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1986 Survey of Current Research into Air Infiltration and Related Air Quality Problems in Buildings

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Air Infiltration and Ventilation Centre
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Annex V Air Infiltration and Ventilation Centre

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PREFACE

International Energy Agency

In order to strengthen co-operation in the vital area of energy policy, an Agreement on an International Energy Programme was formulated among a number of industrialised countries in November 1974. The International Energy Agency (IEA) was established as an autonomous body within the Organisation for Economic Co-operation and Development (OECD) to administer that agreement. Twenty-one countries are currently members of the IEA, with the Commission of the European Communities participating under a special arrangement.

As one element of the International Energy Programme, the Participants undertake co-operative activities in energy research, development and demonstration. A number of new and improved energy technologies which have the potential of making significant contributions to our energy needs were identified for collaborative efforts. The IEA Committee on Energy Research and Development (CRD) assisted by a small Secretariat staff, co-ordinates the energy research, development and demonstration programme.

Energy Conservation in Buildings and Community Systems

As one element of the Energy Programme, the IEA encourages research and development in a number of areas related to energy. In one of these areas, energy conservation in buildings, the IEA is encouraging various exercises to predict more accurately the energy use of buildings, including comparison of existing computer programmes, building monitoring, comparison of calculation methods, as well as air quality and inhabitant behaviour studies.

The Executive Committee

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

Annex V Air Infiltration and Ventilation Centre

The IEA Executive Committee (Building and Community Systems) has highlighted areas where the level of knowledge is unsatisfactory and there was unanimous agreement that infiltration was the area about which least was known. An infiltration group was formed drawing experts from most progressive countries, their long term aim to encourage joint international research and increase the world pool of knowledge on infiltration and ventilation. Much valuable but sporadic and uncoordinated research was already taking place and after some initial groundwork the experts group recommended to their executive the formation of an Air Infiltration and Ventilation Centre. This recommendation was accepted and proposals for its establishment were invited internationally.

The aims of the Centre are the standardisation of techniques, the validation of models, the catalogue and transfer of information, and the encouragement of research. It is intended to be a review body for current world research, to ensure full dissemination of this research and, based on a knowledge of work already done, to give direction and firm basis for future research in the Participating Countries.

The Participants in this task are Belgium, Canada, Denmark, Federal Republic of Germany, Finland, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom and the United States of America.

INTRODUCTION

The Air Infiltration and Ventilation Centre's world wide survey of current research into air infiltration and related topics, provides organisations in participating countries with regularly updated information about ongoing research in this field. In particular, the major objectives of the survey are to encourage the international cross-fertilization of research ideas and to promote co-operation between research organisations in different countries. The results of the first survey were published in October 1980, and contained an analysis of 65 research summaries received from researchers in 14 countries. The second edition followed in December 1981, with the number of new entries almost doubling to 126. In November 1983 the third survey was published, this edition extended its scope to cover research into indoor air quality. For this survey the response again increased, with 187 summaries being received from organisations in 22 countries. In addition to the increased scope of the survey, researchers were also asked to provide an indication for project size in terms of allocation of staff time.

This, the fourth survey, is based on summaries received from researchers following the distribution of a standardized survey form (Appendix 1) to organisations thought likely to be involved in air infiltration/ air quality research. Essentially similar to the form used for the 1983 survey, additional space was provided in order that specific information regarding the type of building/building component under examination could be obtained. Once again there has been an increase in the number of projects reported, with a total of 219 summaries being received from organisations in 19 countries. The origin and distribution of survey replies is shown in Table 1.

The analysis of the survey is presented in two sections. In the first, the results are analysed in terms of the various headings on the survey form, i.e. specific objectives, project details, building or component type, parameters with which infiltration and indoor air quality are related and allocation of staff time. This information is presented in such a way that the reader may use the analysis to ascertain which research summaries lie within the bounds of any given subject area. In order to facilitate this type of analysis and enable easy access to the data, the research summaries are stored on a micro computer database which can be rapidly searched using the Air Infiltration and Ventilation Centre's free text retrieval system. The task of analysing the research replies was also eased by the allocation of a set of keywords to each research summary. These keywords are presented, both in alphabetical order and by subject classification, in Appendix 2.

All the research summaries are presented in Section Two. They are divided into two sub sections i.e. participating countries and non-participating countries. Each project is identified by a reference number comprised of a country identification code (Table 1) followed by a number indicating the order in which it appears under the relevant country heading (countries listed in alphabetical order within each sub section). A list of principal researchers and organisation addresses is contained in Appendix 3.

The preparation of this report was only possible as a result of the co-operation of researchers in forwarding details of their studies. The assistance of all who contributed to this survey is acknowledged with gratitude.

SECTION 1

ANALYSIS OF RESULTS

SECTION 1 – ANALYSIS OF RESULTS

1.1 Specific Objectives

The specific objectives of the research summaries have been divided into 15 categories (Table 2). The categories and the range of subjects covered by each are described in further detail below. In many instances a single project encompasses several specific objectives and may, therefore, appear under more than one heading.

The objectives are:

(i) To develop/use/assess measurement techniques designed to evaluate air leakage, infiltration or air movement in buildings (65 replies).

Measurement of these parameters still provides the cornerstone of air infiltration research. Techniques involving tracer gas, fan pressurization, infra-red thermography and smoke visualisation have been reported. Much interest is currently being shown in the evaluation of inter zone air flows, and the further refinement of control systems for the constant concentration technique.

(ii) To develop/use/evaluate calculation techniques to predict air infiltration or air flow in buildings/ building components (39 replies).

The development of calculation techniques continues to be a popular topic of research. Models are now being produced which can predict air infiltration and inter zone air movement in a variety of building types. These models are being applied to topics such as pollutant dispersal and the spread of fire within buildings. Much interest is currently being shown in the validation of this type of model with actual full scale measurements. Projects in this section also include the modelling of the leakage distribution and moisture levels in buildings and the theoretical analysis of internal air movement in large single spaces.

(iii) To design or assess the efficiency of heating/ventilating systems or ventilation strategies (38 replies).

With buildings generally being constructed or retrofitted so as to be more airtight, the design and assessment of purpose provided natural and mechanical ventilation systems has become increasingly important. This section covers projects ranging from the design and placement of air inlets, to the evaluation of carbon dioxide controlled ventilation systems. Other topics include the assessment of hot water and warm air heating systems and the design of heating stove components.

(iv) To develop/assess construction techniques/retrofit measures designed to reduce air leakage/energy consumption in buildings (34 replies).

Air infiltration and ventilation can account for a significant amount of the space heating demand of a building. Projects in this section deal with the means by which air infiltration, and hence energy consumption, may be reduced. Several retrofit measures have been assessed, e.g. draughtproofing, insulation and air vapour barriers, as have several building types, e.g. passive solar and timber built houses. It is the major aim of many projects to produce energy efficient housing without imparing indoor air quality. This section also includes projects designed to assess the effect of air infiltration on the heat loss from buildings.

(v) To monitor indoor air quality in buildings (31 replies).

The subject of indoor air quality has become a key issue. It is recognised that the demands of indoor air quality govern the minimum level of fresh air exchange that is permissible in buildings. This therefore sets a limiting value for any energy conservation measures involving the reduction of air infiltration or ventilation rates. This and the next three categories deal with air quality investigations. The projects in this section are concerned with the direct measurement of indoor pollution levels. Pollutants evaluated include radon, formaldehyde, oxides of nitrogen and tobacco smoke (see Table 5 for full details).

(vi) To assess the effect of airtightness/air leakage/ventilation on indoor air quality (23 replies).

Projects in this section are essentially designed to assess the relationship between indoor air quality and air infiltration or ventilation rate. Several studies designed to evaluate the effect of weatherization measures (draughtproofing, etc.) on indoor air quality, i.e. with before and after monitoring, are reported. Attics and roof structures are prone to condensation problems. The estimation of the airtightness/ventilation required to prevent such problems is another topic included in this category.

(vii) To determine the effect of indoor air quality/air movement on occupant health/comfort (19 replies).

The ill effects which a building can have on the health and comfort of its occupants has become a topic of major concern. Occupants of buildings often complain of a set of symptoms which have collectively been named the 'sick building syndrome'. These symptoms are most often, but not exclusively, exhibited by occupants of large, relatively airtight, mechanically ventilated buildings. Many projects in this section deal with the effect that specific indoor air pollutants, e.g. formaldehyde, have on building occupants. Other topics, not directly related to air quality, include the measurement of convective heat transfer from humans under various air velocity and turbulence conditions.

(viii) To study/assess sources/causes of indoor air pollution (15 replies).

Indoor air pollution can arise from several sources. Building materials, e.g. formaldehyde; ventilation systems, e.g. volatile organic compounds; the ground, e.g. radon; and gas appliances, e.g. nitrogen dioxide. Air pollution can be the result of inadequate ventilation caused by short-circuiting between air inlets and air outlets. Projects in this section evaluate and quantify indoor air pollution from these various sources. Several projects also address the problem of how indoor air pollution levels may be reduced.

(ix) To develop/recommend airtightness and related guidelines (22 replies).

The production of guidelines and standards which are based on the results of research work enables the findings of such research to be put into general practice. Standards and guidelines reported in this section cover a variety of topics including indoor air quality and minimum ventilation rate, measurement techniques for air infiltration and air leakage, retrofitting, weatherization and air leakage through building components. Standards and guidelines must be rigorously tested as part of their development and several projects reported here cover this area of research.

(x) To determine the performance (heat loss, air leakage) of specific building components (16 replies).

The performance, in terms of air leakage and heat loss, of several building components is being examined. These include walls, windows, facades and doorways. A knowledge of the leakage of individual components is necessary in order to be able to determine the leakage distribution of a building and to assess the contribution each component makes to the overall heat loss from the building.

(xi) To determine the effect of occupants on air infiltration or to assess their interaction with heating/ventilating systems (15 replies).

The benefits of energy conservation measures can be greatly affected by the actions of occupants, especially with regard to window and door opening. Several observational studies are being made of window opening. These are being linked with questionnaire studies designed to assess the motivation of occupants with regard to this behaviour. Other projects include research into the use, by occupants, of various ventilation systems and the assessment of the benefits to be gained by educating inhabitants in the correct use of draughtproofing procedures.

(xii) Overviews of research into air infiltration, air quality and related topics (11 replies).

Projects reported in this section include reviews of literature and research needs, bibliographic and numerical databases and the co-ordination of ventilation related research topics.

(xiii) To determine the factors which effect air infiltration and ventilation (13 replies).

Much of the research reported in this section relates to the effect of environmental parameters (wind speed, temperature) on air infiltration. The influence of pressure distribution, occupancy (see also section xi), weatherization and ventilation systems are also examined.

(xiv) To determine (predict/measure) building air pressure distribution (internal/external) (9 replies).

Full scale measurements are being made of the external pressure distribution of a building. The distribution is primarily related to the windspeed and wind direction. Small scale boundary layer wind tunnel studies are also being performed. Methods of predicting internal pressure distribution from external pressure data are being developed mainly using computer modelling techniques.

(xv) Investigations dealing with combustion venting (5 replies).

Research into this rather specialized field is being performed mainly in Canada. Specific topics include computer modelling of flue behaviour and developing an understanding of combustion failure and backdraughting.

1.2 Project Details

The project details have been summarised in terms of experimental work (Table 3), tracer gas methods (Table 4), indoor climate measurements (Table 5), theoretical work (Table 6), building occupancy (Table 7) and heating and ventilation systems (Table 8). Each table contains several entries and the survey replies relating to each entry are indicated by their project identification code. The remainder of this section discusses the contents of Tables 3–8 and highlights several important points which have arisen from the analysis of the project details.

The most widely reported experimental work involves the measurement of air infiltration and inter-zone air flows using tracer gas techniques. This is followed by whole building pressurization tests using 'blower door' type equipment. Leakage tests are also being performed on individual building elements such as windows, walls and vapour barriers. One research project (USA7) reports on the continuing development of an AC (alternating current) pressurization rig. Energy consumption and heat loss measurements form a large part of several projects. These measurements range from whole house energy monitoring, to the evaluation of the heat loss through individual building components using hot box/cold box test rigs. Pressure measurements are being made both in full-scale buildings and wind tunnel models. Finally, experiments involving the use of thermography, (for leak detection), and smoke (for air flow visualization) have been reported.

A detailed analysis of the reported tracer gas measurements (Table 4) shows that the three main tracer techniques, i.e. decay rate, constant emission and constant concentration, are all currently being used as research tools. Since the last survey, in 1983, there has been a relative increase in the use of the constant concentration technique and multiple tracer gas methods have also become more popular. Sulphur hexafluoride is the most widely used single tracer gas with freons and perfluorocarbons being preferred for multi tracer experiments. The use of passive techniques continues to be explored as a means of obtaining the long term average air exchange rate in buildings. Passive techniques are also being extended to facilitate the use of multiple tracer gases.

Table 5 presents details of the various indoor air pollutants which are being studied. Major areas of concern are radon, moisture and combustion products, followed by carbon dioxide, formaldehyde and tobacco smoke. The main aim of many of the projects involving the monitoring of indoor quality is to be able to produce energy efficient buildings which also provide adequately low levels of indoor air pollution.

The vast majority of the reported theoretical work involves the use and development of calculation techniques. Several multi-cell models, for the evaluation of inter-zone air flows, have been reported as have models which can take into account indoor air pollution sources and occupant behaviour. Model comparison and validation is taking place and in Canada combustion venting models are being developed. Other theoretical work includes the creation of databases, reviews of literature and the preparation of guidelines.

A total of 70 researchers returned information regarding building occupancy patterns. Of these the majority were normally occupied buildings (77%) and most of the remainder unoccupied (test houses, etc). Simulation of occupancy was reported in only three projects. One involved a real building, the other two, computer models.

Table 8 provides information regarding heating and ventilating systems. Although there are fewer reported instances of natural ventilation than mechanical ventilation, it can be assumed that, for many projects where no information is provided, the building in question is ventilated by natural means, particularly in the United Kingdom. Projects involving studies of heat recovery systems, warm air heating systems and demand control ventilation, (e.g. controlled by expirated carbon dioxide) are also reported.

1.3 Building and Building Components

For the first time space was provided on the survey form for researchers to give specific information regarding the type of building/building component under examination. Table 9 presents the information gathered from this part of the survey. The majority of work is being performed in dwellings, although industrial, commercial and educational buildings are also being examined. Of individual building components, windows are given the most attention with regard to both their leakage and use by building occupants.

1.4 Parameters to which Air Infiltration and Indoor Air Quality are Related

In almost all instances air infiltration data is being related to weather parameters, specifically wind speed, wind direction and internal/external temperature difference. The effect of building characteristics and performance is also being examined, e.g. airtightness, leakage distribution and building dimensions. Other studies include the effects of occupant behaviour and mechanical ventilation systems. A full list of parameters is given in Table 10.

The factors which affect air quality are presented in Table 11. Pollution sources, such as building materials, combustion appliances and outdoor air, are of major importance. Other parameters include air change rate, occupant behaviour and health, building characteristics and heating and ventilation systems.

Whilst only two projects (SWZ6 and UK34) specifically mention minimum ventilation rate as a parameter, it can be assumed that the aim of many air quality projects is the determination of an acceptable minimum level for air infiltration and ventilation.

1.5 Allocation of Staff Time and Distribution of Survey Replies

Information about the staff time allocated to each project was stated in 75% of the survey replies. These results are summarized in Figure 1. The median time allocation for each project is approximately 2000 hours (1.3 person years), while the research effort for 75% of the reported projects is under 5000 hours (three person years). Thus, as in the 1983 survey, the time being expended on individual projects is in the region of between one and three person years. There are notable exceptions, however, with several long term projects of 25,000 hours and over being reported. These projects tend to involve research into more than one topic, e.g. UK26, SWZ11, or the coordination of research, as is the case with FIN 9. The overall picture is again very similar to that of the 1983 survey with an estimated one million hours of research effort being documented by this survey.

The distribution of replies by country is given in Table 1. From this table it can be seen that just over half the total number of replies come from only three countries, i.e. Canada, the United States and the United Kingdom. As may be expected, all AIVC participating countries are represented in the survey. Four participating countries have produced fewer than six replies each. However, as response to the survey is entirely voluntary there may be work being performed in these countries, and indeed others, which has not been reported in the survey. Of the non-participating countries the greatest response to the survey came from France and Japan. These countries produced ten and nine replies respectively.

An analysis of the distribution of projects among types of organisations was also performed. Approximately 41% of projects are being undertaken by government or public sector research establishments, 36% by academic institutions, e.g. universities and polytechnics, and 23% by commercial or private sector organisations.

1.6 Concluding Remarks

In terms of the total number of replies received and the subject areas covered, this survey represents the most comprehensive review of current research yet published by the AIVC. The project summaries, obtained from 19 countries, essentially cover all aspects of air infiltration and air quality research. It is of particular interest to note that two areas of weakness pointed out in the last survey, published in 1983, have seen a distinct improvement in the amount of research time allocated to them, i.e. occupancy effects (19 replies) and studies of various ventilation systems and strategies (38 replies).

Since the last survey there has also been a significant increase in work dealing with inter-zone air flows in multi-compartment buildings. Projects involving multi-tracer and multi-fan work have been reported, as have projects involving multi-zone calculation techniques. Measurement techniques have generally become more automated with the constant concentration method now being the most favoured tracer gas technique. There has, however, been an increase in the use of simple 'passive' techniques for the evaluation of the long term average air change rate in buildings. These passive techniques allow air change rates to be unobtrusively monitored in occupied buildings.

The monitoring of indoor climate has once again proved to be a popular topic for research. This underlines the continuing interest being shown in the use of indoor air quality as a criterion for evaluating minimum ventilation rates. Of specific interest have been sources and causes of air pollution, the effect of indoor climate on occupant health and comfort, and the effect of airtightness measures on indoor air quality. Several computer models are being developed which can take into account sources of indoor air pollution. The overall aim of such projects is the development of energy efficient buildings which also have low levels of indoor air pollution.

It was noted in the 1983 survey that a move towards air infiltration studies in non-domestic buildings had taken place. This trend has continued and projects involving measurements in commercial, industrial and educational buildings have been reported. Residential properties are still being examined, although here the trend appears to be away from single family houses and more towards multi-unit dwellings.

The analysis of research effort being devoted to each project reveals that the reported research studies are generally of a fairly short duration, typically between one and three person years. There are exceptions to this, with a total of 19 projects having over six person years of effort being devoted to them.

The Air Infiltration and Ventilation Centre will continue to gather information about current research into air infiltration and air quality. It is envisaged that the next full survey and analysis of research will be performed in 1989.

Figure 1: Allocation of staff time

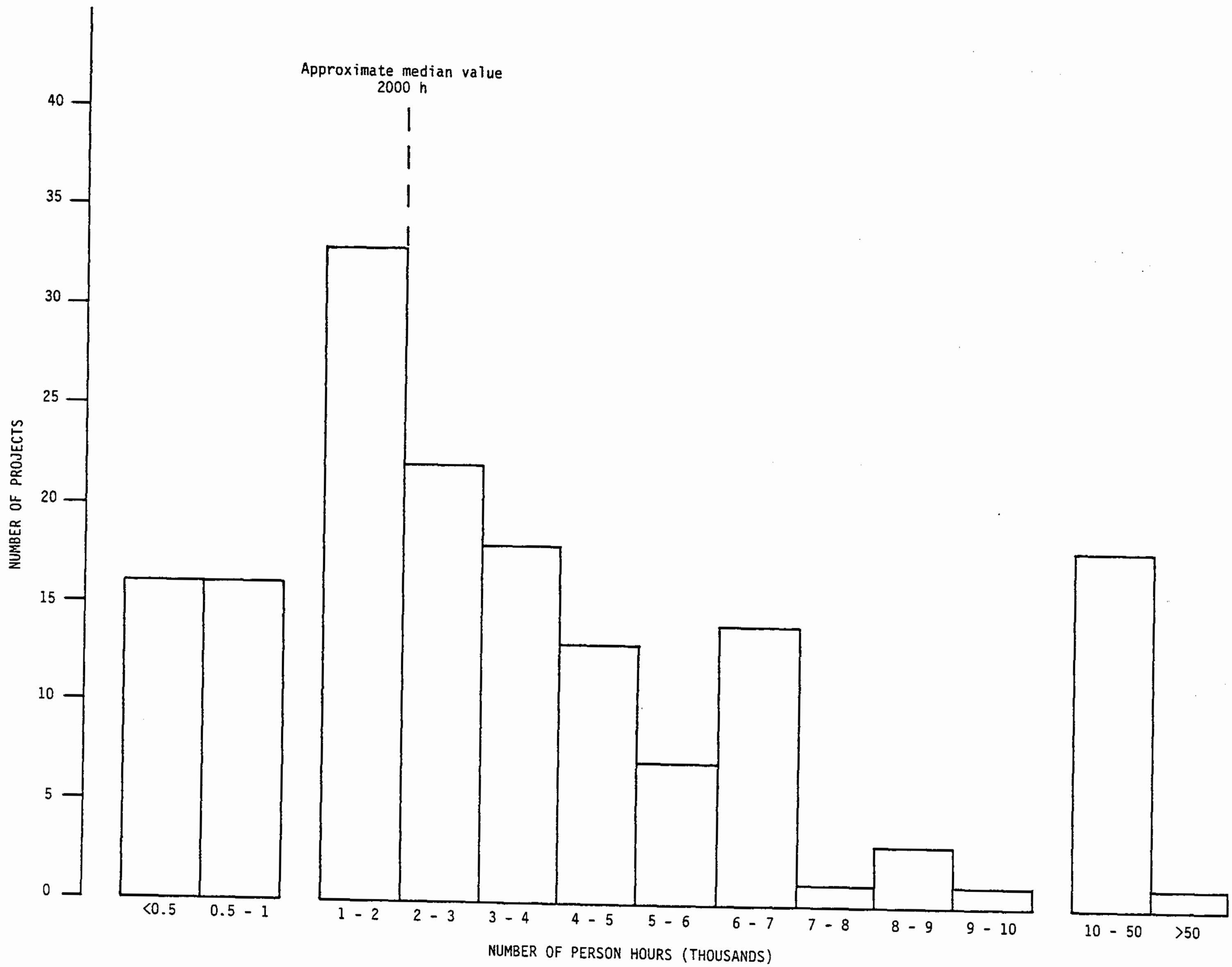

TABLE 1

Origin and Distribution of Survey Replies

Participating countries			Non-participating countries		
Country	Identification code	Number of replies	Country	Identification code	Number of replies
Belgium	BE	8	Australia	AU	1
Canada	CAN	31	France	FRA	10
Denmark	DK	3	Hungary	HUN	3
Federal Rep. of Germany	FRG	5	Italy	ITL	2
Finland	FIN	12	Japan	JAP	9
Netherlands	NL	17	Poland	POL	1
New Zealand	NZ	1	Saudi Arabia	SDA	1
Norway	NOR	2			
Sweden	SWE	13			
Switzerland	SWZ	12			
United Kingdom	UK	45			
United States of America	USA	43			
TOTAL		192			27
GRAND TOTAL					219

TABLE 2 – SPECIFIC OBJECTIVES

Objectives and Project Reference Numbers

1. To develop/use/assess measurement techniques designed to evaluate air leakage, air infiltration or air movement in buildings (65 replies) *(see also Tables 3 and 4)*

BE1	FIN10	SWZ8	UK26	USA28
BE6	FIN12	SWZ9	UK37	USA40
BE8	NL17	SWZ10	UK38	USA42
CAN1	NZ1	SWZ11	UK39	USA43
CAN4	NOR2	UK2	UK40	AU1
CAN6	SWE3	UK4	UK41	FRA5
CAN7	SWE4	UK6	USA3	FRA7
CAN23	SWE7	UK10	USA5	ITL2
CAN24	SWE8	UK13	USA7	JAP1
CAN25	SWE12	UK14	USA8	JAP4
CAN27	SWZ1	UK19	USA10	JAP5
DK2	SWZ4	UK21	USA26	JAP6
FIN6	SWZ7	UK23	USA27	JAP8

2. To develop/use/evaluate calculation techniques to predict air infiltration or airflow in buildings/ building components (39 replies) *(see also Table 6)*

BE1	NZ1	UK1	UK44	FRA6
BE5	SWE1	UK14	USA10	FRA8
CAN3	SWE8	UK21	USA27	ITL1
CAN5	SWE9	UK26	USA36	JAP1
CAN9	SWE11	UK32	USA39	JAP3
FIN1	SWE13	UK35	FRA1	JAP4
NL3	SWZ7	UK40	FRA2	JAP9
NL11	SWZ11	UK43	FRA4	

3. To design or assess the efficiency of heating/ventilating systems or ventilation strategies (38 replies) *(see also Table 8)*

BE8	NL12	UK1	UK29	USA31
CAN14	NL13	UK3	UK33	FRA5
CAN20	SWE5	UK5	USA3	FRA9
DK3	SWE6	UK18	USA6	JAP2
FIN2	SWZ6	UK20	USA11	JAP6
NL5	SWZ8	UK26	USA16	POL1
NL6	SWZ11	UK27	USA19	
NL7	SWZ12	UK28	USA22	

4. To develop/assess construction techniques/ retrofit measures designed to reduce air leakage/energy consumption in buildings (34 replies)

CAN1	NL8	UK9	USA16	USA42
CAN6	NL9	UK11	USA17	AU1
CAN12	SWE2	UK30	USA18	FRA7
CAN15	SWE5	UK31	USA20	HUN1
CAN28	SWZ1	UK36	USA21	HUN3
CAN29	SWZ9	USA5	USA30	SDA1
FRG4	UK7	USA15	USA33	

Continued

5. To monitor air quality in buildings (31 replies) *(see also Table 5)*

CAN2	FIN8	UK15	USA23	JAP7
CAN10	FIN9	UK16	USA29	JAP8
CAN11	FIN11	UK17	USA34	JAP9
CAN13	SWZ2	USA2	USA38	
CAN23	SWZ5	USA4	USA41	
CAN24	SWZ6	USA14	FRA3	
CAN25	SWZ12	USA22	JAP2	

6. To assess the effect of airtightness/air leakage/ventilation on indoor air quality (23 replies)

BE4	CAN23	NL14	USA16	FRA3
CAN2	CAN24	SWE10	USA17	JAP7
CAN5	CAN28	UK41	USA29	JAP9
CAN10	FIN5	USA2	USA30	
CAN12	NL9	USA14	FRA1	

7. To determine the effect of indoor air quality/air movement on occupant health/comfort (19 replies)

CAN11	FIN8	SWZ2	UK42	USA35
CAN13	FIN9	SWZ5	USA4	USA38
FRG2	NL9	SWZ12	USA14	FRA3
FIN4	NL15	UK16	USA34	

8. To study assess sources/causes of indoor air pollution (15 replies) *(see also Table 11)*

CAN2	DK1	UK15	USA2	USA39
CAN17	NL2	UK16	USA23	USA41
CAN22	SWZ2	UK20	USA36	JAP7

9. To develop/recommend airtightness and related standards/guidelines (22 replies)

CAN3	CAN31	SWZ10	UK41	USA25
CAN17	DK3	UK27	UK42	USA32
CAN20	FRG1	UK34	USA1	
CAN28	NL17	UK39	USA12	
CAN29	SWZ1	UK40	USA13	

10. To determine the performance (heat loss, air leakage, etc.) of specific building components (16 replies)

BE5	CAN16	NL8	UK19	USA32
BE7	FIN1	NOR1	UK25	USA37
CAN5	NL1	UK12	UKA13	FRA10
CAN7				

11. To determine the effect of occupants on air infiltration or assess their interaction with heating/ventilating systems (15 replies)

BE2	FIN7	NL16	SWZ3	UK45
BE3	NL3	NOR2	UK28	USA15
FRG1	NL4	SWE3	UK40	USA20

Continued

Table 2 continued

12. Overviews of research into air infiltration/air quality and related topics (11 replies)

CAN8	CAN29	FRG3	UK39	USA24
CAN17	FRG1	FIN9	UK42	USA25
CAN22				

13. To determine the factors which affect air infiltration (13 replies) *(see also Table 10)*

CAN27	NOR2	SWE13	USA23	USA40
FIN3	SWE3	UK18	USA15	JAP5
NL10	SWE4	UK40		

14. To determine (predict/measure) building air pressure distribution (internal/external) (9 replies) *(see also Table 3)*

CAN5	CAN21	SWE4	USA9	HUN2
CAN9	NOR1	UK22	USA24	

15. Investigations dealing with combustion venting (5 replies)

CAN18	CAN19	CAN26	CAN30	USA2

TABLE 3 – EXPERIMENTAL WORK

Type of Measurement and Project Reference Numbers

1. Tracer gas *(See also Table 4)*

BE6	FIN12	UK6	UK39	USA41
BE8	NOR2	UK9	UK40	USA43
CAN4	SWE2	UK14	USA3	AU1
CAN14	SWE3	UK19	USA12	ITL2
CAN23	SWE4	UK21	USA27	JAP5
CAN27	SWE7	UK25	USA28	JAP7
DK2	SWE12	UK26	USA30	JAP8
FRG4	SWZ4	UK36	USA36	
FIN3	SWZ7	UK37	USA38	
FIN10	UK4	UK38	USA40	

2. Pressurization

a) Whole buildings (air leakage) (DC)

BE2	CAN15	SWZ9	UK31	USA12
BE6	FIN3	SWZ10	UK36	USA21
BE8	SWE3	UK9	UK37	USA27
CAN1	SWE8	UK10	USA3	AU1
CAN6	SWZ1	UK13	USA5	
CAN7	SWZ7	UK26	USA7	

b) Buildings - multi fan/support pressure (DC)

CAN7	SWE3	UK10	USA27

c) Building components (DC)

BE7	SWE3	UK10	UK27	FRA10
CAN5	SWE8	UK12	USA32	
CAN7	UK8	UK24	USA37	

d) AC pressurization

USA7

3. Energy consumption/heat loss

BE5	FRG4	NOR1	UK30	USA23
CAN15	FIN1	SWE2	UK31	USA42
CAN24	NL3	UK3	USA17	
CAN25	NL14	UK9	USA18	
CAN27	NL17	UK28	USA21	

4. Internal/external pressure

FRG5	UK19	USA9	HUN2	JAP8
NOR1	UK22	USA24	HUN3	JAP9
SWE4	USA6	FRA8	JAP5	

Continued

Table 3 continued

5.	Wind tunnel models				
	FRG5	UK26	UK41	HUN1	HUN3
	UK18	UK29	USA9	HUN2	JAP5
	UK22	UK40			
6.	Thermography				
	SWZ1	SWZ9	UK10	UK12	USA5
7.	Flow visualisation				
	CAN14	NL2	FRA5		

TABLE 4 – ANALYSIS OF TRACER GAS TESTS

Tracer Details and Project Reference Numbers

a)	Techniques				
1.	Decay method				
	FIN3 UK19	UK26	UK37	USA36	ITL2
2.	Constant emission				
	BE6	SWE12	USA26		
3.	Constant concentration				
	BE6 FIN3	NOR2 SWZ4	UK26 USA27	USA28 USA43	AU1
4.	Multi-tracer gas				
	DK2 NZ1	SWE3 UK4	UK6 UK19	UK37 UK40	USA10 USA26
5.	Passive techniques				
	CAN23 DK2	FIN10 SWE2	SWE12 SWZ4	UK40 USA30	USA38 USA40
b)	Tracer gas				
1.	Freons				
	NZ1	UK19	UK37	USA10	
2.	Perfluorcarbons				
	FIN10 SWE3	UK4 UK6	USA38 USA40	USA41	USA43
3.	Sulphur hexafluoride				
	CAN4 CAN23	CAN27 NZ1	UK26 USA3	USA27 USA28	USA36
4.	Nitrous oxide				
	SWE12	UK26	AU1	ITL2	
5.	Carbon dioxide				
	FIN10	UK38	JAP8		
6.	Water vapour				
	ITL2				

TABLE 5 – ANALYSIS OF INDOOR CLIMATE

Pollutants and Project Reference Numbers

1. Bacteria

DK1	FIN8			

2. Carbon dioxide

CAN12	CAN25	FIN8	UK28	USA14
CAN13	FRG3	SWZ6	USA2	JAP9

3. Carbon monoxide (combustion product)

CAN25	USA14	USA34	USA36	JAP9
USA2	USA17			

4. Condensation (moisture/humidity)

CAN5	CAN24	FIN4	UK28	USA34
CAN10	CAN25	FIN8	UK41	USA41
CAN11	CAN28	SWE11	UK44	POL1
CAN12	FRG1	UK16	USA2	

5. Formaldehyde

CAN2	CAN12	FRG3	USA17	USA34
CAN10	CAN24	FIN8	USA30	FRA3
CAN11	CAN25			

6. Nitrogen oxides (combusion product)

CAN2	USA2	USA17	USA38	USA41
CAN24	USA14	USA36	USA39	JAP9
CAN25				

7. Odour

SW26	UK37	USA34		

8. Radon

CAN2	CAN24	SWZ2	USA17	USA40
CAN10	CAN25	UK15	USA21	USA43
CAN12	FRG3	UK41	USA22	FRA3
CAN23	FIN8	USA2	USA29	JAP7

9. Radon daughters

CAN12	CAN23	FRA3	JAP7	

10. Sulphur dioxide

FRG3				

Continued

Table 5 continued

11.	Suspended particles				
	DK1	FIN8	USA17		
12.	Tobacco smoke				
	CAN11	SWZ5	UK42	USA34	FRA3

TABLE 6 – THEORETICAL WORK

Project Details and Project Reference Numbers

1.	Calculation techniques				
	BE1	FIN1	SWZ7	UK41	FRA1
	BE4	FIN3	SWZ11	UK43	FRA2
	BE5	NL3	UK1	USA10	FRA3
	CAN3	NL11	UK14	USA11	FRA4
	CAN5	NL14	UK15	USA16	FRA8
	CAN9	NL16	UK21	USA18	FRA9
	CAN16	NZ1	UK26	USA19	HUN3
	CAN18	SWE1	UK27	USA23	ITL1
	CAN19	SWE8	UK29	USA24	JAP1
	CAN21	SWE9	UK32	USA27	JAP3
	CAN26	SWE11	UK35	USA36	JAP4
	CAN30	SWE13	UK40	USA39	
a)	Multi-cell models				
	NZ1	SWZ11	UK32	USA27	FRA4
	SWE1	UK26	UK40	USA39	JAP1
	SWE13	UK27	USA10	FRA2	
b)	Air quality/pollution models				
	CAN3	SWZ11	USA16	USA23	JAP3
	NL11	UK15	USA19	USA39	JAP4
	NL14				
c)	Model validation				
	SW27	UK35	FRA4	JAP1	JAP4
	UK26	USA10			
d)	Combustion venting models				
	CAN18	CAN19	CAN26	CAN30	
e)	Model occupant behaviour				
	NL3	NL16	SWE9	FRA2	
f)	Comparison of models				
	CAN9				
2.	Databases				
	CAN17	USA8	USA24	USA25	USA34
3.	Literature reviews				
	CAN8	CAN28	UK25	UK34	USA6
	CAN22	FRG3			

Continued

Table 6 continued

4.	Preparation of guidelines			
	DK3	UK20	UK34	UK39

TABLE 7 – BUILDING OCCUPANCY

Occupancy Patterns and Project Reference Numbers

1.	Occupied				
	BE2	NL3	SWZ4	UK31	USA14
	BE3	NL4	SWZ5	UK37	USA15
	CAN11	NL7	SWZ7	UK38	USA20
	CAN13	NL9	SWZ12	UK40	USA21
	CAN15	NL15	UK5	UK42	USA23
	CAN24	NL16	UK9	UK45	USA34
	CAN25	NOR2	UK11	USA2	USA35
	DK2	SWE3	UK15	USA4	USA38
	FRG4	SWE5	UK17	USA5	USA41
	FIN4	SWE6	UK26	USA6	USA42
	FIN8	SWZ3	UK28	USA11	
2.	Unoccupied				
	BE6	FRG3	SWE6	UK37	USA28
	BE8	FIN1	UK10	USA3	AU1
	CAN27	SWE5	UK26		
3.	Simulated occupancy				
	CAN27	SWE9	FRA2		

TABLE 8 – HEATING AND VENTILATING SYSTEMS

Systems and Project Reference Numbers

1.	Natural ventilation				
	CAN3	FIN6	SWE7	USA2	USA24
	CAN5	NL7	UK37	USA3	HUN3
	FIN3	NL12	UK40	USA11	JAP5
2.	Mechanical ventilation				
	CAN5	FIN6	SWZ8	UK27	USA40
	CAN7	FIN7	SWZ12	UK33	FRA1
	CAN9	NL2	UK5	UK37	FRA5
	CAN10	NL4	UK7	UK41	FRA5
	CAN12	NL7	UK20	USA19	ITL2
	FRG4	SWE2	UK26	USA22	POL1
	FIN2	SWE4			
3.	Demand control ventilation				
	SW26	SW28	UK17	UK28	
4.	Warm air heating system				
	CAN14	FRG4	NL4	NL5	UK28
5.	Heat recovery				
	CAN5	SWZ12	UK26	UK41	USA22
	NL4	UK5	UK28		

TABLE 9 – BUILDING/BUILDING COMPONENTS

Building/Building Components and Project Reference Numbers

1.	Residential				
a)	Detached houses				
	BE8	CAN11	USA20	FRA7	JAP8
	CAN3	CAN27	USA43	JAP1	JAP9
	CAN6	SWE6	AU1		
b)	Terrace/row houses				
	CAN7	NL4	SWE5	UK31	USA42
	NL3	NL16			
c)	Multi-unit dwellings (apartments, etc.)				
	BE2	NL5	SWE5	USA8	FRA2
	BE3	NL7	SWZ3	USA11	HUN1
	BE6	NL8	SWZ9	USA19	HUN2
	FIN3	NL9	USA4	USA27	HUN3
	NL3	SWE3	USA7	USA42	JAP7
d)	Test houses				
	BE8	FIN1	NOR1	USA26	JAP6
	CAN27	FIN2	SWE12	JAP5	
2.	Commercial/industrial				
a)	Factories				
	NL15	UK35	UK37	UK43	USA4
	UK3	UK36			
b)	Offices				
	CAN13	FIN4	FIN10	UK38	USA6
	DK1	FIN5	FIN11	UK40	FRA2
	FRG3	FIN8	SWZ7	USA4	SDA1
c)	Others				
	FIN12	UK23	UK29		
3.	Educational buildings				
a)	Schools				
	FIN11	SWZ12	UK38	USA38	JAP2
b)	Universities				
	SWZ6	UK28	UK38	SDA1	

Continued

c)	Library				
	UK28				
4.	Hospitals				
	SWE1	UK38	USA23		
5.	Leisure buildings				
	FRG5	UK2	UK20		
6.	Individual rooms/spaces				
a)	General				
	CAN20	FIN6	SWZ8	UK21	JAP4
	DK1	FIN12	SWZ11	UK43	JAP6
	FRG5	NL8	UK2	UK45	POL1
	FIN5	NL10	UK4	FRA3	
b)	Test rooms (climatic chambers, etc.)				
	BE1	CAN14	UK12	UK33	USA37
	BE4	FRG2	UK19	USA34	ITL2
	BE5	SWZ6			
c)	Roofs/attics				
	BE4	SWZ10	UK1	UK18	UK25
	BE5				
d)	Crawlspaces				
	NL2	SWE4			
7.	Building components/elements				
a)	Walls				
	BE5	CAN16	NOR1	UK25	FRA8
	CAN5	FIN1	UK10	UK31	FRA10
	CAN7	NL8	UK19	USA37	
b)	Floors				
	CAN5	UK25			
c)	Vapour barriers				
	CAN6	UK12	USA37		

Continued

Table 9 continued

d)	Windows				
	BE2	FIN3	UK2	UK40	USA24
	BE7	NL1	UK8	UK42	USA27
	CAN27	NL4	UK30	USA1	USA32
	FRG1	NL16	UK31	USA13	JAP5
	FIN2	SWZ3	UK37		
e)	Doors				
	CAN27	UK19	UK32	UK37	USA32
	FIN5	UK31	UK36	USA1	JAP5
	UK6				

TABLE 10 – PARAMETERS TO WHICH AIR INFILTRATION IS RELATED

Parameters and Project Reference Numbers

1. Weather/climate

a) General

BE6	NL1	SWE3	SWE10	USA15
CAN3	NL9	SWE5	SWZ2	USA41
CAN27	NL17	SWE6	USA3	USA43
FIN1	SWE2	SWE9	USA10	

b) Wind speed

BE8	UK5	UK37	UK44	FRA2
CAN23	UK14	UK38	USA27	JAP2
DK3	UK19	UK40	USA28	JAP5
FRG4	UK23	UK41	USA40	JAP8
NL1	UK29	UK43	AU1	JAP9
UK4	UK36			

c) Wind direction

BE8	FRG4	UK23	USA28	FRA2
DK3	UK19	UK37	AU1	JAP5

d) Wind pressure

BE8	UK8	USA43	HUN2	JAP8
NOR1	UK19	FRA8	JAP1	JAP9
SWE13	UK27			

e) Temperature difference (stack effect)

BE8	SWE13	UK27	UK41	USA40
CAN23	UK4	UK29	UK43	AU1
DK3	UK5	UK36	UK44	JAP1
FRG1	UK19	UK37	USA27	JAP8
FRG4	UK23	UK40	USA28	JAP9

f) Humidity

DK3	FRG1	FRA2	JAP8

2. Building characteristics/performance

a) General (e.g. type/design)

BE6	SWE3	SWE9	UK37	USA43
CAN3	SWE5	UK4	USA3	HUN3
CAN25	SWE6	UK13	USA40	JAP5
NL17				

Continued

Table 10 continued

b)	Building airtightness				
	CAN15 FIN3	NL9 UK36	UK41	UK43	AU1
c)	Leakage distribution				
	UK14	UK23	UK44	USA10	
d)	Building dimensions				
	UK14	USA10	USA41	AU1	
e)	Building internal layout				
	UK23	USA10			
f)	Building location				
	DK3	NL1	AU1		
3.	Mechanical ventilation system				
	CAN24 CAN25	CAN27	FIN3	SWE13	UK7
4.	Heating system				
	CAN24	CAN25	NL13	UK43	
5.	Energy consumption				
	CAN24	CAN25	NL14	USA42	
6.	Occupant behaviour *(see also Table 2)*				
	CAN24 CAN25 FRG1	FRG4 FIN3 NL13	SWE3 SWE5 SWE6	UK30 UK38 UK40	USA15 USA27 USA41
7.	Simulated occupancy				
	CAN27	SWE9	FRA2		
8.	Indoor air pollution level				
	DK2	FRG1	NL14	SWE2	USA43
9.	Internal air movement				
	DK2				

TABLE 11 – PARAMETERS TO WHICH INDOOR AIR QUALITY IS RELATED

Parameters and Project Reference Numbers

1.	Sources				
a)	General				
	SWZ6	USA2	USA16	USA36	USA39
	SWZ11	USA14	USA23		
b)	Building materials				
	CAN2	CAN17	CAN31	UK15	JAP7
c)	Combustion appliances				
	CAN19	USA14	USA39	USA41	
d)	The ground				
	UK15	USA40			
e)	Outdoor air				
	CAN12	NL10	USA14	USA41	
2.	Air change rate				
	CAN2	FRG1	SWZ2	UK16	USA17
	CAN10	NL14	SWZ5	USA14	
	CAN17	NL14	SWZ6		
3.	Weather/climate				
	SWE11	SWZ11	UK15	USA16	USA43
	SWZ2	SWZ12	UK44	USA41	JAP9
4.	Occupant behaviour				
	CAN22	FRG1	SWZ12	UK17	USA23
	CAN25	SWE11	UK15	USA14	USA41
5.	Occupant health/comfort				
	CAN11	CAN17	FIN8	USA4	USA35
	CAN13	FIN4	SWZ5	USA6	USA38
6.	Building construction/design/tightness				
	CAN2	CAN31	SWE11	UK15	UK43
	CAN12	FIN8	SWZ11	UK41	JAP7
	CAN25	FIN11			

Continued

Table 11 continued

7.	Mechanical ventilation				
	CAN12	CAN25	FIN11	SWZ12	USA23
	CAN13	DK1	SWE11	UK15	JAP3
	CAN22	FIN7			
8.	Heating systems				
	CAN22	UK15	USA2	USA14	USA39
	CAN25				
9.	Energy consumption				
	CAN22	NL14	UK28	USA17	USA19
	CAN25	UK16			
10.	Minimum ventilation rate				
	SWZ6	UK34			

SECTION 2

SURVEY REPLIES

Participating Countries

BELGIUM

REF BE1 Study of natural convection due to solar radiation (research supported by the SPPS)
CONTACT
E. Gratia
ADDRESS
Universite Catholique de Louvain
Unite d'Architecture – Batiment Vinci
Place du Levant No.1
1348 Louvain-la-Neuve
Belgium
TEL: 010/432223 TLX: 59037 UCL B
SPECIFIC OBJECTIVES
Study of natural convection due to solar radiation by measurements in a research unit. The elaboration of a simulation model would follow this work and it would be tested by measurements operated in the experimental cell.
PROJECT DETAILS
The Research Center in Architecture of UCL has built a research unit in the field of passive solar energy. The southern facade of this unit is glazed. Inside, an intermediary floor forms a mezzanine: this floor can move horizontally, to allow the impact of its position on the convective heat transfer to be studied. The instrumention (115 points of measurement) is connected to a monitoring system. All these measurements are analysed with the help of graphics (this research is supported by the SPPS).
BUILDING TYPE
Experimental cell
PARAMETERS
The influence of wind, outside temperature and sun on the thermo- circulation.
#STARTDATE 07:03:1983 #ENDDATE 30:06:1986
#TIME 1200
KEYWORDS Experimental cell, natural convection, passive solar, air movement
BIBLIOG
Gratia, E.
Thermo-circulation de l'air:analyse des measures (report) 1985

#**REF BE2** Namur – Level 40
CONTACT
F. Daue
ADDRESS
Facultes Notre-Dame de la Paix
Facultes des Sciences Economiques
Namur University
8 Rempart de la Vierge
B-5000 Namur
Belgium
TEL: 081 229063 TLX: 59922 FACNAM B
SPECIFIC OBJECTIVES
The aim of Level 40 is to answer the question, 'Why do people behave the way they do ?'
PROJECT DETAILS
The enquiry was carried out during March, April and May 1985 on 40 dwellings in the neighbourhood of Namur. Firstly, a very detailed questionnaire was sent to the occupants of 40 houses to discover their behaviour patterns. The occupants also kept diaries over a 2-month period. External observations of their house fronts were also made by investigators and pressurization tests were carried out on the 40 dwellings by the Belgian Building Research Institute.
BUILDING TYPE
30 houses and 10 apartments
PARAMETERS
Ventilation intensity will be related to the general characteristics of the building, e.g. type of building (house or apartment), age of dwelling, socio-economic and behavioural variables, climatic variables (temperature, wind, humidity, insulation) and motivation variables (spontaneous reasons for window opening).
#STARTDATE 00:02:1985 #ENDDATE 00:04:1986
#TIME 0
KEYWORDS Residential, houses, apartments, occupant behaviour, window opening, questionnaire, pressurization, construction details
BIBLIOG
Daue, F., Mont, J.
Inhabitants' behaviour with regard to ventilation (Level 40) March 1986

#**REF BE3** Namur – Level 3000
CONTACT
C. Dubrul
ADDRESS
Facultes Notre-Dame de la Paix
Facultes des Sciences Economiques
Namur University
8 Rempart de la Vierge
B-5000 Namur
Belgium
TEL: 081 229063 TLX:59922 FACNAM B
SPECIFIC OBJECTIVES
The aim of Level 3000 is to describe the actual behaviour of the householders with regard to ventilation and to give a first look at their motivations.
PROJECT DETAILS
A questionnaire will be distributed to 3000 households. This will consist of two parts: 1. Behavioural. 2. Technical. The first part of the questionnaire is to be completed by the householders. The second part will be completed by the investigators. The behavioural part has a sequence of questions specifically devoted to ventilation where all variables of interest in the Level 40 analysis are involved. Besides this specifically behavioural part, the other part will provide us with new technical and behavioural variables.
BUILDING TYPE
Houses and apartments
PARAMETERS
Same as for Level 40. In addition other variables will be analysed such as status, family factors, technical characteristics of the building, etc.
#STARTDATE 00:10:1985 #ENDDATE 00:09:1986
#TIME 0
KEYWORDS Residential, houses, apartments, occupant behaviour, questionnaire
BIBLIOG
Dubrul, C.
Inhabitants' behaviour with regard to ventilation – Level 3000
Report expected for October 1986.

#**REF BE4** The influence of air infiltration on the condensation behavour of lightweight roofs
CONTACT
H. Hens
ADDRESS
Laboratory of Building Physics
KU Leuven
Kasteel van Arenberg
B-3030 Leuven-Heverlee
Belgium
TEL: 016 220931 TLX:
SPECIFIC OBJECTIVES
To estimate the necessary airtightness of lightweight roof systems to prevent condensation problems.
PROJECT DETAILS
Measurements in hot box/cold box. Measurements on test roofs. Numerical simulation.
BUILDING TYPE
Lightweight roof
#STARTDATE 00:00:1979 #ENDDATE 0:0:00 On-going

#TIME 0
KEYWORDS Roof, experimental cell, condensation, airtightness, numerical model
BIBLIOG
Hens, H., Vaes, F.
The influence of air leakage on the condensation behaviour of lightweight roofs
Air Infiltration Review, Vol.6 No.1, November 1984
Vaes, F.
Hygrothermal behaviour of lightweight, externally ventilated roofs
Report Research Program KUL-TCHN-IWONL, KU Leuven, 1984 (in Dutch)
Hens, H.
Moisture behaviour of sloped roofs
Report Research Program KUL-TCHN-IWONL, KU Leuven, 1984 (in Dutch)
Lecompte, J., Mulier, G.
Airtightness and moisture flow through sloped roofs
KU Leuven, 1984 (in Dutch)

#**REF BE5** Convection in building elements with insulated cavities
CONTACT
J. Lecompte
ADDRESS
Laboratory of Building Physics
KU Leuven
Kasteel van Arenberg
B-3030 Leuven-Heverlee
Belgium
TEL: 016 220931 TLX:
SPECIFIC OBJECTIVES
Evaluation of cavity insulation, development of a numerical model for natural and forced convection heat transport in building elements.
PROJECT DETAILS
The increase of heat loss due to natural and forced convection around the insulation layer – measurements in a hot/cold box, numerical simulation.
BUILDING TYPE
Cavity wall, lightweight roof
PARAMETERS
#STARTDATE 00:00:1984 #ENDDATE 00:09:1988
#TIME 0
KEYWORDS Cavity wall, roof, natural convection, forced convection, experimental cell, numerical model
BIBLIOG
Lecompte, J.
The influence of natural convection on the hygrothermal behaviour of building elements.
Annual Report to the IWONL
(Further publications being prepared in both Dutch and English)

#**REF BE6** Air infiltration in buildings
CONTACT
P. Wouters
ADDRESS
Belgian Building Research Institute
Rue du Lombard, 41
1000 Brussels
Belgium
TEL: (02) 653 88 01 TLX: 25682 CETEX B
SPECIFIC OBJECTIVES
This is the first large-scale project on ventilation in the framework of the Belgian National R&D Program of Energy.
PROJECT DETAILS
Measurements (a) pressurization (+/- 100) and (b) constant injection/ concentration tracer gas. Until now measurements have only been carried out in unoccupied buildings.
BUILDING TYPE
Mostly dwellings and apartments
PARAMETERS
Weather, building performance
#STARTDATE 01:09:1982 #ENDDATE 31:08:1986
#TIME 14,000
KEYWORDS Residential, air infiltration, air leakage, pressurization, constant concentration, constant emission
BIBLIOG
Wouters, P. et al
Ventilatie en infiltratie
BBRI, December 1985
Wouters, P. et al
Ventilatie en infiltratie: overzicht van meetechnieken en bespreking van een aantal meetresultaten.
International Climatic Architecture Congress, Louvain-la-Neuve, 1-3 July

#**REF BE7** IEA Annex XII 'Windows and fenestration'. Handbook on thermal and solar performances of windows.
CONTACT
P. Wouters (infiltration part)
ADDRESS
Belgian Building Research Institute
Rue du Lombard, 41
1000 Brussels
Belgium
TEL: (02) 653 88 01 TLX: 25682 CETEX B
SPECIFIC OBJECTIVES
One of the chapters in the handbook deals with infiltration.
PROJECT DETAILS
The situation of the performance of windows with regard to infiltration and ventilation.
BUILDING TYPE
Windows
PARAMETERS
#STARTDATE 00:00:1983 #ENDDATE 00:12:1986
#TIME 0
KEYWORDS Window, air infiltration, air leakage, building component
BIBLIOG
IEA Annex XII
Windows and fenestration
Handbook on thermal and solar performance of windows, Chapter 5 'Infiltration', 1986

#**REF BE8** IDEE: Integration of possibilities of energy conservation in domestic buildings.
CONTACT
M. Guillaume, P. Wouters, M. Gengoux
ADDRESS
Belgian Building Research Institute
Rue du Lombard, 41
1000 Brussels
Belgium
TEL: (02) 653 88 01 TLX: 25682 CETEX B
SPECIFIC OBJECTIVES
One part of the project concerns detailed pressurization and infiltration measurements in two unoccupied test houses in order to estimate precisely the influence of infiltration on the heat balance.
PROJECT DETAILS
Two identical houses (average U-value) were built in 1981 at our Research Centre. The major aim is the measurement on site of the efficiency of different heating systems. An accurate determination requires a precise estimation of the infiltration.
BUILDING TYPE
Residential
PARAMETERS
Wind velocity, orientation, wind pressure, temperature difference
#STARTDATE 00:00:1981 #ENDDATE 0:0:00 On-going
#TIME 0
KEYWORDS Residential, air infiltration, energy conservation, pressurization, heating systems, tracer gas

BIBLIOG
Integration de differentes possibilities d'economies d'energie dans le domaine de l'habitation (IDEE)
a) Biennale 1981-1983 CSTC 1984, 1983-85 CSTC 1986
b) Studie van de ventilatiehuishouding deel 1, 1986

CANADA

REF CAN1 Determination of air leakage characteristics of residences and development of means of reducing leakage.
CONTACT
R.S. Dumont
ADDRESS
Institute for Research in Construction
National Research Council
Saskatoon
Saskatchewan
S7N OW9
Canada
TEL: 306 975 4200 TLX: 074 2471
SPECIFIC OBJECTIVES
1. Determination of air leakage characteristics of residences. 2. Development of means of reducing air leakage.
PROJECT DETAILS
Approximately 300 houses of varying ages and types have been surveyed using a blower door technique.
Measurements have been made on a significant number of very well sealed residences (less than 1.5 ach at 50 Pa). A second report on this larger sample is being prepared.
BUILDING TYPE
Residences
PARAMETERS
Building style, airtightness details.
#STARTDATE 01:01:1980 #ENDDATE 00:00:1988
#TIME 4000
KEYWORDS Residential, houses, pressurization, blower door, air leakage, leakage reduction, airtight house
BIBLIOG
Dumont, R.S.
Airtightness measurements of houses sealed to reduce air leakage.
ASHRAE Journal, pp64-68, 1984

#**REF CAN2** Air quality measurements in residences.
CONTACT
R.S. Dumont
ADDRESS
Institute for Research in Construction
National Research Council
Saskatoon
Saskatchewan
S7N 0W9
Canada
TEL: 306 975 4200 TLX:074 2471
SPECIFIC OBJECTIVES
1. Determine pollutant levels of major pollutants in Canadian residences.
Determine interaction of pollutant levels with (a) building materials and (b) air change rates.
PROJECT DETAILS
1. A preliminary survey of 50 residences has been undertaken to test for formaldehyde and radon gas. 2. A follow-up study has been undertaken with 50 well-sealed houses to test for formaldehyde, radon and nitrogen dioxide.
BUILDING TYPE
Residences
PARAMETERS
Building tightness, materials used, air change rates.
#STARTDATE 00:00:1982 #ENDDATE 00:00:1988
#TIME 2000
KEYWORDS Residential, air quality, formaldehyde, radon, nitrogen dioxide, air infiltration, airtight house
BIBLIOG
Dumont, R.S.
The effect of mechanical ventilation on Rn, NO2 and CH2O concentrations in low-leakage houses and a simple remedial measure for reducing Rn concentration.
Proceedings APCA Speciality Conference 'Indoor air quality in cold climates: hazards and abatement measures', Ottawa, 1985.

#**REF CAN3** Calculation of ventilation provided by natural infiltration
CONTACT
G.K. Yuill
ADDRESS
G.K. Yuill and Associates Ltd.
1441 Pembina Highway
Winnipeg,
Manitoba
R3T 2C4
Canada
TEL: (204) 474-2461 TLX:
SPECIFIC OBJECTIVES
Development of a method of determining if ventilation requirements (such as those of ASHRAE 62-81) are satisfied by natural infiltration.
PROJECT DETAILS
The model used is based on the LBL infiltration model and a pollutant concentration equation. The equation is set up in dimensionless form so that a single 8760 hour run with real weather data is all that is required for any location. After that, a simple hand calculation provides the annual minimum ventilation rate.
BUILDING TYPE
Detached houses.
PARAMETERS
Two dimensionless numbers, one characterising local weather, the other characterising the house.
#STARTDATE 01:03:1985 #ENDDATE 01:03:1986
#TIME 2000
KEYWORDS Residential, detached house, computer model, air infiltration, ventilation requirements
BIBLIOG
Yuill, G.K., Lovatt, J.
Prediction of pollutant concentration in houses
IAQ '86, Atlanta, GA, USA.
Yuill, G.K.
Development of a technical basis for a procedure for relating equivalent leakage area measurements to minimum natural ventilation rates in residences.
September 1985
Yuill, G.K.
Investigation of sources of error and their effects on the accuracy of the minimum natural ventilation procedure
November 1985

#**REF CAN4** Development of tracer gas methods for measuring air flows in buildings
CONTACT
C.Y. Shaw
ADDRESS
Institute for Research in Construction
Building M24
National Research Council
Montreal Road
Ottawa
Ontario
K1A 0R6
Canada
TEL: (613) 993 9702 TLX: 0533145
SPECIFIC OBJECTIVES
To develop tracer gas methods for measuring air inflows and outflows of an enclosed space.
PROJECT DETAILS
1. Development of equipment. To modify existing tracer gas apparatus to receive samples from up to 16 locations;

to modify the SF6 detector to include backflush. This will reduce the sampling time to about 10 seconds and eliminate the problem of background gases such as Freon interfering with the detector output. 2. Development of measuring technique. Work to be conducted in the laboratory to check the accuracy of some of the prediction methods published in the journals . The experiments will be repeated in a two storey house later.
BUILDING TYPE
PARAMETERS
#STARTDATE 01:09:1984 #ENDDATE 01:03:1987
#TIME 4800
KEYWORDS Air flows, tracer gas, sulphur hexafluoride, prediction methods

#**REF CAN5** Airtightness and ventilation of residential buildings
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TEL: (613) 993 9702 TLX: 0533145
SPECIFIC OBJECTIVES
To develop methods for estimating the air change rate and air pressure distribution of a house, as these factors affect the space heating requirement, indoor air condition and potential for moisture problems.
PROJECT DETAILS
1. Residential ventilation – to study the interaction (airchange and pressure distribution) of house airtightness, weather factors, combustion systems (furnaces), mechanical ventilation systems (with and without heat recovery apparatus) and passive ventilation measures (vent stack, fresh air openings in the basement wall and to the furnace return air duct). 2. Development of airtightness measurement techniques – to develop methods for in-situ measurement of air leakage rates through building envelope elements such as walls, floors and ceilings, and to obtain air leakage data for design purposes. 3. Development of air change prediction methods – to develop computer algorithms for predicting air leakage, air movement and moisture movement in buildings, and to develop a simple air leakage prediction method.
BUILDING TYPE
PARAMETERS
Weather factors, forced ventilation rates, airtightness values, neutral pressure level, RH, moisture content of wood framing.
#STARTDATE 00:00:0000 #ENDDATE 00:09:1985
#TIME 4000
KEYWORDS Residential, airtightness, mechanical ventilation, building components, air quality, air leakage, computer model, ventilation strategies
BIBLIOG
Shaw, C.Y.
Methods for estimating air change rates and sizing mechanical ventilation systems for houses.
BRN237, DBR, NRC, Nov.1985
Shaw, C.Y.
The effect of mechanical ventilation on the air leakage characteristic of a two-storey detached house.
(To be published)

#**REF CAN6** Time-dependent changes in air leakage of low energy houses having polyethylene air vapour barriers.
CONTACT
M.E. Lux
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S7N OW9
Canada
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SPECIFIC OBJECTIVES
Re-pressure test of houses sealed with polyethylene to determine if air leakage characteristics have changed.
PROJECT DETAILS
30 houses, each having an original pressure test carried out at the time of their completion, were re-pressure tested and the results compared with original results. A survey of the home owners was performed to determine what changes were done between the two tests. If possible, aged polyethylene will be examined and compared to new material. Characteristics such as strengh and strain, embrittlement and flexibility will be of particular interest.
BUILDING TYPE
Detached housing, polyethylene vapour barriers.
PARAMETERS
#STARTDATE 00:09:1984 #ENDDATE 00:09:1987
#TIME 700
KEYWORDS Residential, airtightness, vapour barrier, pressurization, construction details, air leakage
BIBLIOG
Lux, M.E.
Changes in air leakage characteristics of low energy houses having polyethylene vapour barriers.
(Report is currently in progress; to be published by NRCC)

#**REF CAN7** Airtightness measurement techniques in multi-compartment buildings.
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SPECIFIC OBJECTIVES
To apply the balanced fan pressurization technique for measuring the airtightness of the exterior walls and interior partitions of a multi-level, multi-unit row house. To combine measurement results with previous data to produce a paper describing the technique for single and multi-compartment buildings.
PROJECT DETAILS
The airtightness of the exterior walls and interior partitions of upper and lower dwelling units in a row house, which has experienced severe condensation problems in its lower units, was measured with the balanced fan pressurization technique. Analysis of results has verified the applicability of the method for such buildings. Data have been used to determine how much additional ventilation is required for problem units.
BUILDING TYPE
Single and multi-compartment buildings
PARAMETERS
Airtightness, temperature difference, mechanical ventilation devices
#STARTDATE 00:06:1985 #ENDDATE 00:03:1986
#TIME 550
KEYWORDS Residential, row house, pressurization, balanced fan, airtightness, walls, condensation, multi-zone
BIBLIOG
Reardon, J.T., Kim, A., Shaw, C.Y.
The balanced fan pressurization technique for measuring

the air leakage through sections of a building.
Building Practice Note, Institute for Research in Construction (formerly Division of Building Research), NRCC, (to be published).

#**REF CAN8** Identification of ventilation problems, modelling requirements and measurement techniques.
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SPECIFIC OBJECTIVES
To review research needs in the area of ventilation performance and air movement in buildings; to identify specific ventilation-related problems; to establish priorities for research and prepare strategies for future projects aimed at solutions to the problems.
PROJECT DETAILS
A literature survey for houses has been completed and contacts with industry, government and outside research groups have been established that have identified problems and solution strategies and current research activities on ventilation and air movement in houses. The need for a model of house air movement and many of its requirements has been identified. These requirements will be further identified and refined.
BUILDING TYPE
Houses
PARAMETERS
#STARTDATE 00:09:1984 #ENDDATE 00:03:1986
#TIME 1600
KEYWORDS Residential, houses, literature survey, ventilation, air movement
BIBLIOG Reardon, J.T.
Ventilation in houses – a literature survey report
Institute for Research in Construction (formerly Division of Building Research), NRCC, draft version, (to be published).

#**REF CAN9** Development of a model for predicting air movement in houses
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SPECIFIC OBJECTIVES
To develop a computer model to predict air flows and pressures in a house resulting from a combination of wind, temperature difference, and operation of various types of combustion, ventilation and air distribution systems.
PROJECT DETAILS
The requirements for an air movement model will be specified. Existing computer models will be identified and examined to determine the feasibility of modifying them to meet the requirements. Based on the above, a plan for that development/modification will be prepared. The model development will then proceed, adding features as appropriate and and as ability to verify them develops concurrently with other projects within the IRC Ventilation Program.
BUILDING TYPE
Houses
PARAMETERS
Wind temperature, indoor air distribution, mechanical ventilation devices, combustion devices, pollutant sources, moisture sources.
#STARTDATE 00:04:1986 #ENDDATE 00:03:1988
#TIME 3200
KEYWORDS Residential, houses, computer model, air movement, air flows, internal pressure, ventilation strategies

#**REF CAN10** Various studies on formaldehyde and radon in homes
CONTACT
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SPECIFIC OBJECTIVES
Measurements of formaldehyde and radon in 'airtight' new houses with mechanical ventilation systems. Formaldehyde level in a mobile home.
PROJECT DETAILS
Long term and short term measurements of formaldehyde, radon, air change rate, temperature and humidity in 2 groups of new 'low energy' houses in Canada (33 homes and 20 homes). Case study of formaldehyde levels and sources and ventilation in a new mobile home.
BUILDING TYPE
Wood frame, single family dwellings
PARAMETERS
Outdoor air supply rate, air circulation/ventilation efficiency, indoor/outdoor envelope pressure difference.
#STARTDATE 00:10:1983 #ENDDATE 00:09:1989
#TIME 1000
KEYWORDS Residential, airtight houses, mobile home, air quality, formaldehyde, radon, mechanical ventilation
BIBLIOG
Marchant, R., Yoshida, K., Figley, D.A.
Mobile home residents' exposure to a high concentration of formaldehyde – a case study.
Proceedings of the APCA Speciality Conference on Indoor Air Quality in Cold Climates, Ottawa, Canada, April 1985
Figley, D.A.
The relationship between indoor air formaldehyde concentrations and ventilation rates for a group of 16 new houses
Proceedings of the 78th Annual Meeting of the Air Pollution Control Association, Detroit, USA, June 1985
Figley, D.A.
Indoor formaldehyde levels in houses with different ventilation strategies
Proceedings of 6th AIC Conference, Netherlands, 1985
Figley, D.A.
Indoor air quality: an engineering approach
Environmental Health Review, Vol.19, No.3, September 1985
Figley, D.A.
Radon levels in houses with controlled ventilation
Accepted for publication in Proceedings of 79th Annual Meeting of the Air Pollution Control Association, Minneapolis, Minnesota, USA, June 1986.

#**REF CAN11** Study of health status of residents in homes insulated with urea formaldehyde foam (UFF) before and after remedial measures are undertaken.

CONTACT
Dr.I. Broder
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SPECIFIC OBJECTIVES
To determine whether the health of occupants of houses insulated with UFF differs from that of other households and whether there is any change after remedial measures have been carried out.
PROJECT DETAILS
The health status of 1,800 residents of urea formaldehyde foam insulated (UFF) homes is to be compared with that of 600 residents of non-UFF homes. The characteristics to be examined will include formaldehyde exposure, the presence of medical symptoms, tests of nasal and and pulmonary function, test of sense of smell, a skin test for formaldehyde allergy and the equivalent of a 'pap smear' on cells obtained from the nose. The health status of all residents is to be re-examined after a period of one year, during which 2 subgroups of the UFF homes will have undertaken different forms of remedial action, while a third UFF subgroup will have taken none.
BUILDING TYPE
Detached homes
PARAMETERS
Temperature, humidity, smoking, symptoms of ill-health, pulmonary and nasal function, nasal cytology, sense of smell and contact allergy to formaldehyde.
#STARTDATE 02:01:1983 #ENDDATE 30:06:1986
#TIME 5500
KEYWORDS Residential, detached house, air quality, formaldehyde, occupant health, remedial measures, smoking
BIBLIOG
Broder, I., et al
Health status of residents in homes insulated with urea formaldehyde foam compared with controls
J. Indoor Air, 3:23-27, 1984
Broder, I., et al
Health status of residents in homes insulated with urea formaldehyde foam
In 'Indoor Air Quality in Cold Climates: Hazards and Abatement Measures', published by Air Pollution Control Association, Pittsburgh, USA, 1986

#**REF CAN12** 1455, 1475, 1515 Larch and 2506 Cornwall Townhouse Complex, Vancouver, B.C.
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Canada
TEL: (604) 733-2701 TLX:
SPECIFIC OBJECTIVES
To design and construct energy efficient townhouses that also provide good air quality and ventilation.
PROJECT DETAILS
The design and construction of four energy efficient townhouses incorporating air quality control features. The ongoing monitoring of radon, formaldehyde, carbon dioxide, temperature, humidity, energy use. and ventilation rates. Two of the townhouses are completed and are currently being monitored.
BUILDING TYPE
Residential
PARAMETERS
Ventilation building design, outdoor air quality and mechanical ventilation.
#STARTDATE 00:00:0000 #ENDDATE 00:00:0000
#TIME 0
KEYWORDS Residential, low energy house, air quality, radon, formaldehyde, carbon dioxide, building design
BIBLIOG
McIntyre, E.D., Sterling, E.M., Sterling, T.D.
Improving air quality in energy efficient houses: an architectural approach.
ACEEE 1986 Summer Study on Energy Efficiency in Buildings, Santa Cruz, California, USA, August 1986. (in press)
Sterling, T.D., Arundel, A., Sterling, E.M.
Effectiveness of air vapour barriers combined with ventilated crawl spaces in decreasing residential exposure to radon daughters
APCA International Special Conference on Indoor Radon, Philadelphia, PA, USA, February 1986. (in press)
Energy vs. environment: indoor air quality and energy conservation workshop 'Technical and analytical information on indoor air quality'.
Cities and Energy Conference, Vancouver, B.C., Canada, March 5-8, 1985.
McIntyre, E.D. Sterling, E.M.
Energy and environment optimisation
Proceedings Building Use & Safety Technology Conference, pp. 212-217, Los Angeles, CA, USA, March 1985

#**REF CAN13** Indoor air quality studies of 8 occupied office blocks
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SPECIFIC OBJECTIVES
To monitor indoor air quality, ventilation and occupant comfort and to develop mechanical system and architectural retrofits.
PROJECT DETAILS
A survey questionnaire was administered to all occupants. The mechanical system was inspected and the design documents were evaluated. The recommendations for system modifications were made and the modifications completed.
BUILDING TYPE
Office
PARAMETERS
Ventilation system performance and health
#STARTDATE 00:00:0000 #ENDDATE 00:00:0000
#TIME 0
KEYWORDS Office, air quality, questionnaire, mechanical ventilation, retrofit
BIBLIOG
Sterling, E.M.
Indoor air quality-total environment performance: comfort and productivity issues in modern office buildings.
Resources. Published by the Real Estate Institute of Canada. p. 21- 24, February 1986.
Sterling, E.M., et al.
Field measurements for ventilation, CO and CO2 in office buildings: a three-phased approach to diagnosing building performance problems.
ASTM Special Technical Publication, 1986. (in press).
Sterling, E.M., et al.
Building performance database.
10th CIB Congress International Council for Building

Research, Studies and Documentation, Washington, D.C., September 1986. (in press).
Sterling, E.M., et al.
A phased technique for researching air quality and related ventilation problems.
Second International Symposium on Human Factors in Organization Design and Management, Vancouver, BC, August 1986. (in press).
Collett, C.W., et al.
The building performance database: an analytical tool for indoor air quality research.
IAQ '86: Managing Indoor Air for Health and Energy Conservation, Atlanta, GA, April 1986. (in press).
Hedge, A., Sterling, E.M., Sterling, T.D.
Building illness indices based on questionnaire responses.
IAQ '86, Atlanta, GA, USA, April 1986 (in press)
Sterling, T.D., Sterling, E.M.
A phased technique for diagnosing air quality and related ventilation problems.
IAQ '86, Atlanta, GA, USA, April 1986 (in press)
Cole, R., Sterling, E.M.
Designing office buildings for improved air quality.
IAQ '86, Atlanta, GA, USA, April 1986 (in press)
Sterling, E.M. et al.
Examples of phased studies of air quality in office building leading to retrofitting of ventilation systems.
IAQ '86, Atlanta, GA, USA, April 1986 (in press)

REF CAN14 Ventilation test room
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SPECIFIC OBJECTIVES
Investigate ventilation effectiveness and thermal comfort in forced warm air low energy dwellings in cold climates, in support of revisions to residential HVAC system design manuals.
PROJECT DETAILS
A test room (3m x 3m x 2.5m) insulated to RS16 has been constructed. A forced warm air heating system with relocatable ductwork is being added. Ventilation effectiveness and thermal comfort effects of ductwork location, diffuser types, heating system characteristics, etc. Will be evaluated using flow visualization and measurements of temperature, air flow and tracer gas distribution.
BUILDING TYPE
PARAMETERS
Design parameters of the HVAC system
#STARTDATE 01:03:1985 #ENDDATE 31:12:1987
#TIME 4000
KEYWORDS Test room, ventilation efficiency, thermal comfort, mechanical ventilation, tracer gas, ventilation strategies

REF CAN15 The effect of thermal envelope upgrading in residential dwellings.
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SPECIFIC OBJECTIVES
To determine the heating demand reductions and energy savings that are possible by upgrading the thermal envelopes of existing houses and to identify any resulting problems, in support of customer information programs.
PROJECT DETAILS
Six occupied frame-construction houses were thermally upgraded (3 homeowner airseal, 4 contractor airseal, 4 basement insulation, 4 airseal and basement insulation, 1 attic insulation) and monitored with digital demand recorders (15 min electric space heating demand) for two heating seasons. The previous heating season was similarly monitored in a dual fuel (oil/electric) experiment. Analysis comparing before and after load lines (best fit of space heating vs outdoor temperature) and energy consumption (degree-day normalized) showed 13% power and 6% energy average reductions. Airtightness tests using fan depressurization were conducted before and after upgrading but they did not give reliable indications of the effects of airsealing. Lowered natural air change rates after retrofitting in a few cases required occupant accommodation (exhaust fans were installed in one house).
BUILDING TYPE
PARAMETERS
Extent of retrofit airsealing
#STARTDATE 01:05:1983 #ENDDATE 31:12:1986
#TIME 5000
KEYWORDS Residential, retrofit, air infiltration, energy conservation, pressurization, airtightness
BIBLIOG
Jones, W.R.
The effect of thermal envelope upgrading in residential dwellings.
Proceedings of ASHRAE/DOE/BTECC Conference 'Thermal Peformance of the Exterior Envelope of Buildings III', Clearwater Beach, Florida, USA, December 2-5, 1985.
Published summer 1986.
Jones, W.R.
The effect of thermal envelope upgrading in residential dwellings.
Final Report for Canadian Electrical Association Project No 207 U 324/Ontario Ministry of Energy Project No 6981, March 1986.

REF CAN16 Drying of walls in low-rise residential housing
CONTACT
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SPECIFIC OBJECTIVES
To test the central hypothesis that the rate of air flow or air change behind the siding of a wood frame wall will significantly affect the ability of the wall to rid itself of excess moisture.
PROJECT DETAILS
Complete a state-of-the-art review of the drying performance of outer wall systems. Develop a mathematical model to provide an estimated drying performance of the chosen wall systems. Provide assessment of the approach using mathematical modelling.
BUILDING TYPE
Single dwellings
PARAMETERS
Heat flow, air flow, and moisture across a wall cross-section will be coupled with air flow in the outer cavity.

#STARTDATE 00:04:1986 #ENDDATE 00:05:1987
#TIME 0
KEYWORDS Residential, walls, literature survey, mathematical model, air flow, moisture

#**REF CAN17** Studies on indoor air quality in Canadian homes
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SPECIFIC OBJECTIVES
To define the extent of existing, or potential, indoor air quality problems in Canadian homes. To also define effective means of addressing such problems.
PROJECT DETAILS
Three reports have been produced in draft form. 'Legislation, Regulation and Standards' addresses the regulatory powers and jurisdictions in indoor air pollution problems in Canadian housing. 'Research and Information Base' lists the firms, agencies and individuals involved in Canadian indoor air quality research. 'Exploring Low Pollution Design' details building techniques to reduce pollution exposure, and includes a description of the population at risk.
BUILDING TYPE
Canadian low-rise residential
PARAMETERS
Building materials, ventilation rates, susceptibility of individuals, and others
#STARTDATE 00:00:1984 #ENDDATE 00:00:1986
#TIME 0
KEYWORDS Residential, air quality, standards, database, building design
BIBLIOG
Small, B.
Indoor air pollution and housing technology.
Small Associates, for CMHC, 1983

#**REF CAN18** The thermal and flow performance of furnace flues in houses
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M. Swinton of Scanada Consultants Ltd. (for CHMC)
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TEL: 613-748-2658 TLX: 0533674
SPECIFIC OBJECTIVES
To develop an understanding of chimney performance, using building science and a computer to model flue behaviour. To verify the model against field results. To pay particular attention to stall or near-stall conditions.
PROJECT DETAILS
The project has been completed except for the editing of the final report. The 'Flue Simulator' computer program (for an IBM compatible P.C.) allows dynamic simulation of flue performance from start-up to steady state. Inputs include house airtightness and neutral pressure plane, chimney thermal characteristics, furnace characteristics, exhaust fan use, outdoor conditions and more. This permits prediction of chimney thermal and flow performance under varying conditions.
BUILDING TYPE
Low-rise residential
PARAMETERS
Combustion spillage due to improper venting (partial to full). Interaction of the furnace flue with fan and fireplace exhaust rates.
#STARTDATE 00:00:1984 #ENDDATE 00:00:1986
#TIME 0
KEYWORDS Residential, houses, chimney performance, computer model

#**REF CAN19** Residential combustion venting failure – a systems approach
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SPECIFIC OBJECTIVES
To address combustion spillage in Canadian houses, through a survey of houses, revision of a checklist for combustion safety, and the refinement of a computer program to simulate flue behaviour, especially in stall or near-stall conditions.
PROJECT DETAILS
A survey of 1000 Canadian houses will indicate how many units are affected by chimney backdraughting or spillage. Several 'failure' houses will be extensively tested to determine the range of indoor air pollution due to this spillage. Remedial measures will be developed and evaluated concurrently. The existing Flue Simulator computer program will be broadened to include fireplace modelling, bi-directional flow, wind effects, flue connector factors, etc.
BUILDING TYPE
Canadian low-rise residential
PARAMETERS
Frequency and quantity of combustion spillage
#STARTDATE 00:10:1985 #ENDDATE 00:08:1986
#TIME 6000
KEYWORDS Residential, houses, questionnaire, chimney performance, remedial measures, computer model, air quality, flues
BIBLIOG
Moffatt, S.
Draft report: Residential chimney backdraft checklist
Sheltair Scientific for CMHC, 1984
Swinton, Monette, Haysom and Platts
Draft report: The thermal and flow performance of furnace flues in houses
Scanada Consultants for CMHC, 1985

#**REF CAN20** Field evaluation of residential ventilation system guidelines
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SPECIFIC OBJECTIVES
To validate the technical correctness and comprehensibility of guidelines written for house building contractors.

PROJECT DETAILS
Eight building contractors attempted to install ventilation systems according to the guidelines. Ventilation flows were measured per room and per house, compared with intended rates. Large discrepancies were found due to difficulties in matching ventilation and thermal requirements in forced warm air distribution systems.
BUILDING TYPE
Single dwellings
PARAMETERS
Ventilation rates compared with those recommended by ASHRAE Standard 62-81 upon which guidelines are based.
#STARTDATE 00:06:1984 #ENDDATE 00:02:1986
#TIME 0
KEYWORDS Residential, houses, ventilation systems, guidelines, ventilation installation

#**REF CAN21** Analytical determination of building internal pressures induced by wind
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SPECIFIC OBJECTIVES
Evaluation of mean and fluctuating wind-induced internal pressures in buildings with known porosity given the external wind pressure distribution.
PROJECT DETAILS
A computer program has been developed to evaluate the wind-induced internal pressure (mean value) based on the wind-induced external pressure distribution and the building porosity (wall openings, cracks, etc). Good agreement has been found between analytically evaluated internal pressures and those obtained in experimental studies. Comparisons with Codes and Standards have been carried out. Work continues for the evaluation of fluctuating internal pressures.
BUILDING TYPE
Residential/industrial buildings
PARAMETERS
Exposure, wind speed and direction, building geometry
#STARTDATE 01:01:1983 #ENDDATE 31:01:1988
#TIME 0
KEYWORDS Residential, industrial, computer model, internal pressure, external pressure, standards
BIBLIOG
Stathopoulos, T., and Kozutsky, R.
'Wind-induced internal pressures in buildings' ASCE J. of Structural Engineering, February 1986

#**REF CAN22** Short-circuiting between fresh air intakes and exhausts of buildings as source of indoor air pollution.
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SPECIFIC OBJECTIVES
To study short-circuiting as a cause of air pollution
PROJECT DETAILS
Literature survey and report on case studies where such short-circuiting was a cause of indoor air pollution. Identify design defects and code infringements and, if possible, identify code improvements.
BUILDING TYPE
PARAMETERS
#STARTDATE 01:01:1981 #ENDDATE 0:0:00 on-going
#TIME 0
KEYWORDS
Air quality, literature survey, short-circuiting
BIBLIOG
Ferahian, R.H.
'Indoor air pollution – some Canadian experiences'
'Research Advances in Health Science and Technology', Vol 1, INDOOR AIR, Proceedings of the 3rd International Conference on Indoor Air Quality and Climate, Swedish Council for Building Research, Stockholm, August 1984, pp 207-212
Ferahian, R.H.
'Indoor air pollution caused by short circuiting of fresh air intakes with exhausts of buildings' CLIMA 2000, Vol 4: Indoor Climate VVS – Congress – VVS Messe, Copenhagen
(Proceedings of the CLIMA 2000 World Congress on Heating and Air Conditioning held in Copenhagen 25-30, August 1985) Ed. P.O. Fanger. pp 307-312
Ferahian, R.H.
'Contravention of building bylaws for HVAC systems and bad maintenance as causes of indoor air pollution. Session 3A: Exposure
IAQ'86, 'Managing Indoor Quality for Health and Energy Conservation, organised by ASHRAE, April 20-23, 1986, Atlanta, Georgia, USA

#**REF CAN23** The R-2000 Home Program: air infiltration method evaluations
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SPECIFIC OBJECTIVES
Validation of BNL-AIMS (Brookhaven National Laboratory's air infiltration method) and investigation of radon daughter ratio technique.
PROJECT DETAILS
Validation of BNL-AIMS passive air infiltration method with continuous SF6 system at University of Alberta experimental huts. Ten 30-day validation tests conducted. Comparison of radon daughter ratio (RaA/RaC') to ventilation rates.
BUILDING TYPE
Residential – experimental
PARAMETERS
Indoor/outdoor temperature, windspeed.
#STARTDATE 01:11:1985 #ENDDATE 00:12:1986
#TIME 150
KEYWORDS Experimental houses, air infiltration, tracer gas, sulphur hexafluoride, computer validation, radon

#**REF CAN24** The R-2000 Home Program: ventilation and air quality monitoring.
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SPECIFIC OBJECTIVES
To document the ventilation and air quality characteristics of R-2000 energy-efficient homes.
PROJECT DETAILS
Measurement of ventilation system flowrates, infiltration rates, indoor levels of formaldehyde, radon, nitrogen dioxide, temperature and humidity over a three year period in approximately 300 homes across Canada. Analysis of results data to determine trends and inter-relationships.
BUILDING TYPE
Residential – occupied
PARAMETERS
Energy consumption, mechanical ventilation system performance, occupant lifestyles, heating systems.
#STARTDATE 00:00:1983 #ENDDATE 00:00:1990
#TIME 0
KEYWORDS Residential, occupied, air infiltration, air quality, formaldehyde, radon, nitrogen dioxide, energy consumption
BIBLIOG
Riley, M., Piersol, P., Lubun, M.
Formaldehyde and radon: measured results for R-2000 homes.
ASHRAE IAQ'86, Atlanta, Georgia, USA, 1986.
Riley, M., Piersol, P., Lubun, M.
Radon and air infiltration: instrumentation evaluation and field surveys for the R-2000 program.
APCA, Minneapolis, MN, USA, 1986.

#**REF CAN25** Flair homes energy demo: air quality and ventilation
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TEL: (204) 633 6363 TLX:
SPECIFIC OBJECTIVES
To document the ventilation and air quality characteristics of 20 energy-efficient homes.
PROJECT DETAILS
Measurement of air infiltration, indoor levels of formaldehyde, radon, nitrogen dioxide, CO, CO2, airborne micro-organisms, temperature and humidity in 20 homes which utilize various building techniques and heating/ventilation systems. Monthly seasonal and annual monitoring.
BUILDING TYPE
Residential – occupied
PARAMETERS
Energy consumption, occupant lifestyles, construction techniques, heating/ventilation systems.
#STARTDATE 00:09:1985 #ENDDATE 00:00:1989
#TIME 0
KEYWORDS Residential, occupied, air quality, air infiltration, formaldehyde, radon, nitrogen dioxide, carbon monoxide, carbon dioxide, energy consumption

#**REF CAN26** Residential combustion venting failure – a systems approach
CONTACT
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Scanada Sheltair Consortium Inc
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K2P 0M8
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SPECIFIC OBJECTIVES
1. To collect data that will enable an estimate of the extent of combustion venting failures in Canadian houses. 2. To refine techniques for identifying houses at risk of experiencing combustion venting failure. 3. To research and develop measures to prevent or correct combustion venting failure. 4. To begin the process of transferring the resulting information to the heating and related industries.
PROJECT DETAILS
The project includes seven main sub-projects: 1.
Installation of combustion venting failure detectors in 1000 houses in all parts of the country.
Refinement and expansion of a computer model of the combustion venting process and its interface with the house envelope and exhaust equipment. 3. Refinement of field procedures for determining how prone to combustion venting failures a given house is. 4. Assessment of the health hazard created by combustion venting failure. 5. Research on remedial/preventative measures.
Investigation of problem houses identified in the 1000 house survey.
Drafting of a technology transfer strategy.
BUILDING TYPE
Residential
PARAMETERS
Envelope airtightness, operation of exhaust equipment, operation of fuel-burning heating equipment.
#STARTDATE 00:11:1985 #ENDDATE 00:09:1986
#TIME 5800
KEYWORDS Residential, combustion venting, computer model, remedial measures
BIBLIOG
Residential combustion safety checklist
(prepared by Sheltair for CMHC), 1984
Residential chimney backdraft checklist: design and evaluation
(prepared for CMHC), February 1984
The thermal and flow performance of furnace flues in houses
Scanada Consultants Ltd for Research Division, CMHC, March 1984
Monitoring chimney performance in four Ottawa houses: a pilot study for monitoring combustion gas spillage and backdrafting in four houses with naturally aspirated gas-fired appliances
Sheltair for Sackatchewan Research Council and BETT, April 1985
Swinton, M.C. (Scanada) and White, J.H. (CMHC)
Avoidance of chimney backdrafting in houses: identifying the critical conditions
Presented at the APCA Speciality Conference on Indoor Air Quality in Cold Climates, May 1985
Validation and refinement of the transient furnace-flue model: FLUESIM
Scanada Consultants Ltd for BETT-EMR/SRC, June 1985
Flue simulator user's manual
Scanada Consultants Ltd for BETT-EMR/SRC, June 1985
A review of design options for the combustion ventilation safety check: a discussion paper
Sheltair for Saskatchewan Research Council and BETT, June 1985
Developing maximum allowable depressurization limits: a background paper
Sheltair for Saskatchewan Research Council and BETT, June 1985 Thermal and aerodynamic performance of chimney flues: ARMSTRONG HOUSE field testing, Phase 1 and 2
Scanada Consultants Ltd for Project Implementation Division, CMHC,1985
To date, several progress reports on the various sub-projects have been submitted to CMHC but not published broadly.

A final summary report is expected to be completed in September 1986.

#**REF CAN27** Measured air infiltration and ventilation in unoccupied test houses.
CONTACT
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SPECIFIC OBJECTIVES
To develop infiltration/weather correlations and to assess effects of flues, open windows and doors, mechanical ventilation and ventilation efficiency.
PROJECT DETAILS
Continuous computer monitoring of 6 unoccupied test houses with SF6 injection. Five wood frame and one brick single storey houses with identical size and varying wall and window design gives factor of 3 in heat loss and factor of 5 in infiltration. Computer controlled door, window and exhaust fan operation. More than 25,000 hours of data have already been collected on each house plus on-site meteorological data.
BUILDING TYPE
Single storey detached residences
PARAMETERS
Weather, simulated occupancy, mechanical ventilation, radon measurements.
#STARTDATE 31:12:1980 #ENDDATE 21:12:1988
#TIME 16,000
KEYWORDS Residential, detached houses, air infiltration, tracer gas, sulphur hexafluoride, simulated occupancy, mechanical ventilation, ventilation efficiency
BIBLIOG
Wilson, D.J., Kiel, D.E.
Air flow rates through open doors induced by temperature difference.
Submitted to Building and Environment, 1986
Sherman, M.H., Wilson, D.J.
Relating actual and effective ventilation in determining indoor air quality
Building and Environment, 1986
Kiel, D.E., Wilson, D.J.
Density-driven flows through open doors
Proceedings 7th AIC Conference, Stratford-upon-Avon, UK, 1986
Wilson, D.J., Kiel, D.E.
Measured effect of mechanical ventilation on natural air infiltration
ASHRAE Trans., Vol.92, Part 1.

#**REF CAN28** Avoiding moisture problems when retrofitting Canadian houses to conserve energy
CONTACT
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SPECIFIC OBJECTIVES
Develop a practicable house assessment/prescription procedure that enables contractors to reduce the risk of moisture problems when 'energy retrofitting' houses.
PROJECT DETAILS
1. Literature analysis. 2. Extensive testing of a score of troubled/ untroubled houses re airtightness, air change, moisture source strength, moisture travel and deposition, etc. 3. Field assessment of many more without sophisticated equipment or test procedures. 4. Empirical fitting of assessment/predictive/prescriptive procedure.
BUILDING TYPE
Low rise houses, mostly timber frame.
PARAMETERS
These relate to essentially all parameters (air quality is assessed only in terms of water vapour 'pollutant').
#STARTDATE 00:12:1985 #ENDDATE 00:12:1987
#TIME 10,000
KEYWORDS Residential, literature survey, retrofit, energy conservation, moisture, condensation
BIBLIOG
Papers for BTECC (Building Thermal Envelope Co-ordinating Council) Symposium, Fort Worth, Texas, USA, December 1986
Technology transfer strategy
Final report December 1987

#**REF CAN29** The state-of-the-art of retrofit weatherstripping: practice and standards.
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TEL: (306) 933-6925 TLX: 074-2484 SARECO
SPECIFIC OBJECTIVES
To identify the needs for standards to achieve quality control of retrofit weatherstrip products and practices. (A companion to an earlier study on caulks & sealants).
PROJECT DETAILS
This consists of a review of the current state-of-the-art of weatherstrip products and practices, as they relate to retrofit work. Main topics include a summary of relevant standards, the Canadian infrastructure, the USA infrastructure, relevant R&D, manufacturing constraints, catalogue of products, recommended new system of standards.
BUILDING TYPE
Low-rise residential
PARAMETERS
Airtightness and durability performance of weatherstrip.
#STARTDATE 00:00:1984 #ENDDATE 00:9:1986
#TIME 1000
KEYWORDS Residential, retrofit, standards, draughtproofing
BIBLIOG
Eyre, D., and Jennings, D.
A study of the indoor use of caulks and sealants (Vols.1 and 2)
SRC Publication Nos. R-820-4-E-85 and R-820-5-E-85, April 1985

#**REF CAN30** Bi-directional flue model
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TEL: (306) 933-6925 TLX: 074-2484 SARECO
SPECIFIC OBJECTIVES
To develop a theory and a computer model of flue behaviour which can be used to evaluate backdraughting effects for various operating conditions.

PROJECT DETAILS
The model will take account of wind effect, house airtightness, operation of exhaust systems and remedial ventilation systems. Transitions from full updraught to full downdraught are treated as a bi-directional flow problem. Spillage, draught-dilutions, thermal capacity of the flue structure and mass transfer in bi-directional flow are built into the model. The model will be tested and refined against practical data.
BUILDING TYPE
Low-rise residential, naturally-aspirated gas furnaces.
PARAMETERS
Weather, interaction of exhaust appliances with furnace, effect of redemial ventilation, effect of airtightening, backdraughting.
#STARTDATE 00:11:1985 #ENDDATE 00:10:1986
#TIME 300
KEYWORDS Residential, computer model, flues

#**REF CAN31** Knowledge base: caulks, sealants and weatherstrip.
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TEL: (306) 933-6925 TLX: 074-2484 SARECO
SPECIFIC OBJECTIVES
To develop and prove a system of standards, and health and safety controls relating to the indoor use of caulks and sealants, and weather- stripping (based on past SRC studies).
PROJECT DETAILS
The primary aim is to establish a foundation of quality control relating to product and practice of retrofit caulking, sealing and weatherstripping. Draft standards will be developed and tested on a short list of products. The secondary aim is to establish a basis for air quality control during sealing work and during the subsequent outgassing period. Harmful products will be identified and their outgas histories will be measured. This information will be used to establish safety criteria assuming various sensitivities.
BUILDING TYPE
Low-rise residential.
PARAMETERS
Performance of building components. Short-term pollution from outgassing effects.
#STARTDATE 00:11:1985 #ENDDATE 00:03:1987
#TIME 1500
KEYWORDS Residential, retrofit, standards, air quality, draughtproofing
BIBLIOG
Eyre, D., and Jennings, D.
A study of the indoor use of caulks and sealants (Vols.1 and 2)
SRC Publications R-820-4-E-85 and R-820-5-E-85

DENMARK

#**REF DK1** Mechanical ventilation systems as sources for air pollutant. A pilot study.
CONTACT
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SPECIFIC OBJECTIVES
Suspended particulates, volatile organic compounds and microbiological pollutants as air pollutants originating from ventilation systems are monitored in a office building.
PROJECT DETAILS
The specific emission rates of pollutants from sources in the room and in the ventilation system are assessed in order to evaluate the relative importance of such a source.
BUILDING TYPE
Office building
PARAMETERS
VOC, suspended particulates, microbiological contamination
#STARTDATE 01:09:1985 #ENDDATE 01:06:1986
#TIME 1000
KEYWORDS Office, ventilation system, air quality, suspended particles, volatile organic compounds, microbiological pollutants
BIBLIOG
Not yet published

#**REF DK2** Investigation of air change rates in modern dwellings
CONTACT
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SPECIFIC OBJECTIVES
A practical test of a simple method for investigating infiltration and exfiltration rates and internal air movements in dwellings will be carried out.
PROJECT DETAILS
The method is based upon the passive sampling technique and use of multiple tracer-gasses. Through measurements in 20-30 modern occupied dwellings, with and without mechanical ventilation systems, it is the aim of the project, to form a empirical basis for later accomplishment of a more comprehensive investigation of several hundred Danish dwellings
BUILDING TYPE
Modern Danish Dwellings with and without mechanical ventilation systems
PARAMETERS
Measurements will include infiltration/exfiltration rates, internal air movements, room temp., rel.humidity, org.vapours
#STARTDATE 00:10:1986 #ENDDATE 00:06:1986
#TIME 830
KEYWORDS Residential, multi-tracer, passive sampling, tracer gas, air infiltration

#**REF DK3** Placement and Function of Air Inlets
CONTACT
K. Johnsen and N. Bergsoe
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Danish Building Research Institute
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TEL: + 45 2 86 55 33 TLX:
SPECIFIC OBJECTIVES
Design, placement and operation of air inlets.
PROJECT DETAILS
The primary aim of the project is to elaborate guidelines concerning design, placement and operation of air inlets, in order to achieve the nessesary flow and distribution of outdoor air in dwellings. The guidelines will apply to consulting and munufacturing technicians. The most widely used air inlets in Denmark will be investigated regarding draught, sound insulation, filtration and condensation. The

investigation will primarilly be carried out as field measurements.
BUILDING TYPE
Multistorey buildings with mech. extract.
PARAMETERS
Infiltration will be related to meteorological data (temperature, humidity, wind speed and direction) and site of the building
#STARTDATE 00:10:1986 #ENDDATE 00:10:1987
#TIME 600
KEYWORDS Residential, air infiltration, air flow, component development.

FEDERAL REPUBLIC OF GERMANY

#**REF FRG1** Ventilation and air infiltration in residential buildings
CONTACT
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Dornier System GmbH
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Federal Republic of Germany
TEL: 07545 82244 TLX: 734209-0
SPECIFIC OBJECTIVES
Indoor air quality, economic energy use, ventilation systems, technical solutions.
PROJECT DETAILS
Organisational and technical contributions to IEA-Annex V 'AIVC', IEA-ANNEX VIII 'Inhabitant Behaviour' and IEA-Annex IX 'Minimum Ventilation Rates'. Investigations concerning inhabitants' behaviour and support to German standardisation activities. Stimulation of transfer of results of previous programme phases into practical application.
BUILDING TYPE
Residential buildings
PARAMETERS
Temperatures, air change, window opening frequency and duration, humidity, pollutant concentration.
#STARTDATE 00:12:1985 #ENDDATE 00:09:1988
#TIME 8000
KEYWORDS Residential, air infiltration, air quality, occupant behaviour, standards, energy conservation
BIBLIOG
Meyringer, V.
'Luftung im Wohnungsbau, Zusammenfassung der bisherigen Ergebnisse' June 1986 (in German)

#**REF FRG2** Improving working conditions in airconditioned rooms/spaces. Investigating the physical causes of negative effects on health and well-being caused by draughts.
CONTACT
E. Mayer
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Fraunhofer Institut fur Bauphysik
Postfach 1180
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Federal Republic of Germany
TEL: 08024 643 0 TLX:
SPECIFIC OBJECTIVES
Measurements of the convective surface heat transfer coefficient of human beings in various air velocities and turbulence degrees.
PROJECT DETAILS
Measurements of 100 subjects (male and female) in a climatic chamber under specific conditions of ventilation to get the resulting value of the coefficient in conjunction with a questionnaire.
BUILDING TYPE
Climatic chambers
PARAMETERS
Temperature, mean value of air velocity, turbulence degree, frequency and direction of air velocity.
#STARTDATE 01:01:1985 #ENDDATE 00:12:1987
#TIME 3200
KEYWORDS Climatic chamber, thermal comfort, forced convection, occupant health, draughts
BIBLIOG
Mayer, E.
Untersuchungen von Zugerscheinungen mit Hilfe physikalischer Messmethoden Gesundheits-Ingenieur 106 (1985), Heft 2, S. 65-73

#**REF FRG3** Indoor air quality – gaseous pollutants; a literature review.
CONTACT
W. Stratmann, Prof.Dr. Loewer.
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SPECIFIC OBJECTIVES
The primary aim is a literature review about indoor air quality, gaseous pollutants in homes, dwellings, residences and offices.
PROJECT DETAILS
Pollutants and their sources; SO2, CO2, NOx, radon, formaldehyde, biocides and other organic compounds; measurement of pollutants; standards; ventilation.
BUILDING TYPE
Unoccupied buildings.
PARAMETERS
#STARTDATE 00:03:1986 #ENDDATE 00:06:1986
#TIME 500
KEYWORDS Literature survey, air quality, standards, sulphur dioxide, carbon dioxide, radon, formaldehyde, unoccupied buildings

#**REF FRG4** Demonstration Project 'Landstuhl': Energy-saving and the use of solar energy within one and two family houses.
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SPECIFIC OBJECTIVES
A study of energy-saving building designs and techniques that incorporate both active and passive solar components.
PROJECT DETAILS
Comparison of the results of energy-balance calculations with measured data for different types of components of occupied buildings. Quantification of the air change rate components of the overall heat balance for natural and mechanically-driven ventilation systems for different types of heating systems (including warm air heating). Air change rate measurements with a tracer gas.
BUILDING TYPE
Passive solar houses
PARAMETERS
Temperature inside and outside. Wind direction and velocity. Behaviour of occupants.
#STARTDATE 01:01:1983 #ENDDATE 30:06:1987
#TIME 750
KEYWORDS Residential, passive solar, tracer gas, air infiltration, occupant behaviour, energy consumption

#**REF FRG5** Mean internal pressure inside buildings induced by wind
CONTACT
W. Baechlin

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Institute for Hydrology and Water Resources
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Federal Republic of Germany
TEL: 0729/6083904 TLX:
SPECIFIC OBJECTIVES
Internal pressure, wind tunnel study, full scale measurements, parameter study
PROJECT DETAILS
The present investigation deals with the problem of the internal pressure on porous, one room, cubical buildings in a turbulent boundary layer. Part I gives a comparison between pressure distributions in and around a covered tennis court. In the second part the mean internal pressure inside different cubic buildings was determined in a boundary layer wind tunnel.
BUILDING TYPE
One room, porous buildings
PARAMETERS
Wind velocity, wind direction, wind turbulence, wind profile, building dimensions, position of openings, opening ratio, porosity of buildings
#STARTDATE 00:08:1981 #ENDDATE 00:05:1986
#TIME 0
KEYWORDS Internal pressure, wind tunnel model, covered tennis court
BIBLIOG
Baechlin, W.
Belastung von Gebasuden durch den windinduzuerten Innendruk
Inst., for Hydrology & Water Resources,
Karlsruhe University, 1985
Baechlin, W., Plate, E.J.
Mean internal pressure inside buildings induced by wind – a wind tunnel study
Proc. Specialty Conf. 'Advancements in Aerodynamics, Fluid Mechanics and Hydraulics', Minneapolis, MN, USA, June 1986.

FINLAND

#**REF FIN1** Thermal and hygrothermal effects of air flows in building components.
CONTACT
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SPECIFIC OBJECTIVES
To obtain a better understanding of the effects of air flows on thermal and hygrothermal behaviour in building structures and whole buildings and to present principles for the product development of integrated wall structures (supply air intake).
PROJECT DETAILS
Calculative study: computer simulations of building components and buildings, typical building structures and most typical building types will be considered, calculative analysis of supply air intake through building envelope.
Experimental study: calorimetric measurements of building components with guarded hotbox, building level measurements in an unoccupied test house (air change rates, energy consumption).
BUILDING TYPE
Typical Finnish buildings
PARAMETERS
Weather performance of building components
#STARTDATE 01:04:1985 #ENDDATE 31:12:1987
#TIME 6500
KEYWORDS Residential, air flow, computer model, building components, air infiltration, energy consumption
BIBLIOG
Kohonen, R., et al
Thermal effects of air flows in building structures
VTT Research Reports 367, 1985
Kohonen, R.
Thermal effects of air flow and moisture in exterior wall structures
Proceedings of the ASHRAE/DOE/BTECC Conference 'Thermal performance of the exterior wall envelopes of buildings', Florida, USA, 2-5 Dec., 1985

#**REF FIN2** Controlled outdoor air intake through the building envelope – Phase II.
CONTACT
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Laboratory of Heating and Ventilating
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TEL: 358 0 4561 TLX: 122972 VTTHA SF
SPECIFIC OBJECTIVES
The aim of the study is to present solutions for air intake through the building envelope without draught and in an energy saving way in dwellings that have mechanical extract ventilation.
PROJECT DETAILS
In Phase I of the study, the thermal economy of the air coming through the structures has been studied with calculations and, among others, the impact of weather and the flow paths of building envelope to the ventilation of a dwelling is considered. The draught caused by the supply air window has been studied in the laboratory. In Phase II of the study, the results of Phase I will be completed and assured with user tests. Commercially available outdoor inlets will be tested in laboratory, especially from the point of view of draught. In addition to the supply air window, the use of constant flow air inlet and structural windshield for the control of intake air stream is also studied. The favourable air intake solutions will be tested in dwellings and in the test houses of Research Centre.
BUILDING TYPE
PARAMETERS
#STARTDATE 01:01:1985 #ENDDATE 30:09:1987
#TIME 4000
KEYWORDS Residential, experimental house, air intake, draughts, window, mechanical ventilation
BIBLIOG
Korkala, T. and Siitonen, V.
Outdoor air intake through the building envelope, Phase I summary
ESPOO 1986. Technical Research Centre of Finland, Research Notes (to be published). 35p and app 2p (In Finnish)
Korkala, T.
The impact of the supply air window on indoor air. Laboratory tests
ESPOO 1985. Technical Research Centre of Finland, Research Reports 352. 55p and app. 31p (In Finnish)

#**REF FIN3** Performance of natural ventilation
CONTACT
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SPECIFIC OBJECTIVES
The aim of the research project is to clarify the factors

influencing and the possibilities of improving natural ventilation in buildings.
PROJECT DETAILS
Measurements in single and multi-family houses with all types of construction. Ventilation system is natural with extract ducts and possible kitchen hood fan. Heating mainly with water or electric radiators, under the window. Measurements consist of air quantity and temperature measurements from extract opening, room humidities and temperatures, hood fan operation. Pressure differences over the envelope, pressurization, tracer gas constant concentration and decay (mean-age) measurements. Model calculations with program VUOTO.
BUILDING TYPE
PARAMETERS
The opening of extract vent, the opening of window (on/off), outdoor climate, hood fan position/operation, infiltration distribution, envelope tightness.
#STARTDATE 00:04:1984 #ENDDATE 31:03:1986
#TIME 3500
KEYWORDS Residential, air infiltration, pressurization, constant concentration, tracer decay, computer model
BIBLIOG
Saarnio, P.
Performance of natural ventilation.
Intermediate report 1. Technical Research Centre of Finland, Laboratory of Heating and Ventilating, ESPOO, 1984. 19p and app. 15p.
Korkala, T.
Intermediate report 2. Technical Research Centre of Finland, Laboratory of Heating and Ventilating. ESP00 1985. 33 p and app 4 p. (In Finnish)

#**REF FIN4** Air temperature, relative humidity and human health in offices
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SPECIFIC OBJECTIVES
The effect of air temperature, relative humidity and ventilation on office employees' health and comfort. A pilot study.
PROJECT DETAILS
In Finland it is typical that in office buildings without humidification, relative humidity during the heating seasons falls below 10% RH. Simultaneously the indoor air temperature may be between 23 and 25 degrees C. The health effects of this combination will be investigated in a case study.
BUILDING TYPE
Office
PARAMETERS
#STARTDATE 01:09:1986 #ENDDATE 01:03:1987
#TIME 1000
KEYWORDS Office, air quality, humidity, occupant health

#**REF FIN5** Ventilation and air quality
CONTACT
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SPECIFIC OBJECTIVES
To study the relationship between ventilation and air quality.
PROJECT DETAILS
1. Study of the properties of mixing and displacement air distribution system (room air movement, thermal environment, air quality). 2. Studies in multi-room fullscale model (air movement and mixing between rooms and related pollutant movement). 3. Development of openings in doors to improve cross ventilation in multi-room dwellings. 4. Study of displacement ventilation in dynamic conditions.
BUILDING TYPE
Dwellings, offices.
PARAMETERS
#STARTDATE 01:04:1986 #ENDDATE 31:12:1988
#TIME 20,000
KEYWORDS Residential, offices, multi-zone, air quality, air infiltration, air flow

#**REF FIN6** Characteristics of room air movement
CONTACT
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Finland
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SPECIFIC OBJECTIVES
To study mean velocity, turbulence and time-dependent characteristics of room air movement.
PROJECT DETAILS
To discover if there is a relationship between turbulence, fluctuation of air velocity and mechanical or natural ventilation, type of air supply system and air exchange rates.
BUILDING TYPE
PARAMETERS
#STARTDATE 01:09:1985 #ENDDATE 01:03:1987
#TIME 4000
KEYWORDS Air infiltration, air flow, turbulence, air movement, mechanical ventilation

#**REF FIN7** Air quality and ventilation in dwellings.
CONTACT
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Finland
TEL: 358-04512684 TLX: 12 51 61(HTKK SF)
SPECIFIC OBJECTIVES
To study the operation of ventilation systems in dwellings and inhabitants' opinion of them.
PROJECT DETAILS
1. To study the operation of ventilation systems in 50 dwellings (mostly with mechanical ventilation system) and air quality in those dwellings.
Simultaneous with measurements, the inhabitants will complete a questionnaire about their opinions of ventilation and air quality. 3. Both measurements and inquiries will be made during various weather conditions to investigate the ability of ventilation systems to satisfy inhabitants' requirements concerning air quality in different weather conditions.
BUILDING TYPE
Dwellings
PARAMETERS
#STARTDATE 01:04:1986 #ENDDATE 31:12:1987
#TIME 6000.
KEYWORDS Residential, ventilation systems, mechanical ventilation, air quality, questionnaire

#**REF FIN8** Indoor air quality in Pasila office centre
CONTACT
O. Seppanen and M. Sivukari

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02150 Espoo
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TEL: 358-04512684 TLX: 12 51 61 (HTKK SF)
SPECIFIC OBJECTIVES
To study indoor air quality and reasons for prevalence of building illness in Pasila office center in Helsinki.
PROJECT DETAILS
1. About 1700 employees will complete a questionnaire at their workplace.
Evaluation of indoor climate includes thermal environment, relative humidity, airborne particles, bacteria, fungal spores, formaldehyde, volatile organics, carbon dioxide, radon, ions and noise level. 3. Reduction of outdoor air rate and its effects on employees' wellbeing. 4. A statistical analysis to find out possible correlation between building illness and environmental factors.
BUILDING TYPE
Office
PARAMETERS
#STARTDATE 01:01:1985 #ENDDATE 31:12:1986
#TIME 5000
KEYWORDS Office, air quality, humidity, formaldehyde, carbon dioxide, radon, occupant health

#**REF FIN9** Indoor climate project.
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TEL: 358-04512684 TLX: 12 51 61 (HTKK SF)
SPECIFIC OBJECTIVES
To study indoor air quality in Finland with the co-operation of ten research institutes and engineering offices.
PROJECT DETAILS
The general goal of the research work is to define factors effecting the quality, healthiness and comfort of indoor air, to establish design values for consultants and manufacturers and to develop new systems for the control of indoor climate. The primary object is to collect data and improve the understanding of various factors affecting the indoor climate. The final goal is the definition of design.
BUILDING TYPE
PARAMETERS
Values for various indoor climate parameters so that unnecessary energy consumption and health hazards are avoided
#STARTDATE 01:08:1983 #ENDDATE 01:09:1986
#TIME 40,000
KEYWORDS Air quality, occupant health, energy consumption, occupant comfort
BIBLIOG
Seppanen, O.
Effectiveness of ventilation in practice.
IAQ '86, Atlanta, Georgia, USA, 20-23 April 1986
Klobout, C.
Model tests of ventilation effectiveness and air distribution – literature survey.
Helsinki University of Technology, HVAC-laboratory, Report C:13, 1985
Suomi, U.
Controlling of the outdoor air intake by the use of contaminant monitoring.
Clima 2000, Copenhagen, 1985, Vol.4 Indoor Climate, pp321-326
Rajala M., et al
The control of radon progeny by air treatment devices.
The Science of the Total Enviroment, 1985, 45, pp493-498.

#**REF FIN10** Determination of short- and long-term average air exchange rate in buildings.
CONTACT
O. Seppanen and A. Majanen
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Helsinki University of Technology
Laboratory of Heating, Ventilation and Air-Conditioning
02150 Espoo
Finland
TEL: 358-04512684 TLX: 12 51 61 (HTKK SF)
SPECIFIC OBJECTIVES
1. Determination of actual air exchange rates by using CO2 as tracer gas.
Determination of long-term average air exchange with passive source and collector.
PROJECT DETAILS
There is a great need to study and develop simple, light and cheap methods for measuring the air exchange rates in buildings. Carbon dioxide and perfluorocarbons will be studied.
BUILDING TYPE
Dwellings, offices, etc.
PARAMETERS
#STARTDATE 01:01:1986 #ENDDATE 31:12:1987
#TIME 3000
KEYWORDS Residential, office, air infiltration, tracer gas, carbon dioxide, perfluorocarbons

#**REF FIN11** Indoor air classification
CONTACT
V. Matilainen, J. Railio
ADDRESS
Association of Finnish Manufacturers of Air Handling Equipment
Fabianinkatu 34
00100 Helsinki
Finland
TEL: +358-0-170922 TLX: 124997 FIMET SF
SPECIFIC OBJECTIVES
To define different quality criteria for indoor air parameters, ventilation/air cond. systems, system design, construction, commissioning
PROJECT DETAILS
The purpose of the project is to develop (for users, builders, and designers) a practical method of determining suitable indoor air characteristics, to be applied in design, case by case. The method will be tested by case studies among builders and designers. Practical applications of inspection methodology will also be studied
BUILDING TYPE
Dwellings, offices, schools, public buildings
PARAMETERS
Ventilation systems and equipment, quality of design and construction
#STARTDATE 00:05:1986 #ENDDATE 00:12:1987
#TIME 5500
KEYWORDS Residential, school, office, air quality, ventilation systems, building design

#**REF FIN12** Tracer gas injection methods for ventilation efficiency measurements
CONTACT
R. Niemela
ADDRESS
Institute of Occupational Health
Laafaniityntie 1,
01620 Vantaa
Finland
TEL: 358-0-890022 TLX: 121394
SPECIFIC OBJECTIVES
1) Usefulness of various tracer gas injection methods. 2) Simulation of contaminant generation by the tracer gas release

PROJECT DETAILS
1) Benefits and restrictions of pulse, step and period tracer inputs will be found out in laboratory conditions. 2) Simulation of actual contaminant (gas or vapor) generation by the tracer gas release will be investigated in industrial work rooms
BUILDING TYPE
Industrial buildings
PARAMETERS
Contaminant removal effectiveness
#STARTDATE 01:01:1987 #ENDDATE 30:01:1988
#TIME 1600
KEYWORDS Industrial, tracer gas, ventilation efficiency, air quality, contaminant flow
BIBLIOG
Hampl, V., Niemela, R., Shulman, S., Bartley, D. L.
Use of tracer gas technique for industrial exhaust hood efficiency evaluation – where to sample?
Am. Ind. Hyg. Assoc. J. 47 (1986), 281-287.
Niemela, R., Toppila, E., Rolin, I.
Characterization of supply air distribution in large industrial premises by the tracer gas technique.
Ventilation '85. (Ed. HD Goodfellow). Elsevier, Amsterdam (1986), pp 797-804

NETHERLANDS

#**REF NL1** Analysis of ventilation through one opening only
CONTACT
R.D. Crommelin
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Division of Technology for Society-TNO
PO Box 217
2600 AE Delft
Netherlands
TEL: 015 569330 TLX: 38071 ZPTNO NL
SPECIFIC OBJECTIVES
To determine the ventilation rate through one opening only, by fluctuations due to turbulence.
PROJECT DETAILS
Literature study, measurements on site and of scale models, study of possibilities and limitations in large halls. The aim of the study is to find the relationship between ventilation rates, meteorological and local wind, local turbulence and temperatures.
BUILDING TYPE
PARAMETERS
Weather (wind), obstacles, e.g. houses, trees, etc.
#STARTDATE 01:08:1982 #ENDDATE 31:12:1987
#TIME 1600
KEYWORDS Air infiltration, single opening, turbulence, scale model, window
BIBLIOG
Vrins, E.
Ventilation through an open window by turbulent air flows.
Technical University of Eindhoven, Thesis Report, 1986.

#**REF NL2** Influence of crawl-spaces on climates in houses.
CONTACT
A.R. De Borst
ADDRESS
Bouwcentrum Groningen
Capellastraat
9742 LJ Groningen
Netherlands
TEL: 050-716400 TLX:
SPECIFIC OBJECTIVES
The humidity of crawlspaces influences the climate of houses by: a) airstreams b) absorption of moisture by porous materials c) condensation.
PROJECT DETAILS
30 single-family houses; concrete floors and walls, limestone walls, brick veneer, mechanical ventilation in kitchen, gas central heating. Instrumentation for long term and momentary measurement of climates, smoke for tracing airstreams.
BUILDING TYPE
PARAMETERS
Humidity and wind outdoors, use of reference houses.
#STARTDATE 00:12:1985 #ENDDATE 00:07:1986
#TIME 1300
KEYWORDS Residential, houses, humidity, condensation, crawlspaces, air flow, smoke visualisation
BIBLIOG
Blauwdruk
Problems met Kruipruimten
Gasunie, April 1984
Oldengarm, Pietsman
Enkelersultaten van praktykonderzoek by kruipruimten
Verwarming en Ventilatie, January 1986 – 1
Kruipruimten
Stichtung Bouwresearch, B2-20, 1983

#**REF NL3** Assessment of occupants' behaviour on behalf of mathematical models, predicting the energy use of households.
CONTACT
M. Dubbeld and J.E.F. van Dongen
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PO Box 214
2600 AE Delft
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2) J.E.F. van Dongen
NIPG-TNO
PO Box 124
2300 AC Leiden
Netherlands
TEL: 1) 015-569330 2) 071-170441 TLX:
SPECIFIC OBJECTIVES
Assessment of occupants' behaviour on behalf of mathematical models predicting the energy use of households.
PROJECT DETAILS
Information from five case studies is gained. In these studies ventilating and airing behaviour has also been studied.
BUILDING TYPE
Terraced dwellings and apartments
PARAMETERS
Mean and variation in energy use, inhabitants' behaviour and internal heat production.
#STARTDATE 00:02:1985 #ENDDATE 00:00:1986
#TIME 0
KEYWORDS Residential, terraced houses, apartments, energy consumption, computer model, occupant behaviour

#**REF NL4** Experience and behaviour of inhabitants of dwellings with different heating (and ventilating) systems
CONTACT
J.E.F. van Dongen
ADDRESS
TNO Institute of Preventive Health Care
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The Netherlands
TEL: 071-170441 TLX:
SPECIFIC OBJECTIVES
To assess the behaviour of the occupants which influences the energy use of four applicated heating systems.
PROJECT DETAILS
In 104 newly built terraced houses (31 with radiator heating, 36 with air heating, 32 with air heating with heat recovery and 5 with floor heating) extensive verbal interviews were taken. The dwellings are densely insulated and provided with mechanical ventilation.

BUILDING TYPE
4-room dwelling with a flat roof
PARAMETERS
Socio-demographic, heating systems, use and functioning of heating systems, use of windows and mechanised ventilation, motives of behaviour.
#STARTDATE 00:01:1985 #ENDDATE 00:12:1985
#TIME 250
KEYWORDS Residential, terraced houses, mechanical ventilation, occupant behaviour, questionnaire, heating systems
BIBLIOG
van Dongen, J.E.F.
Patterns in ventilating and airing behaviour in relatively well insulated newly built terraced houses.
Proceedings of Indoor Air, SCBR, Stockholm 1984, Vol 5, p. 421-427.
van Dongen, J.E.F.
Experience and behaviour of inhabitants of dwellings with different heating systems
NIPG-TNO, Leiden, 1985
Phaff, J.C., van Dongen, J.E.F., de Gids, W.F.
Inhabitants behaviour with regard to ventilation, the use of windows. First heating season.
Proceedings of 6th AIC Conference, The Netherlands, 1985

#**REF NL5** Radiator-heating/air-heating. A comparison of actual performance in recently built houses.
CONTACT
M. de Langen
ADDRESS
Stichting Woon/Energie
Crabethstraat 38j
2801 AN Gouda
Netherlands
TEL: 01820 24233 TLX:
SPECIFIC OBJECTIVES
To compare the performance of a heating system using warm air with that of a heating system using warm water radiators.
PROJECT DETAILS
Two blocks, each of approximately 100 houses (multi-family) have been compared. Because the actual performance of the warm air system particularly showed many shortcomings, the project started with diagnosing weak and strong points of the different systems. Expanding the comparison to a larger number of houses/system variants is still under discussion.
BUILDING TYPE
Multi-family houses
PARAMETERS
System parameters of the specific heating systems
#STARTDATE 01:09:1985 #ENDDATE 01:01:1986
#TIME 150
KEYWORDS Residential, apartments, heating systems
BIBLIOG
de Langen, M.
Radiatorenverwarming – luchtverwarming een vergelijking (Fase 1)
Stichting Woon/Energie, Gouda, Netherlands.

#**REF NL6** Development of components for local-heating stoves with ventilation (fresh air) inlet facilities.
CONTACT
M. de Langen and F. de Haas
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Klimaat/Bouw Productonwikkeling
Crabethstraat 38b
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TEL: 01820 16572 TLX:
SPECIFIC OBJECTIVES
Developing components for (1) combined fresh air inlet and burned air outlet, (2) variable heat exchanger stove/ventilation air inlet, (3) temperature regulation of ventilation air, (4) integration of components.
PROJECT DETAILS
Development of a prototye of new local-heater (gas burning) in co-operation with DRU-Ulft (producers of a.o. gas stoves).
BUILDING TYPE
Local-heater (gas burning)
PARAMETERS
Recycling of NOx from burned air in ventilation air
#STARTDATE 01:10:1985 #ENDDATE 01:10:1986
#TIME 2500
KEYWORDS Component development, heating systems
BIBLIOG
No reports available

#**REF NL7** Evaluation 'Swaan'.
CONTACT
H. Korbee
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Stichting Woon/Energie
Crabethstraat 38j
2801 AN Gouda
Netherlands
TEL: 01820 24233 TLX:
SPECIFIC OBJECTIVES
Evaluation of a passive ventilation air inlet collector in a newly- built block of 125 multi-family houses with mechanical ventilation.
PROJECT DETAILS
After preliminary tests with a ventilation air inlet collector, based on natural ventilation through the collector (passive), a prototype of the collector was built in multi-family houses in Voorburg. The present project evaluates how the collectors function in practice.
BUILDING TYPE
Multi-family (concrete), passive air collector.
PARAMETERS
Satisfaction of inhabitants, distribution of air flows within the houses.
#STARTDATE 01:01:1986 #ENDDATE 01:01:1986
#TIME 300
KEYWORDS Residential, apartments, ventilation system, air flow, occupant satisfaction, mechanical ventilation
BIBLIOG
Korbee, H.
Evaluatie swaan
Stichting Woon/Energie, Gouda, Netherlands.

#**REF NL8** Flat renovation with climate-facades
CONTACT
E. Hasselaar and M. de Langen
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Stichting Woon/Energie
Crabethstraat 38j
2801 AN Gouda
Netherlands
TEL: 01820 24233 TLX:
SPECIFIC OBJECTIVES
To develop and test the prototype of a climate-facade to be used in flat-renovation, which has integrated insolation, ventilation and heating.
PROJECT DETAILS
In the past year (1985), Klimaat/Bouw has developed a prototype of a Climate-facade in which insolation, ventilation and heating facilities are integrated in order to minimise the the amount of renovation work needed in the interior of houses. Partially financed under the EG Energy Demonstration Program, the present project is a full-scale experiment with 50 houses.
BUILDING TYPE
Climate-facade
PARAMETERS
Fresh air and heating demand of each specific room within the house.

#STARTDATE 01:01:1986 #ENDDATE 31:12:1987 (Phase 2) 31:12:1987 (Phase 4)
#TIME 2000
KEYWORDS Retrofit, climate-facade, residential, multi-storey
BIBLIOG
Hasselaar, E., de Langen, M.
Flat renovation with Climate-facades
Woon/Energie/Klimmat/Bouw, Gouda, Netherlands.

#**REF NL9** Ventilation air inlet facilities in locally heated houses
CONTACT
E. Vrins and M. de Langen
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Stichting Woon/Energie
Crabethstraat 38j
2801 AN Gouda
Netherlands
TEL: 01820 24233 TLX:
SPECIFIC OBJECTIVES
Diagnosis of ventilation problems in locally-heated houses (gas stoves) after facade renovation leading to very low natural infiltration rates through cracks, etc.
PROJECT DETAILS
Facade renovation in multi-storey houses by replacing almost complete old facade elements with new ones reduces uncontrolled natural infiltration of air to a very low level. As a result, air inlet is concentrated at the very few remaining openings and air flow towards the gas-stove/chimney causes severe comfort problems. The project diagnoses the problems and proposes and tests air inlet facilities to reduce the problems.
BUILDING TYPE
Multi-storey, multi-family houses (brick/concrete)
PARAMETERS
Airtightness of new facades, flow resistance of ventilation ducts and chimneys and of proposed air inlet facilities, outdoor climate conditions.
#STARTDATE 01:01:1986 #ENDDATE 01:11:1986
#TIME 500
KEYWORDS Residential, multi-storey, air infiltration, occupant comfort, air flow
BIBLIOG
Vrins, E., de Langen, M., de Haas, F.
Ventilation problems in locally heated, multi-family houses after facade renovation
Woon/Energie, Gouda, Netherlands
(to be published approx. 01:12:1986)

#**REF NL10** Air movement in rooms
CONTACT
R.D.Crommelin
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POB 217
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Netherlands
TEL: 15-569330 TLX: 38071
SPECIFIC OBJECTIVES
To study the effects of outdoor air supply on air movement and indoor- climate
PROJECT DETAILS
Phase 1 Literature study Phase 2 Experimental work (scale model) Phase 3 Field measurements/evaluation Phase 4 Modelling
BUILDING TYPE
Rooms
PARAMETERS
Climate, air movement, air velocity, form of openings and flow
#STARTDATE 30:06:1986 #ENDATE 30:12:1989
#TIME 2000
KEYWORDS Air flow, room, air quality, scale model

#**REF NL11** Developing models on infiltration/ventilation/heat transfer/moisture/pollutants
CONTACT
J.C.Phaff
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MT-TNO
POB 217
2600 AE Delft
Netherlands
TEL: 15-969330 TLX: 38071
SPECIFIC OBJECTIVES
To develop models and interaction between models to evaluate ventilation/energy/indoor air quality
PROJECT DETAILS
Phase 1 Study of separate models Phase 2 Updating the separate models,Phase 3 Formation of input data, Phase 4 Network system developed, Phase 5 Tests on interaction/evaluation, Phase 6 Description of the complete system
BUILDING TYPE
Buildings
PARAMETERS
Models, air movement
#STARTDATE 30:06:1986 #ENDDATE 30:12:1990
#TIME 3000
KEYWORDS Model, air quality, ventilation

#**REF NL12** Ventilation in industrial buildings
CONTACT
W.F.de Gids
ADDRESS
MT-TNO
POB 217
2600 AE Delft
Netherlands
TEL: 15-569330 TLX: 38071
SPECIFIC OBJECTIVES
To study the relationship between local and general ventilation systems
PROJECT DETAILS
Phase 1 Aspects of mechanical and natural ventilation, Phase 2 Local exhaust systems, Phase 3 Improvement of techniques used,Phase 4 Evaluation.
BUILDING TYPE
Industrial
PARAMETERS
Ventilation systems, local exhaust, hood construction, air movement, ventilation efficiency
#STARTDATE 01:01:1986 #ENDDATE 30:12:1986
#TIME 3000
KEYWORDS Industrial, ventilation systems, ventilation efficiency
BIBLIOG
Crommelin,R.D.
Aspects in relation to the choice between mechanical and natural ventilation systems in factories.

#**REF NL13** Infiltration and ventilation in relation to heating systems
CONTACT
M.Dubbeld and W.F.de Gids
ADDRESS
MT-TNO
POB 217
2600 AE Delft
Netherlands
TEL: 15-569330 TLX: 38071
SPECIFIC OBJECTIVES
To study the effects of advanced heating systems on infiltration and ventilation systems
PROJECT DETAILS
Phase 1 Desk study,Phase 2 Experimental laboratory tests, Phase 3 Field tests.
BUILDING TYPE
Houses

PARAMETERS
Heating system, user influence
#STARTDATE 01:01:1986 #ENDDATE 30:06:1989
#TIME 2000
KEYWORDS Residential, air infiltration, ventilation systems, heating systems

#**REF NL14** Infiltration and ventilation aspects in airtight dwellings
CONTACT
W.F.de Gids
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POB 217
2600 AE Delft
Netherlands
TEL: 15-569330 TLX: 38071 ZPTNO
SPECIFIC OBJECTIVES
To study the relationship between infiltration/ventilation/indoor air quality
PROJECT DETAILS
Measurements and model calculations will be carried out in houses. Levels of pollutants and energy use will be compared and evaluated.
BUILDING TYPE
Houses
PARAMETERS
Pollutant levels/infiltration/ventilation/energy
#STARTDATE 30:01:1986 #ENDDATE 30:06:1988
#TIME 1000
KEYWORDS Residential, air quality, air infiltration, energy consumption

#**REF NL15** Ventilation in welding halls
CONTACT
B.Knoll
ADDRESS
MT-TNO
POB 214
2600 AE Delft
Netherlands
TEL: 15-569330 TLX: 38071
SPECIFIC OBJECTIVES
To collect data for ventilation and air movement in halls with welding processes
PROJECT DETAILS
The study is part of a large survey on health conditions in factories. Measurements will be carried out in about 7 factories. The measurements consist of air flow rates, air flow patterns, air velocity, etc.
BUILDING TYPE
PARAMETERS
#STARTDATE 01:04:1983 #ENDDATE 30:12:1987
#TIME 1000
KEYWORDS Industrial, occupant health, factory, air movement

#**REF NL16** Occupants' behaviour in relation to ventilation
CONTACT
J.E.F.van Dongen, W.F.de Gids
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POB 217
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Netherlands
TEL: 15-569330 TLX: 38071
SPECIFIC OBJECTIVES
To obtain information about the use of ventilation provisions in houses
PROJECT DETAILS
Measurements and enquiries will be carried out in about 40 single family houses. Positions of windows will be recorded. Models for several groups of behaviour will be developed
BUILDING TYPE
Single family houses, terraced houses
PARAMETERS
Weather, indoor climate, behaviour, ventilation system
#STARTDATE 30:06:1987 #ENDDATE 30:12:1989
#TIME 2500
KEYWORDS Residential, occupant behaviour, window opening
BIBLIOG
de Gids, W.F. et al
Bewoners gedrac en ventilatie
C581, Juli 1985, IMG-TNO Delft
Phaff, J.C.
Inhabitants' behaviour with regard to ventilation,
6th AIVC Conference, 1985
Phaff, J.C., de Gids, W.F.
Effects of instructions to inhabitants of their window behaviour
7th AIVC Conference 1986
de Gids, W.F., Phaff, J.C.
Seasonal effects on window behaviour
7th AIVC Conference, 1986

#**REF NL17** Air leakage of buildings
CONTACT
W.F.de Gids
ADDRESS
MT-TNO
POB 217
2600 AE Delft
Netherlands
TEL: 15-569330 TLX: 38071
SPECIFIC OBJECTIVES
To study air leakage in order to establish standards
PROJECT DETAILS
This study includes measurement of a representative sample of houses and other buildings on air leakage over the building envelope, calculations for different air leakages and pressure distributions of infiltration and heat loss due to infiltration, methods to improve air leakage paths in building construction. The study will be carried out in different steps.
BUILDING TYPE
PARAMETERS
Weather, performance of building components
#STARTDATE 01:01:1982 #ENDDATE 30:12:1988
#TIME 600
KEYWORDS Air leakage, standards, heat loss, air infiltration
BIBLIOG
Draft Standard. NEN 2686, Air permeability of buildings
Method of measurement

NEW ZEALAND

#**REF NZ1** Air infiltration and air flows in buildings
CONTACT M.R. Bassett
ADDRESS Building Research Association of New Zealand
Private Bag
Porirua
New Zealand
TEL: 357 600 TLX: 30256 BRANZ NZ
SPECIFIC OBJECTIVES
Measure and model airflows between rooms and building cavities so that heat and moisture flows can be investigated.
PROJECT DETAILS
Simultaneous use of SF6 and F12 as tracer gases to measure air flows between building cavities including room spaces. Also monitoring of house airtightness as houses age.
BUILDING TYPE
PARAMETERS #STARTDATE 00:00:1985 #ENDDATE 00:00:1987 #TIME 0
KEYWORDS Air flows, multi-zone, multi-tracer, sulphur hexafluoride, freons, airtightness

BIBLIOG Bassett, M.R.
The infiltration component of ventilation in New Zealand houses
Proc. 6th AIC Conference, The Netherlands, 1985
Bassett, M.R.
Infiltration in New Zealand Houses
Proc. 4th AIC Conference, Switzerland, 1983.

NORWAY

#**REF NOR1** Wind pressure behind ventilated claddings
CONTACT
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Norwegian Building Research Institute
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7034 Trondheim NTH
Norway
TEL: 07 593390 TLX: Telefax 07 593380
SPECIFIC OBJECTIVES
To obtain more information about the influence of wind pressure on the heat loss from timber frame walls.
PROJECT DETAILS
The project is divided into three parts (1) calculations, (2) hot-box measurements and (3) wind pressure measurements. Theoretical as well as experimental investigation in the hot box are restricted to heat loss caused by the interchange of air between the insulation and the air space between the wind barrier and the outer cladding. The wind pressure measurements are carried out by means of a rotatable test house.
BUILDING TYPE
Wind barriers, all building types
PARAMETERS
Wind pressure distribution.
#STARTDATE 00:01:1984 #ENDDATE 00:01:1988
#TIME 2500
KEYWORDS Walls, external pressure, heat loss, test house
BIBLIOG
Uvslokk, S.
Preliminary project report
NBI, 22 January 1985
(in Norwegian – restricted),
Uvslokk, S.
Research report from Norway
Air Infiltration Review, Vol 7, No.2, February 1986
Uvslokk,S.
Project report
NBI Summer 1986
(in Norwegian – planned)

#**REF NOR2** The airtightness and the insulation of buildings
CONTACT
J.T.Brunsell
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Norwegian Building Research Institute
PO Box 322
Blindern
0314 Oslo 3
Norway
TEL: 47-2-46 9880 TLX:
SPECIFIC OBJECTIVES
To find the infiltration and the ventilation rate due to climatic forces, the ventilation system and the occupants behaviour.
PROJECT DETAILS
Measure the infiltration rate and the ventilation rate with constant concentration measurements. The characteristics, e.g internal and external tightness, will be measured
BUILDING TYPE
Single family house, multifamily house, commercial building
PARAMETERS
#STARTDATE 01:01:86 #ENDDATE 31:12:89
#TIME 3000
KEYWORDS Residential, air infiltration, tracer gas, constant concentration, occupant behaviour.
BIBLIOG

SWEDEN

#**REF SWE1** Multi-cell calculation model of ventilation and infiltration.
CONTACT
S. Bergstrom
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SPECIFIC OBJECTIVES
The multi-cell building is represented by a system of flow resistances corresponding to airtightness of outer shield, interior partitions and ventilation system. It is exposed to forces from wind, stack effect and fans. Also the case when fans are turned off is handled. Originally it was developed to study infiltration. It has later been applied to study problems like spread of poisonous gas in outdoor air into buildings and spread of fire and smoke gas produced somewhere in the building.
PROJECT DETAILS
BUILDING TYPE
Commercial buildings, hospitals.
PARAMETERS
#STARTDATE 00:00:1978 #ENDDATE 00:02:1986
#TIME 0
KEYWORDS Commercial, hospital, computer model, multi-zone, fire spread, air infiltration
BIBLIOG
Report R129:1985 (in Swedish)
Swedish Council for Building Research
Nylund, P-O.
Spread of gas in hospital buildings exposed to poisonous outdoor air
To be presented at 2nd ASHRAE Symposium on Multi-cell Infiltration, New York, USA, January 1987

#**REF SWE2** SPARSAM – Energy efficient single family houses
CONTACT
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Energy Conservation in Buildings Group – EHUB
The Royal Institute of Technology
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Sweden
TEL: 46 8 7877000 TLX: 10389 KTHB S
SPECIFIC OBJECTIVES
To build energy efficient houses (total energy consumption for heating, ventilation, hot water and household electricity less than 10,000 kWh/year in Stockholm climate) which can be produced in long series.
PROJECT DETAILS
Well insulated airtight envelope, passive solar design, mechanical ventilation with an exhaust air heat pump for preheating supplied air and for producing hot water, water conserved by using water saving system. Comparison between light and heavy structure on energy consumption and installed effect.
BUILDING TYPE
PARAMETERS
Long time measurements of ventilation and air infiltration by using continuous tracer gas technique and a new passive technique. Air distribution in the houses. Indoor and outdoor climate.

#STARTDATE 03:04:1982 #ENDDATE 00:00:1985
#TIME 8000
KEYWORDS Building design, residential, houses, passive solar, mechanical ventilation, tracer gas
BIBLIOG
SPARSAM – five energy efficient single family houses
Report planned for 1986 (in Swedish)

#**REF SWE3** Airtightness in buildings – II
CONTACT
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Royal Institute of Technology
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Sweden
TEL: 468 7878423 TLX: 10389 KTHB S
SPECIFIC OBJECTIVES
Evaluation of ventilation rates in apartments related to building airtightness and different ventilation systems.
PROJECT DETAILS
Measurements of ventilation and airtightness in six apartment buildings. Perfluorocarbon tracer gas method for ventilation with multiple tracer gases. Pressurization method with supporting pressure in adjacent apartments.
BUILDING TYPE
Apartment building
PARAMETERS
Weather, performance of building components, behaviour of occupants
#STARTDATE 01:09:1984 #ENDDATE 30:09:1987
#TIME 2400
KEYWORDS Residential, apartments, tracer gas, air infiltration, multi-tracer, perfluorocarbons, pressurization, occupant behaviour

#**REF SWE4** Microclimate: the influence of fluctuating wind pressure distribution on air infiltration, measurements of rate of air changes in crawl spaces.
CONTACT
K. Handa, J. Gusten
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TEL: 031 81 01 00 TLX:
SPECIFIC OBJECTIVES
Wind pressure measurements
PROJECT DETAILS
Full-scale measurements of wind pressure distributions. Studies of fluctuating wind pressure drops through different constructions. Tracer gas measurements of rate of air change in crawl spaces of dwellings related to pressure differences caused by wind, temperature and mechanical ventilation systems.
BUILDING TYPE
Low-rise buildings
PARAMETERS
#STARTDATE 01:07:1985 #ENDDATE 30:06:1988
#TIME 0
KEYWORDS Residential, crawl spaces, external pressure, tracer gas, mechanical ventilation, air infiltration
BIBLIOG
Gusten, J.
Full-scale wind pressure measurements on low-rise buildings.
Proceedings, AIC Wind Pressure Workshop, Brussels, 1984.
Gusten, J.
Drivkrafter for Luftinfiltration.
Division of Structural Design, Chalmers University of Technology, 1984:4 (in Swedish)

#**REF SWE5** Application of passive solar heating – resource efficient construction in Karlstad – performance monitoring and evaluation.
CONTACT
A. Blomsterberg
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National Testing Institute
Energy Division
Box 857
S-501 15 Boras
Sweden.
TEL: (033) 16 50 00 TLX: 36252 TESTING S
SPECIFIC OBJECTIVES
To monitor and evaluate calculated energy savings and to study the ventilation efficiency, the importance of thermal mass and a sunspace, in three row-houses equipped with exhaust ventilation.
PROJECT DETAILS
Air is circulated within the apartments by fans located in the floor. Fresh air enters through the sunspace.
Unoccupied periods were used for monitoring airtightness, ventilation efficiency, ventilation rates (mechanical and air infiltration), indoor temperatures, air flows in ducts.
During the long-term monitoring energy use (space heating, hot water and household), indoor and outdoor temperatures, solar radiation were recorded.
BUILDING TYPE
Two storey row-houses
PARAMETERS
Weather, performance of building components, real occupancy.
#STARTDATE 01:07:1983 #ENDDATE 31:12:1986
#TIME 0
KEYWORDS Residential, houses, passive solar energy conservation, airtightness, ventilation efficiency
BIBLIOG
Final report by 31:12:1986

#**REF SWE6** Light Construction '85 – energy and resource efficient houses. Performance monitoring and evaluation.
CONTACT
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S-501 15 Boras
Sweden
TEL: (033) 16 50 00 TLX: 36252 TESTING S
SPECIFIC OBJECTIVES
To monitor and evaluate calculated energy savings and comfort conditions and to study a user controlled exhaust ventilation system in 18 well-insulated houses.
PROJECT DETAILS
Unoccupied periods were used for monitoring the following properties: airtightness, ventilation efficiency, ventilation rates (mechanical and air infiltration), indoor temperatures, air flows in ducts. During the long-term monitoring the following factors were recorded: Electric energy use (measured separately for space heating, hot water, and household), indoor and outdoor temperature, run time for different exhaust fan speeds, etc.
BUILDING TYPE
1.5 storey detached one-family houses.
PARAMETERS
Weather, performance of building components, real occupancy.
#STARTDATE 01:07:1984 #ENDDATE 31:03:1987
#TIME 1300
KEYWORDS Residential, detached house, airtightness, energy conservation, ventilation efficiency, air infiltration
BIBLIOG

Final report by 31:03:1987. Paper submitted for 7th AIC Conference, UK,

#**REF SWE7** Alternative tracer gas measurement technique
CONTACT
B. Hedin
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Lund University
Department of Building Science
P.O. Box 118
S-221 00 Lund
Sweden.
TEL: +46 46 10 7000 TLX: 33533 LUNIVER S
SPECIFIC OBJECTIVES
To use the information given in the first part of a tracer gas measurement situation (the gas dilution part).
PROJECT DETAILS
Theoretical modelling (primarily theory of automatic control) and practical measurements with tracer gas.
BUILDING TYPE
Especially large, open buildings.
PARAMETERS
Ventilation, ventilation efficiency, weather, performance.
#STARTDATE 00:00:1986 #ENDDATE 00:00:1988
#TIME 1600
KEYWORDS Tracer gas, ventilation efficiency

#**REF SWE8** Infiltration data
CONTACT
C. Warfvinge
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S-221 00 Lund
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TEL: +46 46 10 7000 TLX: 33533 LUNIVER S
SPECIFIC OBJECTIVES
Determination of leakage distributions of buildings by means of analysing pressure-leakage data in combination with stack effect.
PROJECT DETAILS
Mathematical modelling of leakage types and distributions combined with pressurization tests added to stack effect.
BUILDING TYPE
All types of single cell buildings
PARAMETERS
Weather, leakage characteristics of building components, leakage distribution.
#STARTDATE 00:00:1987 #ENDDATE 00:00:1989
#TIME 2000
KEYWORDS Leakage distribution, pressurization, stack effect, mathematical model

#**REF SWE9** Simulation model for air exchange in buildings and rooms
CONTACT
K. Kallblad
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Department of Building Science
Lund University
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Sweden.
TEL: +46 46 10 7000 TLX: 33533 LUNIVER S
SPECIFIC OBJECTIVES
To introduce air balance as an integrated part in building physics in close connection with heat and moisture balance.
PROJECT DETAILS
Development of a calculation model which takes into account air, heat and moisture balance in an integrated way.
BUILDING TYPE
All types of buildings
PARAMETERS
Weather, building component performance, simulated occupant behaviour, ventilation and heating systems.
#STARTDATE 00:00:1987 #ENDDATE 00:00:1989
#TIME 2000
KEYWORDS Computer model, air infiltration, moisture, simulated occupancy
BIBLIOG
Kallblad, K.
Calculation methods to predict energy savings in residential buildings
Document D4:1983, Swedish Council for Building Research, 1983

#**REF SWE10** Ventilation of roofs
CONTACT
H. Hakansson
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S-221 00 Lund
Sweden.
TEL: +46 46 10 7000 TLX: 33533 LUNIVER S
SPECIFIC OBJECTIVES
To avoid moisture damage in attics and roofs, moisture convection from the heated part of a building to the attic must be minimised and the ventilation of the attic must be effective.
PROJECT DETAILS
Theoretical and practical studies concerning air, heat and moisture balance of attics and roofs.
BUILDING TYPE
Single family houses, attics
PARAMETERS
Weather, infiltration and insulation performance.
#STARTDATE 00:00:1983 #ENDDATE 00:00:1987
#TIME 3000
KEYWORDS Roofs, attic, moisture, condensation, air infiltration
BIBLIOG
Kronvall, J.
Ventilation strategies for crawl-spaces, attics etc
Proceedings, 6th AIC Conference, Netherlands, 1985.

#**REF SWE11** Ventilation requirements for moisture control in different climates.
CONTACT
J. Kronvall
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Lund University
P.O. Box 118
S-221 00 Lund
Sweden
TEL: +46 46 10 7000 TLX: 33533 LUNIVER S
SPECIFIC OBJECTIVES
Simulations by theoretical calculations of moisture in indoor air and investigation of ways to control the moisture level.
PROJECT DETAILS
Parameter study of factors affecting the indoor climate of houses in different climates. Heat, air and moisture balance modelling, heating and ventilation strategies.
BUILDING TYPE
Single family houses
PARAMETERS
Weather, building components, ventilation systems, ventilation habits
#STARTDATE 00:00:1986 #ENDDATE 00:00:1987
#TIME 400

KEYWORDS Air quality, residential, houses, moisture, theoretical model
BIBLIOG
Adamson, B.
Use of passive cooling in buildings
(Under publication), Department of Building Science, University of Lund, Sweden
Adamson, B.
A parametric study of the thermal performance of houses in Swedish climate
Report BKL 1985:4(E), Department of Building of Science, University of Lund, Sweden, 1985

REF SWE12 Determination of the accuracy of the constant flow technique
CONTACT
M. Sandberg
ADDRESS
National Swedish Institute for Building Research
Box 785
S-801 29 Gavle
Sweden
TEL: (026) 10 02 20 TLX: 47396 BYGGFO S
SPECIFIC OBJECTIVES
To determine the accuracy of the constant flow technique for the determination of the total ventilation flow rate in buildings.
PROJECT DETAILS
Tests are carried out in an indoor test house located in the laboratory hall at the Institute. The total flow rate of air entering the house is known with a relative error of 3%. Standard constant flow technique with the use of N20 as tracer gas and miniature traces sources and miniature passive samplers are explored.
BUILDING TYPE
PARAMETERS
#STARTDATE 01:10:1986 #ENDDATE 30:06:1987
#TIME 0
KEYWORDS Tracer gas, constant emission, nitrous oxide, indoor test house, test accuracy
BIBLIOG
Sandberg, M., Blomqvist, C.
A quantitative estimate of accuracy of tracer gas methods for the determination of the ventilation flow rate in buildings.
Building and Environment, Vol.20, No.3, 1985

REF SWE13 AIRCOMP: An infiltration and ventilating system simulation model
CONTACT
M. Herrlin
ADDRESS
The Royal Institute of Technology
Drottning Kristinas vag 37a
S-100 44 Stockholm
Sweden
TEL: 46 8 7877000 TLX: 10389 KTHB S
SPECIFIC OBJECTIVES
To study the interaction between infiltration/exfiltration and ventilating systems (parametric studies).
PROJECT DETAILS
The first part of this project (MOVECOMP: A static-multicell-airflow- model) is finished. This is a general model calculating air infiltration in buildings. The ventilating system is not taken into consideration more than that constant supply and exhaust air flow rates can be simulated to each cell. The present work is an extension of MOVECOMP. A ventilating system will be able to be included.
BUILDING TYPE
Arbitrary buildings, leakage and duct/fan components
PARAMETERS
Windforces (on or off site), thermal forces (with or without gradients), fan forces (arbitrary fan characteristics), leakage opening characteristics (power functions), duct characteristics.
#STARTDATE 00:00:0000 #ENDDATE 01:01:1987
#TIME 0
KEYWORDS Computer model, air infiltration, multi-zone, ventilation system, air flow
BIBLIOG
Herrlin, M.
AIRCOMP: An infiltration and ventilation system simulation model
Royal Institute of Technology, Stockholm, Sweden.
(to be published during 1987)

SWITZERLAND

REF SWZ1 Airtightness of building envelopes made of wood and wood panels
CONTACT
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EMPA
Section 115
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CH-8600 Duebendorf
Switzerland
TEL: 01 8235511 (direct: 8234469) TLX: 825345
SPECIFIC OBJECTIVES
Solutions for improved detail constructions in new houses and improved retrofitting, air change control.
PROJECT DETAILS
Description and analysis of present leakage, definition of future standards, pressurization tests for comparison with foreign examples and between Swiss houses, analysis of the influence of several components to air leakage, checklist for controlling the construction work, transfer of information for architects and others by conferences, speeches and technical papers.
BUILDING TYPE
PARAMETERS
Closed conditions (without kitchen ventilation and others), infra-red photography.
#STARTDATE 01:10:1983 #ENDDATE 30:09:1986
#TIME 7000
KEYWORDS Airtightness, houses, residential, pressurization, standards, thermography
BIBLIOG

REF SWZ2 Radiation dose and effects from radon and its progeny in indoor air
CONTACT
R. Crameri and W. Burkhart
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Swiss Federal Institute for Reactor Research
Biologie und Umwelt
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CH 5303 Wurenlingen
Switzerland
TEL: 056 992338/992353 TLX: 53714 EIR CH
SPECIFIC OBJECTIVES
Indoor radon concentrations and parameters influencing it. Resulting annual dose to general public.
PROJECT DETAILS
Measurements in homes of different types. Uranium and radon content in the subsoils, porosity. Radon in tap water. Variations due to climatic parameters, fluctuations. Air exchange rate. Radioactivity of building materials.
BUILDING TYPE
PARAMETERS
Climatic parameters and air exchange rate.
#STARTDATE 01:09:1982 #ENDDATE 0:0:00 On-going
#TIME 0

KEYWORDS Air quality, radon, radon production, air infiltration, radioactivity
BIBLIOG
Burkhart, W., Chakraborty, S.
Possible health effects of energy conservation: impairment of indoor air quality due to reduction of ventilation rate.
Envir. Int. 10. 455-461, 1984.
Buchli, R., Burkhart, W.
Main sources of indoor radon in the Swiss Central Alps
Proc. Sem. Nat. Rad. and Reg. Implic., Maastricht, NL, Elsevier Science Publications (in press)

REF SWZ3 Inhabitants' behaviour with regard to ventilation
CONTACT
F. Hainard, P. Rossel, C. Trachsel
ADDRESS
IREC – Ecole Polytechnique Federale de Lausanne
14 Avenue de l'Eglise Anglaise
1006 Lausanne
Switzerland
TEL: (021) 47 34 24 TLX:
SPECIFIC OBJECTIVES
To explain why and how inhabitants ventilate their flats
PROJECT DETAILS
This research uses qualitative and quantitative methods of research. First a sociological investigation, with focused interviews and video, to describe attitudes and compartments of ventilation. Second a substantial set of measurements registered by computer of different operations in the flats (temperatures, open/close windows), giving a possibility of comparison with the former approach.
BUILDING TYPE
Block of 24 flats, 1957
PARAMETERS
#STARTDATE 00:11:1985 #ENDDATE 00:06:1986
#TIME 700
KEYWORDS Residential, apartments, occupant behaviour, questionnaire, window opening
BIBLIOG
Favre, P., Trachsel, C.
Publications sur la Chaumiere, service de l'Energie, Lausanne, 1980-83.
Hainard, F.
Modes de vie, comportements quotidiens et consommation energetique
In Chantiers, No 4, pp327-331, 1985
Energy audit, OFEN-IENER, EPFL-Lausanne, pp 121-124

REF SWZ4 Measured methods for air change and air flows in buildings
CONTACT
C. Roulet
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Ecole Polytechnique Federale de Lausanne (EPFL)
Batiment LESO
CH 1015 Lausanne
Switzerland
TEL:(021) 47.11.11/47.45.45 TLX: 24 478 EPFVD
SPECIFIC OBJECTIVES
Development of 2 methods useable in multi-room inhabited buildings.
PROJECT DETAILS
Method CCGT: Constant concentration tracer gas. A sophisticated method for research purposes. Method EDA: Effusion dilution absorption of tracer gas. A simple and cheap method for routine measurements.
BUILDING TYPE
PARAMETERS
#STARTDATE 00:06:1986 #ENDDATE 00:12:1988
#TIME 10,000
KEYWORDS Air infiltration, multi-zone, tracer gas, constant concentration, EDA tracer, occupied
BIBLIOG
Scartezzini, J-L., Roecker, C., Quevit, D.
Continuous measurement of air renewal in an occupied solar office building
CLIMA 2000, Copenhagen, 25-30 August 1985

REF SWZ5 Minimal ventilation rates
CONTACT
H.U. Wanner, J.S. Schlatter
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Swiss Federal School of Technology
Institute of Hygiene and Work Physiology
CH-8092 Zurich
Switzerland
TEL: 01 256 39 73 TLX:
SPECIFIC OBJECTIVES
Indoor air pollution due to tobacco smoke (part of the IEA-Project Annex IX 'Minimum Ventilation Rates')
PROJECT DETAILS
Methods for measuring pollution due to tobacco smoke. Health effects in humans due to passive smoking. Air cleaning devices. Ventilation strategies to avoid health risk and annoyance. Energy aspects.
BUILDING TYPE
PARAMETERS
Tobacco smoke, annoyance, health risks, ventilation rates
#STARTDATE 00:06:1984 #ENDDATE 00:12:1986
#TIME 1200
KEYWORDS Air quality, minimum ventilation rate, smoking, ventilation stategies, occupant health
BIBLIOG
Schlatter J. and Wanner H.U.
Indoor air pollution due to tobacco smoke.
Sozial- und Praventivmedizin, Vol.30, pp270-271, 1985
Schlatter H.U.
Tobacco smoke
Annex IX 'Minimum Ventilation Rates', IEA, August 1983
Schlatter J. and Wanner H.U.
Tobacco smoke
Annex IX 'Minimum Ventilation Rates', IEA, Final Report, 1986.

REF SWZ6 Measurement of carbon dioxide of indoor air to control the fresh air supply.
CONTACT
H.U. Wanner, I. Fecker
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Swiss Federal School of Technology
Institute of Hygiene and Work Physiology
CH 8092 Zurich
Switzerland
TEL: 01 256 39 73 TLX:
SPECIFIC OBJECTIVES
Possibility to save energy (ventilation heat losses) by regulation of the fresh air supply.
PROJECT DETAILS
Relation between carbon dioxide, rise of temperature and odour emissions. Regulation of fresh air supply by measuring continuously the concentration of carbon dioxide. Measurements in a climatic chamber and a lecture theatre.
BUILDING TYPE
PARAMETERS
Carbon dioxide, odour emissions, fresh air supply, minimum ventilation rates.
STARTDATE 00:01:1984 #ENDDATE 00:12:1986
#TIME 1800
KEYWORDS Air quality, ventilation control, carbon dioxide, lecture theatre, climatic chamber, odour
BIBLIOG
Fecker, I. and Wanner H.U.
Measurements of carbon dioxide of the indoor air to control the fresh air supply.
Sozial – und Praventivmedizin, Vol.30, pp268-269, 1985

#**REF SWZ7** Validation of simulation codes of air flows in buildings
CONTACT
J.L. Scartezzini
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Ecole Polytechnic Federale de Lausanne (EPFL)
Batiment LESO
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Switzerland
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SPECIFIC OBJECTIVES
Comparison of computed and measured air change flows in one fully instrumented building.
PROJECT DETAILS
Measurements on the LESO passive solar building. Electrically heated, natural ventilation. Measurements of temperatures, meteorological data air conductances (pressurization) air flows (tracer gas) envelope differential pressures, occupied buildings.
BUILDING TYPE
Office
PARAMETERS
Weather, performance of building components, real behaviour of occupants.
#STARTDATE 00:06:1986 #ENDDATE 00:12:1988
#TIME 2800
KEYWORDS Office, occupied, passive solar, computer model, model validation, pressurization, tracer gas

#**REF SWZ8** VAV (valuable air volume) air conditioning system for two laboratory rooms.
CONTACT
G. Gottschalk
ADDRESS
ETH – Zurich
Lab. fuer Energiesysteme
CH – 8092 Zurich
Switzerland.
TEL: (01) 256 3649 TLX:
SPECIFIC OBJECTIVES
Air flow pattern investigation in presence of VAV AC system.
PROJECT DETAILS
Prototype VAV outlets, DDC (Direct Digital Control), CO2 concentration sensor.
BUILDING TYPE
Metal sandwich panel boxes: inside building
PARAMETERS
CO2 concentration vs flow pattern (induced by mechanical ventilation)
#STARTDATE 00:06:1985 #ENDDATE 00:06:1987
#TIME 1600
KEYWORDS Laboratory, air flow, valuable air volume
BIBLIOG
None to date

#**REF SWZ9** Airtightness of the building envelope of wood and wood composites.
CONTACT
J. Sell and P. Hartmann (Heads), D. Michel, F. Kropf
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EMPA Section 176
Ueberlandstrasse
CH-8600 Duebendorf
Switzerland
TEL: 01/823 55 11 TLX: 825 345 EMPA CH
SPECIFIC OBJECTIVES
Promoting wood construction in residential buildings by improving design and constructional details to achieve acceptable airtightness.
PROJECT DETAILS
Measuring the airtightness of approx. 30 single and multi-family houses (different, partly mixed constructions). Modification or repair of untight details (mainly roof-wall connections) with simple measures followed by a final measurement of airtightness. Measurement methods: depressurization measurement and IR-thermography of air leaks under 50 Pa vacuum, generated by an axial ventilator.
BUILDING TYPE
Residential houses
PARAMETERS
#STARTDATE 00:10:1983 #ENDDATE 00:09:1986
#TIME 8000
KEYWORDS Residential, houses, airtightness, pressurization, thermography,
BIBLIOG
A final report on results and practical recommendations for improving the construction of building envelopes will be completed in September 1986.

#**REF SWZ10** Leakage and air change measurement methods
CONTACT
P. Hartmann and H. Muhlebach
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EMPA
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Uberlandstrasse
CH 8600 Duebendorf
Switzerland
(In conjunction with Dr. C. Roulet from ETHL, LESO, CH 1015 Lausanne)
TEL: 01 823 42 76 TLX: 825 345 EMPA CH
SPECIFIC OBJECTIVES
To check the new Swiss measurement standards for pressurization and air change measurements for use in new and existing buildings
PROJECT DETAILS
To transfer information on measurement technique, which is available in 2 research institutes, into material for teaching purposes, (this project follows previous research reported in AIC-TN-12-83 under Ref:CH6)
BUILDING TYPE
All kinds of residential and service buildings
PARAMETERS
#STARTDATE 00:00:1986 #ENDDATE 00:00:1987
#TIME 600
KEYWORDS Pressurization, air infiltration, standards
BIBLIOG
Swiss (draft) recommendation for pressurization tests
Swiss (draft) recommendation for air change – measurements
(Available from the researchers)

#**REF SWZ11** Airflow in buildings
(Program of the Swiss Federal Institute of Technology)
CONTACT
P. Hartmann
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Section 176
Ueberlandstrasse
CH-8600 Duebendorf
Switzerland
(or Dr. Zollinger, c/o Sulzer Brothers, Postbox, CH-8401 Winterthur, Switzerland)
TEL: 01 823 42 76 TLX: 825345 EMPA CH
SPECIFIC OBJECTIVES
Description of a forthcoming research program, including a series of projects in 2 sub-areas as follows: to evaluate calculations and measurement methods to describe airflow and contaminant flow within a single room and in multiple-room configurations, to evaluate advanced heating/ventilation systems for Swiss application.
PROJECT DETAILS
BUILDING TYPE
Residential, industrial and service buildings

PARAMETERS
Climate, construction, user, pollution emission, systems
#STARTDATE 00:00:1986 #ENDDATE 00:00:1991
#TIME 96,000
KEYWORDS Computer model, air flow, contaminant flow, multi-zone, heating systems, ventilation systems
BIBLIOG
Global program plan existing.

#**REF SWZ12** School building demonstration project
CONTACT
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TEL: 01 823 42 76 TLX: 825345 EMPA CH
SPECIFIC OBJECTIVES
To measure the energy flows in a passive school building with heat recovery in a mechanical ventilation system. To measure comfort and air quality.
PROJECT DETAILS
This new school building has a thoroughly designed energy concept (high insulation values, many details to provide high solar gains) and therefore will be open for interested guests as a 'demonstration project'. Its speciality is a wintergarden, openable in summer time. A detailed measurement project studies energy flows, comfort and air quality in order to improve this existing building and to develop tools for coming buildings with similar concepts.
BUILDING TYPE
Building shell/mechanical ventilation system
PARAMETERS
Climatic conditions, occupancy, air flow of the mechanical system (which is not running all the time).
#STARTDATE 31:12:1985 #ENDDATE 0:0:00
#TIME 2500
KEYWORDS School, passive solar, heat recovery, mechanical ventilation, air quality, thermal comfort
BIBLIOG
Report about detailed control of the existing plant (extended commissioning) in summer 1986.

UNITED KINGDOM

#**REF UK1** Use of ventilating tiles on pitched roofs
CONTACT
W.J. Dammers
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Ubbink (UK) Ltd
County Road
Brackley
Northants
NN13 5TB
United Kingdom
TEL: 0200 700211 TLX:
SPECIFIC OBJECTIVES
To establish a model to determine airflow through roof ventilators (in pitched roofs)
PROJECT DETAILS
BUILDING TYPE
Primarily housing
PARAMETERS
#STARTDATE 00:12:1985 #ENDDATE 00:04:1986
#TIME 0
KEYWORDS Residential, computer model, airflow, roof, ventilation

#**REF UK2** Patterns of air movement in spaces
CONTACT
D.J. Croome
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School of Architecture and Building Engineering
University of Bath
Claverton Down
Bath
BA2 7AY
United Kingdom
TEL: 0225 61244 TLX:
SPECIFIC OBJECTIVES
To define mean velocity, turbulence, standard deviation and periodicity for airflow in rooms due to fans, windows and natural convection sources.
PROJECT DETAILS
This work will be extended to cover auditoria. A revised air movement design procedure will be evolved.
BUILDING TYPE
Theatres/cellular spaces
PARAMETERS
#STARTDATE 00:00:1985 #ENDDATE 00:00:1989
#TIME 9600
KEYWORDS Theatre, air flow, natural convection, window, air movement

#**REF UK3** Design and performance of radiant heating systems in factories
CONTACT
D.J. Croome
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School of Architecture and Building Engineering
University of Bath
Claverton Down
Bath
BA2 7AY
United Kingdom
TEL: 0225 61244 TLX:
SPECIFIC OBJECTIVES
In conjunction with Grayhill-Blackheat a survey of 20 factories will be made to compare energy and comfort performance. Air movement will be one aspect of this.
PROJECT DETAILS
BUILDING TYPE
Factories
PARAMETERS
#STARTDATE 00:00:1986 #ENDDATE 00:00:1990
#TIME 19,200
KEYWORDS Factory, energy consumption, air movement, thermal comfort

#**REF UK4** Characterisation of zone-to-zone air flows in sunspaces and atria.
CONTACT
J. Littler
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School of Building and Surveying
Polytechnic of Central London
35 Marylebone Road
London
NW1 5LS
United Kingdom
TEL: 01 486 5811 exts. 345/433/372 TLX:
SPECIFIC OBJECTIVES
To use a 4+ tracer gas system developed at PCL to measure zone-to-zone air transfer in sunspaces and atria.
PROJECT DETAILS
The system uses 4+ inert perfluorocarbons as tracers. They are captured in sampling tubes at specified time intervals and analysed in the laboratory.
BUILDING TYPE
Domestic and atria
PARAMETERS
Stack effect, wind speed and building form
#STARTDATE 00:03:1986 #ENDDATE 00:03:1989
#TIME 4800
KEYWORDS Residential, multi-zone, multi-tracer, perfluorocarbons, air infiltration, air flow
BIBLIOG
Prior, J., Littler, J.

An automatic multi-tracer gas method for following interzonal air movement
ASHRAE transactions, Vol.91, Part 2, 1985
Prior, J., Littler, J.
Zone-to-zone air movement
Ventilation 1985, Toronto, Canada, 1985
Prior, J.
PhD Thesis, PCL, 1986

#**REF UK5** Superinsulated houses
CONTACT
J.G.F. Littler
ADDRESS
Research in Building Group
School of Building and Surveying
Polytechnic of Central London
35 Marylebone Road
London
NW1 5LS
United Kingdom
TEL: 01 486 5811 exts. 345/433/372 TLX:
SPECIFIC OBJECTIVES
To evaluate the effectiveness of air-to-air heat recovery in domestic situations
PROJECT DETAILS
Four super-insulated and eight control houses have been built and occupied. All are monitored (total 200 channels). Forced air ventilation systems with heat recovery are a feature of the super- insulated houses. The efficiency is under examination.
BUILDING TYPE
Domestic
PARAMETERS
Rate of air exchange, stack effect and wind speed.
#STARTDATE 00:00:1985 #ENDDATE 00:00:1988
#TIME 6400
KEYWORDS Residential, heat recovery, air infiltration, occupied, mechanical ventilation
BIBLIOG
Littler, J.G.F., Ruyssevelt, P.A.
Super-insulated houses
10th Passive and ASES Conference, Boulder, Colorado, USA, 1986.

#**REF UK6** Cheap method for assessing air change rates in houses.
CONTACT
J.G.F. Littler
ADDRESS
Research in Building Group
School of Building and Surveying
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35 Marylebone Road
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United Kingdom
TEL: 01 486 5811 exts. 345/433/372 TLX:
SPECIFIC OBJECTIVES
To streamline the multi-tracer gas technique developed at PCL and characterise air flows in passive solar houses.
PROJECT DETAILS
The existing method will be streamlined and measurements carried out in several European solar buildings, to characterise air flows particularly via doorways and stairwells.
BUILDING TYPE
Domestic
PARAMETERS
Rate of air exchange, stack effect and wind speed.
#STARTDATE 00:00:1986 #ENDDATE 00:00:1988
#TIME 6400
KEYWORDS Residential, passive solar, air flows, multi-zone, multi- tracer, perfluorocarbons

#**REF UK7** Low energy house design and development.
CONTACT
R. Morgan and J. Rosell
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University of Ulster
Coleraine
BT52 1SA
Northern Ireland
TEL: 0265 4141 TLX: 747597 NUUCOL G
SPECIFIC OBJECTIVES
To measure heat flows and heating requirements, to study moisture and condensation, to advise on optimisation of design.
PROJECT DETAILS
A low energy house is being built by a company which makes expanded polystyrene products. A new technique of external insulation and a new structural design for roof support are to be assessed.
BUILDING TYPE
Residential
PARAMETERS
Forced mechanical ventilation and natural infiltration will be measured.
#STARTDATE 31:03:1986 #ENDDATE 31:05:1988
#TIME 0
KEYWORDS Residential, air infiltration, mechanical ventilation, moisture, condensation, building design

#**REF UK8** Weathertightness characteristics of windows
CONTACT
T.F. Provan and J.D. Younger
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Department of Civil Engineering
Paisley College of Technology
High Street
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PA1 2BE
United Kingdom
TEL: 041-887-1241 TLX: 778951 PCT LIB G
SPECIFIC OBJECTIVES
To assess the air permeability, watertightness and wind resistance characteristics of different types of windows under laboratory conditions.
PROJECT DETAILS
Equipment: pressure chamber test rigs (3mx3m max.). Measurements: air infiltration, water penetration, resistance to deformation, pressure difference, temperature using standard instrumentation. Calculations: statistical analysis, correlation of results, comparison with existing literature.
BUILDING TYPE
All types (unspecified)
PARAMETERS
Air infiltration rate, pressure difference, dimensionless parameters.
#STARTDATE 01:05:1983 #ENDDATE 0:0:00 On-going
#TIME 1560
KEYWORDS Windows, air infiltration, water penetration, airtightness
BIBLIOG
Provan, T.F., Younger, J.D.
Weathertightness of windows
Building Technical File No.10, July 1985
Provan, T.F., Younger, J.D.
Air infiltration characteristics of windows
January 1986 (to be published)

#**REF UK9** Energy performance assessments
CONTACT
J. Palmer
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Rutland House
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Birmingham
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United Kingdom
TEL: 021 236 6477 TLX:
SPECIFIC OBJECTIVES
To assess the effect of passive solar features on energy efficiency, capital cost and amenity in a range of passive solar buildings.
PROJECT DETAILS
Application of low profile standardised performance evaluation methodologies to a range of passive solar buildings. In effect a series of case studies. Includes measurement of leakage characteristics by pressurization and ventilation by tracer gas techniques – where appropriate.
BUILDING TYPE
Domestic (occupied) and commercial – passive solar.
PARAMETERS
Building heat loss coefficients, occupant behaviour, overall energy use.
#STARTDATE 00:04:1983 #ENDDATE 00:12:1988
#TIME 6000
KEYWORDS Residential, commercial, passive solar, occupant behaviour, pressurization, tracer gas, energy conservation

#REF UK10 Housing air leakage rates and routes.
CONTACT
M. Trollope
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Rutland House
148 Edmund Street
Birmingham
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TEL: 021 236 6477 TLX:
SPECIFIC OBJECTIVES
To characterise leakage rates and routes in dwellings built between 1945 and 1960.
PROJECT DETAILS
Pressurization (positive and negative) tests using calibrated rig and standardised procedures. These will be repeated for various states of sealing of air leakage routes to quantify leakage rates by specific routes. Parallel pressurization of adjacent dwellings to characterise leakage across party walls. Infra-red thermography for visualisation of leakage routes.
BUILDING TYPE
Whole dwellings, 1945-1960 (especially system built), normally unoccupied.
PARAMETERS
Performance of building components, fabric construction.
#STARTDATE 00:10:1985 #ENDDATE 00:10:1986
#TIME 1000
KEYWORDS Residential, pressurization, air leakage, leakage paths, thermography, party walls

#REF UK11 The factors affecting the control of the environment in houses (with special reference to insulation and condensation).
CONTACT
W.McL. Douglas
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Paisley College of Technology
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Renfrewshire
PA1 2BE
United Kingdom
TEL: 041 887 1241 TLX: 778951 PCT LIB
SPECIFIC OBJECTIVES
To investigate the impact of recently developed energy conservation measures and produce a clear set of ground rules for their cost effective and safe application.
PROJECT DETAILS
Dwelling and laboratory tests in various types of construction and environment. Development of measurement devices for condensation detection. Relationship of previously obtained data to laboratory evaluations.
BUILDING TYPE
Domestic property
PARAMETERS
Weather, performance of structure, behaviour of occupants, method of house usage and environment.
#STARTDATE 01:10:1982 #ENDDATE 0:0:00 Not fully known, possibly October 1986
#TIME 6000
KEYWORDS Residential, energy conservation, condensation, occupant behaviour

#REF UK12 In-situ detection and evaluation of thermal anomalies in timber-framed housing using thermography.
CONTACT
G. Valentine
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Building Science Section
School of Architecture
University of Newcastle-upon-Tyne
NE1 7RU
United Kingdom
TEL: 0632 328511 ext. 2010 TLX:
SPECIFIC OBJECTIVES
Develop thermographic technique application to UK climate and construction types.
PROJECT DETAILS
Build full-scale timber-frame junctions in an environmental chamber and subject them to temperature and pressure regimes. Assess correlation between typical structure and surface temperature pattern as measured by infra-red camera. Produce catalogue of reference thermograms for field use.
BUILDING TYPE
UK type timber-framed houses
PARAMETERS
Integrity of air/vapour barrier. Imposed pressure differential. Surface temperature pattern.
#STARTDATE 00:12:1984 #ENDDATE 00:07:1987
#TIME 5000
KEYWORDS Residential, thermography, building components, pressurization, environmental chamber
BIBLIOG
None to date (February 1986)

#REF UK13 Fan pressurization testing of large buildings.
CONTACT
J.R. Waters
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Dept of Civil Engineering and Building
Coventry (Lanchester) Polytechnic
Priory Street
Coventry
CV1 5FB
United Kingdom
TEL: 0203 24166 TLX: 31469
SPECIFIC OBJECTIVES
To determine the relationship between air leakage measurements and air infiltration measurements in large industrial buildings.
PROJECT DETAILS
Air leakage testing by means of fan pressurization is an accepted procedure for housing and similar procedures could prove even more useful for large industrial buildings. It forms a natural extension of work currently being done in the department to study air leakage characteristics of such buildings and to assess the correlations that exist with air infiltration characteristics.
BUILDING TYPE
Industrial single cell buildings

PARAMETERS
Air leakage characteristics of building fabric.
#STARTDATE 07:04:1986 #ENDDATE 06:04:1988
#TIME 3000
KEYWORDS Industrial, pressurization, pressurization correlation
BIBLIOG
It is anticipated that papers will be published in 1987

#**REF UK14** Ventilation in industrial buildings
CONTACT
J.R. Waters
ADDRESS
Dept of Civil Engineering and Building
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Priory Street,
Coventry
CV1 5FB
United Kingdom
TEL: 0203 24166 TLX: 31469
SPECIFIC OBJECTIVES
To measure the infiltration rate and internal air movement of large single-cell buildings and to develop a suitable theoretical model.
PROJECT DETAILS
A tracer dilution measuring system has been specially designed and built. The system has six independent channels, with a possible future extension to additional channels, for multipoint sampling. The system has been used in buildings up to 40,000 m3 internal volume. Further measurements are in progress and the theoretical model is being developed.
BUILDING TYPE
Single-cell large industrial
PARAMETERS
Volume of building, position of major openings and inlet/outlet points, wind velocity.
#STARTDATE 01:09:1983 #ENDDATE 31:08:1986
#TIME 10,000
KEYWORDS Industrial, air infiltration, air movement, tracer gas, theoretical model
BIBLIOG
Papers in connection with this project are in the course of preparation for 1986 and 1987.

#**REF UK15** Radon in buildings – assessment of exposure, models and remedial and preventive measures.
CONTACT
A.D. Wrixon, K.D. Cliff, B.M.R. Green.
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National Radiological Protection Board
Chilton
Didcot
Oxon
OX11 0RQ
United Kingdom
TEL: 0235 831600 TLX: 837124 RADPRO G
SPECIFIC OBJECTIVES
To develop models and obtain data relevant to the estimation of dose from radon decay products in dwellings and to the control of such doses.
PROJECT DETAILS
The data from the national survey of indoor exposure to natural radiation and the regional studies in areas of high exposure will be analysed, and minor investigations will be mounted in a few houses to improve the interpretation of the results. Studies of remedial and preventive measures will be extended to practical experiments in a test structure to be built over a strong source of radon. A wide range of methods – structural, mechanical, pneumatic – will be tried to prevent radon ingress by diffusion and convection and to eliminate radon decay products. If standards for indoor exposure are introduced, it will be essential to develop procedures for identifying houses that are likely to have high concentrations of radon decay products and building sites that are likely to cause high concentrations in new houses unless appropriate preventive measures are taken.
BUILDING TYPE
PARAMETERS
Radon gas and decay product concentrations, building materials, construction methods, meteorological conditions, local geology, ventilation and heating regimes of occupants.
#STARTDATE 01:01:1980 #ENDDATE 31:12:1989
#TIME 0
KEYWORDS Residential, air quality, radon, remedial measures, theoretical model
BIBLIOG
Cliff, K.D., Miles, J.C.H., Brown, K.
The incidence and origin of radon & its decay products in buildings.
NRPB-R159, 1984
Wrixon, A.D., et al
Indoor radiation surveys in the UK
Radiat. Prot. Dosim. Vol.7, 321, (1-4), 1984
Brown, K., Dimbylow, P.J., Wilkinson, P.
Modelling indoor exposure to natural radiation
Radiat. Prot. Dosim. Vol.7, 91, (1-4), 1984
Green, B.M.R., et al
Surveys of natural radiation exposure in UK dwellings with passive and active techniques
Sci. Tot. Environ., Vol.45, 459, 1985
Cliff, K.C., et al
The levels of radioactive materials in some common UK building materials.
Sci. Tot. Environ., Vol.45, 181, 1985
Wrixon, A.D., O'Riordan, M.C.
The control of indoor radiation exposure
Sci. Tot. Environ., Vol.45, 657, 1985
Wilkinson, P., Dimbylow, P.J.
Radon diffusion modelling
Sci. Tot. Environ., Vol.45, 227, 1985.

#**REF UK16** Improvement in the working environment.
CONTACT
G.R. Winch
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Oxford Road
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M13 9PL
United Kingdom
TEL: 061 273 3333 TLX:
SPECIFIC OBJECTIVES
Instrumented studies of work spaces to secure improvement in air quality and thermal comfort.
PROJECT DETAILS
Quantitative studies of various work spaces to analyse problems and assess causative factors and remedial measures, e.g. airborne particulates and gaseous contaminants, air temperature and motion, air humidity, surface temperatures, ventilation rates, noise levels, lighting levels, etc.
BUILDING TYPE
All types
PARAMETERS
Ventilation rate, thermal comfort, contaminant levels, energy factors.
#STARTDATE 01:01:1974 #ENDDATE 0:0:00 On-going
#TIME 0
KEYWORDS Industrial, commercial, air quality, thermal comfort, air movement, remedial measures
BIBLIOG
Winch, G.R., Tuxford, A.F.
Environmental surveys for comfort and health
Proc. CIBSE Tech. Conf., Birmingham, UK, 1985.

#**REF UK17** Air quality sensor
CONTACT
R. Warner
ADDRESS
Geamatic Control Systems Ltd.,
Unit 10
Lindfield Enterprise Park
Haywards Heath
Sussex
RH16 2LX
United Kingdom
TEL: 04447 4369 TLX: 95395 CBJ G
SPECIFIC OBJECTIVES
To obtain effective low cost sensor to give signal of reducing air quality to reset damper positioning.
PROJECT DETAILS
Continuous monitoring of both field-installed and our own production sensors, in order that a background of air quality levels may be assessed for differing installations and building types.
BUILDING TYPE
Various
PARAMETERS
Occupancy and use of building.
#STARTDATE 00:06:1985 #ENDDATE 00:00:0000
#TIME 0
KEYWORDS Air quality, ventilation control

#**REF UK18** Whole house ventilation
CONTACT
M.J. Allen
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Redland Roof Tiles Ltd.
Redland House
Reigate
RH2 0SJ
United Kingdom
TEL: 07372 42488 TLX: 946836
SPECIFIC OBJECTIVES
To examine temperature and wind effects on the efficiency of roof ventilation terminals when linked to a ducted ventilation system.
PROJECT DETAILS
A variety of roof ventilation terminals will be tested in the Redland wind tunnel under wind conditions and the effect on their performance as ducted ventilation terminals recorded.
BUILDING TYPE
PARAMETERS
#STARTDATE 00:04:1986 #ENDDATE 00:09:1986
#TIME 0
KEYWORDS Roof, ventilators, wind tunnel

#**REF UK19** The controllability of air movements in predominantly naturally ventilated houses.
CONTACT
A.T. Howarth
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Department of Building
Sheffield City Polytechnic
Pond Street
Sheffield
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TEL: 0742 20911 TLX:
SPECIFIC OBJECTIVES
An appraisal of the main mechanisms of internal air flows through dwellings and the extent to which these flows may be controlled.
PROJECT DETAILS
The project can be divided into 2 stages: 1. Laboratory work in which the air flow through a studding partition between two environmental chambers is measured using a multi tracer gas technique. 2. Field work in which measurements between internal zones of dwellings are carried out. The effects of extractor fans and inbuilt ventilators will be studied.
BUILDING TYPE
Dwellings, partitions, doors.
PARAMETERS
Wind speed and direction. Internal/external pressure variation. Temperature difference.
#STARTDATE 01:09:1985 #ENDDATE 31:08:1988
#TIME 4800
KEYWORDS Residential, walls, doors, multi-zone, multi-tracer, air flow, air infiltration, tracer decay, freons

#**REF UK20** Evaporation in swimming pools
CONTACT
D.J. Dickson
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Electricity Council Research Centre
Capenhurst
Chester
CH1 6ES
United Kingdom
TEL: 051 339 4181 TLX: 627124
SPECIFIC OBJECTIVES
To measure swimming pool evaporation rates
PROJECT DETAILS
Six swimming pools will be selected covering three different air distribution geometries. Evaporation rate will be determined from measurements of ventilation rate, moisture distribution and air flows. Results will be compared with present theories. Guidelines for future predictions will be formulated.
BUILDING TYPE
Mechanically ventilated public swimming pool halls
PARAMETERS
Ventilation rate, air flow patterns, local air speeds.
#STARTDATE 00:04:1986 #ENDDATE 00:03:1986
#TIME 1000
KEYWORDS Swimming pool, mechanical ventilation, evaporation, moisture, air flow, guidelines
BIBLIOG
Dickson, D.J.
Ventilation efficiency measurements in occupied mechanically ventilated buildings.
Proceedings, 6th AIC Conference, Netherlands, 1985.

#**REF UK21** Theory of air infiltration rate measurements
CONTACT
J. Dewsbury
ADDRESS
Department of Building Engineering
UMIST
P.O. Box 88
Manchester
M60 1QD
United Kingdom
TEL: 061 236 3311 TLX: 666094
SPECIFIC OBJECTIVES
To examine from a theoretical basis the accuracy possible in measurements of ventilation rate using tracer gas.
PROJECT DETAILS
Air flow and mixing processes in rooms and buildings will be modelled mathematically and related to observable tracer gas behaviour.
BUILDING TYPE
All
PARAMETERS
#STARTDATE 01:01:1984 #ENDDATE 00:00:1990
#TIME 3600
KEYWORDS Air infiltration, tracer gas, air flow, mixing, theoretical model, measurement accuracy
BIBLIOG
Dewsbury J., Potter I.N., and Jones T.J.
The measurement of air infiltration rates in large enclosures

and buildings.
Proceedings, 4th AIC Conference, 1983
Dewsbury J.
Use of a single tracer gas for measurement of ventilation rates in a large enclosure.
Proceedings, 6th AIC Conference, 1985

#**REF UK22** Determination of internal pressure coefficients in multi-cell models using a boundary layer wind tunnel.
CONTACT
I.C. Ward and M. Gadi
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Department of Building Science
Sheffield University
Western Bank
Sheffield
S10 2TN
United Kingdom
TEL: 07427 78555 Ext 4712 TLX: 54348 ULSHEF G
SPECIFIC OBJECTIVES
To establish if variations in internal air pressure can be measured reliably in multi-cell models.
PROJECT DETAILS
The boundary layer wind tunnel at the Department of Building Science is being used. 1/25 scale models of typical housing found in North Africa are being investigated.
BUILDING TYPE
Domestic
PARAMETERS
Gradient wind speed, wind direction, opening area, partitioning
#STARTDATE 01:01:1986 #ENDDATE 01:01:1987
#TIME 1300
KEYWORDS Residential, wind tunnel model, internal pressure, multi-zone, simulated boundary layer
BIBLIOG
Building Science Internal Report on Project – First Part, June 1986

#**REF UK23** Ventilation of offshore platforms
CONTACT
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British Maritime Technology
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United Kingdom
TEL: 01 890 8989 TLX: 263118 FAX: 01 890 3992
SPECIFIC OBJECTIVES
To understand the important parameters determining ventilation and air flows to devise measurement techniques for model scale.
PROJECT DETAILS
The project consists of a parametic study of the ventilation characteristics of offshore platform modules, at model scale, to derive usable testing schedules for the comfort and safety of these buildings.
BUILDING TYPE
Industrial building
PARAMETERS
Wind speed and direction, internal temperature, louvre configuration, internal layout
#STARTDATE 00:01:1986 #ENDDATE 00:03:1988
#TIME 1000
KEYWORDS Industrial, offshore platforms, air infiltration, air flow, scale model

#**REF UK24** A study of domestic background leakage paths through the development of a portable pressurization test rig.
CONTACT
I.C. Ward, S. Sharples, P. Baker
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Department of Building Science
Sheffield University
Western Bank
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S10 2TN
United Kingdom
TEL: (0742) 78555 Ext. 4712 TLX: 54348 ULSHEF G
SPECIFIC OBJECTIVES
The aim of this project is to develop and validate a field testing facility for quantifying background leakage paths in buildings.
PROJECT DETAILS
The work will be carried out by undertaking a laboratory study of flow characteristics of non-standard cracks (typified by very low height-to-length ratios). Once a range of portable testing boxes has been proved in the laboratory, they will be evaluated against cracks found between component joins in Local Authority housing to establish repeatability and spread.
BUILDING TYPE
PARAMETERS
#STARTDATE 01:10:1983 (SERC funded)
#ENDDATE 31:10:1986
#TIME 6600
KEYWORDS Building components, air leakage, cracks, pressurization, background leakage
BIBLIOG
Baker, P., Sharples, S., Ward, I.
Air flow through asymmetric building cracks.
Published in BSER&T, Spring, 1986.

#**REF UK25** Investigation into the effectiveness of current provisions for ventilation of cavities (wall, floor and roof) SSN
CONTACT
A. Gaze
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Timber Research and Development Association (TRADA)
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Hughenden Valley
High Wycombe
Bucks.
HP14 4ND
United Kingdom
TEL: (0240 24) 3091 TLX:
SPECIFIC OBJECTIVES
1. To investigate by measurement air flows and moisture levels in cavities. 2. To establish causal relationships, e.g. with wind, temperature, humidity. 3. To establish more precise bases for provision and location of openings.
PROJECT DETAILS
1. Literature survey. 2. Select appropriate test building. 3. Install monitoring equipment in floor, wall and roof cavities, (tracer gas, temperature, relative humidity etc.). 4. Monitor over a one-year period (possibly on frequent visit basis). 5. Reduce ventilation openings and monitor over a further one-year period.
BUILDING TYPE
Housing
PARAMETERS
Moisture content of timber, relative humidity, wind, temperature.
#STARTDATE 00:04:1986 #ENDDATE 00:03:1989
#TIME 2500
KEYWORDS Building components, cavities, literature survey, tracer gas, humidity, walls, floor, roof

#**REF UK26** Ventilation and the environment
CONTACT
J.P. Lilly

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British Gas Corporation
Watson House
Peterborough Road
London
SW6 3HN
United Kingdom
TEL: 01 736 1212 Ex 3043 TLX: 919082
SPECIFIC OBJECTIVES
1. To develop theoretical and experimental methods for determining ventilation. 2. To develop practical domestic heating and ventilating systems for temperate maritime climates.
PROJECT DETAILS
1(a) Refinement of British Gas multi-cell ventilation model with intercell flows validated with wind tunnel data and measurement in unoccupied dwellings. (b) Continued refinement of constant concentration, emission and decay ventilation measurement techniques in all building types (SF6, N2O). (c) Use of pressurization tests in all building types. 2. Development of combined heating and mechanical ventilation/heat recovery systems for traditional and low energy dwellings.
BUILDING TYPE
Objective 1: All building types. Objective 2: Domestic and low energy buildings.
PARAMETERS
Weather conditions, occupant behaviour, building construction, leakage and exposure, tracer gas measurements, mathematical models.
#STARTDATE 01:04:1985 #ENDDATE 31:03:1989
#TIME 25,000
KEYWORDS Residential, multi-zone, tracer gas, heating systems, ventilating systems, pressurization
BIBLIOG
Etheridge, D.W., Sandberg, M.
A simple parametric study of ventilation
Build. & Environ., Vol.19, No.3, pp163-173, 1984.
Etheridge, D.W.
Air leakage characteristics of houses – a new approach
BSER&T, Jan. 1984
Application of the constant concentration technique for ventilation measurement in large buildings
SERC Workshop, BSER&T, August 1985
Freeman, J., Lilly, J.P.
The measurement of ventilation in large buildings
SERC Workshop, SEGAS Report CLR/47/84
Lilly, J.P., Gale, R.
The reduction of infiltration in an industrial laboratory
Proc. 6th AIC Conference, Netherlands, 1985
Etheridge, D.W., Jones, P.T., O'Sullivan, P.E.
Ventilation of factories
Proc. 6th AIC Conference, Netherlands, 1985.

#**REF UK27** Smoke control using pressurization systems
CONTACT
P.J. Hobson
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Building Services Research and Information Association
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Bracknell
Berkshire
RG12 4AH
United Kingdom
TEL: 0344 426511 TLX: 848288 BSRIAC G
SPECIFIC OBJECTIVES
To produce an application guide on the selection and design of pressurization systems for escape routes in buildings.
PROJECT DETAILS
A comprehensive review of experience and research on the use of mechanical ventilation for controlling smoke movement in building fires has been carried out. The design of pressurization systems is being re-assessed using a multi-cell air infiltration model to determine air flows and pressure differences in escape routes. The cost implications of design options are also being studied. The project will result in updated design guidance and recommended changes to relevant U.K. standards.
BUILDING TYPE
Commercial and institutional.
PARAMETERS
Air leakage through building components. Pressures generated by wind and stack effect.
#STARTDATE 01:04:1985 #ENDDATE 31:01:1987
#TIME 2000
KEYWORDS Commercial, industrial, smoke control, mechanical ventilation, multi-zone, computer model, standards

#**REF UK28** Occupancy-related ventilation control
CONTACT
B.E. Smith, R. Prowse
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Brunel University
Uxbridge
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UB8 3PH
United Kingdom
TEL: 0895 74000 TLX: 261173 G
SPECIFIC OBJECTIVES
The assessment of economic and environmental benefits of occupancy- related ventilation control.
PROJECT DETAILS
A study has been made of the benefits of ventilation control based on CO2 monitoring for Brunel University Library. In principle this is more economic than, for example, heat recovery from the exhaust of the installed warm air heating system. A study has also been made of a proposed system for a leisure centre.
BUILDING TYPE
Library and leisure centre.
PARAMETERS
CO2 level, humidity, temperature (estimated), energy use.
#STARTDATE 00:00:1982 #ENDDATE 0:0:00 Ongoing
#TIME 2000
KEYWORDS Library, ventilation control, carbon dioxide, humidity, air quality, energy consumption
BIBLIOG
Smith, B.E., Prowse. R.W., Owen, C.J.
Development of occupancy related ventilation control for Brunel University library.
Proceedings 5th AIC Conference, 1984
Lee, W.L.
Design of occupancy related ventilation control system for a leisure centre in Hong Kong.
M.Sc. Dissertation, Dept.of Mech. Eng., Brunel University, 1986.

#**REF UK29** Air flow performance of naturally ventilated containers.
CONTACT
R.D. Heap
ADDRESS
Shipowners Refrigerated Cargo Research Association
140 Newmarket Road
Cambridge
CB5 8HE
United Kingdom
TEL: 0223 65101 TLX: 81604
SPECIFIC OBJECTIVES
To design and evaluate naturally ventilated freight containers for carriage of hygroscopic cargoes.
PROJECT DETAILS
Wind tunnel, theoretical model and full scale studies of various types of naturally ventilated containers.
BUILDING TYPE
Freight containers

PARAMETERS
Temperature, wind.
#STARTDATE 00:10:1986 #ENDDATE 00:10:1989
#TIME 4800
KEYWORDS Freight containers, wind tunnel, theoretical model, air infiltration, air flow
BIBLIOG
Baker, P.H., Heap, R.D., Sharples, S.
Airflow through perforated screens at small pressure differences.
BSER&T (to be published).

#**REF UK30** Thermal response of buildings
CONTACT
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Liverpool University
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L69 3BX
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TEL: 051 709 6022 Ext 2205 TLX: 627095 UNILPL G
SPECIFIC OBJECTIVES
The thermal response of buildings has been studied under a series of headings: 1. Internal exchange of heat by radiation and convection 2. Response to daily periodic excitation. 3. Response to transient excitation. 4. Response to moisture. 5. Response to solar gains and energy needs. 6. User reaction to the internal climate. Air infiltration has a bearing on all aspects of building behaviour.
PROJECT DETAILS
BUILDING TYPE
General and passive
PARAMETERS
Opening and closing of windows, perception of 'freshness', energy needs, building thermal response times, condensation rates.
#STARTDATE 00:00:0000 #ENDDATE 0:0:00 On-going
#TIME 0
KEYWORDS Passive solar, moisture, window opening, energy consumption, air infiltration
BIBLIOG
Davies, M.G.
The heat storage/loss ratio for a building and its response time.
Applied Energy, 18, pp179-238, 1984.

#**REF UK31** EEO demonstration of application of internal wall insulation to terrace houses on Merseyside
CONTACT
A.J.A. Sluce
ADDRESS
Building Design Partnership
Sunlight House
Quay Street
Manchester
M3 3JY
United Kingdom
TEL: 061 834 8441 TLX: 668604
SPECIFIC OBJECTIVES
Demonstration of energy saving due to three measures: 1. Draught- stripping. 2. Partial glazing. 3. Internal wall insulation.
PROJECT DETAILS
Sample of 43 houses – 23 improved, 20 controls. Energy consumption logged and related to internal temperature, external temperature and infiltration rate measured by pressure testing. A social survey was also conducted and window/door opening behaviour noted.
BUILDING TYPE
Terrace housing/external fabric
PARAMETERS
Energy consumption, comfort, social factors.
#STARTDATE 00:12:1984 #ENDDATE 00:07:1986
#TIME 3000
KEYWORDS Residential, terraced house, energy consumption, pressurization, occupant behaviour, questionnaire
BIBLIOG
EEO Project Profile 209
August 1985. Availability of final report to be decided.

#**REF UK32** Building energy and air flow simulation
CONTACT
J.A. Clarke
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ABACUS
Dept of Architecture & Building Science
University of Strathclyde
Glasgow
G4 ONG
United Kingdom
TEL: 041 552 4400 Ext 3013 TLX: 77472
SPECIFIC OBJECTIVES
To develop and test software for the combined simulation of heat and mass flows in buildings.
PROJECT DETAILS
An advanced numerical method has been developed which allows the simulation of combined building/plant systems when constrained to conform to some control system. A rigorous air flow model, based on a modified Newton Raphson technique, has been designed to operate in tandem so allowing an explicit treatment of buoyancy and pressure driven air movement.
BUILDING TYPE
All
PARAMETERS
The building's distributed leakage is represented by air volumes connected by restriction types such as cracks, doorways and areas. Pressure distribution is represented by pressure coefficient sets. Air mass balance is then determined as a function of air volume temperature and external wind speed and direction. All problem parameters can vary with time.
#STARTDATE 00:10:1984 #ENDDATE 00:10:1986
#TIME 1600
KEYWORDS Multi-zone, air flow, computer model
BIBLIOG
Clarke, J.A.
Energy simulation in building design
Adam Hilger Ltd., Bristol 1985.

#**REF UK33** Design and performance of mechanical ventilation systems
CONTACT
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RG12 4AH
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TEL: 0344 426511 TLX: 848288 BSRIAC G
SPECIFIC OBJECTIVES
Assess ventilation efficiency of different mechanical ventilation strategies and the measurement/control of fresh air quantities supplied to commercial buildings.
PROJECT DETAILS
1. To utilize a laboratory test room to assess the merits of different mechanical ventilation air supply strategies with respect to ventilation efficiency in terms of contaminant control. 2. Measurement of fresh air quantities and control damper checks in five different designs of ventilation and air conditioning system, and recommendation of design improvements.
BUILDING TYPE
Commercial
PARAMETERS

#STARTDATE 00:04:1985 #ENDDATE 00:03:1987
#TIME 2080
KEYWORDS Commercial, test room, mechanical ventilation, ventilation efficiency, air quality

#**REF UK34** Ventilation requirements in institutional and commercial buildings
CONTACT
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TEL: 0344 426511 TLX: 848288 BSRIAC G
SPECIFIC OBJECTIVES
Guidance documents on the specifications and means of achieving minimum ventilation rates.
PROJECT DETAILS
Review of available information on ventilation in this building sector. Carry out survey of indoor air quality in various Purpose Groups within this sector excluding offices and domestic. Prepare draft guidance notes in an appropriate form for use within Approved Documents on the specification and where possible achievement of minimum ventilation rates.
BUILDING TYPE
Commercial, institutional
PARAMETERS
Minimum ventilation requirements
#STARTDATE 00:04:1984 #ENDDATE 00:03:1988
#TIME 2200
KEYWORDS Commercial, institutional, literature survey, minimum ventilation rate, guidelines, air quality

#**REF UK35** Development of a predictive model for air movement and heat distribution in factories
CONTACT
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SPECIFIC OBJECTIVES
To develop from existing numerical techniques (PHOENICS) a model for predicting air flow in large spaces. To test and validate the model by comparison with measurements made in factories.
PROJECT DETAILS
The project is being carried out in collaboration with CHAM Ltd, the owners of the PHOENICS code. Firstly the existing computer based numerical techniques are being developed for application to buildings. Secondly, the boundary conditions for operating the model are being studied. Thirdly, the model is being tested for factories using a series of measurement experiments.
BUILDING TYPE
Factories, large spaces
PARAMETERS
Air movement and temperature distribution
#STARTDATE 00:01:1984 #ENDDATE 00:12:1986
#TIME 1080
KEYWORDS Industrial, air flow, computer model, model validation
BIBLIOG
Jones, P.J.
Development of a model to predict air flow and heat distribution in factories
Working Group Meeting, December 1984
Jones, P.J., Ahmed, F., Reed, N.
Development of a model to predict air flow and heat distribution in factories: SERC interim report
January 1986

#**REF UK36** Low energy factories
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TEL: (0222) 42588 Ext 3555 TLX:
SPECIFIC OBJECTIVES
To demonstrate and account for energy savings in factories from increased fabric insulation and reduced air infiltration
PROJECT DETAILS
The energy performance of eight 'low energy' advance factories is being monitored to demonstrate energy savings. Ventilation measurements, including tracer gas and air leakage tests, have been carried out on factories of 200 and 900 m2.
BUILDING TYPE
Factories
PARAMETERS
Internal/external temperature, wind velocity, level of 'airtightness', loading door performance
#STARTDATE 00:01:1984 #ENDDATE 00:12:1986
#TIME 6400
KEYWORDS Factory, tracer gas, pressurization, air infiltration, energy conservation
BIBLIOG
Jones, P.J., Powell, G., Bull, D.
Low energy factories
1st Annual Report
Jones, P.J., Powell, G., Bull, D.
Low energy factories
2nd Annual Report
Etheridge, D.W., Jones, P.J., O'Sullivan, P.E.
Ventilation of factories
Proc. 6th AIC Conference, Netherlands, 1985
Factories look to low energy future
Natural Gas, May/June, 1985

#**REF UK37** Ventilation, air infiltration and air movement in dwellings
CONTACT
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SPECIFIC OBJECTIVES
The application of multiple tracer gas techniques to air movement and pollutant dispersal throughout the occupied/unoccupied building.
PROJECT DETAILS
1. Site measurement of buildings up to 500 m3, brick/block and timber frame construction. 2. Natural 'passive' ventilation systems in dwellings (including roofs); mechanical ventilation systems in factory/hospital buildings.

3. Measurements of ventilation rate and multi-cell air movements using Freon tracer gases and gas chromatography. Some whole building fan pressurization measurements in unoccupied housing.
BUILDING TYPE
Houses, factory, hospital.
PARAMETERS
Weather (temperature, wind speed and direction, humidity). Performance of windows, doors, ceilings. Moisture/odour dispersal.
#STARTDATE 00:08:1984 #ENDDATE 00:08:1987
#TIME 3000
KEYWORDS Residential, factory, hospital, multi-zone, multi-tracer, freons, pressurization, air flows
BIBLIOG
Irwin, C.
A method of measuring air movement in compartmentalised buildings.
PhD Thesis, UMIST, 1985
Edwards, R.E., Irwin, C.
Multiple cell air movement measurements
Proceedings, 6th AIC Conference, Netherlands, 1985.

#**REF UK38** Use of metabolic carbon dioxide to monitor ventilation in occupied buildings
CONTACT
J.M. Penman
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Energy Studies Unit
Physics Dept
Exeter University
Exeter
EX4 4QL
United Kingdom
TEL: 0392 264144 TLX:
SPECIFIC OBJECTIVES
Evaluation of metabolic CO2 as tracer for ventilation monitoring
PROJECT DETAILS
Occupancy and CO2 data have been measured at Exeter University and at a school. These are being used to calculate ventilation rates and airflows.
BUILDING TYPE
School/Office
PARAMETERS
Occupancy, windspeed
#STARTDATE 00:03:1979 #ENDDATE 00:00:1987
#TIME 6000
KEYWORDS School, office, air infiltration, air flows, tracer gas, carbon dioxide, occupied
BIBLIOG
Penman, J.
An experimental determination of ventilation rates in occupied rooms using atmosphere carbon dioxide concentration Building Enviroment, Vol.15, No 1, pp45:47
Penman, J., Rashid, A.A.M.
Experimental determination of air-flow in a naturally ventilated room using metabolic carbon dioxide ibid. Vol.17, pp253-256
Smith, P:N.
Determination of ventilation rates in occupied buildings from metabolic CO2 concentrations and production rates. Internal Report

#**REF UK39** Measurement Techniques Guide
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Air Infiltration and Ventilation Centre
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RG12 4AH
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TEL: 0344 53123 TLX: 848288 BSRIAC G
SPECIFIC OBJECTIVES
Production of a Handbook describing the techniques available for measuring air infiltration and leakage of buildings.
PROJECT DETAILS
1. Use of questionnaire to ascertain techniques used by researchers. 2. Obtain detailed manufacturer information about instrumentation used. 3. Produce summary of each technique in a standard format with particular reference to (a) equipment used (b) availability of instrumentation (c) type of building in which method is used (d) verification of performance of technique (e) advantages/disadvantages.
BUILDING TYPE
PARAMETERS
#STARTDATE 00:06:1986 #ENDDATE 00:11:1987
#TIME 2000
KEYWORDS Questionnaire, guidelines, tracer gas, pressurization, measurement techniques

#**REF UK40** Ventilation in buildings other than dwellings.
CONTACT
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Building Research Establishment
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Herts.
WD2 7JR
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TEL: 0923 674040 TLX: 923220
SPECIFIC OBJECTIVES
To establish the health, safety and comfort requirements for ventilation of non-domestic buildings. To develop and validate methods for measuring and controlling ventilation. To identify the factors which determine the magnitude of natural ventilation for incorporation in standards and codes.
PROJECT DETAILS
1. Develop experimental methods for the measurement of air leakage characteristics of non-domestic buildings, like offices. 2. Carry out field trials of techniques for assessing infiltration rates in Government buildings using non-specialist staff. 3. Develop passive techniques for measuring long-term average infiltration and ventilation rates. 4. Incorporate improved procedures for predicting infiltration and natural ventilation rates in the user-friendly multicell computer program BREEZE presently installed on a desk-top computer. 5. Continue to verify BREEZE using results of field and wind tunnel studies. 6. Incorporate window opening behaviour into procedures for predicting the thermal performance and energy consumption of buildings.
BUILDING TYPE
Offices and other non-domestic buildings
PARAMETERS
Windspeed, temperature, window opening.
#STARTDATE 00:00:00 #ENDDATE 00:00:00
#TIME 0
KEYWORDS Office, air infiltration, computer model, multi-zone, occupant behaviour
BIBLIOG
Perera, M.D.A.E.S.
Natural ventilation in large and multicelled buildings: theory, measurements and prediction
Final report to the CEC under Contract No. EE-A-5-050-UK.
Perera, M.D.A.E.S.
Natural ventilation in large and multicelled buildings: theory, measurements and prediction
Summary report to the CEC under Contract No. EE-A-5-050-UK.
Perera, M.D.A.E.S., Walker, R.R.,
Strategy for measuring infiltration rates in large, multicelled and naturally ventilated buildings using a single tracer gas.
Building Services Engineering Research and Technology,

Vol.6(2), pp 83-88, 1985.
Walker, R.R., et al
Evaluation of a simple technique for measuring infiltration rates in large and multicelled buildings using a single tracer gas.
Presented at the ASHRAE Symposium on Multi-Cell Infiltration, Hawaii USA, 1986.
Perera, M.D.A.E.S., et el
Infiltration measurements in naturally ventilated, large, multicelled buildings.
Presented at 1st International Symposium on Ventilation for Contaminant Control, Toronto, Canada, 1985.
Perera. M.D.A.E.S.
Computing ventilation rates.
CIBS Building Services, pp59, July 1985.
Perera, M.D.A.E.S.
Influence of open windows in the interzone air movement within a semi- detached dwelling.
Proceedings, 6th AIC Conference, Netherlands, September 1985.
Breum, N.O., Perera, M.D.A.E.S.
Ventilation measurements using spot sampling of sulphur hexafluoride on a solid absorbent.
Building and Environment, Vol.19(3). pp175-178, 1984.
Perera, M.D.A.E.S.
Surface pressure co-efficients – BRE database.
Presented at the AIC Wind Pressure Workshop, Brussels, Belgium, 1984.
Walker, R.R.
Interpretation of error analysis of multi-tracer gas measurements to determine air movements in a house.
Proceedings, 6th AIC Conference, Netherlands, 1985.

#**REF UK41** Air movement in dwellings
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SPECIFIC OBJECTIVES
To provide information on air movement and air leakage rates and routes in dwellings and the extent to which draughtproofing can safely be introduced. To provide design guidance in relation to natural and mechanical ventilation, on air movement and the control of pollutants, and mechanical ventilation with heat recovery. To contribute to various codes.
PROJECT DETAILS
1. Carry out field studies of air leakage rates and routes in dwellings including large panel system-built structures, to provide information on the desirability and effectiveness of various draughtproofing measures. 2. Use the results of these studies, with the output from ongoing wind tunnel studies, to develop and apply computer models for the prediction of ventilation rates in dwellings. 3. Investigate the effectiveness of ventilation openings using models and also in field studies, for which techniques for studying air movement will be developed. 4. Examine the design implications for transfer of moisture and heat. 5. In collaboration with the National Radiological Protection Board, investigate factors affecting radon entry into dwellings and the implications for ventilation design.
BUILDING TYPE
Dwellings
PARAMETERS
Wind, temperature, draughtproofing.
#STARTDATE 00:00:00 #ENDDATE 00:00:00
#TIME 0
KEYWORDS Residential, air infiltration, air flow, computer model, air quality, radon, draughtproofing, mechanical ventilation

#**REF UK42** Indoor air quality
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SPECIFIC OBJECTIVES
To evaluate existing knowledge on indoor air pollution and where possible to identify the most effective means of control, including where appropriate the specification of ventilation requirements. To develop or improve regulations, codes and standards for indoor air quality and the avoidance of sick buildings.
PROJECT DETAILS
1. Review existing standards and regulations, including those from overseas, relating to ventilation and air quality. 2. Analyse available information on the incidence and production rates of key pollutants as well as on combustion products and tobacco smoke. 3. Identify appropriate methods of control for each pollutant taking into account, inter alia, health aspects and source characteristics.
BUILDING TYPE
PARAMETERS
#STARTDATE 00:00:00 #ENDDATE 00:00:00
#TIME 0
KEYWORDS Air quality, standards, smoking, occupant health

#**REF UK43** Computation of buoyancy-driven air movement and heat transfer within rectangular building spaces
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SPECIFIC OBJECTIVES
Computation methods will be developed to simulate the buoyancy-driven flow and heat transfer within three-dimensional, rectangular enclosures, subject to inter-zone air-infiltration
PROJECT DETAILS
A high-level flow model (the ESCEAT computer code) will be used to compute the convective motion in three cases: (i) domestic heating using wall-mounted 'radiators'; (ii) passive solar heating in atria; and (iii) radiant heating in factories. A intermediate-level air infiltration model (the FLOW program) will be employed to provide inter-zone air flow boundary conditions. 'Short-cut' calculation methods, suitable for incorporating into building thermal simulation programs, will eventually be developed.
BUILDING TYPE
3 case studies: atrium, house and factory
PARAMETERS
Weather (temperature and wind), building construction (leakage), and type of heating system
#STARTDATE 01:06:1986 #ENDDATE 30:09:1989
#TIME 6400
KEYWORDS Residential, factory, computer model, multi zone, air flow, air movement, natural convection

BIBLIOG
Alamdari,F., Hammond,G.P., Melo,C.
'Appropriate' calculation methods for convective heat transfer from building spaces
Proc. 1st UK National Heat Transfer Conf., Leeds, UK. Vol.2, pp1201-1221, I. Chem. E./Pergamon, 1984
Melo, C.
Improved convective heat transfer and air infiltration models for building thermal simulation
PhD Thesis, Cranfield Inst. of Tech., 1985
Alamdari,F., Hammond,G.P., Mohammad,W.S.
Computation of air flow and convective heat transfer within space-conditioned, rectangular enclosures
Proc. CIB 5th Int. Symp., Bath, CIB/CIBSE 1986, pp191-205

#**REF UK44** Infiltration, air movement and ventilation studies
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SPECIFIC OBJECTIVES
Analysis of infiltration, indoor air movement and ventilation effectivness
PROJECT DETAILS
Analysis of numerical techniques used to predict infiltration, air movement and ventilation effectiveness. Also it is intended to undertake further validation studies. Aspects will include the prediction of air quality problems including airborne moisture transfer
BUILDING TYPE
Domestic, commercial, industrial
PARAMETERS
Climate (i.e. wind temperature) distribution of openings, environmental conditions
#STARTDATE 01:06:1986 #ENDDATE 31:05:1989
#TIME 3000
KEYWORDS Residential, industrial, commercial, air infiltration, air movement, ventilation efficiency, moisture

#**REF UK45** Analysis of data on householders' window-opening behaviour
CONTACT
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TEL: 0483 571281 TLX: 859331
SPECIFIC OBJECTIVES
To determine frequency and duration of daily window opening on a room-by-room basis and identify social, behavioural and physical correlations of window opening.
PROJECT DETAILS
Involved secondary analysis of window opening data collected as part of a 2-year monitoring of houses with gas fired central heating. Personal interviews in winter and spring of 2 consecutive years were used to record householders' reports of window opening habits in each room of their house. A number of indices of window opening were calculated and correlational analysis carried out.
BUILDING TYPE
140 owner occupied houses in south east England
PARAMETERS
Air infiltration and air indoor quality not measured
#STARTDATE 01:06:86 #ENDDATE 30:09:86
#TIME 600
KEYWORDS Residential, occupant behaviour, window opening, questionnaire
BIBLIOG

UNITED STATES OF AMERICA

#**REF USA1** E6 on performance of building construction. Subcommittee E06.41 on infiltration performances. Subcommittee E06.51 on windows, curtain walls and doors.
CONTACT
H.R. Treschel (Subcommittee Chairman), T.L. Carrol (Staff Manager)
ADDRESS
ASTM
1916 Race Street
Philadelphia
PA 19103
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TEL: 215 299 5496 TLX:
SPECIFIC OBJECTIVES
Preparation of standards and publications on measurement and location of air infiltration.
PROJECT DETAILS
BUILDING TYPE
PARAMETERS
#STARTDATE 00:00:1961 #ENDDATE 0:0:00 On-going
#TIME 0
KEYWORDS Air infiltration, measurement techniques, standards
BIBLIOG
Standard E 283-73
Test method for rate of air leakage through exterior windows, curtain walls and doors
Standard E 741-80
Practice for measuring air leakage rate by the tracer dilution method
Standard E 779-83
Practice for air leakage measurement by the fan pressurization method
Special Technical Publication 719
Building air change rate and infiltration measurements
Training criteria for conducting air infiltration tests (new standard in progress)
Calibration of fan doors (new standard just started)
Test for detection of air leaks (location) (new standard in draft form)
Conducted ASTM Symposium on 'Measured air leakage performance of buildings'.
April 2/3 1984 (proceedings in preparation)
Standard E 783-81
Test method for field measurement of air leakages through installed exterior windows and doors.

#**REF USA2** Impact of gas appliances on pollutant levels in recently weatherized homes.
CONTACT
S.M. Tikalsky
ADDRESS
Wisconsin Power & Light Company
222 West Washington Avenue
Madison
Wisconsin 53703
USA
TEL: 608 252 5726 TLX:
SPECIFIC OBJECTIVES
Investigate pollutant levels in homes with properly and improperly vented and tuned gas appliances. Contrast levels before and after home insulation.

PROJECT DETAILS
Mostly wood homes with natural ventilation. Measuring radon, NO, NO2, CO, CO2, temperature, humidity. Gas range emissions measured by ansi pot and dome. Occupied homes.
BUILDING TYPE
Single family dwellings
PARAMETERS
Furnace and gas appliance usage, gas range emissions.
#STARTDATE 01:04:1985 #ENDDATE 31:07:1986
#TIME 0
KEYWORDS Residential, air quality, radon, nitric oxide, nitrogen dioxide, carbon monoxide, carbon dioxide, retrofit, heating systems

#**REF USA3** Performance of solar classroom at Hamilton College.
CONTACT
J.W. Ring
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Department of Physics
Hamilton College
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NY 13323
USA
TEL: 315 859 4705 TLX:
SPECIFIC OBJECTIVES
The effect of air infiltration on the performance of the solar classroom.
PROJECT DETAILS
(1) 1000 sq ft building of concrete block. (2) Natural ventilation with electric resistance auxiliary heaters (about 70% passive solar heating). (3) SF6 tracer gas both continuous and transient, also blower door pressurization. (4) Miran IR spectrometer and blower door. (5) Occupied only a few hours each week.
BUILDING TYPE
Classroom and experimental building.
PARAMETERS
(a) Weather, (b) solar heating fraction over heating season (c) performance of building day-by-day including air quality and comfort (d) long term heat storage in the building.
#STARTDATE 01:09:1984 #ENDDATE 01:01:1987
#TIME 0
KEYWORDS School, passive solar, air infiltration, tracer gas, sulphur, hexafluoride, pressurization
BIBLIOG
Ring, J.W.
Radon concentration, source strength and ventilation rate: how well do we know the connection?
Indoor Air '84, Stockholm, Sweden 1984
Hernandez, T.L., Ring, J.W., Sachs, H.M.
The variation of basement radon concentration with barometric pressure
Health Physics, Vol.46, No.2, pp445-447, 1984
Ring, J.W.
Computer energy management: a test case at Hamilton College
CLIMA 2000, Copenhagen, Denmark, 1985

#**REF USA4** Evaluation of indoor air quality using chemical, physical and biological measures.
CONTACT
F.J. Berlandi
ADDRESS
Touchstone Environmental Consultants, Inc.
33 Thompson Street
Winchester
MA 01890
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TEL: 617 729 8450 TLX:
SPECIFIC OBJECTIVES
To measure the variability and acceptability of indoor environment conditions in offices, industrial facilities and homes.
PROJECT DETAILS
The project utilizes both continuous and grab sample techniques to establish an index for quantifying building conditions. Using input from occupants, the optimum conditions of acceptability are calculated and the environment altered to achieve the target values.
BUILDING TYPE
Houses, apartments, factory, office
PARAMETERS
Residential, factory, office, air quality, occupied comfort Physical and mechanical characteristics of the building, occupant discomfort, magnitude of concentrations.
#STARTDATE 01:01:1983 #ENDDATE 01:08:1987
#TIME 4000
KEYWORDS Residential, factory, office, air quality, occupant comfort

#**REF USA5** Research and demonstration to integrate analytical tactics into the New York State Weatherization Program
CONTACT
L.F. Kinney
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Synertech Systems Corporation
472 South Salina Street
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TEL: 315 422 3828 TLX:
SPECIFIC OBJECTIVES
Research ways to raise the savings achieved by the existing Weatherization Assistance Program through integrating blower door and infra-red scanning tactics into the analysis of dwellings, and a range of air sealing techniques into the retrofit work.
PROJECT DETAILS
Twenty five occupied dwellings in the areas of operation of four local weatherization projects in upstate New York are being equipped with devices to quantify energy used for space heating over the latter part of the winter of 1985-86. In the spring and summer, weatherization crew members will be trained in the effective use of blower door and infra-red scanning technologies, and employ these skills to do careful weatherization work with major emphasis on air sealing. Monitoring will be continued in the following winter and savings and paybacks will be quantified as a function of housing type and tactics employed.
BUILDING TYPE
Low-income, occupied, single- and two-family housing.
PARAMETERS
Weather, components and behaviour. A related study conducted by Fleming Associates of Syracuse, New York, will focus on the magnitude of radon and a range of other airborne pollutants.
#STARTDATE 00:12:1986 #ENDDATE 00:05:1987
#TIME 29,000
KEYWORDS Residential, retrofit, pressurization, thermography, energy conservation, draughtproofing

#**REF USA6** Environmental quality: a question of control
CONTACT
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SPECIFIC OBJECTIVES
To identify the source of building pressurization errors induced through the use of industry standard control

techniques, to propose alternate solutions and to maintain client confidentiality.
PROJECT DETAILS
Building 1: Spec. office building of 8 storeys, curtain wall and glass construction, mechanical HVAC gas heat, occupied.
Building 2: Corporate headquarters building of 15 storeys, brick block and glass construction, mechanical HVAC electric heat, occupied.
Both buildings: Building pressure differentials measured via electric manometer (before and after), ASHRAE models and actual fan manufacturer fan curves used, closed loop controls certified via pressures and client's health records.
BUILDING TYPE
Two commercial office buildings
PARAMETERS
Winter: -5 to 30 degrees F, 5 to 25 mph, 20-30% rh. Infiltration moderate to severe. Occupants suffering winter 'colds'. Source: self generated.
#STARTDATE 00:12:1983 #ENDDATE 00:07:1986
#TIME 125
KEYWORDS Commercial, office, air quality, internal pressure, occupant health
BIBLIOG
Stack effect pressure print – 82 storey building
TEAMeng 1984
Outside air costs – 23 North American cities
TEAMeng 1985
Morris, R., Wiggin, M.
Indoor air pollution
HPAC 1985
Trained arrows – air flow control
TEAMeng, Purdue University, May 1986

#**REF USA7** Air leakage measurement techniques
CONTACT
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Lawrence Berkeley Laboratory
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SPECIFIC OBJECTIVES
To develop and validate new techniques for measuring the leakage of single family residences. To develop and validate techniques for measuring air leakage in multi-zone buildings.
PROJECT DETAILS
Accomplishments have included the development and validation of a technique for measuring the leakage of single family buildings at low pressures, AC pressurization. The present efforts are directed towards developing a practical technique for measuring air leakage in multi-zone buildings. Both AC and DC (blower door) pressurization are being examined.
BUILDING TYPE
Residential single- and multi-family
PARAMETERS
Air leakage, weather, building equipment
#STARTDATE 00:00:1977 #ENDDATE 00:00:1990
#TIME 13,000
KEYWORDS Residential, air leakage, pressurization, AC pressurization, multi-zone
BIBLIOG
Sherman, M.H., Modera, M.P.
Low energy measurement of the leakage of enclosures
Review of Scientific Instruments, LBL Report 20121 (to be published)
Modera, M.P., Sherman, M.H.
AC pressurization: a new technique for leakage area measurement
ASHRAE Trans 91 (II), LBL Report 18395

#**REF USA8** Air leakage analysis
CONTACT
M. Modera
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TEL: 415 486 4678 TLX: 910 366 2037
SPECIFIC OBJECTIVES
To characterise the air leakage of the building stack. To examine the variability of leakage in individual houses. To evaluate the effectiveness of air leakage retrofits.
PROJECT DETAILS
Tasks have included compilation of a database of air leakage measurements in North America, including pre- and post-retrofit data, monthly measurements of air leakage in individual buildings, analysis of the data compiled.
BUILDING TYPE
Residential single- and multi-family in the future
PARAMETERS
Air leakage, weather, building equipment
#STARTDATE 00:00:1982 #ENDDATE 00:00:1992
#TIME 10,000
KEYWORDS Residential, air leakage, database, retrofit
BIBLIOG
Dickinson, J.B., Feustel, H.E.
Seasonal variations in effective leakage area
Proceedings 'Thermal performance of the exterior envelopes of buildings III', Clearwater, Florida, USA, December 1985, LBL Report 19337
Sherman, M.H., Wilson, D.J., Kiel, D.E.
Variability in residential air leakage
LBL Report 17587

#**REF USA9** Wind tunnel measurements
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SPECIFIC OBJECTIVES
Investigation of surface pressure coefficient distribution for buildings.
PROJECT DETAILS
Measurements are carried out by using scale models of real buildings in a boundary layer wind tunnel. Pressure coefficients are determined by measuring surface overpressures at different locations and relating them to the dynamic pressure in the undisturbed flow. Different building surroundings are set up to investigate the changes in the pressure distribution.
BUILDING TYPE
Multi-zone buildings
PARAMETERS
Wind speed, wind direction, building surroundings
#STARTDATE 01:10:1983 #ENDDATE 0:0:00 On-going
#TIME 0
KEYWORDS External pressure, wind tunnel, scale model, simulated boundary layer, multi-zone
BIBLIOG
Joint paper with researchers of the Ecole Polytechnique Federale de Lausanne will be published about the correlation of measured and simulated infiltration for the LESO Building.

#**REF USA10** Air infiltration modelling
CONTACT
H.E. Feustel

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SPECIFIC OBJECTIVES
1. To develop a multi-zone infiltration model. 2. To measure ventilation in multi-zone buildings to verify the model.
PROJECT DETAILS
1. In order to reduce the input data and limit the different cases that might occur, buildings are classified into different categories, based on this air permeability distribution. 2. Four lumped parameters have been found to describe the air flow through the building. 3. A detailed multi-zone model is used as a guide for the development of the simplified model. 4. Multi-gas tracer measurements using freons as tracer gases are used to verify the model.
BUILDING TYPE
Multi-zone buildings
PARAMETERS
Building size, floor plan design, weather data, leakage distribution
#STARTDATE 01:01:1978 #ENDDATE 0:0:00 On-going
#TIME 0
KEYWORDS Air infiltration, air flow, computer model, multi-zone, model validation, multi-tracer, freons
BIBLIOG
Feustel, H.E.
Current research at Lawrence Berkeley Laboratory on multi-zone infiltration.
Air Infiltration Review, Vol.6 No.2, February 1985
Feustel, H.E., Kendon, V.M.
Infiltration models for multi-cellular structures – a literature review
Energy and Buildings, Vol.8, p123-136, 1985
Feustel, H.E.
Development of a simplified multi-zone infiltration model
Proceedings 6th AIC Conference, Netherlands, 1985.

#**REF USA11** Ventilation strategies
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SPECIFIC OBJECTIVES
To develop, examine, implement, analyse different strategies for using and supplying ventilation in a cost-effective manner.
PROJECT DETAILS
Tasks have been (1) to examine natural ventilation to reduce cooling loads in dwellings and military buildings (2) to use the LBL model to calculate energy impacts of different strategies in single-family buildings (3) to use detail simulation to develop cost-effective infiltration strategies.
BUILDING TYPE
Residential, multi-family
PARAMETERS
Weather, occupant demands, behaviour, building configuration and systems.
#STARTDATE 00:00:1980 #ENDDATE 00:00:1992
#TIME 18,000
KEYWORDS Residential, ventilation strategies, computer model

#**REF USA12** Infiltration-related standards
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SPECIFIC OBJECTIVES
To help develop and promulgate consensus standards relating to infiltration.
PROJECT DETAILS
Measurement standards are being passed by the American Society of Testing and Materials (ASTM). Specifically ASTM E779 on the fan pressurization technique and ASTM E741 on tracer gases. We are also involved in the American Society of Heating, Refrigerating and Airconditioning Engineers (ASHRAE) in their development of SPC119, a standard on the airtightness of dwellings.
BUILDING TYPE
Single-family dwellings
PARAMETERS
#STARTDATE 00:00:1981 #ENDDATE 00:00:1993
#TIME 12,000
KEYWORDS Residential, standards, pressurization, tracer gas, airtightness
BIBLIOG
Sherman, M.
Description of ASHRAE's proposed airtightness standard
Proceedings, 5th AIC Conference, Nevada, USA, 1984.
Annual Book of ASTM Standards
Section 4, Volume 4.7
Sherman, M.
Infiltration degree-days: a new statistic for quantifying infiltration- related climate
(to be published in ASHRAE Trans.)

#**REF USA13** Window air leakage performance as a function of ambient air temperature
CONTACT
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Schlegel Corporation
1555 Jefferson Road
Rochester
NY 14623
USA
TEL: 716 427 7200 TLX:
SPECIFIC OBJECTIVES
To quantify window air leakage performance against existing ASTM E283 specification and differential air temperatures and time.
PROJECT DETAILS
BUILDING TYPE
Aluminium/vinyl/wood windows
PARAMETERS
External air temperature and time
#STARTDATE 00:00:1982 #ENDDATE 00:00:1988
#TIME 3700
KEYWORDS Window, air leakage, standards

#**REF USA14** Determinants of carbon monoxide concentrations in residences of ischemic heart disease patients.
CONTACT
S.D. Colome and W.E. Lambert
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Program in Social Ecology – Environmental Analysis
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USA

TEL: 714 856 7204 TLX:
SPECIFIC OBJECTIVES
To determine factors influencing measured indoor levels of nitrogen dioxide, including air exchange rates with outside. Nitrogen dioxide indoor levels are related to indoor levels of carbon monoxide.
PROJECT DETAILS
Approximately 50 residences of mixed type in Southern California were selected for ventilation and air quality measurements. Buildings selected are residences of subjects enrolled in study of health effects of exposure to carbon monoxide in persons with ischemic heart disease. Ventilation measured by PFT method, nitrogen dioxide measured with Palmes diffusion tubes, and CO2 measured by electro-chemical methods.
BUILDING TYPE
Residential, of all types.
PARAMETERS
Nitrogen dioxide and carbon monoxide levels will be related to outdoor pollutant concentrations, air exchange rates, interior combustion sources, and occupant behaviour.
#STARTDATE 00:09:1984 #ENDDATE 00:12:1985
#TIME 1000
KEYWORDS Residential, air quality, air infiltration, nitrogen dioxide, carbon monoxide, occupant health, occupant behaviour
BIBLIOG
Colome, S.D., Lambert, W.E., Castaneda, N.
Determinants of carbon monoxide concentrations in residences of ischemic heart disease patients
(in preparation)

#**REF USA15** Residential ventilation research project
CONTACT
D. Zerba
ADDRESS
Pacific Power
920 S.W. Sixth Avenue
Portland
OR 97204
USA
TEL: 503 243 4146 TLX:
SPECIFIC OBJECTIVES
The development of this research project sought to evaluate the impact upon residential ventilation rates resulting from infiltration weatherization measures, operation of an air-to-air heat exchanger, and occupancy.
PROJECT DETAILS
This project involved ventilation testing and energy use monitoring in three test homes. The homes were monitored before and after structural or occupancy changes corresponding to the test plan objectives above were implemented. The homes were all of standard wood frame construction, two of which were built in 1974 and the third in 1982. None of the homes used fossil fuel for their primary space heating, and only one used a wood stove/fireplace as their secondary space heating.
BUILDING TYPE
Single-family residence
PARAMETERS
Weather, behaviour of occupants
#STARTDATE 00:11:1982 #ENDDATE 00:12:1986
#TIME 4900
KEYWORDS Residential, air infiltration, retrofit, occupant behaviour
BIBLIOG
Zerba, D. (Pacific Power) and Parker, G. (Battelle PNW Labs.)
Ventilation research and characterization in three types of residence
Proceedings, 6th AIC Conference, Netherlands, 1985.

#**REF USA16** Residential indoor air quality and energy efficiency
CONTACT
J.H. Morrill
ADDRESS
American Council for an Energy-Efficient Economy
Suite 535
1001 Connecticut Avenue NW
Washington DC 20036
USA
TEL: 202 429 8873 TLX:
SPECIFIC OBJECTIVES
To explore the relationship between indoor air quality and energy efficiency. Identify pollutant-specific control techniques and ventilation strategies to enable construction of energy efficient housing with superior indoor air quality in an economical manner.
PROJECT DETAILS
Our work is comprised of thorough literature reviews, some indoor air quality/ventilation modelling, and assessments of state-of-the-art residential equipment.
BUILDING TYPE
Residential
PARAMETERS
Sources, weather
#STARTDATE 00:07:1983 #ENDDATE 00:00:0000
#TIME 3000
KEYWORDS Residential, air quality, energy consumption, ventilation strategies, literature survey
BIBLIOG
Morrill, J.
Residential indoor air quality in North Carolina
Published by N.C. Alternative Energy Corporation, June 1985
Morrill, J.H.
Residential indoor air quality and energy efficiency
(forthcoming book)

#**REF USA17** Indoor air quality and savings analysis in weatherization program homes (Research sponsored by New York State Energy and Development Authority)
CONTACT
I. Nitschke
ADDRESS
W.S. Fleming and Associates, Inc.
5802 Court Street Road
Syracuse
New York 13206
USA
TEL: (315) 437-1780 TLX:
SPECIFIC OBJECTIVES
Determine the indoor air quality and energy savings in a sample of weatherized low income homes and mobile homes.
PROJECT DETAILS
Before and after blower door measurements and integrated radon, nitrogen dioxide, formaldehyde, respirable suspended particulates and carbon monoxide measurements are to be made in approximately 100 weatherized and low income homes and mobile homes. Estimated energy savings are to be compared with energy savings using utility billing data.
BUILDING TYPE
Low income homes and mobile homes
PARAMETERS
Change in blower door measurements will estimate change in infiltration rate and change in indoor air quality and energy consumption
#STARTDATE 00:02:1986 #ENDDATE 00:02:1988
#TIME 1500
KEYWORDS Residential, mobile home, air quality, radon, nitrogen dioxide, formaldehyde, carbon monoxide, energy conservation, suspended particles, retrofit

BIBLIOG
I. Nitschke, J. Rizzuto,
Indoor Air Quality Final Report
NYSERDA, late 1987
I. Nitschke, N. Karins
Instrumented Audits Savings Analysis
NYSERDA, early 1988
I. Nitschke, J. Rizzuto,
Mobile Homes Savings Analysis
NYSERDA, early 1988.

#**REF USA18** Energy usage in a superinsulated home in Augusta, Georgia
CONTACT
J. Frey
ADDRESS
Architectural Energy Corporation
8753 Yates Drive
Suite 105
Westminster
Colorado 80030
USA
TEL: (303) 428-8228 TLX:
SPECIFIC OBJECTIVES
To determine the cost benefit of superinsulated construction in this climate.
PROJECT DETAILS
Temperatures, energy consumption by end-use and infiltration rates are being measured in the building. Data are being compared to energy information from buildings in the same geographic area. Detailed analysis is being performed with computer simulations.
BUILDING TYPE
Building
PARAMETERS
Seasonal average infiltration rates are being measured using AIMS from Brookhaven National Laboratory.
#STARTDATE 00:06:1985 #ENDDATE 00:08:1986
#TIME 0
KEYWORDS Residential, air infiltration, energy consumption, building design, computer model
BIBLIOG
Reports and publications have not yet been determined.

#**REF USA19** Computer modelling of various ventilation strategies for residential buildings for indoor air quality
CONTACT
C. A. Lane
ADDRESS
Minnesota Department of Energy and Economic Development
900 American Center Building
150 E. Kellogg Blvd
St.Paul
MN 55101
USA
TEL: 612-297-1957 TLX:
SPECIFIC OBJECTIVES
Determine optimum mechanical ventilation systems for residential buildings in cold climates.
PROJECT DETAILS
A validated dynamic mass balance computer model has been developed for assessing the indoor air quality and energy use performance for residential HVAC strategies. Four generic residential designs were evaluated for 5 different HVAC systems and 8 different control strategies. ASHRAE 55-1981 and 62-1981 standards were used as the performance benchmarks.
BUILDING TYPE
Single and multi-family residential
PARAMETERS
ASHRAE 62-1981; 40% RH-control, EPA IAQ recommended standards; energy consumption.
#STARTDATE 00:07:1984 #ENDDATE 00:07:1985
#TIME 1000
KEYWORDS Residential, computer model, ventilation strategies, air quality, mechanical ventilation, energy consumption, standards
BIBLIOG
Lane, C.A.
Dynamic computer simulation to determine the thermal and indoor air quality performance of various heating, ventilation and air conditioning systems in residential buildings in cold climates.
Proceedings 3rd Annual Superinsulation Conference, Minneapolis, MN, March 6 and 7, 1986.

#**REF USA20** Homeowner response to air sealing information
CONTACT
J.J. Kirkwood, D. Valentine
ADDRESS
Center for Energy Research/Education/Service
Ball State University
Muncie
Indiana 47306
USA
TEL: 317 285 5647 1908 TLX:
SPECIFIC OBJECTIVES
1. Define common problems in low income housing in Muncie. 2. To determine effectiveness of education in improving air tightness of tenants' homes
PROJECT DETAILS
Twenty houses are part of a pilot test. The houses are inhabited by low-income families who are receiving municipal support for housing and heating. The 20 houses are being tested for ACH and ELA. On-site inspections are made to determine leakage sites. Residents are given instructions on repairing leaks and sealing the house using commonly available caulks and other appropriate materials. A sample of sealing materials and a caulking gun are given to the residents with instructions for use. Comparison is made through post-testing with a a similar group of houses.
BUILDING TYPE
Low income, older, frame houses, detached
PARAMETERS
Air changes/hour, equivalent leakage area
#STARTDATE 00:10:1985 #ENDDATE 00:06:1986
#TIME 80
KEYWORDS Residential, detached, airtightness, occupant behaviour, draughtproofing
BIBLIOG
Proceedings 7th AIC Conference, UK, 1986

#**REF USA21** Energy use reduction as a function of air leakage reduction in residential structures.
CONTACT
D.J. Groetzinger,H. Buggy
ADDRESS
Current Energy Technologies
2353 Hollywood Drive
Pgh
Pa 15235
USA
TEL: 412 241 8778 TLX:
SPECIFIC OBJECTIVES
To determine from % reduction of air leakage the saving over the 1st year. Relating this information to number of occupants, age and structure of building.
PROJECT DETAILS
Sealing buildings of different types (all residential) and attempting to find a correlation to savings.
BUILDING TYPE
Varied
PARAMETERS
Infiltration – Retrotec 610 door fan. Some radon testing before and after.
#STARTDATE 01:06:1985 #ENDDATE 01:06:1986
#TIME 200-3400

KEYWORDS Residential, air leakage, energy consumption, retrofit, radon, pressurization, blower door

REF USA22 Mitigation of indoor radon using balanced mechanical ventilation heat recovery.
CONTACT
B.W. Wellford
ADDRESS
Airxchange Inc.
30 Pond Park Road
Hingham
Mass 02043
USA
TEL: (617) 749 8440 TLX:
SPECIFIC OBJECTIVES
Determine effect on before and after radon levels of installing heat recovery ventilation systems in radon contaminated homes.
PROJECT DETAILS
Several radon contaminated homes in the Pennsylvania 'Reading Prong' area, are being fitted with heat recovery ventilation systems to reduce indoor radon levels.
BUILDING TYPE
Residential
PARAMETERS
Radon concentrations vs ventilation rates
#STARTDATE 00:11:1985 #ENDDATE 31:12:1986
#TIME 0
KEYWORDS Residential, radon, radon control, ventilation systems, mechanical ventilation
BIBLIOG
B.W. Wellford
Mitigation of indoor radon using balanced mechanical ventilation
Presented at APCA International Speciality Conference on Radon (Indoor) Pennsylvania, February 24-26, 1986.

REF USA23 Hospital ventilation requirements research project
CONTACT
M.A. Ficht
ADDRESS
American Society for Hospital Engineering of the American Hospital Association
840 North Lake Shore Drive
Chicago
IL 60611
USA
TEL: 312/280-6245 TLX:
SPECIFIC OBJECTIVES
To improve indoor air quality in health care facilities while simultaneously increasing their energy efficiency.
PROJECT DETAILS
Phase I-Design of Experiment: Obtain and review currently available data and information regarding indoor air quality in hospitals. Determine research agenda for conducting air quality tests in hospitals. Develop testing protocol and equipment specifications for air quality sampling in hospitals
Phase 2-Validate Experimental Design and Protocol: Conduct a complete broad spectrum indoor air quality monitoring program and comprehensive energy/ventilation system analysis at prototype hospital. Technical advisory committee analyse data from the Phase 2 prototype hospital, recommend modifications to the testing protocols, as required, and identify characteristic (or 'threshold') contaminants for targeting air quality testing in the 44 Phase 3 facilities. Data from prototype hospital used in the development of a computer simulation model designed to predict changes in air quality and energy use relative to proposed HVAC system modifications.
Phase 3-Acquire Indoor Air Quality Field Data in Selected Hospitals: Monitoring program conducted at 44 selected hospitals for trace contaminants in selected functional categories along with an energy analysis. Recommendations for modifying HVAC system modifications are developed for Phase-4 and tested in prototype hospital.
Phase 4-Evaluate Indoor Air Quality Field Data, Manipulate Field Conditions and Evaluate Results: HVAC systems modified in 44 hospitals, selected functional categories monitored to evaluate changes in air quality and energy consumption in comparison to Phase 3 results. Data Data secured from Phase 4, in conjunction with data generated in Phases 2 and 3, used in proposing recommendations in the revision of hospital codes for ventilation requirements, and in the development of design and performance criteria for the energy-efficient operation of HVAC equipment.
BUILDING TYPE
Hospitals
PARAMETERS
Sources of pollutants, dilution of pollutants, occupancy levels, pressure relationships and/or directional air flows for infection control. Air handler unit equipment performance.
#STARTDATE 00:01:1983 #ENDDATE 01:06:1987
#TIME 0
KEYWORDS Hospital, air quality, energy conservation, ventilation systems
BIBLIOG
Ficht, M.A
Hospital ventilation requirements: an opportunity to identify opportunities for increased efficiency and improved indoor air quality in medical facilities. Phase I Final Report
American Hospital Association, July 1984
Woods, J.A.
Development of protocols for Phase II of a research project to identify opportunities for increased energy efficiency and improved indoor air quality in medical facilities
American Hospital Association, April 1984
Woods, J.A., Ficht, M.A., Albrecht, R.J.
Criteria and methods of controlling hospital indoor air quality
February, 1985. Paper read at Clima 2000, Copenhagen, 1985.
Woods, J.A.,
Purpose of ventilation and impact of ventilation controls in health care facilities
American Hospital Association, 1985.

REF USA24 Building pressure distributions for natural ventilation calculations.
CONTACT
S. Chandra
ADDRESS
Florida Solar Energy Center
300 State Road 401
Cape Canaveral
FL 32920
USA
TEL: (305) 783-0300 TLX:
SPECIFIC OBJECTIVES
Summarise building pressure data on low rise buildings in a form useful to researchers and building designers to calculate natural ventilation airflows.
PROJECT DETAILS
Building pressure data from diverse sources will be consolidated into a computer friendly format. This will allow calculations of hourly airflow through open windows in the summertime for ventilative cooling.
BUILDING TYPE
Low-rise residential (primarily)
PARAMETERS
Building form, roof slope, neighbouring buildings, wind turbulence, etc.
#STARTDATE 01:10:1985 #ENDDATE 30:09:1986
#TIME 2240
KEYWORDS Residential, computer model, database, external pressure, air flow

BIBLIOG
None so far.

#REF USA25 A compendium of standards, regulations and other technical criteria related to indoor air quality
CONTACT
D.A. Harris, AIA
ADDRESS
National Institute of Building Sciences
1015, 15th St NW
Suite 700
Washington DC 20006
USA
TEL: 202 347 5710 TLX:
SPECIFIC OBJECTIVES
Bibliographic database of standards, regulations, recommendations, guidelines, etc. related to various indoor air quality subjects.
PROJECT DETAILS
This study, conducted by the National Institute of Building Sciences, involved a survey of over 500 organisations in the USA and other selected countries seeking to identify authoritative documents relating to indoor air quality in non-industrial settings.
BUILDING TYPE
All non-industrial buildings
PARAMETERS
#STARTDATE 00:00:1984 #ENDDATE 0:0:00 Database will be updated periodically
#TIME 1000
KEYWORDS Residential, commercial, air quality, standards, guidelines, database
BIBLIOG
A compendium of standards, regulations and other technical criteria related to indoor air quality
National Institute of Building Sciences, Publications Dept., Washington DC, USA.

#REF USA26 Multi-zone airflow monitoring
CONTACT
D. Wortman
ADDRESS
SERI
Building 15/3
1617 Cole Boulevard
Golden
CO 80303
USA
TEL: 303 231 1453 TLX:
SPECIFIC OBJECTIVES
To measure natural convection airflow in a test house
PROJECT DETAILS
A modified constant injection rate, two tracer system has been built and used in a dedicated test house. Known interzonal flows were set up with fans and ducts and compared to 10% to rate derived from the tracer system. Natural convection results are consistent with a bulk flow Bernoulli model.
BUILDING TYPE
Residential
PARAMETERS
Room-to-room temperature difference
#STARTDATE 00:01:1985 #ENDDATE 00:04:1986
#TIME 3000
KEYWORDS Residential, test house, multi-zone, multi-tracer, constant emission, air flow, natural convection

#REF USA27 Estimating air flow in multi-family buildings
CONTACT
D.L. Bohac, D. Feuermann, G.S. Dutt
ADDRESS
Center for Energy & Environmental Studies
Engineering Quadrangle
Princeton University
Princeton
NJ 08544
USA
TEL: 609 452 5190 (D.Harrje) TLX: 499 1258
SPECIFIC OBJECTIVES
The development of pressurization, tracer gas and air flow models to estimate air flows in multi-family buildings.
PROJECT DETAILS
Three different methods are analysed. 1. Heating load data to compute the heating season average air infiltration rate. 2. Multi- blower door pressurization tests to find the magnitude and distribution of leakage areas in a unit. 3. Constant concentration SF6 tracer gas techniques to measure infiltration and inter-unit air flows and flows through the stairwell. The information obtained from methods 2 and 3 is used to establish a model of the air flows in the building.
BUILDING TYPE
60-unit, gas fired steam heated apartment building.
PARAMETERS
Indoor/outdoor temperature, wind speed and direction and window opening.
#STARTDATE 00:01:1986 #ENDDATE 00:05:1987
#TIME 1000
KEYWORDS Residential, apartments, computer model, pressurization, tracer gas, constant concentration, sulphur hexafluoride, air flow
BIBLIOG
Bohac, D.L., Dutt, G.S., Feuermann, D.
Approaches to estimating air infiltration in large multi-family buildings
To be presented at ASHRAE's winter meeting, 1987.

#REF USA28 Seasonal air infiltration rates in six zones of a bi-level house
CONTACT
D.L. Bohac and D.T. Harrje
ADDRESS
Center for Energy & Environmental Studies
Engineering Quadrangle
Princeton University
Princeton
NJ 08544
USA
TEL: 609 452 5190 (D.Harrje) TLX: 499 1258
SPECIFIC OBJECTIVES
The measurement of infiltration rates into each of the six zones of an unoccupied bi-level house during all four seasons.
PROJECT DETAILS
The constant concentration SF6 tracer gas system developed at Princeton is used to measure infiltration and upstairs/downstairs air flow rates. These flow rates are measured for a 2-4 week period during each season.
BUILDING TYPE
130m2 bi-level unoccupied house heat pump.
PARAMETERS
Indoor/outdoor temperature, wind speed and direction. Seasonal variation.
#STARTDATE 00:04:1985 #ENDDATE 00:05:1987
#TIME 750
KEYWORDS Residential, tracer gas, constant concentration, sulphur hexafluoride, air infiltration, air flow
BIBLIOG
Harrje, D.T., Bohac, D.L. and Nagda, N.L.
Air exchange rates based upon individual and single cell measurements
Proceedings, 6th AIC Conference, Netherlands, 1985
Bohac, D.L., Harrje, D.T.
Improving the accuracy of the constant concentration tracer gas system.
Proceedings, 6th AIC Conference, Netherlands, 1985.

#REF USA29 Radon monitoring in BPA's regional weatherization program
CONTACT
M. Piper
ADDRESS
Department of Energy
Bonneville Power Administration
PO Box 3621
Portland
Oregon 97208-3621
USA
TEL: TLX:
SPECIFIC OBJECTIVES
To provide radon concentration data to participants of BPA's residential weatherization programme.
PROJECT DETAILS
Radon monitoring before and after weatherization.
BUILDING TYPE
Houses
PARAMETERS
#STARTDATE 00:10:1984 #ENDDATE 00:00:0000
#TIME 0
KEYWORDS Residential, house, radon, air quality, retrofit, draughtproofing

#REF USA30 Manufactured house study
CONTACT
S. Onisko
ADDRESS
Department of Energy
Bonneville Power Administration
PO Box 3621
Portland
Oregon 97208-3621
USA
TEL: TLX:
SPECIFIC OBJECTIVES
To evaluate energy efficiency improvements in manufactured homes.
PROJECT DETAILS
Formaldehyde levels will be monitored in five dwellings using passive monitors. Air exchange rates will be measured concurrently using tracer gas methods.
BUILDING TYPE
Manufactured homes
PARAMETERS
#STARTDATE 00:09:1985 #ENDDATE 00:06:1986
#TIME 0
KEYWORDS Residential, energy conservation, retrofit, air quality, formaldehyde, tracer gas, air infiltration

#REF USA31 Residential demonstration project
CONTACT
W. Kingrey
ADDRESS
Washington State Energy Office
400 E Union, 1st Floor, ER-11
Olympia
Washington
WA 98504-2411
USA
TEL: 206 586 5006 TLX:
SPECIFIC OBJECTIVES
To measure the performance of air-to-air heat exchangers (several types were examined).
PROJECT DETAILS
The performance of air-to-air heat exchangers was assessed using a one-time measurement of intake and exhaust air flow during high speed fan operation.
BUILDING TYPE
Residential, multi- and single family.
PARAMETERS
#STARTDATE 00:00:1984 #ENDDATE 00:12:1986
#TIME 0
KEYWORDS Residential, heat exchangers

#REF USA32 Window airtightness standards
CONTACT
K.E. Ekstrom
ADDRESS
National Wood Window and Door Association
205 West Touhy Avenue
Park Ridge
Illinois 60068
USA
TEL: TLX:
SPECIFIC OBJECTIVES
The NWWDA is currently promulgating new performance standards for building components (windows, doors). These documents will reduce current air infiltration maximums.
PROJECT DETAILS
BUILDING TYPE
PARAMETERS
#STARTDATE 00:00:0000 #ENDDATE 00:09:1986
#TIME 0
KEYWORDS Building components, windows, doors, airtightness, standards

#REF USA33 Residential construction demonstration project
CONTACT
M. Lubliner, J. Douglass, P. Thor, J. Harris.
ADDRESS
Washington State Energy Office
400 E Union St
Olympia
WA 98504
USA
TEL:(206) 586 5022 TLX:
SPECIFIC OBJECTIVES
To develop, examine and refine pre-determined conservation techniques and innovations.
PROJECT DETAILS
To develop specifications and techniques to incorporate innovations into energy-efficient construction. To collect and analyse energy information in order to assess the impact of innovations. To provide information on energy efficient home construction and worthwhile innovations to the public.
BUILDING TYPE
Residential, single family.
PARAMETERS
Temperature
#STARTDATE 01:01:1986 #ENDDATE 01:10:1987
#TIME 0
KEYWORDS Residential, energy conservation, building design

#REF USA34 Sensory reactions to indoor air pollution
CONTACT
W.S. Cain
ADDRESS
John B. Pierce Foundation
Yale University
290 Congress Avenue
New Haven
Connecticut 06519
USA
TEL: 203 562 9901 TLX:
SPECIFIC OBJECTIVES
To quantify human sensory reactions (odour, irritation) to indoor contaminants.
PROJECT DETAILS
This primarily psychological effort will seek to decide what combinations, duration and environmental conditions, e.g. humidity, will produce irritation or odour incompatible with human comfort. Such information can make it possible to propose ventilation requirements (or other means of control) to eliminate discomfort. Specific aims include: 1. To discover the influence of particle filtration and gas phase filtration on the perceived odour and irritation from

environmental tobacco smoke. 2. Exploration of the influence of humidity on eye, nose and throat irritation. 3. specification of a likely potentiation of irritation from oscillating concentrations of the irritant formaldehyde. 4. Measurement of the sensory impact of mixtures of tobacco smoke and formaldehyde. 5. Assessment of how temperature and humidity influence the generation rate and stability of occupancy odour. 6. The verification of perceived irritation by objective means, such as nasal resistance, a reflex change in inhalation and voice analysis. In most instances, the experiments will compare the reactions of persons exposed to the contaminants continuously (occupants) in a precisely controlled environmental chamber to persons who only sample the air from the chamber every few minutes (visitors). (This distinction between occupants and visitors is important for recommendations of ventilation requirements because odour often fades during prolonged exposure whereas irritation often increases). The psychological techniques to be employed in the research will include odour matching, numerical and graphic scaling and standard threshold procedures. The objective techniques will include anterior rhinomanometry to gauge stuffiness and the electro-glottograph and harmonics-to-noise voice analysis to gauge hoarseness. The ultimate goal of the search for objective indices is to allow verification of symptoms of airway irritation in field situations where sick building syndrome may occur. Both the specific questions and the general issues addressed in this research have been framed with the goal of gathering information that may lead rapidly to enlightened, data-based recommendations for indoor environmental policy.
BUILDING TYPE
PARAMETERS
#STARTDATE 00:00:1979 #ENDDATE 0:0:00 On-going
#TIME 0
KEYWORDS Air quality, occupant comfort, occupant health, formaldehyde, smoking, humidity, odour
BIBLIOG
Leaderer, B.P., et al
Ventilation requirements in buildings: II. Particulate matter and carbon monoxide from cigarette smoking.
Atmospheric Environment, 1984, 18, 99-106.
Schacter, E.N., et al
Airway effects of low concentrations of sulfur dioxide. Dose response characteristics.
Archives of Environmental Health, 1984, 39, 34-42.
Clausen, G.H.
Stability of body odor in enclosed spaces.
Indoor air: Sensory and hyperreactivity reactions to sick buildings, Vol.3, Swedish Council for Building Research, Stockholm, Sweden, 1984, pp387-391. (B. Berglund et al, eds.)
Clausen, G.H. et al
Stability of tobacco smoke odor in enclosed places.
Indoor air: Sensory and hyperreactivity reactions to sick buildings, Vol.3, Swedish Council for Building Research, Stockholm, Sweden, 1984, pp437-441. (B. Berglund et al, eds.)
Witek Jr., T.T. et al
Respiratory symptoms associated with sulfur dioxide exposure.
International Archives of Occupational and Environmental Health, 1985, 55, pp179-183.

#**REF USA35** Advanced workstation and building systems integration
CONTACT
V. Hartkopf
ADDRESS
Center for Building Diagnostics
Carnegie Mellon University
Pittsburgh
PA 15213
USA
TEL: 412 268 2350 TLX:
SPECIFIC OBJECTIVES
Systems integration for occupant comfort, air quality, thermal/visual/ acoustic comfort, and functional quality
PROJECT DETAILS
A systems integration project for the user friendly accommodation of computer workstations in new, rehabilitated and existing facilities.
BUILDING TYPE
PARAMETERS
Distribution of 'fresh air', control of thermal comfort at the workstation.
#STARTDATE 00:06:1986 #ENDDATE 00:06:1988
#TIME 6400
KEYWORDS Air quality, occupant comfort

#**REF USA36** Modelling and monitoring of CO, NO, NO2 and particulates in a modern townhouse.
CONTACT
C.I. Davidson, J.E. Borrazzo, V. Hartkopf
ADDRESS
Dept of Civil Engineering – Porter Hall
Carnegie Mellon University
Schenley Park
Pittsburgh
PA 15213
USA
TEL: 412 268 2951 TLX:
SPECIFIC OBJECTIVES
To estimate one-compartment mass-balance model parameters (sources, air exchange rates and sinks) and verify the model for CO, NO, NO2 concentrations in a modern energy-efficient townhouse.
PROJECT DETAILS
Emission factors for CO, NO and NO2 were estimated for each of the gas-fired appliances in the house. Airflows were estimated using sulphur hexafluoride (SF6) decay techniques. The whole-house air exchange rate had a mean value of 0.25 hr-1 during experiments in March and October 1984. Loss rates for NO2 were calculated as the difference between NO2 removal rates and estimated air exchange rates; CO and NO concentrations decayed at a rate not significantly different from that for SF6. Controlled pollutant rise and decay experiments involved heating a pot of water on one burner of the gas stove. Concentrations were measured during combustion and for several hours after the stove was turned off.
BUILDING TYPE
PARAMETERS
Source strengths, sink terms
#STARTDATE 01:01:1983 #ENDDATE 30:06:1985
#TIME 5000
KEYWORDS Residential, air quality, carbon monoxide, nitric oxide, nitrogen dioxide, tracer gas, decay rate, sulphur hexafluoride, contaminant flow
BIBLIOG
Davidson, C.I. et al
Modeling and measurement of pollutants inside houses in Pittsburgh, Pennsylvania
3rd Int. Conference on Indoor Air Quality and Climate, Stockholm, Sweden, August 20-24, 1984
Fortmann, R.C. et al
Characterisation of parameters influencing indoor pollutant concentrations
3rd Int. Conference on Indoor Air Quality and Climate, Stockholm, Sweden, August 20-24, 1984
Architectural Energy Corporation. Final Report: Performance evaluation results Prepared for Carnegie Mellon University, Dept of Architecture, 8 May 1985
Hartkopf, V., Loftness, V.
Winning the energy relay: from politicians to guidelines to design to construction to user.
Final report to the US Dept of Energy, July 1985
Borrazzo, J.E. et al

Modeling and monitoring of CO, NO and NO2 in a modern townhouse.
Accepted for publication in Atmospheric Environment

REF USA37 Measurement of water vapour migration and storage in a composite building construction
CONTACT
J.D. Verschoor
ADDRESS
Verschoor Associates
179 Gail Lane
Bailey
CO 80421
USA
TEL: 303 838 7336 TLX:
SPECIFIC OBJECTIVES
To measure, under steady-state laboratory simulated winter conditions, the moisture accumulation rate in an insulated wood-frame wall structure. The investigation was conducted at Manville R&D Center, PO Box 5108, Denver, CO 80217, USA.
PROJECT DETAILS
The moisture accumulation rate was measured by weighing daily the 5x10 ft wall structure, which was exposed to constant conditions of 20 degrees F on the cold side, and 70 degrees F 50% RH on the warm side. Three vapour retarder systems were investigated: excellent (polyethylene film), poor (flat latex paint) and point-source defect (electrical receptacle). The effects of air infiltration and exfiltration are investigated by imposing negative and positive pressure differences on the wall structure. At the conclusion of each test phase, the wall was disassembled and the location of the accumulated moisture determined.
BUILDING TYPE
Residential insulated wood-frame wall structure.
PARAMETERS
Negative pressure difference induced infiltration of 'dry' outside air, reducing moisture accumulation; conversely for positive pressure inducing exfiltration of 'humid' inside air.
#STARTDATE 00:00:1983 #ENDDATE 00:00:1985
(project extension under consideration)
#TIME 3000
KEYWORDS Walls, moisture, humidity, air infiltration, vapour barrier, pressurization, experimental cell, moisture migration, moisture retarders (vapour retarders) air infiltration, thermal performance
BIBLIOG
Verschoor, J.D.
Measurement of water vapour migration and storage in composite building construction.
ASHRAE Trans., 91, Pt.2, 1985
Verschoor, J.D.
Research Note
ASHRAE Journal, 27, 11, 1985

REF USA38 Harvard indoor air quality/acute health study
CONTACT
B.G. Ferris, J.D. Spengler
ADDRESS
Dept of Environmental Science and Physiology
Harvard School of Public Health
665 Huntington Avenue
Boston
MA 02115
USA
TEL: 617 732 1255 TLX:
SPECIFIC OBJECTIVES
Characterize and measure indoor NO2 and RSP levels in 1800 homes in 6 cities. Collect acute health symptoms using daily symptom calendar.
PROJECT DETAILS
Six cities include Watertown, MA, sampled 1984-85; Kingston/Harriman, Tenn., sampled 1985-86; St. Louis, MI, sampled 1985-86; Steubenville, Ohio, sampled 1986-87; Portage, WI, sampled 1986-87, Topeka, KS, sampled 1987-88. Indoor measurements: NO2 using Palmes tubes, water vapour using passive diffusion tube, PM25 (particle measure cut at 2.5), ventilation using perfluorocarbon tracer. Questionnaire: 4 week-long sample periods in 300 childrens homes, each city, over one year. Home selected from new cohort in lung health study. Children in grade 4-6.
BUILDING TYPE
PARAMETERS
Lung health, long term acute health in school children. Characterise residential homes exposure for NO2 and PM2.5 in study cities.
#STARTDATE 00:09:1984 #ENDDATE 00:09:1988
#TIME 0
KEYWORDS Air quality, nitrogen dioxide, tracer gas, perflurocarbon, questionnaire, occupant health
BIBLIOG
Spengler, J.D., et al
Harvard's indoor air pollution/health study
79th Annual APCA Convention, 1986

REF USA39 Two-zone modelling of air exchange and indoor air quality in homes.
CONTACT
R.N. Dietz
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Tracer Technology Center
Brookhaven National Laboratory
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SPECIFIC OBJECTIVES
Characterise the nature and extent of NO2 source and removal terms in a large number of homes (400 to 600).
PROJECT DETAILS
1. Apply a two-zone model to the living and bedroom zones of houses to determine individual air exfiltration, infiltration and exchange rates between zones. 2. Use calculated flow rates in a two-zone NO2 model to determine the NO2 removal rate in the bedroom zone and the approximate source rate in the living zone. 3. Determine a model for predicting indoor NO2 concentrations from a knowledge of the air exchange rates and the type of gas combustion sources giving NO2 emissions.
BUILDING TYPE
Study was done in 400 to 600 dwellings
PARAMETERS
Source rates and decay rates for NO2 plus types of gas-fired appliances and furnaces.
#STARTDATE 00:01:1984 #ENDDATE 00:09:1987
#TIME 4000
KEYWORDS Residential, air quality, nitrogen dioxide, multi-zone, air infiltration, air flow, computer model
BIBLIOG
D'Ottavio, T.W., Dietz, R.N.
Multizone NO2 reactivity measurements in a single family home
Brookhaven National Laboratory, BNL-37497, November 1985
Hoogendyk, C.G. et al
Two-zone modelling for air exchange rates and NO2 source and decay rates in homes with gas devices
Indoor Air 87, Berlin, 17-21 August 1987.

REF USA40 Building infiltration and ventilation
CONTACT
R.N. Dietz
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TEL: 516 282 3059 TLX: 6852 516 BNL DOE
SPECIFIC OBJECTIVES
To improve our understanding of the extent and mechanisms of infiltration and air exchange rates in multizoned homes and buildings.
PROJECT DETAILS
1. Further the development of the passive perfluorocarbon tracer system and assist with technology transfer to the private sector. 2. Characterise the quality and extent of natural infiltration and mechanical ventilation in homes and buildings. 3. Assess and quantify the effect of weather parameters on air infiltration. 4. Demonstrate the utility of the passive tracer system in the design, operation and performance certification of air handling equipment in commercial buildings.
BUILDING TYPE
Homes and commercial buildings
PARAMETERS
Air infiltration is related to temperature difference, wind speed, type of home or building, IAQ to soil gas radon concentration, pressure differences and flows.
#STARTDATE 00:10:1981 #ENDDATE 0:0:00 On-going
#TIME 6400
KEYWORDS Residential, commercial, tracer gas, perfluorocarbon, air infiltration, ventilation systems, air quality, radon, air flow, multi- zone
BIBLIOG
Dietz, R.N. et al
Detailed description and performance of a passive perfluorocarbon tracer system for building ventilation and air exchange measurements
Brookhaven National Laboratory, BNL-36327, February 1985
Dietz, R.N. et al
Multi-zone infiltration measurements in homes and buildings using a passive perfluorocarbon tracer method.
ASHRAE Trans., 91(2), 1761-1775, 1985
d'Ottavio, T.W.
Assessment of radon penetration into New York homes using multi-zone air infiltration modelling
Indoor Air '87, Berlin, Germany, 17-21 August, 1987

#**REF USA41** Residential indoor air quality characterisation study of nitrogen dioxide.
CONTACT
A.L Wilson, S.D Colome, P.E Baker, E.W Becker
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Southern California Gas Company
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Terminal Annex
Los Angeles
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USA
TEL: (818) 307 2691 TLX:
SPECIFIC OBJECTIVES
1. Quantify and characterise indoor levels of NO_2 within the SoCa/Gas service area. 2. Determine the sources that most strongly contribute to indoor NO_2.
PROJECT DETAILS
Approximately 600 residences of all types in Southern California were selected for ventilation, humidity and nitrogen dioxide measurements. Ventilation was measured by PFT method, and NO_2 was measured with Palmes diffusion tubes.
BUILDING TYPE
Residential of all types.
PARAMETERS
Outdoor NO_2, size of home, furnace type, range type, season, gas usage, weather and occupant behavioural patterns
#STARTDATE 00:03:84 #ENDDATE 00:12:87
#TIME 20,000
KEYWORDS Residential, air quality, nitrogen dioxide, tracer gas, perfluorocarbon, air infiltration

#**REF USA42** Comparison of airtightness in two public housing units
CONTACT
J.J. Kirkwood
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Ball State University
Center For Energy Research/Education/ Service
Muncie
I N 47306
USA
TEL: 317 285 1908 TLX:
SPECIFIC OBJECTIVES
To compare two identical housing units (4 apartments each) built by different contractors. Compare leakiness, define leak sites, compare heat costs.
PROJECT DETAILS
Two identical housing units of 4 apartments each were measured for ACH% 50pa and equivalent leakage area. Comparisons were made and found to be the same. Heat costs were higher in one group but did not correlate with leakiness beyond 7%.
BUILDING TYPE
Frame/brick veneer apartments occupied
PARAMETERS
Gas, consumption, heat costs
#STARTDATE 00:05:1986 #ENDDATE 00:08:1986
#TIME 60
KEYWORDS Row house, apartment, airtightness, air infiltration, energy consumption
BIBLIOG
Kirkwood, J., Valentine, D.
Home owner response to air sealing information
Proc. 7th AIC Conference, UK, 1986

#**REF USA43** Radon mitigation/ventilation effects
CONTACT
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ADDRESS
Princeton University
Center for Energy and Environmental Studies
Princeton
N.J. 08544
USA
TEL: (609)452 5190 TLX: 499 1258 TIGER
SPECIFIC OBJECTIVES
Evaluate details of house air infiltration and interzone air flows to relate the transport of radon gas from lower levels in seven houses
PROJECT DETAILS
Constant concentration and perfluorocarbon tracer gas techniques would be used in the seven test homes both before and after the radon mitigation procedures. Both air entering the building and air movement within the building are part of this study.
BUILDING TYPE
Single family detached homes
PARAMETERS
Weather, pressure differentials, building design, indoor air quality (radon emphasis), ventilation effectiveness.
#STARTDATE 01:09:1986 #ENDDATE 00:10:1987
#TIME 1600
KEYWORDS Residential, air quality, radon, multi-zone, tracer gas, constant concentration, perfluorocarbon, air infiltration, air flow
BIBLIOG
Harrje, D.T., Dutt, G.S., Bohac, D.L., and Gadsby, K.J., Documenting air movements and air infiltration in multicell buildings using varius tracer techniques
ASHRAE Trans., Vol.91, Part 2, 1985, pp2012-2026
Harrje, D.T., Bohac, D.L. and Nagda, N.L.
Air exchange based on individual room and single cell measurements
Proc. 6th AIC Conf., Netherlands, 1985

Non-Participating Countries

AUSTRALIA

#REF AU1 Air infiltration characteristics of buildings
CONTACT
K.L. Biggs
ADDRESS
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Division of Building Research
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Victoria 3190
Australia
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SPECIFIC OBJECTIVES
Air infiltration of typical Australian houses. Measurement of their overall permeability at 50 Pa pressure difference. Correlation of the two sets of measurements. Study of the effect of constructional details on infiltration rates.
PROJECT DETAILS
Houses are usually single-storey, detached dwellings 120-200 m2 in plan area, of timber frame construction with brick cladding, but some are of full brick with cavity external walls. Naturally ventilated, with gas or electric heating. Infiltration rates are determined using a modified constant concentration technique with N20 tracer gas. Permeability is measured by the pressurization technique. Unoccupied houses are studied.
BUILDING TYPE
PARAMETERS
Weather (wind speed and direction, indoor/outdoor temperature difference), surface area of building, degree of exposure to weather, permeability.
#STARTDATE 01:01:1979 #ENDDATE 0:0:00 On-going
#TIME 0
KEYWORDS Residential, detached house, constant concentration, nitrous oxide, pressurization, pressurization correlation, air infiltration

FRANCE

#REF FRA1 Air infiltration control to save energy in buildings
CONTACT
C. Nicolas
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Electricite de France (EDF)
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Les Renardieres
Departement 'Applications de l'Electricite' BP No. 1
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France
TEL: 6 070 65 83 TLX: 690971 EDF DER F
SPECIFIC OBJECTIVES
Air infiltration reduction without disturbing comfort and increasing moisture.
PROJECT DETAILS
Development of an air infiltration model inside a thermal simulation of building named 'CLIM'. Improvement of this model by describing mechanical ventilation modulate with hygrometry. Research in balanced ventilation and the possibility of heating a building with ventilation.
BUILDING TYPE
PARAMETERS
Temperature, hygrometry, CO2, building equivalent aperture
#STARTDATE 00:00:1982 #ENDDATE 00:00:0000
#TIME 20,000
KEYWORDS Air infiltration, mechanical ventilation, thermal simulation, computer model
BIBLIOG
Nicolas, C.
Materiel de VMC – description calcul aeraulique
Rapport Interne
Nicolas, C., Segura.
Le vecteur air dans l'habitat
Rapport interne EDF
Nicolas, C., Paterour.
Etude d'un systeme de ventilation hygroreglable
Rapport interne

#REF FRA2 Integration of a ventilation model in a detailed thermal simulation code
CONTACT
A. Roldan
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Laboratoire Equipement de l'Habitat – INSA
Bat. 307
20 Avenue Albert Einstein
69621 Villeurbanne Cedex
France
TEL: 78 94 80 94 TLX:
SPECIFIC OBJECTIVES
Modelling of air infiltration and inter-room air flows. Integration of the model in a multi-zone thermal simulation code.
PROJECT DETAILS
At each time step, flows between rooms are calculated by solving a set of non linear equations by an iterative numerical method. Then these flows participate to the thermal equilibrium of each zone. Resulting flows depend on climatic data, and also on ventilation equipment and thermal building behaviour, so the obtained software is very detailed.
BUILDING TYPE
House, apartment, office
PARAMETERS
Wind, humidity, temperature, building components and ventilation equipment, simulated behaviour of occupants.
#STARTDATE 00:12:1984 #ENDDATE 00:12:1986
#TIME 1000
KEYWORDS Residential, office, computer model, air flows, multi zone, simulated occupancy
BIBLIOG
Roldan, A.
Etude thermique et aeraulique des enveloppes de batiment. Influence des couplages interieurs et du multi-zonnage
These de Doctorat, INSA de Lyon, December 1985
Roldan, A., Allard, F., Achard, G.
Integration of an air infiltration model in a multi-zone building thermal simulation code.
Submitted for publication in Energy and Buildings

#REF FRA3 Indoor air quality
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COSTIC
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France
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SPECIFIC OBJECTIVES
To control pollutant concentration levels in French homes. To provide monitoring and control techniques. To study the link between pollutant concentrations, air exchange, energy conservation and health effects.
PROJECT DETAILS
The first part of the program contains five points: 1. General synthesis about indoor air quality. 2. Measurements and studies in situ of radon and daughters in actual French dwellings. 3. Study and models of 'anti radon' systems. 4. Measurement and studies in situ of formaldehyde levels from all origins in French dwellings. 5. Study about tobacco smoke in dwellings.

BUILDING TYPE
Dwellings and 'tertiary rooms'.
PARAMETERS
#STARTDATE 00:10:1984 #ENDDATE 00:00:0000
#TIME 0
KEYWORDS Residential, air quality, radon, radon daughters, formaldehyde, smoking
BIBLIOG
Cadiergues, R.
Un objectif prioritaire, la qualite de l'air
PME Decembre 1984
Cadiergues, R.
Le radon, element essentiel de la qualite de l'air
PME Decembre 1984
Naour, E.
Le radon dans les habitations, un constat
PME Novembre 1985
Naour, E.
La qualite de l'air dans les locaux
Rapport AFME 1986
Donnars, J., Naour, E.
Solutions anti-radon
(not yet published)
Tahon, C., Naour, E.
Le formaldehyde dans l'habitat, un constat
(not yet published)
Togbedji, S., Naour, E.
La fumee de tabac, synthese
(not yet published)

#**REF FRA4** Development and validation of a mathematical model of ventilation.
CONTACT
P. Valton
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Z.I. Berlanne
64160 Morlaas
France
TEL: 59 30 42 90 TLX:
SPECIFIC OBJECTIVES
To develop a mathematical model of ventilation for multi-cell buildings. To make a trial of validation of this model.
PROJECT DETAILS
A mathematical model of ventilation for multi-cell buildings has been developed. This model is based on the solution of the pressure-flow equations between cells. A methodology of study, comparison and validation of models will be developed and used for this model.
BUILDING TYPE
PARAMETERS
Wind, indoor/outdoor temperatures, humidity.
#STARTDATE 00:10:1980 #ENDDATE 00:00:0000
#TIME 0
KEYWORDS Computer model, multi-zone, model validation, air flow
BIBLIOG
Valton, P.
Prevision et controle des taux de ventilation des grandes volumes
Report AFME, April 1985

#**REF FRA5** Estimate and control of ventilation rates in dwellings fitted with controlled mechanical ventilation.
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P. Valton
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SPECIAL OBJECTIVES
To adapt the measurement method used for natural ventilation to dwellings fitted with controlled mechanical ventilation.
PROJECT DETAILS
To settle a measurement method able to (a) determine 'crossing flows', (b) study indoor air exchange between rooms. A study of the level of helium concentrations (and differences) in different parts of different rooms of dwellings was undertaken. A method of visualisation of air exchanges was envisaged.
BUILDING TYPE
Dwellings fitted with controlled mechanical ventilation
PARAMETERS
Wind speed/direction, temperature, controlled mechanical ventilation flows
#STARTDATE 00:10:1985 #ENDDATE 00:10:1986
#TIME 1000
KEYWORDS Residential, mechanical ventilation, air flow, multi-zone

#**REF FRA6** Effects of boundary conditions on air movement in buildings
CONTACT
B. Fleury
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ENTPE/LASH
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69120 Vaulx En Velin
France.
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SPECIFIC OBJECTIVES
Determination of the impact of the type of boundary condition (1st, 2nd, 3rd type, air velocity, conductive or radiative, obstacles) on natural or mixed convection.
PROJECT DETAILS
Numerical approach: 1. Effect of non-uniform boundary conditions in temperature and flux 2. Conjugated problems. 3. Effect of air velocity and pressure as boundary conditions. 4. Impact of obstacles.
BUILDING TYPE
PARAMETERS
Point (3) above
#STARTDATE 00:01:1984 #ENDDATE 00:12:1988
#TIME 0
KEYWORDS Natural convection, air velocity, boundary conditions, air movement
BIBLIOG
Kammerind, M.M.E., Webster, T.
Parasitic power requirements for night ventilated non residential buildings
Lawrence Berkeley Laboratory. USA, 1984.
Ventilation cooling through hollowcore concrete floor slabs in a small office building
Master Thesis, Berkeley, 1984
Influence of boundary condition irregularities on natural convection in buildings
Part 1, ASES Conference, 1986. Part 2, December 1986.

#**REF FRA7** Optimisation of the improvement in airtightness of dwellings (at Sancoins)
CONTACT
F. Wolf and M. Janody
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38317 Bourgoin Jallieu Cedex
France
TEL: (74) 27 28 50 TLX: 900 427 CETIDA
SPECIFIC OBJECTIVES
The airtightness of dwellings can be improved. The impact of certain improvements is measured, in situ. A negative pressure device is used.
PROJECT DETAILS
18 dwellings constructed according to the same principle.

Different permeability treatments are used. The various values of the law of flow are measured and the main infiltration points analysed.
BUILDING TYPE
18 PHENIX detached houses
PARAMETERS
Nature of the leakage treatment used.
#STARTDATE 00:00:1986 #ENDDATE 00:06:1986
#TIME 0
KEYWORDS Residential, detached house, pressurization, airtightness, retrofit

#**REF FRA8** Evaluation of air replacement in a dwelling, using numerical modelling.
CONTACT
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SPECIFIC OBJECTIVES
To forecast the ventilation balance of dwellings when their permeability characteristics, the pressure ranges at the external walls and the desired ventilation flow rates are known.
PROJECT DETAILS
The program solves, by numerical means, the complex equation linking internal pressure, external pressure and controlled mechanical ventilation flow rate. From this, it deduces the incoming flow rates and the outgoing flow rates. At equilibrium, these flow rates are equal to the overall ventilation flow rate. The difference in law of flow of the air terminal devices between the pressurized walls and the negative pressure walls is taken into account.
BUILDING TYPE
Any
PARAMETERS
Law of permeability of external walls, pressure ranges due to the wind (measured or calculated).
#STARTDATE 00:09:1985 #ENDDATE 00:01:1986
#TIME 40
KEYWORDS Computer model, air flow, air infiltration, mechanical ventilation
BIBLIOG
This method outlined in the study 'Permeabilite a l'air des logements neufs' (air permeability of new dwellings) CETE-LYON, March 1983.

#**REF FRA9** Analysis of hygro-adjusted ventilation in zones H1, H2 and H3.
CONTACT
F. Wolfe and M. Kilberger
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38317 Bourgoin Jallieu Cedex
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TEL: (74) 27 28 50 TLX: 900 427 CETIDA
SPECIFIC OBJECTIVES
To determine the operation and savings possible with an approved hygro-adjusted system, according to the climatic zone.
PROJECT DETAILS
All air change parameters are measured – controlled mechanical ventilation of the external walls, humidity of the air, temperature. The simultaneous changes in these parameters combined with the use of a significant numerical model are used to determine, according to the climate, the overall ventilation balance (desired and unwanted).
BUILDING TYPE
3 dwellings with hygro-adjustable ventilation.
PARAMETERS
Climatic parameters (zones Bordeaux, Lyon, Aix).
Technical parameters (ventilation system, quality of the casing).
#STARTDATE 00:09:1985 #ENDDATE 00:08:1986
#TIME 500
KEYWORDS Residential, mechanical ventilation, humidity, computer model, ventilation balance
BIBLIOG
Smaller study carried out at Villefontaine, France. Use of the models established in the study 'Permeabilite a l'air des logement neufs', (CETE-LYON), March 1983).

#**REF FRA10** Procedure for evaluating flow rates of unwanted ventilation.
CONTACT
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SPECIFIC OBJECTIVES
Law of flow of air in the walls for the normal pressure ranges in the building (envelope pressure difference less than 10 Pa). Laboratory study.
PROJECT DETAILS
Study carried out in the CETIAT Laboratories at Orsay. Initial analysis on calibrated elements and then study on ordinary wall elements. For each construction type, the law linking pressure and flow rate is established. The study will enable air replacement in a real situation to be forecast.
BUILDING TYPE
PARAMETERS
Construction system used (type of walls)
#STARTDATE 00:12:1985 #ENDDATE 00:06:1986
#TIME 100
KEYWORDS Walls, air flow, pressurization

HUNGARY

#**REF HUN1** Standard method of heat loss calculation – infiltration heat loss.
CONTACT
(1) A. Zold (2) K. Balazs
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Hungary
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(1) 225931 (2) 224285 ETI H
SPECIFIC OBJECTIVES
Elaboration of the standardised method of heat loss calculation.
PROJECT DETAILS
Thousands of variations of buildings, temperature and wind were investigated by computer and in a wind tunnel. The results of the calculations have been generalised and tabulated for the simplified standardised method. It has been proved that the design conditions of infiltration heat loss differ from those of transmission heat loss.
BUILDING TYPE
Multi-storey buildings
PARAMETERS
#STARTDATE 01:01:1985 #ENDDATE 30:05:1986
#TIME 2000
KEYWORDS Residential, multi-storey, air infiltration, heat loss, wind tunnel model, simulated boundary layer

BIBLIOG
Zold, A.
Design heat load: theoretical problems and a practical solution
Clima 2000, Copenhagen, 1985, Vol 2 p 429-435
K. Balazs, K., Zold, A.
Untersuchung zur Bestimmung des Luftungswarmebedarfs
Heizung, Luftung, Haustechnik. Bd 36/1985/ No.10 p 512-514

REF HUN2 Wind tunnel measurements of pressure distribution over the building envelope for air infiltration calculations
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Hungarian Institute for Building Science (ETI)
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TEL: (36-1) 852 544 Ext 393 TLX: 224285 ETI H
SPECIFIC OBJECTIVES
The compilation of a wind pressure data bank in the form of mean coefficients for different multi-storey buildings of residential type and low-rise industrial building shapes for ventilation and infiltration calculations.
PROJECT DETAILS
Hundreds of wind tunnel runs are accomplished with a number of building geometries; simulations of rural, suburban and urban boundary layers; buildings in free exposure; two types of shelter by upwind adjacent buildings. Data are stored on floppy discs for further analysis and reduction. Comparisons are intended to be made with similar data in the literature.
BUILDING TYPE
4,6 and 10-storey residential, low rise industrial
PARAMETERS
Wind pressure coefficients (will be used in simple single-cell and more complex multi-cell simulation models)
#STARTDATE 01:03:1985 #ENDDATE 30:11:1987
#TIME 4500
KEYWORDS Residential, industrial, external pressure, wind tunnel model, simulated boundary layer, multi-storey
BIBLIOG
Balazs, K.
Wind pressure coefficients for infiltration calculations. Vol.1
ETI Report No.22416, November 1985, Budapest (in Hungarian)
Balazs, K., Zold, A.
Untersuchungen zur Bestimmung des Luftungswarmebedarfs
Heizung, Luftung, Haustechnik, No.10, 1985 (in German)
Balazs, K.
Wind pressure coefficients for infiltration calculations. Vol.2 (1,4 & 6-storey buildings), Vol.3 (Low rise workshop buildings)
Hungarian publication is expected in 1986 and 1987 in the form of ETI Reports

#**REF HUN3** Comparison of infiltration and natural ventilation heat losses between two housing alternatives. A case study.
CONTACT
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TEL: (36-1) 852 544 Ext.393 TLX: 224285 ETI H
SPECIFIC OBJECTIVES
Quantification of differences in annual infiltration heat losses between two different types of housing in the same area.
PROJECT DETAILS
Two housing alternatives of the same total volume are compared. One is a 5-storey pitched roof, the other a 10-storey housing block. Wind tunnel tests at 1:500 scale provide the pressure distribution on a number of instrumented, representative, houses for 16 wind directions. 8x8 array of outdoor temperatures and wind speeds, together with occurrence statistics are used in single cell models to predict infiltration losses.
BUILDING TYPE
5-storey pitched roof, 10-storey block
PARAMETERS
Housing type, building airtightness, ventilation strategies
#STARTDATE 10:03:1986 #ENDDATE 30:07:1986
#TIME 600
KEYWORDS Residential, multi-storey, wind tunnel model, external pressure, air infiltration, computer model
BIBLIOG
Balazs, K.
Effect of architectural and environmental factors on air infiltration of multi-storey buildings
To be presented at ICBEM Conference, September 28 – October 2 1987, Lausanne, Switzerland.

ITALY

#**REF ITL1** PC computer program for calculating infiltration flows in buildings
CONTACT
F. Balduzzi
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Istituto Ricerche Breda
Vile Sarca 336
20126 Mila
Italy
TEL: 0039 2 6430541 TLX: 330895 IRB I
SPECIFIC OBJECTIVES
To build an up-to-date program for calculating air exchanges in buildings without inside partitions or with airtight partitions.
PROJECT DETAILS
State-of-the-art, selection of algorithms, development of computer program
BUILDING TYPE
PARAMETERS
√STARTDATE 00:00:1984 √ENDDATE 00:12:1986
√TIME 1200
KEYWORDS Computer model, air infiltration
BIBLIOG
Balduzzi, F.
Metodi e modelli al calcolatore per il controllo energetico della progetiazione edile ed impiantistica.
Final Report for CNR-PFE Contract No. 83.02951.59, December 1984.

#**REF ITL2** Experimental and theoretical evaluation of air infiltration and distribution in buildings
CONTACT
M.Cali
ADDRESS
Dipartimento di Energetica
Politecnico di Torino
Corso Duca degli Abruzzi 24
10129 Torino
Italy
TEL: (011)556-7406 TLX: 221158 POLI-TO I
SPECIFIC OBJECTIVES
To assess the accuracy of the tracer gas technique (decay method) using N20 and water vapour as tracer gases in a controlled ventilation chamber.
PROJECT DETAILS
An 8m3 test chamber has been equipped with a mechanical ventilation system; the air flow rate is measured directly

with a high precision sensor installed on the air supply duct and compared with the air exchange rate, measured with the tracer gas decay method. Six moveable sampling probes are installed in the chamber in order to assess the ventilation efficiency. An IR analyser is used to measure the N20 concentration; water vapour is monitored by means of a psychrometer.
BUILDING TYPE
PARAMETERS
Ventilation efficiency
#STARTDATE 00:11:1984 #ENDDATE 00:12:1987
#TIME 800
KEYWORDS Experimental cell, tracer gas, decay rate, nitrous oxide, water vapour, mechanical ventilation
BIBLIOG
Sandberg,M., Fracastoro,G.V.
Misure diportata d'aria di ricambio e di efficienza della ventilazione negli edifici
Il Condizionamento, Feb. 1984 (in Italian)
Cali,M., Fracastoro,G.V.
Studio con la tecnica dei gas traccianti delle infiltrazioni d'aria in una camera a ventilazione controllata
Vacchelli, XLI Congresso ATI, Naples, September 1986

JAPAN

#**REF JAP1** Theoretical calculation for infiltration in multi rooms
CONTACT
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Medeshima
Natori
Japan
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SPECIFIC OBJECTIVES
To investigate the calculation for infiltration in multi rooms compared with the measurement results of a detached house.
PROJECT DETAILS
1. Theory: Japanese Calculation of Ventilation (JCV model). 2. Model: A detached house is modelled as two rooms. 3. Leakage: The leakages are distributed uniformly over the envelope. 4. Calculation: With a program written in BASIC and with a personal computer.
BUILDING TYPE
Wooden detached house
PARAMETERS
Indoor and outdoor air temperature, wind speed, wind pressure coefficient, effective leakage area, exponent of pressure difference.
#STARTDATE 00:11:1985 #ENDDATE 00:01:1986
#TIME 60 per month
KEYWORDS Residential, detached house, computer model, air infiltration, multi-zone, model validation
BIBLIOG
Utsumi, Y., Hasegawa, F., Yoshino, H.
Prediction of air infiltration in dwellings. Part 3: Validation study of predicting method for multi room house considering airtightness.
Report for Tohoku branch meeting of the Architectural Institute of Japan, 1986.3. (in Japanese)

#**REF JAP2** Investigation of air quality in schools
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Japan
TEL: 0222 22 1800 ext. 4652 TLX:
SPECIFIC OBJECTIVES
To clarify air quality in schools with different types of heating systems
PROJECT DETAILS
1. Number of schools: 3. 2. Size: 8mx8m for one classroom. 3. Heating system: (a) vented air heater (b) electric convector (c) hot water heating system.
Measurement instrument: infrared thermometer, resistant type thermometer.
Period of measurement: one week.
BUILDING TYPE
School (reinforced concrete)
PARAMETERS
Indoor and outdoor temperature
#STARTDATE 00:01:1986 #ENDDATE 00:00:1988
#TIME 720
KEYWORDS School, air quality, heating system

#**REF JAP3** Numerical analysis of indoor air movement and pollution.
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SPECIFIC OBJECTIVES
The primary aims are predicting the indoor air movement or pollution by computer simulation and evaluating the ventilation systems.
PROJECT DETAILS
The two-equation model of turbulence (k-E) model is applied to the governing equations of room air, and the basic equations are solved by the penalty finite element method. Using this numerical method, the ventilation efficiency is also estimated by the computer simulations.
BUILDING TYPE
Building or house
PARAMETERS
Sol-air temperature and solar radiation, ventilation system, simulated, general gas.
#STARTDATE 00:00:1978 #ENDDATE 00:00:1988
#TIME 12,000
KEYWORDS Residential, air quality, air flow, computer model, ventilation system, ventilation efficiency, air movement
BIBLIOG
Matsumoto, H., Hasegawa, F., Utsumi, Y.
Numerical analysis of room air distribution by the finite element method
Transactions of AIJ No.352, 32-40, 1985
Matsumoto, H., Hasegawa, F., Utsumi, Y.
Diffusion of air pollutant in room – numerical method to predict the concentration of air pollutant.
Preprint (to be submitted to Transactions of AIJ).

#**REF JAP4** Numerical simulation of room air convection by means of three-dimensional techniques.
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SPECIFIC OBJECTIVES
The main purpose of this investigation is to verify the numerical simulation of the distribution of air velocity and the contaminant diffusion in a room.
PROJECT DETAILS
1. 3-D numerical simulation of room air is based on a turbulence model. 2. Numerical integration is conducted following the MAC method. 3. Validation of numerical simulation is conducted by comparing the predicted values with the experimental results. 4. In the model experiment, 3-D turbulence components are measured by tandem-type parallel hot wire anemometer.
BUILDING TYPE
Room
PARAMETERS
Distribution of gas concentration in the room with respect to the location of contaminant source.
#STARTDATE 00:04:1984 #ENDDATE 00:03:1988
#TIME 16,000
KEYWORDS Room, air flow, air quality, computer model, model validation, turbulence
BIBLIOG
Murakami, S., Kato, S.
Three-dimensional numerical simulation of turbulent air flow in ventilated room by means of 2-equation model. International Symposium of Computational Fluid Dynamics, Tokyo, Japan, 1985.

#**REF JAP5** Experimental study on natural ventilation of dwelling
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SPECIFIC OBJECTIVES
The influence of opening conditions such as window, door, etc. on natural ventilation are investigated by means of field experiment with the full-scale house and by means of the wind tunnel experiment.
PROJECT DETAILS
1. Test house is 2-storey, size approx. 6.3m wide x 8m deep x 10m high. 2. Characteristics of ventilating system are analysed. 3. Approaching wind and the distribution of wind pressure near the opening were measured. The air velocity through the open window was measured and the air change rate was calculated. The distribution of ASHRAE's new ET is calculated using the velocity distribution of the room.
BUILDING TYPE
Wooden house
PARAMETERS
Wind speed, wind direction, shape of opening, configuration of house.
#STARTDATE 00:04:1983 #ENDDATE 00:03:1987
#TIME 3000
KEYWORDS Residential, house, air infiltration, wind tunnel model, ventilation system, fullscale, window opening
BIBLIOG
Akabayashi, S., Murakami, S.
Experimental study of natural ventilation of dwellings. Part 4: Estimation of air change rate by tracer gas method with wind tunnel experiment.
Summaries of technical papers of Annual Meeting of Architectural Institute of Japan, 1985.

#**REF JAP6** Experimental study on passive solar system by means of full scale test houses.
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TEL: 03 402 6231 TLX: 0242 3216 IISTYO J
SPECIFIC OBJECTIVES
The main purpose of this investigation is to verify the transportation system of the solar heat gain from south-facing windows to north side room.
PROJECT DETAILS
1. The same two test houses were constructed. One called 'Air Circulation Type' was equipped with air circulation system, the other called 'Ordinary Type' was not equipped. 2. Temperature distribution in both houses was measured and compared. The efficiency of the air circulation system was estimated. 3. The air circulation rate in the 'Air Circulation Type' house was estimated.
BUILDING TYPE
Wooden house
PARAMETERS
Wind speed, wind direction, solar radiation, shape of room, shape of window.
#STARTDATE 00:02:1982 #ENDDATE 00:02:1987
#TIME 2000
KEYWORDS Residential, test house, passive solar, air flow, natural convection
BIBLIOG
Kobayashi, N., et al
Experiments on passive solar system with full-scale test houses. Air circulation technique for heating rooms using solar heat gain taken at south windows.
Solar World Congress, Proceedings of 8th Biennial Congress of the International Solar Energy Society, Perth, Australia, 14-19 August 1983 (Ed. S.V. Szokolay, Pergamon Press).

#**REF JAP7** Investigation of annual variation of indoor concentration of radon and its daughters in Hokkaido.
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SPECIFIC OBJECTIVES
1. To determine pollutant level of radon in Hokkaido residences. 2. To determine the interaction of pollutant level with (a) building materials and (b) air change rate.
PROJECT DETAILS
1. A preliminary survey of 18 residences has been undertaken for radon gas. 2.A follow-up survey of radon has been undertaken in a well insulated and airtight residence. 3. Construction types are wood, concrete block and reinforced concrete. 4. Measurement of air change rate with tracer gas.
BUILDING TYPE
House and apartment
PARAMETERS
Type of building material, air change rate, airtightness.
#STARTDATE 01:01:1985 #ENDDATE 01:12:1987
#TIME 200

88

KEYWORDS Residential, radon, radon daughters, air quality, air infiltration, tracer gas, airtightness
BIBLIOG
Ochifuji, K., Yokoyama, S.
Investigation of annual variation of indoor concentration of radon and its daughters in Hokkaido
Annual Meeting of Society of Heating, Airconditioning and Sanitary Engineering of Japan, October 1986.

#**REF JAP8** Study of air infiltration in a detached house installed with air-to-air heat exchangers
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SPECIFIC OBJECTIVES
To measure temperature and humidity for a long term and to measure infiltration rates in multi rooms using one tracer gas.
PROJECT DETAILS
1. Number of houses: one detached house. 2. Size: 130 m2. 3. System: the house has central air heating unit and air-to-air heat exchangers. 4. Instruments: thermo couples, infrared carbon dioxide measuring instrument, anemometer, manometers and sensors of humidity.
BUILDING TYPE
Wooden, detached house
PARAMETERS
Wind speed, wind pressure coefficient, concentration of carbon dioxide, temperature and humidity.
#STARTDATE 01:04:1986 #ENDDATE 00:11:1986
#TIME 240
KEYWORDS Residential, detached house, multi-zone, tracer gas. air infiltration, heat exchanger, humidity

#**REF JAP9** Study of indoor air quality in well-insulated and airtight houses
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SPECIFIC OBJECTIVES
1. To measure infiltration rates of airtight houses under various outdoor conditions. 2. To measure concentration of pollutants for a long term. 3. To establish the method to predict infiltration rates.
PROJECT DETAILS
1. Numbers of houses: two airtight detached houses. 2. Size: 80-90 m2. 3. System: the houses have vented kerosene heaters. 4. Instruments: manometers, anemometers, measurement resistors, infrared carbon monoxide and carbon dioxide measuring instrument and portable nitrogen dioxide measuring instrumentation.
BUILDING TYPE
Wooden detached houses
PARAMETERS
Wind speed, wind pressure coefficient, indoor and outdoor temperature, leakage areas and concentrations of CO, CO2 and NO2
#STARTDATE 00:07:1986 #ENDDATE 00:03:1988
#TIME 400
KEYWORDS Residential, detached house, air infiltration, air quality, airtightness

POLAND

#**REF POL1** A method for the removal of exhaust air by means of a central supply air and exhaust air system
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SPECIFIC OBJECTIVES
Reduction of noxious substance concentrations in ventilated rooms by a central supply air and exhaust air sytem.
PROJECT DETAILS
The method for the removal of polluted exhaust air and for ventilation, uses a central supply air and exhaust air system and eliminates the problem of secondary penetration of pollutants into industrial buildings due to emission from nearby sources situated at a lower level. The principle of this method consists of aspiring the external air instead of the weather-side air, since the aspiration aperature is stationary and is situated above the exhaust air aperature which itself is directed to the lee-side.
BUILDING TYPE
PARAMETERS
Air pollutants concentration, wind velocity, relative air humidity, air temperature, specific enthalpy.
#STARTDATE 01:01:1977 #ENDDATE 31:12:1988
#TIME 0
KEYWORDS Industrial, air quality, mechanical ventilation, pollution removal
BIBLIOG
Trojanowski, T.J.
Abfuhrung verunreinigter Luft durch eine zentrale Zu- und Fortluftanlage. Staub-Reinhalt. der Luft. 45 1985 nr. 5, S.224-228.

SAUDI ARABIA

#**REF SDA1** Energy conservation on the campus of the University of Petroleum and Minerals
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Saudi Arabia
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SPECIFIC OBJECTIVES
To identify the major energy consuming areas of the university campus and to recommend practical solutions to reduce the consumption.
PROJECT DETAILS
The first phase deals with an engineering review of the buildings, collection of energy data and analysis of this

data as well as evaluation of systems performance.
BUILDING TYPE
Offices, classrooms, residential, commercial
PARAMETERS
Infiltration will be included in the second phase
#STARTDATE 00:05:1985 #ENDDATE 00:12:1986
#TIME 6400
KEYWORDS University, energy conservation, air infiltration
BIBLIOG
Seasonal performance of a central conditioner in Dhahran, Saudi Arabia – a computer simulation study
Rev. Int. Froid., Vol.8, September 1985
First interim report
February 1986
A preliminary assessment of energy conservation in the campus of the University of Petroleum and Minerals, Saudi Arabia.
(in process)

APPENDIX 1

SURVEY FORM

Air Infiltration Centre's Survey Form for
Current Research into Air Infiltration and Related Air Quality Problems in Buildings

For office use only	
££T # REF	Title of project
££N CONTACT ££T	Principal researcher
££N ADDRESS	Organisation
	Address
	Telephone Telex
# infodate	Date survey form completed <
££N DESCRIP	**Description of Project**
	Specific objectives
££P <	Project details
££P <	Building and/or component type
££P <	Parameters with which infiltration and indoor air quality will be related
	<
# startdate	Date project began
# endate	Expected termination date
# time	Estimated number of man hours
££N KEYWORDS	
££N BIBLIOG	Important reports and publications, both past and future (titles, authors, publishers, dates of publication)
££A	*Please return completed form to:* *The Air Infiltration Centre, Old Bracknell Lane West, Bracknell, Berkshire RG12 4AH, Great Britain.*

APPENDIX 2

KEYWORDS

THESAURUS OF KEYWORDS

1. Buildings
    - residential
        - house
            - detached house
            - terraced house
            - row house
            - passive solar house
            - airtight house
            - low energy house
            - experimental house
            - test house
            - indoor test house
        - apartment
        - mobile home
    - commercial building
        - office
        - swimming pool
        - theatre
        - covered tennis court
    - industrial building
        - factory
        - offshore platform
        - freight container
    - institutional building
        - library
        - childrens'home
        - school
        - university
        - hospital
    - multi-storey
    - building design
    - construction details

1.1 Rooms
- attic
- crawlspace
- laboratory
- lecture theatre
- experimental cell
- test room
- climatic chamber

1.2 Building components
- walls
    - cavity wall
    - party wall
- facade
- floor
- roof
- vapour barrier
- chimney performance
- flue
- single opening
    - door
    - window
- climate-facade

2. Measurement techniques
    - smoke visualisation
    - thermograhy
    - measurement accuracy
    - test accuracy

2.1 Pressurization
- air leakage
    - airtightness
    - leakage reduction
    - leakage path
    - cracks
    - background leakage
- presurization correlation
- ac pressurization
- blower door
- balanced fan

2.2 Tracer gas
- air infiltration
    - air movement
    - natural convection
    - forced convection
    - turbulence
    - boundary conditions
    - air flow
- tracer decay
    - decay rate
- constant concentration
- constant emission
- passive sampling
- mixing
- multi-tracer
- multi-zone
- gases
    - freons
    - nitrous oxide
    - perfluorocarbons
    - sulphur hexafluoride
    - carbon dioxide

3. Air quality
    - minimum ventilation rate
        - short circuiting
        - pollution removal
        - contaminant flow
        - moisture
        - humidity
        - condensation
    - pollutants
        - carbon monoxide
        - carbon dioxide
        - formaldehyde
        - nitric oxide
        - nitrogen dioxide
        - sulphur dioxide
        - suspended particles
        - microbiological pollutant
        - volatile organic compounds
        - odour
    - radioactivity
        - radon
        - radon daughters
        - radon control
    - smoke
        - smoking
        - smoke control

4. Ventilation
    - Ventilation systems
        - mechanical ventilation
        - ventilation installation
        - ventilators
    - ventilation requirements
    - ventilation strategies
    - ventilation balance
    - ventilation control
    - ventilation efficiency

5. Energy
    - energy consumption
    - energy conservation
    - retrofit
        - remedial measures
        - draughtproofing

heating system
  heat exchanger
heat loss
heat recovery

6. Occupancy
   - occupant behaviour
     - questionnaire
     - window opening
     - ventilation control
   - occupant comfort
     - thermal comfort
     - draughts
   - occupant health
   - occupant satisfaction
   - simulated occupancy

7. Models
   - computer model
     - computer validation
     - model validation
   - mathematical model
     - prediction methods
   - numerical model
   - theoretical model
     - thermal simulation
   - wind tunnel
     - scale model
     - simulated boundary layer

8. Miscellaneous
   - standards
   - guidelines
   - literature survey
   - database
   - internal pressure
   - external pressure
   - stack effect
   - air intake
   - air velocity
   - component development
   - evaporation
   - fire spread
   - valuable air volume
   - water penetration

ALPHABETICAL INDEX TO THESAURUS

APPENDIX 3

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