with which air infiltration is related are given in Table 4. These are in addition to those measurements referred to in the previous section.

Air infiltration is being almost universally related to wind speed and direction, air temperature and internal temperature. Those organisations looking into the effects of occupancy on air infiltration are also considering such parameters as external humidity, room humidity, solar radiation and rainfall. The remaining parameters are structural design, building components, year of construction, terrain and the interaction of heating, ventilation and heat exchange systems.

1.4 Conclusions and Discussion

This survey has been successful in uncovering a wide range of research projects in air infiltration. It has also highlighted areas where there is little or no research currently in progress.

The results in Table 2 clearly illustrate that few measurements are being made in commercial and industrial buildings. Some studies relating to office blocks are being undertaken but none in factories and warehouses. The absence of such work is, in part, indicative of the practical difficulties involved. Nevertheless, efforts should be made to overcome these problems as there is little doubt that there is considerable energy loss from such buildings.

There is a growing interest in studies into the effects of occupancy on air infiltration. This is an important area of research because it will illustrate the extent to which behavioural influences prevent the full benefit of 'tight' building design and retrofit from being achieved.

The effects on air infiltration of the gradual deterioration of building components due to ageing did not appear as a specific objective. This seemed surprising as ageing will have an undesirable effect on air infiltration rates. Research into quantifying the importance of this problem will aid future building design and will enable recommendations regarding remedial action to be made.

The direct measurement of building envelope pressure, under natural conditions, is becoming widespread. This is a desirable measurement and is preferable to the alternative approach of inferring the pressure distribution from wind and temperature data alone. If the relationships between climatological conditions, pressure distribution and air infiltration are to be properly understood, then these pressure measurements are essential.

Information on current research will be updated regularly and will be freely available to organisations in participating countries. In addition, it is envisaged that a detailed survey will take place annually.

TABLE 1 – SPECIFIC OBJECTIVES

OBJECTIVE	ORGANISATION
1. To determine the effects of construction methods and retrofitting on air infiltration.	AU1, AU2, AT1, BE1, CA1, CA5, CA6, CA7, CH2, FI1, GB2, GB3, IE1, NZ1, SE4, SE5, SE6, US4, US9, US10, US11.
2. To develop mathematical models.	CA1, CA2, CA3, CA4, DE1, DE2, DE3, FI1, GB1, GB5, GB6, IE1, NL4, SE1, US5, US7, US8.
3. To determine energy losses due to air infiltration.	AT1, CA1, CA7, CA10, CH2, CH6, GB3, GB4, GB8, GB10, IE1, NL2, NL3, NL6, SE4, US4.
4. To develop/use methods to measure/locate sources of air infiltration.	AU2, CA4, CA6, CA8, DK1, FI1, GB5, GB9, GB12, GB13, NL2, NZ1, SE6, US1, US6, US7.
5. To measure air leakage through building components and specific openings.	AU1, BE1, CA2, DE3, GB7, GB11, SE1, US5.
6. To determine minimum ventilation requirements.	CH4, CH5, DE1, FI1, NL1, NL4, SE4, US3.
7. To determine the effects of occupancy on air infiltration.	CA1, CH3, CH5, GB8, GB9, GB10, US4.
8. To determine representative values of air infiltration.	AU1, AU2, CA9, CH1, NL5, NZ1, SE3.
9. To determine the pressure distribution in buildings.	DE1, DE2, DE4, FI1, GB1, GB12.
10. To study the effects of air infiltration on the performance of heating and ventilation systems.	BE2, CA3, DE2, GB3, SE2, US2.

TABLE 2 – PROJECT DETAILS–BUILDING

BUILDING DETAILS	ORGANISATION
Low rise dwelling.	AU1, AU2, CA1, CA3, CA5, CA6, CA7, CA8, CA10, CH1, DK1, FI1, GB1, GB3, GB5, GB8, GB10, GB11, IE1, NL2, NL3, NL6, NZ1, SE2, SE3, SE4, SE5, SE6, US1, US3, US4, US5, US7, US9, US10, US11.
High rise dwelling.	AU2, CA4, CH2, CH3, DE1, DE4, FI1, GB1, GB7, GB9, NL1, NL4, NL6, US8, US10.
Low rise commercial.	GB1, GB6, NL4, NL6, US10.
High rise commercial.	CA4, DE4, GB1, US8, US10.
School/University.	CA4, GB4, GB9.
Hospital.	DE2.
Supermarket	CA4.
Climatic chamber.	CA2, CH4, CH5, US2.
Individual rooms.	BE1, CH4, CH5, NL6.
Specific building components.	AU1, BE1, CA2, DE3, GB2, GB7, GB11, NL5, SE1, US5.
Other.	CA9 (greenhouse), CH6 (laboratories), GB12, US6, US10 (all buildings).
Occupied.	AU2, CA1, CA7, CA8, CH2, CH3, CH5, DK1, GB3, GB4, GB6, GB7, GB8, GB9, GB10. IE1, NL3, NZ1, SE2, SE3, SE4, US1, US4, US7, US9.
Unoccupied.	AU1, CA1, CA2, CA4, CA6, CA7, CA8, CH1, GB4, GB5, GB11, NL6, NZ1, US2, US5.
Simulated occupancy.	CH1, IE1, NL1.

TABLE 3 – PROJECT DETAILS–MEASUREMENTS AND TESTS

MEASUREMENTS	ORGANISATION
1. Tracer gas.	AU1, AU2, CA4, CA6, CA7, CA8, CA9, CH1, CH2, GB3, GB4, GB5, GB6, GB7, GB9, GB11, GB12, NL3, NL6, NZ1, SE2, SE3, SE4, SE5, US1, US2, US3, US4, US5, US8, US11.
2. Pressure tests.	AU1, AU2, BE1, CA1, CA3, CA4, CA6, CA7, CA8, CA9, CA10, CH1, FI1, GB3, GB5, GB7, NL2, NL5, SE2, SE4, SE5, SE6, US3, US4, US5, US6, US8, US11.
3. Energy consumption/heat loss.	CA1, CA7, CA10, CH2, CH3, CH6, GB3, GB4, GB6, GB8, GB10, IE1, NL2, NL3, NL6, SE2, SE4, US2, US4, US9.
4. Facade pressure distribution/pressure difference	BE2, CA4, CH2, DE3, DE4, FI1, GB6, NL3, NL6, US8.
5. Internal pressure distribution.	DE1, DE2, DE4, FI1, NL1, SE4.
6. Wind tunnel tests.	AU2, CA3, CA4, GB13, US10.
7. Thermography.	CA1, FI1, GB3, SE4, SE5.
8. Radon.	GB13, SE3, US3.
9. Smoke	FI1, GB1, GB12.
10. Odours.	CH4, CH5.
11. Numerical/computer model.	CA1, CA2, CA3, CA4, DE1, DE2, DE3, FI1, GB1, GB4, GB5, GB6, IE1, NL1, NL3, NL4, NL5, NZ1, SE1, US5, US7, US8, US10.

TABLE 4 – PARAMETERS WITH WHICH AIR INFILTRATION IS RELATED

PARAMETER	ORGANISATION
1. Wind direction and speed.	AU1, AU2, BE2, CA1, CA3, CA4, CA6, CA7, CA8, CA10, CH1, CH2, CH3, CH6, DE1, DE2, DE4, DK1, FI1, GB1, GB2, GB3, GB4, GB5, GB6, GB7, GB8, GB9, GB10, GB11, GB13, IE1, NL1, NL2, NL3, NL4, NL5, NL6, NZ1, SE3, SE4, SE5, US1, US2, US3, US5, US7, US8, US10, US11.
2. Air temperature.	AU1, AU2, BE2, CA1, CA2, CA3, CA4, CA6, CA7, CA8, CA10, CH1, CH2, CH3, CH4, CH6, DE1, DE2, DE4, DK1, FI1, GB1, GB2, GB3, GB4, GB5, GB6, GB7, GB8, GB9, GB10, GB11, GB13, IE1, NL1, NL2, NL3, NL4, NL5, NL6, NZ1, SE2, SE3, SE4, SE5, US1, US2, US3, US5, US7, US8, US11.
3. Internal temperature.	AU1, AU2, BE2, CA1, CA2, CA3, CA4, CA6, CA7, CA8, CA10, CH1, CH2, CH3, CH4, CH6, DE1, DE2, DE4, DK1, FI1, GB1, GB2, GB3, GB4, GB5, GB6, GB7, GB8, GB9, GB10, GB11, GB13, IE1, NL1, NL2, NL3, NL4, NL5, NL6, NZ1, SE2, SE3, SE4, SE5, US1, US2, US3, US5, US7, US8, US11.
4. External humidity.	AU2, GB7, NL5.
5. Room humidity.	CH1, CH2, CH4, GB8, SE5.
6. Solar radiation.	CA2, GB7, US2.
7. Rainfall.	GB7.
8. Structural design, shape and dimensions.	CA6, CA7, DE2, DE4, FI1, SE3, SE4.
9. Effect of heating, ventilation, heat exchanger.	CA3, CH4, CH5, CH6, DE1, DE2, FI1, GB9, IE1, US2, US3, US8.
10. Performance of building components.	AU2, BE2, CA1, CA6, DE1, DK1, GB1, GB2, IE1, NL1, NL2, NL3, NL4, NL5, US5, US7, US11.
11. Terrain.	CA4, CA6, SE3, GB5, IE1, NZ1.
12. Year of construction.	CA7, DK1, FI1, GB3.
13. Other.	SE1 (roughness of flow path).

Section 2 - Research summaries

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Austria	H.Stocher	AT1

ADDRESS

Technische Universitat Wien
A-1040 Vienna
Karlsplatz 13

Telephone: 0222-65-7641

PROJECT TITLE

Critical configuration of climatological data regarding heat loss.

PROJECT DESCRIPTION

Specific objectives: Critical configuration of outdoor temperature, wind velocity, sunshine, based on meterological statistics and various realizations of the building envelopes.

Project details: see paper in bibliography.

Date project began: 1980 Project completion date: 1981

BIBLIOGRAPHY

Stocher H.
"Der Windeinfluss auf den Warmebedarf von Wohnbauten."
Veroff. Inst. fur Hochbau fur Bauing, 1974

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Australia	D. Mitchell	AU1

ADDRESS

Division of Building Research
Commonwealth Scientific & Industrial Research Organisation
P.O. Box 56
Highett
Victoria 3190

Telephone: 95 0333
Telex: AA33766

PROJECT TITLE

Ventilation in Domestic Dwellings

PROJECT DESCRIPTION

Specific objectives: Determination of representative values of infiltration rates for typical Australian homes under a range of climatic conditions. To establish the degree to which variations in constructional detail of under-floor, wall cavity and attic spaces affect infiltration rates.

Project details: The typical Australian home is a single storey detached dwelling of 120-200 m2 in floor area, of timber frame construction, with an external cladding of timber or brick but some houses, particularly in Western Australia, are of all-brick construction with cavity double brick external walls. Roof construction is most commonly a pitched roof with either concrete or terra-cotta tiles. Floors are either suspended timber or concrete slab-on-ground.

Measurements of infiltration are made by the tracer gas method using nitrous oxide as the gas and an infra-red gas analyser (Analytical Development Company, Model 225-2B-SS) to determine decay times. Some measurements of permeability of the external fabric will be made by the pressurization method.

Sequential sampling of room air at up to 12 locations is possible and room and external temperatures, wind velocity and direction are recorded. The gas is released and distributed manually but the data is recorded automatically by data-logger and teletype.

The measurements are being made in established homes but the occupants are normally absent during the measurement period.

Date project began: Jan.1979 Project completion date: July 1981

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Australia	Richard Aynsley	AU2

ADDRESS

Dept of Architectural Science
University of Sydney
Sydney NSW 2006

Telephone: Sydney 692 2686
Telex AA 20056 FISHLIB

PROJECT TITLE

A study of techniques for estimating summer ventilation and winter infiltration in residential buildings.

PROJECT DESCRIPTION

Specific objectives: To determine typical infiltration and summer ventilation rates for current Australian residential construction methods and evaluate the accuracy of existing estimation techniques.

Project details: (a) Infiltration measurements will be made in detached dwellings, low rise semi-detached and high rise apartments. Size of dwelling range typically from 100 sq.m. to 150 sq.m. with construction being brick cavity or brick veneer walls, tile and metal deck roofs and concrete and timber floors.

Measurements will be taken using both pressurization and tracer gas (CO) techniques. Pressurization instrumentation will be "Setra" differential pressure transducers. Gas detector will be an "Interscan" CO concentration meter.

(b) Boundary layer wind tunnel studies of models will be used to measure external pressure distributions for use in discharge equations using gross orifice discharge data from pressurization studies for correlation with infiltration rates determined from tracer gas decay.

Parameters with which infiltration will be related: (a) Wind speed and direction will be taken from a 10m high anemometer with a strip chart reader. Air temperature and humidity will be measured using a Stephenson screened enclosure following typical Commonwealth Bureau of Meteorology methods.

(b) Masking techniques will be used to determine the infiltration contributions from doors and windows and benefits of airlock entries.

(c) Building use will be as close as possible to normal using long term building occupants.

(d) Comfort parameters will be monitored and occupants surveyed together with records of heating equipment.

Date project began: Dec 1979 Project completion date: Dec 1982

BIBLIOGRAPHY

Howard, J.S.
"Ventilation measurements in houses and the influence of wall ventilators"
Building Science, Vol.1, pp 251-257, Pergamon Press 1966

Aynsley, R., Melbourne, W. and Vickery, B.
"Architectural aerodynamics"
Applied Science Publishers, London 1977

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Belgium	E.Meert	BE1

ADDRESS

C.S.T.C.
41 Rue de Lombard
1000 Bruxelles

Telephone: 02/511.06.83

PROJECT TITLE

Air and water tightness of facades

PROJECT DESCRIPTION

Specific objectives: Determination in situ of the rate of air (and water) infiltration in facades.

Project details: Air infiltration is measured in situ by creating a pressure difference between a room and the outside with an adjustable fan, equipped with a device for measuring the pressure and the rate of flow of the air extracted from the room. The infiltration joints are sealed one after the other and on each occasion the air flow rate is measured. This has been done in different buildings.

Parameters with which infiltration will be related: Air pressure. Different types of infiltration points.

Date project began: July 1975 Project completion date: June 1979

BIBLIOGRAPHY

"Etancheite des facades et des toitures" (E.Meert, G. Van Ackere)
Rapport final IC-IB june1977 Bruxelles.

"Mesures in situ de l'etancheite a l'air et a l'eau" (M.Guillaume E.Meert)
Congres International des Entrepreneurs de Menuiserie.
Luxembourg 10-13/03/1978.

"Apercu des mesures d'etancheite in situ" (fin 1980?)

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Belgium	M Guillaume	BE2

ADDRESS

C.S.T.C.
41 Rue du Lombard
1000 Bruxelles

Telephone: 02/511.06.83

PROJECT TITLE

Airduct systems - Mechanical ventilation

PROJECT DESCRIPTION

Specific objectives: Efficiency of mechanical ventilation systems.

Parameters with which infiltration will be related: Air tightness of windows, doors, etc. Wind velocity. Outside and inside temperatures. Pressure due to wind upon outside walls.

Date project began: 1974 Project completion date: 1978

BIBLIOGRAPHY

"Circuits d'air - Economie d'energie dans les Equipements de ventilation. 1ere et 2eme partie."
Published by IC-IB Syndicat d'etudes Unterindustries - Construction.

"Measurements of ventilation rates in houses with natural and mechanical ventilation systems."
Meeting of CIB S-17 September Holzkirchen.
Authors: BRE P.Warren and B.Webb
: C.S.T.C. M.Guillaume and J.Ptacek

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Canada	Paul Jansen	CA1

ADDRESS

Fiberglas Canada Ltd
Technical Centre
PO Box 3005
Sarnia
Ontario

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Telex: 06476121

PROJECT TITLE

Air leakage and Air Infiltration

PROJECT DESCRIPTION

Specific objectives: (1) Understand what air infiltration is through other research and our own experimentation. (2) Provide products or systems which will minimise the heat losses associated with air infiltration.

Project details: (a) Presently measuring air leakage coefficients as per N.R.C. Canada test method, i.e. pressurization and correlating these to air infiltration rates. Some thermograms are also being taken and examined for possible likely problem areas such as sill plates and header zones. Measurements are only being made on detached residential structures. Both occupied and unoccupied buildings are being examined.

(b) Hope to develop computer model for typical home settings which may be used in a flow rate equation generated for different classes of homes to give realistic values for the tightness of homes. This can be used to develop new products based on their performance.

Parameters with which infiltration will be related: (1) Weather as per description of possible computer simulation. (2) Performance of building components existing and new. (3) Since some homes are occupied ,it will be necessary to study the behaviour of occupants.

Date project began: June 1978 Project completion date: (not known)

BIBLIOGRAPHY

No reports to date and none anticipated in the next 12 months.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Canada	R W Guy and H Homma	CA2

ADDRESS

Centre for Building Studies
Concordia University
1455 de Maisonneuve Boulevard, W.
Montreal
Quebec H3G 1M8

Telephone: 879-8575.

PROJECT TITLE

Effect of air infiltration in cavities and in porous insulation materials of assembled walls.

PROJECT DESCRIPTION

Specific objectives: To survey the effect of air leakage in wall cavities and in porous insulation materials on thermal performance. To survey the measures to release solar radiation on walls for cooling load reduction and for protection of insulation and sealing materials.

Project details:

(a) Type of test facility: a weather-exposed box, three sides of which are used as real scale models of walls with various insulation and siding arrangements.
Size and construction: 2.6m high x 1.2m wide and 3.7m long, wood frame construction.
Temperatures are being measured at external and intermediate surfaces of assembled walls, by thermocouples. Surface heat fluxes are measured by home-built heat flux sensors. Automatic continuous data logging will be made for several weeks in each of the hottest, coldest and intermediate seasons.
Unoccupied.
Inside of the box is maintained at room temperature.

(b) Theoretical simulation: a computer program to simulate the air flow in a wall cavity and its effect on the heat flow across the wall is completed based on the laminar flow theory. The buoyant force of the air in a cavity is taken to be the motive force of air movement. The simulation results and the experimental results from the above mentioned facility will be compared.

Parameters with which infiltration will be related: The air infiltration in wall cavities, air permeable insulation layers and spaces between glasses, will be analysed as the result of buoyancy of the air. Solar radiation is considered as an important parameter to cause the buoyancy in an air space.

Date project began: March 1978 Project completion date: (not given)

BIBLIOGRAPHY

Homma, H., and Guy, R.
Ventilation effect of back space of building enclosure siding as a releasing measure for solar radiation.
To be published in Proceedings on ASHRAE/U.S. Dept of Energy Conference on Thermal Performance of the Exterior Envelopes 3-5 December 1979, Kissimme, Florida, U.S.A.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Canada	H Homma and T Stathopoulos	CA3

ADDRESS

Centre for Building Studies
1455 de Maisonneuve Boulevard, W.
Montreal
Quebec H3G 1M8

Telephone: 879-8575

PROJECT TITLE

Analytical study of natural wind effects on ventilation of low rise buildings.

PROJECT DESCRIPTION

Specific objectives: To establish a method for prediction of infiltration and performance of mechanical ventilation systems under different weather conditions.

Project details: Total air balance is calculated as an organic result of air balance in each part of the building. Pressure balances in various spaces of a building are calculated by numerical methods. Weather data are supplied to the computer, and the effects of weather changes on the air leakage and the performance of mechanical ventilation is analysed.

Parameters with which infiltration will be related: Air leakage characteristics of each component of the building envelope are obtained from laboratory test results from building pressurization tests. Wind pressure distributions for various types of buildings will be obtained from an experimental wind tunnel study.

Date project began: June 1979 Project completion date: June 1983

BIBLIOGRAPHY

Stathopoulos, T. and Homma, H.
Natural wind effects on the infiltration of low rise buildings
To be presented at 8th CIB Congress "Building Research World Wide"
15-19 June, 1980 in Oslo, Norway.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Canada	C Y Shaw	CA4

ADDRESS

Division of Building Research
National Research Council
Building M-24, DBR, National Research Council
Montreal Road
Ottawa K1A OR6

Telephone: (613) 993-1421

PROJECT TITLE

Air movement in large buildings

PROJECT DESCRIPTION

Specific objectives: To develop methods for calculating air infiltration in large buildings (schools, high-rise apartments, high-rise office towers and supermarkets) and to evaluate the tracer gas techniques as a measurement tool.

Project details:

(a) Measurements in buildings
Type: Schools, high-rise apartments, high-rise office towers, supermarkets and large retail stores.
Size and construction type: All
Measurements: (1) air leakage rates using fan pressurization methods (all building types)
(2) inside/outside pressure differences (residential houses, schools and high-rise apartment buildings)
(3) surface pressures - wind tunnel measurements (tall buildings - shielded or exposed)
(4) infiltration rates using the tracer gas decay method (CO2 for residential houses and SF6 for schools)
(5) measurements have been conducted on two unoccupied houses. Attempt will be made to measure air infiltration in schools in evenings and weekends.

(b) Theoretical/model calculations: An equivalent pressure difference model (EPD) has been developed for predicting air infiltration in inside/outside pressure differentials. This study will be continued on other types of buildings. The tracer gas techniques will be used to validate the EPD model.

Parameters with which infiltration will be related: temperature, wind speed, direction and terrain.

Date project began: (not given) Project completion date: 1981

BIBLIOGRAPHY

Shaw, C.Y. and Jones, L.
Air tightness and air infiltration of school buildings
ASHRAE Transactions, Vol. 85, Part 1, 1979

Shaw, C.Y.
A method for predicting air infiltration rates for a tall building surrounded by lower structures of uniform height
ASHRAE transactions, Vol. 85, Part 1, 1979

Shaw, C.Y.
Methods for conducting small scale pressurization tests and air leakage data for multi-storey apartment buildings.
ASHRAE Transactions, Vol. 86, Part 1, 1980

Shaw, C.Y.
Wind and temperature induced pressure differentials and an equivalent pressure difference model for predicting air infiltration in schools.
ASHRAE Transactions, Vol. 86, Part 1, 1980

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Canada	B E Roth	CA5

ADDRESS

Housing of Urban Development Association of Canada
15 Toronto Street, 10th floor
Toronto
Ontario M5C 2E3

Telephone: (416) 364-4135

PROJECT TITLE

Mark XI Research houses

PROJECT DESCRIPTION

Specific objectives: Comparing traditional construction with tighter, more highly insulated homes.

Project details: Air infiltration is being tested on the four test houses to compare the effects of building homes with continuous vapour barriers and better construction techniques as related to conventional Canadian practices.

Parameters with which infiltration will be related:
(i) Consider testing procedures and standard measurement techniques
(ii) Evaluate total air leakage rates, window and door losses and identify main sources of losses.

Date project began: Dec 1977 Project completion date: Dec 1982

BIBLIOGRAPHY

NOTE: A new research project will be started in 1980 on "Controlled ventilation of heat recovery for Canadian homes"

PUBLICATION: (1) Builders' Guide to Energy Efficiency in New Housing.
(2) Effects of high levels of insulation on the heating fuel consumption of Canadian houses.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Canada	R.S.Dumont	CA6

ADDRESS

Division of Building Research
National Research Council
Saskatoon
Saskatchewan
Canada S7N OW9

Telephone: 665-4204

PROJECT TITLE

Determination of air leakage characteristics of a new house using standard and improved methods of sealing.

PROJECT DESCRIPTION

Specific objectives: 1) Identify air leakage locations in the conventionally constructed house.
2) Test practical methods of acheiving airtightness through upgrading of the air barrier.

Project details: A house under construction will be leased at the stage when the drywall interior finish is installed but not taped. Measurements of the air leakage characteristics of the house will be made using SF6 tracer gas and pressurization methods both initially and at the completion of each of the upgrading steps.
- Unoccupied building, detached bungalow, 100sq.m. main floor, 100sq.m. basement, wood frame construction, concrete basement
- Tracer gas method using constant concentration technique.

Parameters with which infiltration will be related: Building size, shape, orientation, wind speed and direction, outside temperature, inside temperature, pressurization data.

Date project began: Oct 1979 Project completion date: Apr 1980

BIBLIOGRAPHY

1) R.Kumar, A.D.Ireson and H.W.Orr.
An automated Air Infiltration measuring system using SF6 Tracer gas in constant concentration and decay methods.
ASHRAE Trans. 1979 vol.85 part.2

2) Low Energy Passive Solar Handbook.
Department of Extension and Community Relations, University of Saskatchewan Saskatoon, Canada.(This booklet describes many of the sealing and airtightness details)

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Canada	H W.Orr	CA7

ADDRESS

Division of Building Research
National Research Council
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PROJECT TITLE

Determination of Air Leakage Characteristics of Residences.

PROJECT DESCRIPTION

Specific objectives: To quantify the energy loss component associated with air leakage in residences.

Project details: Measurements using both pressurization and tracer gas are being taken of air leakage in a sample of residences located in Western Canada. Both occupied and unoccupied buildings are being tested.
On a small sample of the houses, retrofit measures are to be undertaken, and before and after measurements will be carried out on the air leakage behavior.

Parameters with which infiltration will be related: Wind speed, temperature difference, building size and shape, year of construction, pressurization characteristics.

Date project began: 1977 Project completion date: 1981

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Canada	H W.Orr	CA8

ADDRESS

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Telephone: 665-4200

PROJECT TITLE

Air infiltration equipment development for building measurements.

PROJECT DESCRIPTION

Specific objectives: Development of Automated Equipment to provide continuous recording of air infiltration in buildings using the constant concentration method.

Project details: Ongoing project to refine some earlier equipment developed for air infiltration measurement. Buildings under test include both occupied and unoccupied residences, primarily detached bungalows with basements. Pressurization tests are also conducted on the same buildings. Multiple sampling columns will be added to allow one apparatus to record air infiltration rates in different parts on the same building.

Parameters with which infiltration will be related: Temperature and wind.

Date project began: 1977 Project completion date: 1981

BIBLIOGRAPHY

1) R.Kumar A.D.Ireson H.E.Orr.
An automated air infiltration measuring system using SF6 tracer gas in constant concentration and decay methods.
ASHRAE Trans. 1979 vol.85 part.2

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Canada	G.H.Green	CA9

ADDRESS

Department of Mechanical Engineering
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PROJECT TITLE

Air Infiltration into Greenhouses

PROJECT DESCRIPTION

Specific objectives: To determine the range of air infiltration rates in greenhouses.

Project details: Measurement of air changes with 50 pascal pressurization and corresponding tracer gas measurements.

Parameters with which infiltration will be related: Only comparison between greenhouses as work is explanatory.

Date project began: Jan 1980 Project completion date: Jan 1981

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Canada	R.M.Graham	CA10

ADDRESS

Saskatchewan Power Corporation Research and Development Centre
2025 Victoria Avenue
Regina
Saskatchewan S4P OS1

Telephone: 525-7384

PROJECT TITLE

Evaluation of Electric Heating - Cronach Heating Study.

PROJECT DESCRIPTION

Specific objectives: The objective of this project is to evaluate different types of electric heating with respect to their load characteristics and their effect on the system load. (The air leakage test is used to assist in correlating the energy consumption of the test houses.)

Project details: The overall study includes monitoring of 30 houses - 5 houses with 6 different types of electric heating. The houses are instrumented with two recording watt-hour meters to record total house energy consumption and the heating system energy consumption. The leak testing is used to compare house construction, relative amount of air infiltration, and therefore compare energy consumption. The method of leak testing is to create a vacuum in a house with a powerful exhaust fan and then measure the relative pressure drop. Note that this is following the technique of Mr.S.Stricker of Ontario Hydro. A door is fitted with an exhaust fan, and is placed inside the doorway of the house. A measurement of the pressure drop is made with an inclined manometer after the fan has run 10-15 seconds.

Parameters with which infiltration will be related: The relative airtightness of the houses will compared to the energy consumption. The weather data has been collected from a local weather station.

Note: The leak tests were performed on 24 houses in September 1979. At this time energy consumption data is still being collected on the houses. Also, before any report on the leak testing will be available, further tests will be done to check the exhaust fan characteristics and the effect of screens.

Date project began: 1 Mar 77 Project completion date: 30 Sept 1980

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Switzerland	P.Hartmann	CH1

ADDRESS

EMPA
Building Physics Section
Ueberlandstrasse
CH-8600 Duebendorf

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Telex: 53817

PROJECT TITLE

Long term infiltration rate measurements of an occupied house.

PROJECT DESCRIPTION

Specific objectives: Leakage rate and range of infiltration rates of a typical single family house.

Project details:
a) - detached building, single family, two main floors, living area about 130sq.m., water heating system.
   - measurements: Automatic tracer gas (N2O); pressurization weather data; inside climate; window positions (usually closed), special measurements with partially opened windows.
   - Instrumentation: Data logger for all measurements, automatic.
   - unoccupied, in short periods with simulated occupancy
b) - simulation is planned.

Parameters with which infiltration will be related: weather data (temp. wind) simulated user influence.

Date project began: Jul 1979 Project completion date: Oct 1980

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Switzerland	P.Hartmann	CH2

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PROJECT TITLE

Air change rates of typical Swiss buildings; influence of specially tight windows on infiltration and energy conservation.

PROJECT DESCRIPTION

Specific objectives: Comparison of infiltration between two appartments with and without installation of insulating shutters.

Project details: a) - residential block (4 floors), heavy brick construction measurements: Tracer gas (N2O); meteorological data; inside climate; pressure difference between facades ; occupied building.
b) No simulation. Comparison of measurements with hygienic requirements.

Parameters with which infiltration will be related: Performance of building; on/off exhaust air fan; on/off shutter (insul. type); weather.

Date project began: 1977 Project completion date: Dec 1979

BIBLIOGRAPHY

EMPA report no.39400/a, Sept.1979
Einfluss von waermegadaemmten Klappladen auf den Luftwechsel und den Heizenergiverbrauch in Wohnungen.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Switzerland	H.Muehlebach & P.Hartmann	CH3

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PROJECT TITLE

Air change rates and air heating consumption of not airconditioned rooms

PROJECT DESCRIPTION

Specific objectives: Determination of window opening and behaviour of inhabitants depending on weather parameters.

Project details: a) - 2 residential blocks (4 floors, about 40 families) measurements: climatic data, energy consumption, window and shutter position (one entire winter, measurements frequently during one day each month, normally two times a day). instrumentation: none except weather station and total energy consumption. occupied dwellings.

Parameters with which infiltration will be related: - infiltration can only be estimated, - main purpose : user pattern correlated with weather data.

Date project began: Oct 1977 Project completion date: Jul 1980

BIBLIOGRAPHY

-final report to be expected in summer 1980

Rebsamen E.
Zusaetzlicher Luftungswaermebedarf
nur beheizter Wohnhaeuser 5 1978
internal report

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Switzerland	H.U.Wanner	CH4

ADDRESS

Swiss Federal School of Technology
for Hygiene and Workphysiology.
CH - 8092 Zurich

Telephone: 01/32 62 11

PROJECT TITLE

Indoor Pollutants emitted by building materials.

PROJECT DESCRIPTION

Specific objectives: Investigation of pollutants emitted by building materials, surface coating materials, insulation and consumer products.

Project details: a) Review of relevant literature. b) Elaborate the relation between the concentration of some gaseous compounds as formaldehyde and the odourous compounds (measured with a sensoric method). c) Studies will be performed in a climatic chamber and in living rooms. d) Elaboration of standards or guidelines to minimize the emissions of gaseous compounds.

Parameters with which infiltration will be related: ventilation, temperature, humidity,

Date project began: 1 Apr 1980 Project completion date: 31 Mar 1983

BIBLIOGRAPHY

Int. Indoor Climate Symposium, Copenhagen 30.8.-1.9.78
"Effects of indoor climate on human comfort."

Report of a WHO Working Group
Regional Office for Europe (1979)

Wanner H.U.
"Hygienische Beurteilung von Verunreinignung der Wohnraumluft."
In "Organische Verunreinigungen in der Umwelt"
herausgegeben von K.Aurand et.al.
Erich Schmidt Verlag, Berlin (1978).

Wanner H.U.
"Luftqualitaet in Innern von Gebaeuden."
Referat am XXI Int. Kongress fuer Techn. Gebaeudeausruestung.
17./18.4.80 in Berlin.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Switzerland	H.U.Wanner	CH5

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Swiss Federal School of Technology
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CH - 8092 Zurich

Telephone: 01/32 62 11

PROJECT TITLE

Minimum ventilation requirements.

PROJECT DESCRIPTION

Specific objectives: To establish objective crieria for ventilation standards. To establish minimum ventilation rates based on the number of persons and their activities.

Project details: Review of relevant literature and available standards. Elaborate a sensoric method to measure odourous compounds. Measuring the concentration of carbon dioxide and odours depending on the number of persons and their activity. Elaborate the relation between the odourous compounds, the concentration of carbon dioxide and the subjective evaluation of the air quality by the occupants of the room.

Studies will be performed in a climatic chamber and in different living rooms.

Parameters with which infiltration will be related: - number of persons and their activities, - ventilation rate.

Date project began: 1 Jan 1979 Project completion date: 31 Dec 1981

BIBLIOGRAPHY

Int. Indoor Climate Symposium, Copenhagen 30.8-1.9.78
"Effects of indoor climate on human comfort."

"Health Aspects related to Indoor Air Quality."
Report of a WHO working group, Regional Office for Europe (1979).

Wanner H.U.
"Hygienische Beurteilung von Verunreinigungen der Wohnraumluft."
In:Organische Verunreinigungen in der Umwelt
Herausgegeben von K.Aurand et.al., Erich Schmidt Verlag, Berlin (1978)

Wanner H.U.
Luftqualitat im Inneren von Gebauden
Proc. XXI Int. Congress for Building Services Engineering, Berlin
April 1980

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Switzerland	G.Gottschalk	CH6

ADDRESS

Inst.Therm.Appl.
Ecole Polytechnique Federale de Lausanne
1015 Lausanne

Telephone: 473525

PROJECT TITLE

Energy Consumption in Laboratory Buildings; Long Time Measurements.

PROJECT DESCRIPTION

Specific objectives: Determine heat losses due to different causes, among them infiltration losses.

Project details: Monitoring of different modern laboratory buildings for long time measurements (2 winters, 2 summers), and with different types of heating/ventilation installation.

Parameters with which infiltration will be related: Meteorological

Date project began: Jan 1977 Project completion date: May 1980

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Germany	H.Esdorn	DE1

ADDRESS

Hermann-Rietschel-Institut
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Telephone: 030 314 2618/4170

PROJECT TITLE

Numerical Investigation about pressure distribution and airflow in multi storey buildings with mechanical ventilation.

PROJECT DESCRIPTION

Specific objectives: Pressure distribution and airflow inside buildings due to different weather conditions will be calculated.

Project details: The ingoing and exhaust air due to wind pressure, thermal buoyancy and ventilation systems will be calculated for typical floor plans of multi storey buildings by a computer programme. As the result statements are expected to be made about the influence of structural design for the internal flow routes, about the pressure distribution and ventilation rates. The aim is to find out how to secure the necessary ventilation rates. These problems are important too in buildings with tight windows to provide fireplaces with the necessary oxygen.

Parameters with which infiltration will be related: outdoor temperature wind speed, wind direction and tightness of doors and windows.

Date project began: Apr 1980 Project completion date: Mar 1982

BIBLIOGRAPHY

Esdorn H.
"Luftdurchlassigkeit der Fenster und Druckverteilung in Gebaude"
In "Das Hochhaus der BASF"
Hoffman-Verlag, Stuttgart 1958

Esdorn H. Rheinlander J.
"Zur rechnerischen Ermittlung von Fugendurchlasskoeffizienten und Druckexponenten fur Bauteilfugen"
Heizung, Luftung, Klimatechnik, Haustechnik. 29 (1978) no.3 p.101-108.

Esdorn H. Brinkmann W.
"Der Luftungswarmebedarf von Gebauden unter Wind- und Auftriebseinflussen - Ein Vorschlag fur den Entwurf der DIN 4701"
Gesundh Ing. 99 (1978) no.4 p.81-94 & 103-105.

Esdorn H. Feustel H.
"Maschinelle and freie Luftung von Wohngebauden - ein Vergleich"
paper to be published at XXI Internationaler Kongress fur technische

Gebaudeausrustung, April 1980 Berlin.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Germany	H.Esdorn	DE2

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PROJECT TITLE

Air transfer inside hospitals due to pressure distribution.

PROJECT DESCRIPTION 1

Specific objectives: Development of a computer programme for the determination of the pressure distribution and air transfer due to wind pressure,thermal buoyancy and ventilation systems.

Project details: For the calculation the building will be described by three grid systems, one grid for the building itself, one for the duct-system for the air supply and one for the duct system for the exhaust air. The pressure distribution and air transfer is calculated from a large system of non linear equations. The programme was developed for buidings of arbitrary structure. It is written in Fortran IV for a Control Data CD 6500 computer.

Parameters with which infiltration will be related: Weather conditions,size of the buildings,permeability to air of the facade.

PROJECT DESCRIPTION 2

Specific objectives: Experimental investigation on the pressure distribution in specified areas of real hospitals.

Project details: The pressure will be measured at up to twenty points in specific areas of hospitals with an off-line system. The data will be punched onto tape and transferred to a computer to work out the reliability of methods to influence the pressure distribution and thereby the direction of airflow. These problems are of especial importance in hospitals because of the transport of airborne contaminants.

Parameters with which infiltration will be related: Open and closed doorways in the inspected area,design of the floor plan.

Date project began: Jan 1978 Project completion date: Dec 1979

BIBLIOGRAPHY

Esdorn,H. Feustel H. and Schmidt M.
"Einfluss naturlicher und erzwungener Druckfelder auf den Luftaustausch innerhalb von Krankenhausern."
Final report TP F 2/5 des SFB 159, TU 1980

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Germany	H.Esdorn	DE3

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PROJECT TITLE

Calculation of air flow through structural slits.

PROJECT DESCRIPTION

Specific objectives: To provide empirical formulae for prediction of air flow through structural slits as function of pressure difference.

Project details: For a variety of slits with different basic geometries air flow rate as a function of pressure difference was measured. Results were evaluated by adaptation of a potential equation to the measured values.

Parameters with which infiltration will be related: pressure-difference, slit geometry.

Date project began: 1970 Project completion date: 1978

BIBLIOGRAPHY

"Zur rechnerischen Ermittlung von Fugendurchlasskoeffizienten und Druckexponenten fur Bauteilfugen"
H.Esdorn and J.Rheinlander
Heiz.Luft.Haustech. vol.29 (1978) p.101-108.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Germany	H.Esdorn	DE4

ADDRESS

Hermann-Rietschel-Institut
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PROJECT TITLE

Heat loss due to natural ventilation.

PROJECT DESCRIPTION

Specific objectives: Development of an easy algorithm for the pressure distribution and air flow in high rise buildings.

Project details: The pressure distribution in and outside of the building was measured in various altitudes. The measured pressure differences were plotted by recording pen. A proposal for a new standard for heat loss calculation (DIN 4701) is partly based on results of these investigations.

Parameters with which infiltration will be related: different structural design of the building, wind speed, wind direction.

Date project began: 17 Sept 1970 Project completion date: 30 Nov 1976

BIBLIOGRAPHY

Esdorn H.
"Luftdurchlassigkeit der Fenster and Druckverteilung im Gebaude"
In "Das Hochhaus der BASF"
Hoffmann-Verlag, Stuttgart 1958.

Esdorn H. Rheinlander J.
"Zur rechnerischen Ermittlung von Fugendurchlasskoeffizienten und Druckexponenten fur Bauteilfugen"
Heizung, Luftung, Klimatechnik, Haustechnik 29 (1978) no.3 p.101-108.

Esdorn H. Brinkmann W.
"Der Luftungswarmebedarf von Gebauden unter Wind und Auftriebseinflussen - Ein Vorschlag fur den Entwurf der DIN 4701"
Gesundh.Ing. 99 (1978) no.4 p/81-94 & 103-105.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Denmark	P.F.Collet	DK1

ADDRESS

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PROJECT TITLE

Continuous measuring at the natural air change rate in occupied dwellings.

PROJECT DESCRIPTION

Specific objectives: Developing a method for continuous measuring of air change rate (ACR) (constant concentration) in inhabited dwellings with up to 10 rooms (including temperature gradient, and dew point in each room).

Project details: The dwellings will be of general type, e.g. detached, semi-detached, town house, residential block, of different age and construction type equal to the typical Danish dwellings.

Measurements to be taken: a) ACR with internal doors open, b) ACR with internal doors closed (constant concentration), c) like b) when the dwellings are occupied and used as they are normally.

Instrument: constant concentration, (N_2O,SF_6) regulated and data stored by mini computer, perhaps combined with a pressure test.

Parameters with which will be related: ACR will be combined with weather, building age, people inside, height of flat, weather stripping of internal doors versus external doors and windows.

Date project began: 1 Oct 1979 Project completion date: 30 Dec 1981

BIBLIOGRAPHY

Collet P.F. et.al.
"Boligers luftskifte."
Technologisk Institut. Tastrup, Denmark.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Finland	J.Railio	FI1

ADDRESS

Technical Research Centre of Finland (VTT)
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Espoo 15

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Telex: 12-2972

PROJECT TITLE

Air Infiltration Research.

PROJECT DESCRIPTION

Specific objectives: Development of airtightness requirements, calculation models, measurement methods and airtight buildings.

Project details: (more details in ref. /1/)
Caculations: multi-cell models, flow equations for each room

output: leakages, mech. air flows, pressure conditions.
(PARTS: "EXHAUST AIR MODEL" "SUPPLY AIR MODEL" "LEAKAGE MODEL")
Measurements: pressure method for whole small houses or flats, collector chamber for local leakages, smoke test or IR-thermography for localization, pressure diff. with multimanometers; possibly "cooling method" as preliminary test. Special attention will be paid for appropriate method combinations in large buildings.
Constructions: airtight joints; possibly also supply air intake through building envelope will be developed.
Requirements: for whole buildings, parts of buildings, structures and joints. Main parameters are type of building and ventilation system.

Parameters with which infiltration will be related: Weather, building components, ventilation system, (possible "auxiliary parameters": age size and type of buildings)

Date project began: 1 Feb 1979 Project completion date: 31 Dec 1982

BIBLIOGRAPHY

/1/ Railio J.
Infiltration and ventilation, research in Finland.
Presented in Res. Colloquium BRE,Garston, 14-16 April, 1980
To be published as VTT's report.

/2/ Ahvenginen S.
Determination of the airflow conditions in an exhaust ventilation system with a computer program.
LVI 31 (1979) pp 58-62 (in Finnish with Swedish and English summary).

/3/ Railio J.
Rahennusten triviysongelmat. Espoo 1978.
VTT/LVI Report 39. (infiltration problems of buildings, a preliminary study. With English summary).

/4/ Saarmio P.
Predicting the interconnection between airtightness and air change rate. LVI 32 (1980) 5 (to be continued in no.6) In Finnish with Swedish and English summary).

to be published:
- results of projects. (4-5 reports) VTT's report series. Summary and figure texts also in english.
- preliminary results and summaries (3-5 per year) In Finnish (possibly also foreign) journals, with English summaries.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
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Telex: 889072

PROJECT TITLE

Air and smoke movement through buildings.

PROJECT DESCRIPTION

Specific objectives: To develop a suite of computer programs to predict movement of air and/or smoke through a building.

Project details: This project is concerned with the detailed simulation of air and smoke movement through buildings. The programs take account of wind, stack, mechanical ventilation, and local effects due to the fire itself. Leakage characteristics of building components are fed in as data. The programs can cater for any building from single family dwellings to large commercial premises. The program uses a nodal representation of the flow network, and uses a Newton-Raphson iterative technique to solve for the flowrates and pressures. The program has been validated against output from similar programs, and will shortly be validated against the results of a real fire.

Date project began: Jun 1977 Project completion date: (ongoing)

BIBLIOGRAPHY

Irving S.J.
"The computer simulation of smoke movement during building fires."
Fire Prevention Science and Technology. no.22 Dec.1979 p.3-8.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Great Britain	G.Brackley	GB2

ADDRESS

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Building Research Establishment
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Buckinghamshire HP17 9PX

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PROJECT TITLE

Jointing between components.

PROJECT DESCRIPTION

Specific objectives: To evaluate factors governing the performance of joints, particularly in exterior walls and to develop techniques for assessing and predicting the performance, not only of the overall design, but also of constituent parts such as sealants and non-adhering gaskets. To provide the basis for the development of quality assurance procedures associated with joints and jointing products.

Project details: Continue studies of air and water movement in and around building joints in service. Initiate survey of incidence of water and air leakage associated with specific joint types in use, determine cause of leakage and develop and assess improved joint detail. Continue evaluation of weathertightness prediction test for use in UK against natural exposure conditions.

Note only part of the complete program is concerned with air infiltration.

Parameters with which infiltration will be related: Performance of building components and elements. Weather.

Date project began: (not given) Project completion date: continuing

BIBLIOGRAPHY

Thorogood R.P.
"Resistance to air flow through external walls."
B.R.E. Information Paper IP 14/79.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Great Britain	P.O'Sullivan	GB3

ADDRESS

Welsh School of Architecture, R & D.
24 St.Andrews Cres.
Cardiff

Telephone: 0222 24733

PROJECT TITLE

Operating efficiency of domestic central heating systems.

PROJECT DESCRIPTION

Specific objectives: a) To assess the benefits of higher standards of insulation in 39 houses. b) To measure the operating efficiency of domestic gas boilers. c) To assess the affect of air infiltration on a) and b).

Project details: the main experimental programme involves the continuous measurement of 1) inside temperatures 2) energy inputs 3) boiler efficiency 4) weather conditions 5) living pattern. In addition to the main programme a thermographic survey has been performed as well as the following infiltration measurements:

1) 1978 (a) Pressure tests on eight houses.
   (b) Tracer gas measurements on one house (performed by BRE)
2) 1979 Pressure tests on three houses (performed by BRE)
3) 1980 (Proposed) Pressure and gas tracer tests on twelve houses (to be performed by British Gas) including the continuous measurement in one house for a two week period.

Parameters with which infiltration will be related: 1) Age of houses 2) The parameters listed in "Project details".

Date project began: 1 May 1977 Project completion date: 31 Oct 1981

BIBLIOGRAPHY

Internal reports:-

1) "Better insulated houses, Abertridwr: Monitoring of domestic central heating systems."
   Jones, McGeevor, O'Sullivan. Sept.1978

2) "Better insulated houses, Abertidwr: Monitoring of domestic central heating systems."
   Jesson, Jones, McGeevor, Smith, O'Sullivan. Sept.1979

3) "Monitoring of Chaucer Infant School, Ilkeston."
   Jones, O'Sullivan. Sept.1979

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Great Britain	M.G.Davies	GB4

ADDRESS

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PROJECT TITLE

Passive solar heating.

PROJECT DESCRIPTION

Specific objectives: To process and evaluate existing data on the Wallasey school, regarding its energy consumption, thermal response, and user reaction.

Project details: a) Building: St.Georges School, Wallasey. MAssive, much glazing, part passively heated. Size: houses 300 pupils. Measurements: Mostly temperatures. A few spot values for ventilation rate were once made with N2O. Instrumentation mainly thermocouples. Occupation: Occupied and unoccupied.

b) A thermal model has been used to infer daily mean vent rates. The work requires revision.

Parameters with which infiltration will be related: Weather and behavour of occupants.

Date project began: (not given) Project completion date: ongoing

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Great Britain	D.Etheridge	GB5

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Watson House
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London SW6 3HN

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Telex: 919082

PROJECT TITLE

Ventilation of dwellings

PROJECT DESCRIPTION

Specific objectives: To develop theoretical and experimental methods for determining ventilation.

Project details:
a) - Dwellings, detached and terraced.
   - one-family, English construction
   - pressurisation and tracer gas (SF6, N2O)
   - automatic ventilation measurement
   - mainly unoccupied dwellings.

b) Multi-cell crack flow model, validated with data from detached house.

Parameters with which infiltration will be related:
a) Temperature, wind terrain
b) Leakage of houses and rooms.

Date project began: (not given) Project completion date: (not given)

BIBLIOGRAPHY

1) "Crack flow equations and scale effect"
D.W.Etheridge
Build. and Env. 12 181-189 (1977)

2) "The prediction of ventilation rates"
D.Etheridge and P.Phillips.
CIB Meeting proceedings. Holzkirchen, W.Germany Sept 1977.

3) "Natural ventilation in well insulated houses"
D.Nevrala and D.Etheridge.
ICHMT Seminar, Dubrovnik, Aug/Sept. 1977

4) "Ventilation measurements at model scale in a turbulent flow"
D.Etheridge and J.A.Nolan
Build. And Env. 14 53-64 (1979)

5) "Air infiltration in the U.K. and its impact on the thermal environment"
D.W.Etheridge and D.J.Nevrala
Indoor Climate symposium, Copenhagen, Aug/Sept. 1978

6) "Ventilation heat loss outside in"
R.Gale
Gas Engng. and Management, November 1979

7) "Natural and mechanical ventilation rates in a detached house.
Part 1. Measurement."
D.W.Etheridge, R.Gale, M.Gell, and L.Martin
Accepted for Applied Energy.

8) "Natural and mechanical ventilation rates in a detached house.
Part 2. Prediction."
D.K.Alexander and D.W.Etheridge

9) "Theoretical and experimental studies of heat loss due to ventilation"
D.K.Alexander D.W.Etheridge and R.Gale
Prepared for XXI Int. Cong. for Building Services Engineering
Berlin 1980.

10) "The British Gas multi-cell model for calculating infiltration"
D.K.Alexander and D.W.Etheridge.
Prepared for ASHRAE symposium, June 1980.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
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PROJECT TITLE

Glasgow Commercial Building Monitoring Project (IEA Annex IV)

PROJECT DESCRIPTION

Specific objectives: Comparison of several computer predictions of thermal performance with measurements in an occupied low-rise commercial building. This project stems directly from the Annex I work now completed.

Project details: As part of the comprehensive energy monitoring infiltration measurements will be made on a continuous basis. The building is air-conditioned and is therefore nominally sealed. It measures 47 x 93 x 24m. Sulphur hexafluoride tracer gas equipment, supplied by the U.S. participant, will be used to obtain decay type measurements in each of four zones in the building. The measurements will be correlated with external surface pressures and outside wind speed, direction and temperature.

Date project began: Mar 1979 Project completion date: 1982

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
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PROJECT TITLE

The effects of turbulent wind on airflows through buildings.

PROJECT DESCRIPTION

Specific objectives: To achieve a better understanding of the interactions between the flow of air at building surfaces and through openings in the external fabric, with particular reference to dynamic effects.

Project details: An experimental investigation using a small storeroom (4 x 7 x 2m) at the top of a high rise service tower. This room has been thoroughly sealed, and special windows mounted flush with the external fabric surface. Special instrumentation has been developed for this study which enables rapid sampling of the uni-axial component of velocity in the region near an opening in a window. These measurements will be correlated with continuous release tracer gas measurements and pressure measurements. External wind speed and direction are also being recorded.

Parameters with which infiltration will be related: Infiltration will be correlated with velocity based measurements at the experimental opening to the sealed room. This will determine the important effects that cause wind induced infiltration in buildings.

Date project began: 1977 Project completion date: 1980

BIBLIOGRAPHY

J.P.Cockroft & P.Robertson
"Ventilation of an enclosure through a single opening"
Building and Environment II p.29-35 (1976).

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Great Britain	G.Conan	GB8

ADDRESS

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Kingston Lane
Uxbridge UB8 3PH

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PROJECT TITLE

Consumer variability in gas consumption.

PROJECT DESCRIPTION

Specific objectives: Assessment of attitudinal and behavioral determinants of domestic gas consumption.

Project details: local authority semi-detached and terraced dwellings (no.=112) all with partial central heating. The results will be interpreted in terms of a human ecosystems model.

Parameters with which infiltration will be related: (1) Data obtained from an in-depth interview - a) occupant characteristics, b) thermal requirements, c) ventilation requirements,, d) related behaviour patterns, e) internal temperatures and humidities in each room at time of interview.

(2) With 100 window observations (for each room in each house) at a particular time (9a.m. - 6 p.m.) on a specified day (Mon. - Fri.)

(3) With quarterly gas consumption.

(4) With mean hourly wind speed and direction, sunshine, rainfall, humidity and temperature.

(5) With data from a postal questionnaire covering reported (i) motivations underlying window opening and closing in summer and winter. (ii) frequency duration and extent of window opening in specific climatic conditions.

Date project began: Oct 1979 Project completion date: Oct 1981

BIBLIOGRAPHY

Conan G.
"Variations in gas consumption - a behavioral and attitudinal study"
To be published in "Building Energy Management" Pergamon Press.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Great Britain	J.M.Penman	GB9

ADDRESS

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PROJECT TITLE

Determination of ventilation rate in occupied buildings using atmospheric carbon dioxide concentration.

PROJECT DESCRIPTION

Specific objectives: To investigate the practicality of determining the ventilation rate in occupied buildings by recording the CO2 concentration in the internal air and relating it to the number and level of activity of the occupants.

Project details: A successful trial of the method has been made in a mechanically ventilated part of Exeter University Library. Results of further trials in a school classroom and an office (both naturally ventilated) are awaiting analysis. It is hoped to test further and apply the method as part of a project to monitor the performance of a low energy school at present under construction in Devon.

Parameters with which infiltration will be related: In the school project; wind speed, outdoor temperature, happenings in the School.

Date project began: Mar 1979 Project completion date: 1984

BIBLIOGRAPHY

Penman J.
"An experimental determination of ventilation rate in occupied rooms using atmospheric carbon dioxide concentration"
Building and Environment vol.15 no.1 p.45:47.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Great Britain	G.W.Brundrett	GB10

ADDRESS

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PROJECT TITLE

Window opening behaviour.

PROJECT DESCRIPTION

Specific objectives: To identify behavioural patterns of ventilation. To link behaviour with physical parameters. To quantify the energy cost of such behaviour.

Project details: One site containing detached semi- and terraced houses (Connahs Quay) was surveyed daily for a year and window behaviour recorded for 128 family houses. This behaviour was linked to weather. No energy or temperature records were taken. A second site, similar but of wooden construction, (Kenmay) was fully instrumented to record energy and temperature in 24 houses. Window behaviour was monitored for one winter.

Parameters with which infiltration will be related: Window opening behaviour linked to weather.

Date project began: 1974 Project completion date: 1981

BIBLIOGRAPHY

G.W.Brundrett
"Window opening in houses: an estimate of the reasons and magnitude of the energy wasted"
E.C.R.C./M801.

G.W.Brundrett & R.Barker.
"An investigation into the air quality of three working mens clubs."
E.C.R.C./N1078.

G.W.Brundrett.
"Ventilation: a behavioural approach."
Energy Research, 1 p.289-298 (1977).

J.B.Siviour & A.E.Mould
"A tracer gas method for the continuous monitoring of ventilation rates."
CIB S17 Meeting at Holzkirchen, 28-30.Sept. 1977.

R. Strudwick
"Infiltration at Ringway House Basingstoke."
E.C.R.C./R1088

G.W.Brundrett & R.Barker
"Opportunities for energy conservation by heat pump dehumidifier and and odour treatment."
Unipede, Bordeaux 1977.

R.Barker
"A UV/Ozone method of odour control."
IEE conference on effective use of electricity in buildings,
29 April - 2 May, 1980.

G.W.Brundrett
"Electricity and comfort in the home."
International Conference on energy use in buildings, Arizona Oct. 1977.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
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PROJECT TITLE

Infiltration through open windows.

PROJECT DESCRIPTION

Specific objectives: To quantify the influence of an open window.

Project details: two unoccupied houses were used
(1) E.C.R.C. test house (semi)
(2) Kemnay house (detached - timber construction)
Nitrous oxide was the tracer using the decay technique.

Parameters with which infiltration will be related: Ventilation was assessed terms of wind speed and direction in combination with different open windows.

Date project began: 1978 Project completion date: 1981

BIBLIOGRAPHY

Dickson D.J.
"Ventilation with open windows."
E.C.R.C. M1329 1980

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Great Britain	J.G.F.Littler	GB12

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PROJECT TITLE

Detailed study of air movement within buildings.

PROJECT DESCRIPTION

Specific objectives: Development of instrumentation technique. To look at such phenomena as heat-mass transfer from/via: doorways, Trombe walls, south direct gain spaces to north cool spaces.

Project details: Up to 6 compounds (fine dispersions, sols, gases, smokes) will be injected at spatially distinct points in a building. Several (at least 6) simultaneous sampling points will take samples at (variable) real-time intervals. Samples will be subsequently analysed.

Parameters with which infiltration will be related: Project is initially only to develop the technique.

Date project began: 1 Oct 1980 Project completion date: 1 Oct 1982

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PROJECT TITLE

Air Infiltration Studies

PROJECT DESCRIPTION

Specific objectives: Develop further methods for predicting the natural ventilation performance of buildings.

Project details: (i) Wind tunnel studies of pressures on typical building types and arrangements, (ii) Full scale measurements, primarily in office and school buildings, (iii) Theoretical and laboratory studies of the mechanisms of ventilation, (iv) Survey of occupant behaviour as it affects natural ventilation requirements in buildings, and (v) Studies to investigate radon levels and methods of alleviation.

Parameters with which infiltration will be related: Weather, occupancy, pressure distribution.

Date project began: (not given) Project completion date: (not given)

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
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PROJECT TITLE

A techno-economic study of the effects of insulation and alternative energy conservation techniques in housing.

PROJECT DESCRIPTION

Specific objectives: To study effects of energy conservation measures both technically and with respect to an economic model. Some less comprehensive work had been done at the institute before.

Project details: a) Measurements in buildings: detached, semi-detached, and terraced houses were considered, of typical sizes in Ireland, of Hollow Block, Cavity Wall, and Timber Frame construction. Buildings were considered occupied. No direct measurements were taken, but account was taken of measurements made by other studies, and of some measurements taken on air infiltration with the sulphur hexafluoride tracer gas.

b) Theoretical calculations: As input to larger model of system, infiltration parameters were obtained with the aid of zoned model of infiltration phenomena - one, two and four zones being considered. Constants estimated from literature and/or measurements of crack dimensions etc. Results compared to real measurements validated models to be in the right area.

Parameters with which infiltration will be related:
a) Temperature, wind speed, exposure of site.
b) Windows, doors, heating appliances, chimneys, vents, walls.
c) Simulated behaviour of occupants.
d) Assumed pressure distribution around buildings.

Date project began: May 1977 Project completion date: Mar 1979

BIBLIOGRAPHY

(1) Energy conservation options in housing vol.1 and 2.
H.M.Clyne I.J.Cowan P.J.McGilligan
IIRS. March 1979

(2) Energy conservation options for householders.
I.J.Cowan P.J.McGilligan
IIRS, March 1979

(3) Ventilation and air infiltration in buildings.

I.J.Cowan
Building Progress, IIRS 5 (5) Sept./Dec. 1978

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Netherlands	W.F.De Gids	NL1

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PROJECT TITLE

Control of mechanical ventilation in houses.

PROJECT DESCRIPTION

Specific objectives: Getting information about the consequences of reduction of the mechanical extracted or exhaust air for the control system in relation to minimum ventilation rate and other hygienic factors.

Project details: Measurements on a typical existing system will be carried out in a 12 storey apartment building with a calculation model. The consequences of switching off or switching over to lower rpm of the fan will be studied. The measurements consist of a) pressure distribution in the exhaust system; b) air flow rates in the exhaust system.

Parameters with which infiltration will be measured: weather, fan performance, building components and simulated behaviour.

Date project began: Mar 1979 Project completion date: Jul 1980

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Netherlands	W.F.De Gids	NL2

ADDRESS

Institute for Environmental Hygiene TNO
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PROJECT TITLE

Pressurisation tests in dwellings.

PROJECT DESCRIPTION

Specific objectives: The aim of the study is to examine the accuracy of predictions of energy consumption due to infiltration based on pressurisation tests.

Project details: Pressurisation tests for five dwellings have been carried out, -including separate tests for each room. Infiltration rate measurements were carried out for three of the houses. The dwellings are all typical low cost houses.

Parameters with which infiltration will be related: Weather, performance of building components.

Date project began: Nov 1978 Project completion date: Aug 1980

BIBLIOGRAPHY

Improvements of the pressurisation test method for measuring the air leakage of buildings.
W.F.De Gids, AIC Conference Oct.1980

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Netherlands	W.F.De Gids	NL4

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PROJECT TITLE

Natural ventilation of small utility buildings.

PROJECT DESCRIPTION

Specific objectives: The aim of the study is to establish minimum ventilation openings in the external and internal walls.

Project details: Model calculations on minimum ventilation openings in walls.(low rise commercial). Developing internal walls with enough openable ventilation area. Preventing draught and noise problems.

Parameters with which infiltration will be related: Weather,performance of external and internal walls.

Date project began: May 1980 Project completion date: Mar 1982

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Netherlands	W.F.De Gids	NL3

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PROJECT TITLE

Natural ventilation and energy consumption.

PROJECT DESCRIPTION

Specific objectives: To predict the ventilation in low cost dwellings and flats and the energy consumption resulting from the ventilation rate.

Project details: Measurements were made, in dwellings and appartments, of infiltration,pressure differences,temperatures,position of windows and doors, airtightness of building and building components. Infiltration measurements were made using katharometers with He as tracer pressure differences using electronic pressure transducers (VALYDINE) temperatures with copper-constantan thermocouples and the positions of windows and doors with micro-switches. All buildings are low-rise and have volumes of approx.200 to 300 cubic metres.The houses were occupied. Measurements and model calculated results will be compared.

Parameters with which infiltration will be related: Weather,performance of building components and behaviour of occupants.

Date project began: Sept 1978 Project completion date: Jul 1980

BIBLIOGRAPHY

Investigation of the relationship between the natural ventilation of a flat and meteorological conditions.
W.F.De Gids, a.o.IMG-TNO,Delft 1977

Natural ventilation and energy consumption.
W.F.De Gids a.o.EC-Brussels Oct.1979

Wind-tunnel and on site pressure distribution measurements on a house and its effect on infiltration.
W.F.De Gids,a.o.ASHRAE, Detroit 1979

Calculation method for the natural ventilation of buildings.
W.F.De Gids,IMG-TNO, Delft 1978

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PROJECT TITLE

Performance of windows and external walls on air-tightness.

PROJECT DESCRIPTION

Specific objectives: To measure the air-tightness of twenty typical external wall constructions - depending on season.

Project details: The pressure difference vs. airflow curves will be measured for each of the twenty constructions during the year in each season and time. Measurement equipment: Fan, pressure transducers, pitot tube, flow meters, orifice plates. The wall constructions are all in the low-cost housing area. This study will give us up to date information about the leakage of outside walls which can be used for our models.

Parameters with which infiltration will be related: Weather, temperature, humidity, seasonal performance of building components.

Date project began: Jan 1979 Project completion date: Apr 1981

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
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PROJECT TITLE

Ventilation through open windows.

PROJECT DESCRIPTION

Specific objectives: To predict energy losses and possible savings by opening and closing windows on time.

Project details: Measurements in an office room and two houses on infiltration and the indoor climate in the room with open window.
Room volumes:53cu.m, 37.5cu.m., 23.5cu.m.
Measurements: air velocities,air-change rates and temperatures.
Methods:Hot wire anemometer, pressure transducer, Katharometers using He as tracer, copper constantan thermocouples. Pivoting and sliding windows were investigated. the rooms were unoccupied.

Parameters with which infiltration will be related: Weather,indoor climate, energy consumption.

Date project began: Jan 1979 Project completion date: Aug 1980

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
New Zealand	T.S.Clarkson	NZ1

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PROJECT TITLE

Preliminary investigation of air infiltration into typical NZ timber frame dwellings.

PROJECT DESCRIPTION

Specific objectives: 1) development of the tracer gas technique for local use. 2) Determination of relationships between air infiltration and wind-speed and temperature difference for typical NZ houses in order to make comparisons with results obtained elsewhere.

Project details: a) Buildings studied are new detached dwellings, about 100 sq. m. timber frame usually clad with wooden weatherboards, and usually galvanised iron roofs. Measurements taken are wind speed and direction, inside-outside temperature differences, concentration decay of tracer gas (SF6) at several indoor sites. Standard meteorological recording instruments are used together with automatic air sample collectors. The air samples are analysed for SF6, the chromatograph with an ECD. Both occupied and unoccupied buildings have been studied.

b) Only the simplest models have been applied e.g. an assumed exponential decay of tracer gas concentration and a linear relationship between windspeed and ventilation rate. These seem adequate for this preliminary study.

Parameters with which infiltration will be related: Wind and location are the parameters we have concentrated on. By using identical houses on different sites effects due to construction are lessened. The only data analysis relates to getting a quantitative estimate of ventilation versus wind speed for a typical house built by the NZ Government. No attempt has been made to study performance of building components - although we have observed effects obviously due to these.

Date project began: July 1978 Project completion date: 1980

BIBLIOGRAPHY

No publications so far. From time to time interim reports have been made to the Ministry of Energy who convene a small committee (including a representative of the Building Research Association of NZ). The results and experience gained during the present experiments could lead to a more comprehensive project carried out by some other organisation.

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PROJECT TITLE

Air leakage of building components

PROJECT DESCRIPTION

Specific objectives: To use the concept of fluid mechanics to make it possible to calculate air flows in and through building components.

Project details:
Theoretical part: Fluid mechanics - building physics
Computer programming for air flow calculations
Field investigations: Measurement device for local leak paths
Verification of calculation models
Laboratory investigations: Surface roughness of building materials
Flow in slits, cracks, etc.
Potential flow
Verification model

Parameters with which infiltration will be related: Materials, dimensions, etc. of the leak path. Surface roughness along the flow path.

Date project began: 1 Jan 1979 Project completion date: 31 Dec 1980

BIBLIOGRAPHY

1. Testing whole houses for air leakage using a pressure method.
ASHRAE transactions 1978.

2. Measurements and methods of measuring air tightness of buildings.
(In Swedish) Report T6:1979 from the Swedish Council for Building Research also in English.
3. Air flows in and through building components. Planned to be published late 1980.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Sweden	A.Svensson	SE2

ADDRESS

National Swedish Institute for Building Research
Box 785
S-801 29 Gavle
Sweden

PROJECT TITLE

Heat recovery from exhaust air

PROJECT DESCRIPTION

Specific objectives: To determine the energy saving of heat recovery systems compared to conventional exhaust air systems.

Project details:
-low rise residential blocks as well as single family houses.
-measurements: pressurization, air change rates with N20 , temperatures

inside and outside.
-instruments: IR-analyser, special made temperature integrater,
tightness equipment.
-occupied buildings.

Parameters with which infiltration will be related: Temperature difference inside/outside.

Date project began: Mar 1980 Project completion date: Apr 1981

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Sweden	C.A.Boman, B.E.Erikson	SE3

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PROJECT TITLE

Air change rates in dwellings with natural ventilation.

PROJECT DESCRIPTION

Specific objectives: The aim of the measurements is to get the relationship between wind and temperature and air changes in dwellings.

Project details: low rise residential blocks of light weight concrete structure, N20 used as a tracer gas, IR analyzer (MIRAN 101), occupied buildings.

Parameters with which infiltration is related: a) weather (temperature, wind and terrain, b) windows, vents, c) radon gas.

Date project began: Jan 1980 Project completion date: Jun 1980

BIBLIOGRAPHY

B.E.Erikson
Ventilation requirements in dwellings and single family houses.
Bulletin from SIB, M17:1976

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Sweden	A.Elmroth	SE4

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100 44 Stockholm

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PROJECT TITLE

An investigation of airtightness, indoor climate, air change and energy consumption in airtight buildings.

PROJECT DESCRIPTION

Specific objectives: Relationship between airtightness, ventilation, indoor climate and energy consumption in new detached houses.

Project details: Dwellings (detached), 1.5 floors of wood construction. Pressurization, thermography, tracer gas (N20) and pressure distribution.

Parameters with which infiltration will be related: (a) Temperature, wind. (b) Vents, building construction. (c) Behaviour.

Date project began: 1978 Project completion date: 1980

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PROJECT TITLE

Airtightness of Buildings - Building Design Aspects and Problems.

PROJECT DESCRIPTION

Specific objectives: Testing and designing building design solutions from thermal insulation and airtightness aspects. Recommendations for builders.

Project details: Mostly single family dwellings and wood construction. Testing methods: Pressurization, thermography, guarded pressure box and sometimes tracer gas (N2O).

Parameters with which infiltration will be related: Temperature, wind, humidity, pressure differences.

Date project began: 1 Jan 1979 Project completion date: 31 Dec 1981

BIBLIOGRAPHY

B.Carlsson A.Elmroth P.Engvall
"Thermal insulation and airtightness: Building design solutions"
Swedish Council for Building Research, T24:1979 Stockholm.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
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PROJECT TITLE

Building design aspects during building work.

PROJECT DESCRIPTION

Specific objectives: Polyurethane foam - risk of moisture damage? Simplified method for pressurization; penetrations in airtight layer.

Project details: Mostly single family dwellings are investigated.
Pressurization: Rough estimate of airtightness in buildings with the help of manometer and existing fans.
Penetration: System for sealing penetrations.

Date project began: 1 Feb 1979 Project completion date: (not given)

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PROJECT TITLE

Modular retrofit experiment - field data on air exchange rates using bottle samples.

PROJECT DESCRIPTION

Specific objectives: Obtain air exchange rates in retrofitted housing using simple sampling technique with tracer gas.

Project details: SF6 tracer gas is seeded via a small plastic bottle throughout the house. Five individual samples are taken at 1/2 hour intervals. Sixteen ounce polyethylene bottles with natural rubber septum gaskets under the caps are used. The bottles are repeatedly squeezed to collect a true air sample. Analysis takes place by inserting a hypodermic needle through the septum. The analysis equipment squeezes the bottle to ensure that no room air enters as the air sample is removed. An electron-capture gas chromatograph sensitive to SF6 concentrations to 1ppb is used to determine gas concentrations.

These are occupied, detached dwellings of wood frame construction, 2-storey "colonial" design with approximately 2500 square foot floor space. Over the coming year sampling very likely will also take place in other smaller wood frame housing.

Parameters with which infiltration will be related: Temperature and wind will be factored into this air infiltration sampling. Performance with additional house tightening will also be measured.

Date project began: Oct 1979 Project completion date: Apr 1981

BIBLIOGRAPHY

1. Air infiltration reduction through retrofitting
ASTM Special Publication, (March 1978 ASTM Conference Proceedings)
in press, (with Thomas A. Mills, Jr).

2. Approaches to evaluation of air infiltration energy losses in buildings (with A. Blomsterberg) ASHRAE Transactions 1979 (also ASHRAE Journal, May 1979).

3. Locating and eliminating obscure but major energy losses in residential

buildings.
(with G. Dutt and J. Beyea), ASHRAE Transactions 1979.

4. Instrumenting energy audits
(with Jack B. Cooper and special assistance from Thomas A. Mills, Jr)
Princeton University Center for Energy and Environmental Studies
Report No. 91, July 1979.

5. Saving energy in the home - Princeton experiments at Twin Rivers
edited by Robert H. Socolow, Ballinger Publishing Company, September 1978.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
U.S.A.	D T Harrje & A K Persily	US2

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PROJECT TITLE

In-situ tests of air infiltration dependence on weather and opening position including use of air-to-air heat exchanger.

PROJECT DESCRIPTION

Specific objectives: The tests are being conducted in an unoccupied structure of wood frame construction on the roof of a two storey building. The so-called "testchamber" is 2.5 x2.5 x 4 metres approximately. It was built airtight and is instrumented for temperature energy consumption and air infiltration rate. The tracer gas being used is ethane; its concentration is measured by absorption at infrared radiation. The outputs of the ethane detector, interior thermistors, the watt-hour meter and outside weather variables are transmitted down to the laboratory where they are automatically recorded on magnetic tapes for later analysis.
The heat loss rate of the structure is well understood and predictable.
By measuring the air exchange rate and heat loss rate of the structure with the heat exchanger running, the efficiency of the heat exchanger under the different operating conditions can be determined. The variable conditions include fan speed, outside wind conditions, solar heating of the units.....

In addition, air infiltration rates for the structure will be measured under various conditions. The tightness of the test chamber along with controlled openings presents a unique opportunity for such tests. Air Infiltration rates will be related to temperature difference, wind speed and direction, and to different arrangements of openings relating to wind and stack mechanisms.

Date project began: Jan 1980 Project completion date: Sept 1980

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
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PROJECT TITLE

Air infiltration reduction and indoor air quality

PROJECT DESCRIPTION

Specific objectives: To determine the indoor air quality implications of intensive efforts to reduce the air leakage in houses.

Project details: The air leakage in two houses was reduced by a combination of measures. The leakage sites and retrofit effectiveness were determined using a blower door. Blower door flow measurements before and after the retrofits indicate change in leakage characteristics. Levels of radon are measured before and after the retrofit for extended time intervals using a passive electrostatic radon monitor on loan from the Lawrence Berkeley Laboratory of the University of California. Air infiltration measurements using a tracer gas, as well as monitoring of other indoor contaminants are in progress. Tests of air-to-air heat exchangers to improve air quality in retrofitted houses is anticipated.

Parameters with which infiltration will be related: Temperature difference, wind speed, infiltration and indoor air quality in other houses.

Date project began: Dec 1979 Project completion date: Apr 1981

BIBLIOGRAPHY

(see US1)

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PROJECT TITLE

Demonstration of energy conservation through reduction of air infiltration in electrically heated houses.

PROJECT DESCRIPTION

Specific objectives: To demonstrate the energy savings that can be achieved when air leakage is reduced by retrofitting electrically heated houses.

Project details: Program sponsored by the Electric Power Research Institute, Palo Alto Ca. Ninety single family detached houses averaging 1600 sq.ft. floor area are involved, thirty received infiltration retrofit, thirty received no retrofit (participating controls) and thirty are unaware that their energy usage is being monitored (blind controls). The retrofit houses were evaluated for leakage before and after retrofit using pressurization/evacuation fan. Leakage at 0.1 ins. water pressure differential under evacuation conditions was reduced 30 Two retrofit houses also tested for air changes per hour using SF6 tracer gas method with similar results. Retrofit and participating controls houses are submetered to determine heating energy only. They also respond to monthly questionnaire relating to life style changes or energy conservation activities Blind controls monitored only by total energy usage and represent general population.

Parameters with which infiltration will be related:
a) Heating energy usage vs. air leakage.
b) Heating energy usage before and after retrofit.
c) Effect of known participation (participating controls vs. blind controls).

Date project began: 1 Jun 1978 Project completion date: 31 Oct 1980

BIBLIOGRAPHY

"Air infiltration measurement and reduction techniques on electrically heated homes."
J.O.Collins
Presented to ASHRAE/DOE Conference on Thermal Performance of the exterior Envelopes of buildings, Dec.3-5 1979.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
U.S.A.	J.G.Winston and M.B.Stewart	US5

ADDRESS

Owens-Corning Fiberglas Corporation
Technical Center, P.O.Box 415.
Granville
Ohio

Telephone: (614) 587-7082

PROJECT TITLE

Three test homes infiltration analysis.

PROJECT DESCRIPTION

Specific objectives: To develope an infiltration model for each of the three test houses at the Granville, Ohio, U.S.A. test site. To rank the houses in terms of relative tightness. To determine the relative contribution to infiltration of envelope components.

Project details: The three houses were built at the Granville, Ohio, USA test sites in late 1977. The houses were all built by the same contractor at approximately the same time, with the same orientation and indentical. The houses were built to the same, three-bedroom ranch floor plans.

Although the insulation levels in houses A and B were different, the furnaces in houses A and B are of the same capacity. House C has a larger sized furnace since the house in uninsulated. The houses are essentially the same in all other aspects, and are unoccupied.

Natural infiltration measurements were obtained using sulphur hexafluoride as a tracer gas. Pressurization and depressurization tests have been scheduled for the spring of 1980.

The natural infiltration measurements were obtained by a tracer gas unit. A gas chromatograph sampled the room air every fifteen minutes. A metered amount of SF6 was injected into the furnace just upstream of the blower every 7.5 hours. the blower operated continuously throughout the natural infiltration tests. Sampling, injection, and recording of data on a cassette tape was controlled by an electronics package mounted on the unit.

Pressurization and depressurization tests will be conducted using a blower unit designed and built for this purpose. The unit consists of a vane axial fan, a straight section of ductwork and a pitot tube rake. Envelope pressure drop and volumetric flowrate through the fan can be measured and recorded. These curves can be used to compare the relative tightness of the houses.

Pressurization tests will also be used to determine the fraction of infiltration through various envelope components. Windows, doors, electric switches and outlets, exhaust fans, and any additional infiltration paths will be sealed with tape and plastic. A 50 Pa envelope pressure drop will be created with the blower unit. The various sealed items will be

unsealed, one component at a time. After each component is unsealed, the blower flowrate will be increased to maintain the 50 Pa pressure difference. This increase in flowrate will be the flowrate through the unsealed items.

The infiltration models for the three houses were determined from the tracer gas data. the form of the infiltration equations was obtained from previous work (McBride, ASHRAE Trans. vol.85 part.1 1979). A regression program was run on the tracer gas data for each house in order to determine the regression coefficient for the model of each house.

Parameters with which infiltration will be related: wind effects, inside-outside temperature difference,

Date project began: May 1978 Project completion date: 31 July 1980

BIBLIOGRAPHY

Reeves G.McBride M. Sepsy C.
"Infiltration models for residences"
ASHRAE Trans. vol.85 part 1. 1979.
(This report develops form of infiltration model we employed)

Stewart M.B. Jacob T.R. Winston J.G.
"Analysis of infiltration by tracer gas technique, pressurization tests and infrared scans"
Presented at ASHRAE/DOE conference on Thermal Performance of the Exterior Envelopes of Buildings, Dec.3-5 1979.
(This report provides results of natural infiltration measurements in the Granville test houses along with work carried out by another researcher, T.R.Jacob in the same test houses).

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
U.S.A.	D T Grimsrud	US6

ADDRESS

Lawrence Berkeley Laboratory
University of California
One Cyclotron Road.
Berkeley
California 94720

Telephone: (415) 486-6651
Telex: 910-386-8839

PROJECT TITLE

Development of Instrumentation and Measurement Techniques to Characterize Air Infiltration in Buildings.

PROJECT DESCRIPTION

Specific objectives: See title of project.

Project details: The following instrumentation has been developed and/or modified and has been used in field measurement.
a) A microprocessor-based data acquisition system.
b) An automated controlled-flow tracer gas system.
c) A "DC" pressurization system.
d) An "AC" pressurization system (oscillating plunger).
Development work is continuing on the "AC" system to make it portable.

Design and development studies are in progress to produce a portable system which measures average infiltration over a period of time ranging from one week to one month.

Date project began: Aug 1977 Project completion date: 1 Oct 1981

BIBLIOGRAPHY

Condon P.E. Grimsrud D.T. Sherman M.H. and Kammerud R.C.
"An automated controlled-flow air infiltration measurement system".
to be published in the Proceedings of the ASTM symposium on Air Infiltratio
n
and Air Change Rate Measurements, Washington D.C. MArch 1978, LBL report
no.6849 March 1978.

Sherman M.H. Grimsrud D.T. and Sonderegger R.C.
"The low pressure leakage function of a building"
to be published in the Proceedings of the DOE/ASHRAE Conference on Thermal
Performance of Exterior Envelopes of Buildings, Florida 3-5 Dec. 1979
LBL report no.9162, Nov.1979.

Grimsrud D.T. Sherman M.H. Janssen J.E. Pearman A.N. and Harrje D.T.
"An intercomparison of tracer gases used for air infiltration measurements.
"
ASHRAE Trans. vol.86 part.1 1080.

LBL report no.8394, November 1979.

Sherman M.H. Grimsrud D.T. Condon P.E. and Smith B.V.
"Air infiltration measurement techniques"
to be presented at the AIC Symposium on Instrumentation and Measurement techniques, Windsor, England Oct.1980 LBL report no.10706.

COUNTRY | PRINCIPAL RESEARCHER | REFERENCE NO

U.S.A. | D.T.Grimsrud | US7

ADDRESS

Lawrence Berkeley Laboratory
University of California
One Cyclotron Road.
Berkeley, CA 94720

Telephone: (415) 486-6651
Telex: 910-386-8339

PROJECT TITLE

Model development to predict air infiltration in buildings.

PROJECT DESCRIPTION

Specific objectives: To develop models to predict air infiltration in buildings based upon simple field measurement procedures.

Project details: Our modelling efforts to this point have concentrated on residential buildings. In constructing the models we have measured air leakage ⅔with both "DC" (blower door) and "AC" (oscillating plunger) style equipment⅓, surface pressures, weather variables ⅔indoor and outside temperature, wind speed and direction⅓ and air infiltration rates. The houses tested have both been occupied and unoccupied.

Our current model will be described in its preliminary form in a paper which will be presented at the ASHRAE summer meeting in Denver (June 1980). The model uses the effective leakage area of the building, the distribution of leakage among the floor, walls and ceiling, and the average wind speed and indoor-outdoor temperature difference as input parameters. The output of the model is the infiltration (volume/time) averaged over the same time interval as the weather value.

Date project began: 1 Oct 1978 Project completion date: 1 Oct 1982

BIBLIOGRAPHY

Grimsrud D.T. Sherman M.H. Diamond R.C. Condon P.E. and Rosenfeld A.H.
"Infiltration-pressurization correlations: detailed measurements on a California house."
ASHRAE Trans. vol.85 part.1 p.851-865 1979, LBL report no.7824

Sherman M.H. Grimsrud D.T. and Diamond R.C.
"Infiltration-pressurization correlation: surface pressures and terrain eff ects"
ASHRAE Trans. vol.85 part.2 p.458-479 1979, LBL report no.8785

Grimsrud D.T. Sherman M.H. Blomsterberg A.K. and Rosenfeld A.H.
"Infiltration and air leakage comparisons: conventional and energy-efficient housing designs"
In "Changing energy use futures" ed.R.A.Fazzolare and C.B.Smith,
Pergamon press, NY. 1979 vol.3 p.1351-1359, LBL report no.9157

Sherman M.N. and Grimsrud D.T.
"Infiltration-pressurization correlation: simplified physical modelling"
to be published in ASHRAE transactions vol.86 1980 LBL report no.10163

Blomsterberg A.K. Sherman M.H. and Grimsrud D.T.
"The mobile infiltration unit - its design and capabilities: preliminary experimental results."
LBL report no.10705 July 1980.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
U.S.A.	C.M.Hunt	US8

ADDRESS

Center for Building Technology,
742 National Engineering Laboratory
National Bureau of Standards
Washington D.C. 20234

Telephone: (301) 921-3560

PROJECT TITLE

Building Infiltration Evaluation.

PROJECT DESCRIPTION

Specific objectives: To develop experimental data on air exchange phenomena in large buildings and test and advance the modelling of these phenomena.

Project details: a) Measurements in buildings.
Type and size of building - Large buildings typically 500,000 - 10,000,000 cu.ft. office buildings primarily selected because of their air circulation systems, but apartment houses are of interest.

Measurements taken - SF6 tracer, fan pressurization, inside-outside pressure differences, in one instance CO2 concentration.

Brief instrumentation details - SF6 by gas chromatograph with electron capture detector. Pressure difference by variable capacitance gauge or Magnehelic gauge. CO2 by non-dispersive infrared. Currently upgrading level of SF6 system and developing a fan system large enough to pressurize a 500,000 to 1,000,000 cu.ft building.

b) Theoretical and model calculations - Comparing results with existing infiltration models.

Parameters with which infiltration will be related: Related parameters -
a) Wind velocity and direction, inside-outside temperature difference.
b) Effect of buildings forced ventilation system.

Date project began: 1978 Project completion date: 1982

BIBLIOGRAPHY

Hunt C.M.
"Ventilation measurements in the Norris Cotton Federal Office Building "
ASHRAE Trans. vol.85 part 1 p.828-839 1979

Hunt C.M. Treado S.J.
"Air exchange measurements in a high rise office building."
ASHRAE/DOE Conference on Thermal Performance of the Exterior Envelopes of Buildings, Orlando Florida Dec.3-5 1979.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
U.S.A.	J.C.King	US9

ADDRESS

Civil Engineering Laboratory
Code L63, Naval Construction Battalion Center
Port Hueneme
CA 93043

Telephone: 805-982-5975

PROJECT TITLE

Air leakage reduction techniques for Navy Family Housing Units.

PROJECT DESCRIPTION

Specific objectives: Determine by air leakage tests and/or metering the effectiveness of a number of building retrofits.

Project details: Six-unit row townhouses (wood frame construction, 1400 sq.ft. unit) were retrofitted with (1) additional ceiling insulation, (2) additional ceiling and additional wall insulation, (3) repeat of item (2) plus patch obvious cracks, (4) fiber glass mat applied to interior surfaces of exterior walls, (5) repeat of item (4) except strips only were applied to cracks at the baseboards, window frames, and door frames, (6) polystyrene insulation boards applied to exterior surfaces of exterior walls. Tracer dilution measurements made using SF6 injected into HVAC ducts; pressurization tests made with a fan-door system. Buildings were occupied during tests and energy monitoring period.One six-unit non-retrofitted structure was measured also for base-line data.

Parameters with which infiltration will be related: Type of retrofit.

Date project began: Aug 1977 Project completion date: Dec 1980

BIBLIOGRAPHY

Lagus P.L.et.al.
"Air leakage measurements and energy consumption economic analyses in navy housing at Norfolk, VA, volumes I and II"
Civil Engineering Laboratory Contract Report
Systems,Science and Software, P.O. Box 1620, La Jolla, CA 92038 Feb.1980

NOTE: This report covers retrofits (1), (2) and (3). A second report on retrofits (4), (5) and (6) should be issued in December 1980.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
U.S.A.	S.K.Ashley	US10

ADDRESS

Civil Engineering Laboratory
Code L63, Naval Construction Battalion Center
Port Hueneme, CA 93043.

Telephone: 805-982-5975.

PROJECT TITLE

Trade wind cooling of buildings.

PROJECT DESCRIPTION

Specific objectives: Develop a design manual for Trade Wind Cooling of Buildings.

Project details: All types of buildings. All sizes and construction types of buildings. Generalization of surface pressures from previous wind tunnel testing. Computer program connecting weather, wind velocities, surface pressures, cross ventilation, human comfort, mechanical assistance, best architectural designs, site selection etc. (not necessarily in that order). Field data acquisition and comparison with computer program data.

Parameters with which infiltration will be related: Inducing infiltration to enhance cross ventilation.

Date project began: Jun 1980 Project completion date: Sept 1983

BIBLIOGRAPHY

Ashley S.K.
"Inviscid two-dimensional vortex-panel method for calculating the pressure distribution over noncircular cylinders at various flow incidence angles."
Mechanical Engineering dept. Old Dominion University, Aug.1978
Sponsored by NASA, Langley Center, Hampton, VA.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
U.S.A.	R A Grot	US11

ADDRESS

National Bureau of Standards
Washington DC 20234
U.S.A.

Telephone: (301)-921-3470

PROJECT TITLE

Optimum weatherization of low income housing

PROJECT DESCRIPTION

Specific objectives: To measure reduction in air infiltration rates obtained by optimum weatherization of low income housing.

Project details: Approximately 250 single family houses in 14 cities in the United States are being weatherized and air infiltration rates are being measured before and after weatherization using tracer gas and pressure depressurization. The tracer gas measurements are being done by air bag sample technique. Approximately 5 to 10 measurements are being made on each dwelling before and after weatherization.

Parameters with which infiltration will be related: Weather, air tightening measures applied to buildings.

Date project began: Sept 1977 Project completion date: Sept 1980

BIBLIOGRAPHY

1. R.A. Grot
Low cost method for measuring air infiltration rates in a large sample of dwellings.
NBSIR 79-1728, April 1979

2. R.A. Grot, R.C. Clark
Air leakage characteristics and weatherization techniques for low income housing.
Proceedings of ASHRAE/DoE Conference of Building Envelope Performance, December 1979.

3. R.A. Grot, M.C. Chang
Reduction of air leakage achieved by optimum weatherization of low income homes.
NBS Report, November 1980

APPENDIX 1—SURVEY FORM.

International Energy Agency

AIC

Operating Agents for International Energy Agency:
The Oscar Faber Partnership, St. Albans, Great Britain.

Air Infiltration Centre

Old Bracknell Lane, Bracknell,
Berkshire, Great Britain, RG12 4AH.

Tel: National 0344 53123
International +44 344 53123
Telex: 848288 (BSRIAC G)

Head of Centre: Peter J Jackman BTech CEng MIMechE MCIBS

SUMMARY OF ONGOING RESEARCH IN AIR INFILTRATION IN BUILDINGS

1. Country: _____

2. Organisation: _____

3. Address: _____

_____

4. Telephone: _____ Telex: _____

5. Principal researcher: _____

6. Position held: _____

7. Title of project: _____

_____

8. Date project began: _____

9. Expected termination date: _____

10. Total expected cost: _____

11. Description of the project (see attached instructions):

11.1 Specific objectives:

11.2 Project details:

11.3 Parameters with which infiltration will be related:

12. Important reports and publications, both past and future, (titles, authors, publishers, dates of publications):

INSTRUCTIONS FOR DESCRIBING ONGOING RESEARCH PROJECTS

IN AIR INFILTRATION IN BUILDINGS

The following information should be included in the project description:

11.1 Specific objectives - include primary aims of the project and its relationship (if any) with previous or other ongoing studies.

11.2 Project details -

a) Measurements in buildings; please indicate:

- type of building, e.g. dwelling (detached, semi-detached, town house, residential block) commercial (low rise, high rise), institutional, industrial.
- size and construction type
- measurements being taken (e.g. pressurization, type of tracer gas, surface pressures, etc.)
- brief instrumentation details
- occupied or unoccupied building

b) Theoretical / model calculations: please indicate conceptual approach, estimation technique and validation trials.

11.3 Parameters with which infiltration will be related. Please indicate expected form of data analysis with respect to:

a) - weather (e.g. temperature and wind, humidity, terrain)

b) - performance of building components (e.g. windows, doors, heating appliances, chimneys, vents, walls)

c) - behaviour of occupants (real or simulated behaviour)

d) - other parameters

Please complete and return the form to the Air Infiltration Centre as soon as possible.

APPENDIX 2–INDEX OF ORGANISATIONS.

Page

14) U.M.I.S.T.*
Department of building
P.O. Box 88
Manchester M60 1QD

15) ditto *

IRELAND (IE)

1) Institute for Industrial Research and Standards. 2.48
Ballymun Road.
Dublin 9

NETHERLANDS (NL)

1) Institute for Environmental Hygiene TNO. 2.50
P.O.Box 214 2600 AE Delft.

2) ditto 2.51

3) ditto 2.52

4) ditto 2.53

5) ditto 2.54

6) ditto 2.55

NEW ZEALAND (NZ)

1) New Zealand Meterological Service 2.56
P.O.Box 722
Wellington.

NORWAY (NO)

1) Norwegian Building Research Institute*
Forskningsveien 3B
P.O. Box 322
Blindern

SWEDEN (SE)

1) Division of Building Technology 2.57
Lund Institute of Technology
Fack
S-220 07 Lund 7

2) National Swedish Institute for Building Research 2.58
Box 785
S-801 29 Gavle
Sweden

3) ditto 2.59

4) Royal Institute of Technology 2.60
Dept. of Building Technique
Brinellvagen 34
100 44 Stockholm

*Summaries from these organisations arrived after analysis and appear in Appendix 4.

APPENDIX 3—INDEX OF PRINCIPAL RESEARCHERS.

NAME	RESEARCH PROJECT
Ashley, S.K.	US10
Aynsley, R.	AU2
Boman, C.A.	SE3
Brackley, G.	GB2
Brundrett, G.W.	GB10
*Brunsell, J.	NO1
*Burberry, P.	GB14, GB15
Clarkson, T.S.	NZ1
Cockroft, J.P.	GB6, GB7
Collet, P.F.	DK1
Collins, J.O.	US4
Conan, G.	GB8
Cowan, I.J.	IE1
Davies, M.G.	GB4
De Gids, W.F.	NL1, NL2, NL3, NL4, NL5
Dickson, D.J.	GB11
Dumont, R.S.	CA6
Dutt, G.S.	US1, US3
Elmroth, A.	SE4, SE5. SE6
Erikson, B.E.	SE3
Esdorn, H.	DE1, DE2, DE3, DE4
Etheridge, D.	GB5
Graham, R.M.	CA10
Green, G.H.	CA9
Gottschalk, G.	CH6
Grimsrud, D.T.	US6, US7
Grot, R.A.	US11
Guillaume, M.	BE2
Guy, R.W.	CA2
Harrje, D.T.	US1, US2, US3
Hartmann, P.	CH1, CH2, CH3
Homma, H.	CA2, CA3
*Howarth, A.T.	GB14, GB15
Hunt, C.M.	US8
Irving, S.J.	GB1
Jansen, P.	CA1
King, J.C.	US9
Kronvall, J.	SE1
Littler, J.G.F.	GB12
Meert, E.	BE1
Mitchell, D.	AU1
Muehlebach, H.	CH3
Orr, H.W.	CA7, CA8
O'Sullivan, P.	GB3

NAME	RESEARCH PROJECT
Penman, J.M.	GB9
Persily, A.K.	US2
Phaff, I.C.	NL6
Railo, J.	FI1
Robertson, P.	GB7
Roth, B.E.	CA5
Shaw, C.Y.	CA4
Stathopoulos, T.	CA3
Stewart, M.B.	US5
Stocher, H.	AT1
Svensson, A.	SE2
*Uvsløkk, S.	NO1
Wanner, H.U.	CH4, CH5
Warren, P.	GB13
Winston, J.G.	US5

*These summaries arrived after analysis and appear in Appendix 4

APPENDIX 4–RESEARCH SUMMARIES RECEIVED AFTER ANALYSIS.

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Great Britain	P.Burberry and A.T.Howarth	GB14

ADDRESS

U.M.I.S.T.
P.O. Box 88
Manchester M60 1QD

Telephone: 061-236 3311 ext.2438
Telex: 666094

PROJECT TITLE

Ventilation rates and air movement between the dwelling space and roofs of houses of typical English construction.

PROJECT DESCRIPTION

Specific objectives: To investigate air movement through roof spaces of conventional English pitched roofs with various facilities for ventilation. The flows from roof space to outside and from dwelling to roof space will be examined.

Project details: Existing unoccupied dwellings of a range of sizes and types will be the subject of measurements of air flow using tracer gas methods. Both chromatographic and infrared techniques are to be used. Pressurization methods will be used to highlight the flow paths.

Date project began: June 1980 Project completion date: June 1983

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Great Britain	P.Burberry and A.T.Howarth	GB15

ADDRESS

U.M.I.S.T.
Department of building
P.O. Box 88
Manchester M60 1QD

Telephone: 061-236 3311 ext.2438
Telex: 666094

PROJECT TITLE

Air movement between bounded spaces in the building envelope.

PROJECT DESCRIPTION

Specific objectives: Measurement of air flows between spaces within buildings in order to obtain a better understanding of the factors governing air movements and to provide information to aid the selection of constructional materials and standards of workmanship in order to design for conservation of energy and reduction of condensation risk.

Project details: Measurements are carried out in existing dwellings using sulphur hexafluoride and nitrous oxide tracer gases. At the same time pressurization tests emphasise air flow paths. The tracer gases are detected by a gas chromatograph for the sulphur hexafluoride and by an infrared analyser for the nitrous oxide. The emphasis will be on flows from room to room and room to cavity.

Parameters with which infiltration will be related: The parameters with which the air flows are related are wind pressure and temperature differences between adjacent internal zones and between inside and outside air. The type of dwelling and its construction are also major variables of importance.

Date project began: June 1980 Project completion date: June 1982

COUNTRY	PRINCIPAL RESEARCHER	REFERENCE NO
Norway	S.Uvslokk and J.Brunsell	NO1

ADDRESS

Norwegian Building Research Institute
Forskningsveien 3B
P.O. Box 322
Blindern
Oslo 3

Telephone: 02-46 98 80

PROJECT TITLE

Energy Conservation - Construction Measures for New Buildings.

PROJECT DESCRIPTION

Specific objectives: Study the importance of thermal insulation and air tightness on energy consumption for space heating, in view of new energy cost development. Work out proposals for cost effective requirements on insulation and airtightness. Study new building techniques and work out information on how to build to conserve more energy.

Project details: Work on air infiltration is one part of the project described above, and the following covers only this part and only work going on at the moment.

1) Different types of wall/roof construction details are studied in the laboratory, and the air tightness of various detail designs are measured.

2) Proposed requirements for air tightness in buildings are being worked out on the basis of theoretical analysis of the importance of air infiltration and from the results of measurements on Norwegian houses built according to standard practice.

3) Analysis of the effect of air infiltration on energy consumption is made by the computer program ENCORE. The analysis is being based on the air tightness measured by the pressurization method. The calculations can be carried out hour for hour, using original meteorology data as input. The calculated results will be compared with old and new tracer gas measurements.

This project comes in addition to the continuous activity the institute does on testing the air tightness of building components such as windows doors and exterior wall elements.

Parameters with which infiltration will be related: Temperature, wind speed, landscape, air tightness measured by pressurization test, shape of the building, the distribution and position of leakages.

Date project began: June 1978 Project completion date: June 1981

BIBLIOGRAPHY

J.T.Brunsell and S.Uvslokk
"Boligers lufttetthet. Resultater fra lufttetthetsmalinger av nyere norske boliger."
Air tightness of buildings. Results from air tightness measurements in new Norwegian houses.
Arbeidsrapport 31. Norwegian Building Research Institute.
Oslo 1980 (In Norwegian, no English summary.)

#3294

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

Canada, Denmark, Italy, Netherlands, 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.

Air Infiltration Centre Old Bracknell Lane, Bracknell, Berkshire, Great Britain, RG12 4AH
Tel: 0344 53123
Telex: 848288 (BSRIAC G)