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1994 Survey of Current Research into Air Infiltration and Related Air Quality Problems in Buildings

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Mark J Limb

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PREFACE

International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an International Energy Programme. A basic aim of the IEA is to foster co-operation among the twenty-one IEA Participating Countries to increase energy security through energy conservation, development of alternative energy sources and energy research development and demonstration (RD&D).

Energy Conservation in Buildings and Community Systems

The IEA sponsors research and development in a number of areas related to energy. In one of these areas, energy conservation in buildings, the IEA is sponsoring various exercises to predict more accurately the energy use of buildings, including comparison of existing computer programs, building monitoring, comparison of calculation methods, as well as air quality and studies of occupancy.

The Executive Committee

Overall control of the programme is maintained by an Executive Committee, which not only monitors existing projects but identifies new areas where collaborative effort may be beneficial.

To date the following have been initiated by the Executive Committee (completed projects are identified by *):

I	Load Energy Determination of Buildings*
II	Ekistics and Advanced Community Energy Systems*
III	Energy Conservation in Residential Buildings*
IV	Glasgow Commercial Building Monitoring*
V	Air Infiltration and Ventilation Centre
VI	Energy Systems and Design of Communities*
VII	Local Government Energy Planning*
VIII	Inhabitant Behaviour with Regard to Ventilation*
IX	Minimum Ventilation Rates*
X	Building HVAC Systems Simulation*
XI	Energy Auditing*
XII	Windows and Fenestration*
XIII	Energy Management in Hospitals*
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XV	Energy Efficiency in Schools*
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Annex V Air Infiltration and Ventilation Centre

The Air Infiltration and Ventlation Centre was established by the Executive Committee following unanimous agreement that more needed to be understood about the impact of air change on energy use and indoor air quality. The purpose of the Centre is to promote an understanding of the complex bahaviour of air flow in buildings and to advance the effective application of associated energy saving measures in both the design of new buildings and the improvement of the existing building stock.

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

INTRODUCTION

An important objective of the Air Infiltration and Ventilation Centre is to disseminate information related to infiltration, ventilation, indoor air quality and energy use within buildings. The Survey of Current Research provides a platform for such an activity by supplying organisations in participating countries with regularly updated information about ongoing research in these fields. In particular, the major objectives of this survey are to encourage the international cross fertilization of research ideas and to promote co-operation between research organisations in different countries.

Continuing interest in this research area has meant that, since 1980 when the first survey was conducted, there has been an increase in reported research projects of nearly 400%, seen diagrammatically in Figure 1.

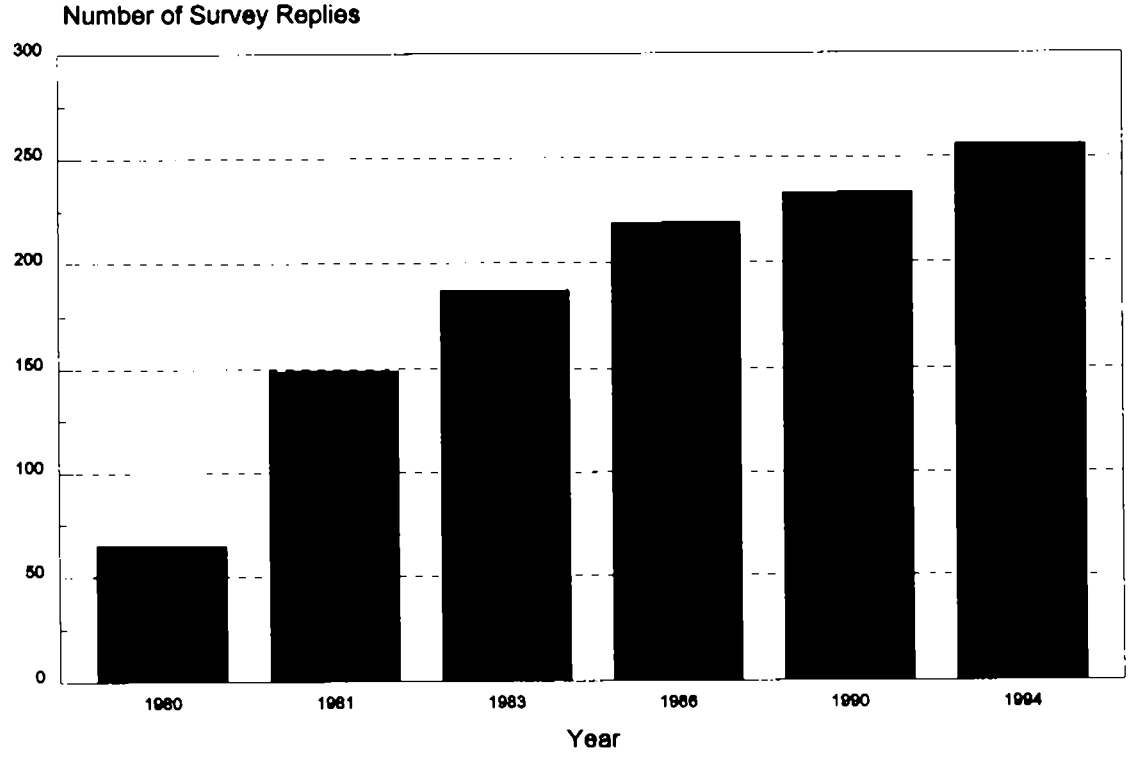

Figure 1 Air Infiltration, Ventilation and Indoor Air Quality - Trends in Research

In this, the latest survey, a total of 256 replies have been received from seventeen different countries. The origin and distribution of these are outlined in Figure 2.

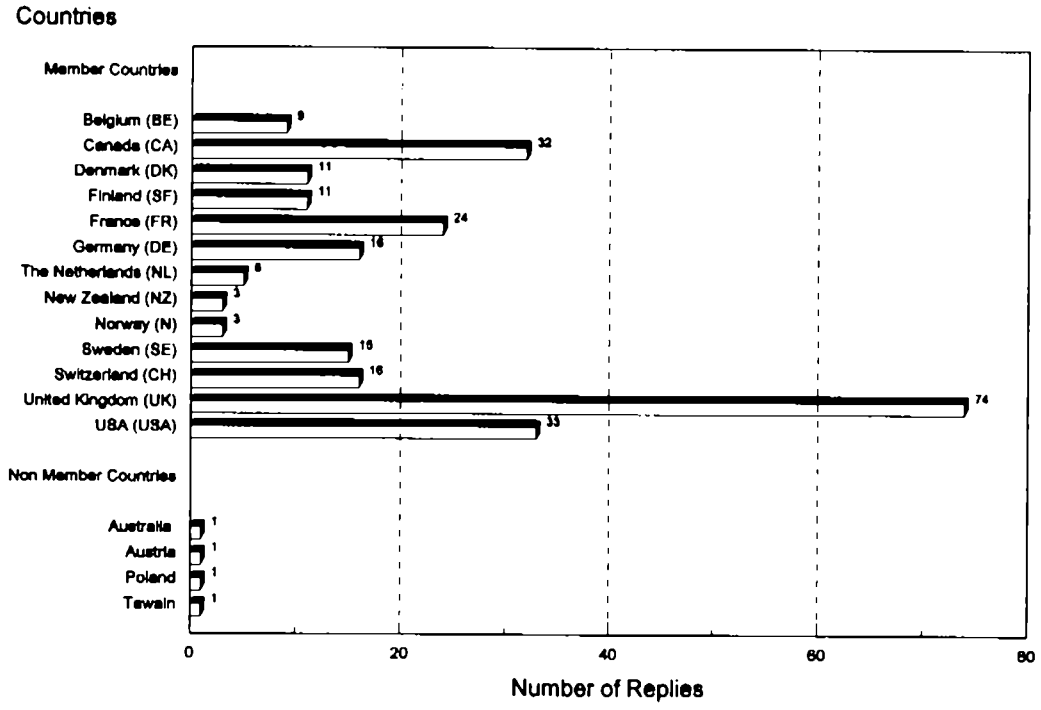

Figure 2 Distribution and Origin of Survey Replies

Each survey form received has been coded, both in numerical order and the country of origin. For example, BE01, is reply number 1 from Belgium. A complete list of survey replies, indexed by country of origin, are given in Section Two.

The survey forms have also been organised under several headings, which are the basis for the analysis in Section One, including for example, Specific Objectives, Project Details, Building and Component Type, etc. This analysis is presented in two ways. Firstly, where possible, a pie chart gives a broad overview of the number of replies received under various sub-headings for particular categories. Secondly, a more in depth examination is given by a series of tables outlining the reference of each survey entry that falls under particular sub-headings. From these tables individual research projects can be easily identified and with further reference to Section Two, can be more fully understood.

The information presented in Section Two is also available in database format. Full details of how to receive this database can be obtained directly from the AIVC, at the address given on the front cover of this publication.

Researchers' contact addresses are outlined in Appendix A. Principal researchers are listed in Appendix B together with their relevant research projects and an copy of the survey form is reproduced in Appendix C.

The preparation of this report was only possible because of the cooperation of the researchers in forwarding details of their studies and their valuable contribution is gratefully acknowledged.

SECTION ONE

ANALYSIS OF RESULTS

1.1 Specific Objectives

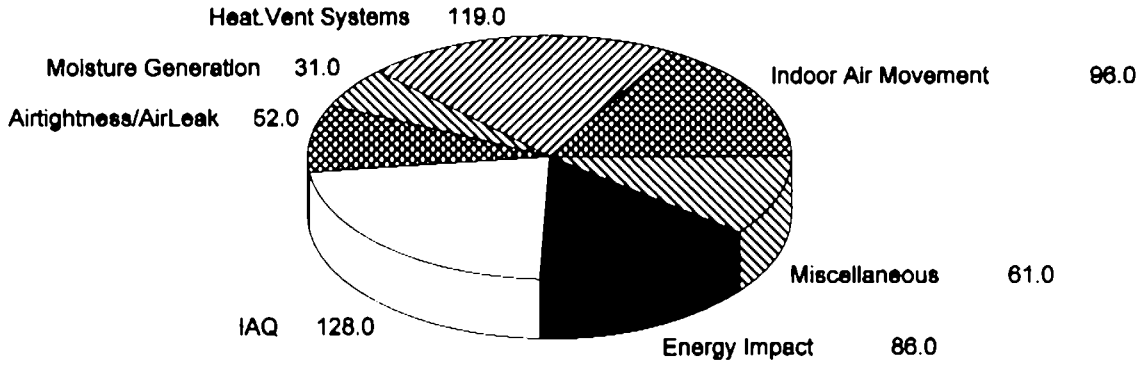

Figure 1.1.1 Classification of Specific Objectives

Specific objectives are outlined in Figure 1.1.1 and Table 1.1.1.

The most popular objectives are those relating to Indoor Air Quality (128 replies) and Heating and Ventilation Systems (119 replies). Indoor Air Movement and Energy Impact studies can be identified next, with 96 and 86 replies respectively.

The final two main categories are Airtightness/Air Leakage, with 52 replies and Moisture Generation with 31 replies. The remaining 61 replies can be classified as miscellaneous, of which there are 13 different sub divisions. These include Thermal Comfort, Soil Gas Studies, Model Development, CFD Evaluation and Research into Passive Cooling. Under the miscellaneous category the largest number of replies (13) related to soil gas studies. The other main area of interest was thermal comfort with 10 replies.

Table 1.1.1 Specific Objectives

Indoor Air Movement (98 replies)

Belgium	1,4,6,8
Canada	1,2,4,6,8,10,11,24,26,27,28
Denmark	6,7,8,9,10,11
Finland	7
France	2,4,5,6,7,8,10,12,18,20,21,22
Germany	2,3,4,5,6,8,11,14,15,16
Norway	3
Netherlands	1,4
Sweden	1,5,7,8,12
Switzerland	5,6,8,9,10,11,16
United Kingdom	5,6,7,10,11,17,18,19,20,21,22,24,25,32,35,37,38,39,40,52,55,66,67,70,71
USA	4,8,9,11,17,18,22,24,26,29,30,33
Poland	1
Taiwan	1

Heating and Ventilation Systems and Strategies (119 replies)

Belgium	1,2,4,5
Canada	1,2,4,5,7,10,11,13,17,18,19,21,22,26,27,28
Denmark	9
Finland	1,2,5,8,10,11
France	1,2,3,5,6,10,12,17,18,20,21,22
Germany	2,4,6,10,13,14,16
Netherlands	1,2,3,4
New Zealand	2
Norway	2,3
Sweden	2,4,5,6,7,9,12,13,14,15
Switzerland	1,2,3,4,7,13,14
United Kingdom	1,5,7,10,12,15,16,17,18,19,20,21,22,25,26,28,31,32,36,41,42,45,53,55,56,58, 59,60,61,68,69,73,74
USA	2,4,7,9,10,12,17,20,22,23,26,29,30,31,32
Austria	1

Moisture and Mould Generation (31 replies)

Belgium	3,4
Canada	4,6,8,14,16,20,27
Finland	7
France	11,21
New Zealand	1,3
Norway	3
Switzerland	15
United Kingdom	19,24,25,26,29,33,39,46,66,67,73,74
USA	1,14,17

Airtightness/ Air Leakage (51 replies)

Belgium	2,3,5
Canada	2,4,6,7,8,11,12,23,27,29,30,31
Finland	7,9,11
France	7,11,20
Germany	5,8,16
New Zealand	1,3
Sweden	5,7,12
Switzerland	6,8
United Kingdom	2,3,4,17,22,25,26,31,46,47,48,52,61,62,64
USA	1,4,17,26
Poland	1

Indoor Air Quality (IAQ) (128 replies)

Belgium	4,5,7,8,9
Canada	2,4,6,7,8,9,10,15,20,25,30,31,32
Denmark	1,6,7,8
Finland	3,5,6,7,8,10,11
France	1,3,6,7,9,10,11,12,13,14,15,16,17,18,19,21,23,24
Germany	1,2,3,5,6,8,16
Netherlands	1
New Zealand	3
Norway	1,3
Sweden	2,3,4,5,6,8,11,13
Switzerland	1,2,4,5,8,9,14,15,16
United Kingdom	1,8,9,10,11,13,14,17,18,23,24,25,27,29,35,37,38,41,48,51,5 5,56,59,65,68,69, 70,71,72,73
USA	2,5,7,8,9,10,11,13,15,16,18,20,21,23,25,26,27,28,29,32,33
Australia	1
Poland	1

Energy Impact (86 replies)

Belgium	2,4,5,6,7
Canada	5,7,17,19,28,30,31
Denmark	9
Finland	6,7,9
France	7,10,12,18
Germany	5,6,8,13,16
Netherlands	1,3
New Zealand	3
Norway	2,3
Sweden	3,4,6,9,10,12,14
Switzerland	1,3,4,6,7,9,12,13,14,16
United Kingdom	2,6,7,9,10,11,12,15,16,17,18,22,27,31,32,36,45,46,49,52 ,53,54,55,58,59, 61,62,70,71,72
USA	1,9,11,16,17,26,24,29
Poland	1

Specific Objectives - Miscellaneous (61 replies)

Thermal Comfort (10 replies)

Belgium	1,4
Canada	1,24
France	9
Germany	2
Switzerland	6,14
United Kingdom	41
USA	6

Standards/Codes/Guidelines (4 replies)

Canada	9
United Kingdom	51,63
USA	20

7.3 Soil Gases (Radon) (13 replies)

Belgium	9
Canada	15
Finland	11
Netherlands	2
Switzerland	4
Sweden	7
United Kingdom	13,14,57
USA	3,21,22,27

External Pollutants (8 replies)

Finland	4,6
France	13,14,15,16
Switzerland	4
United Kingdom	61

Occupant Reaction (3 replies)

Canada	25
France	17
United Kingdom	65

Passive Cooling (2 replies)

Belgium	6
Switzerland	3

Model Development (11 replies)

Germany	12
Switzerland	11,12
United Kingdom	34,40,43,50,62
USA	12,13,19

CFD Evaluation (4 replies)

United Kingdom	20,21,30
USA	30

Survey of Research (1 reply)

Netherlands	5

Retrofit Measures (1 reply)

Canada	23

Pitched Roofs (1 reply)

Belgium	3

Allergies (2 replies)

France	19
United Kingdom	73

HVAC (1 reply)

France	19

1.2 Project Details

Project details are summerised in terms of Measurement Analysis and Theoretical Studies in Table 1.2.1.

1.2.1 Measurement Analysis:

Measurement Studies cover 21 broad categories. The largest being Energy Consumption/Heat Loss/Airtightness which accounts for 54 replies. Tracer Gas Studies attracted 38 replies with a further 5 studies using PFT techniques. Indoor air quality studies realised 37 replies, 20 projects focused on thermal comfort, 6 on moisture and 2 simply on general comfort. Measurement analysis on ventilation systems reported 5 studies. A more detailed analysis of the Indoor Climate based on the above replies revealed Thermal Comfort/Draughts representing the largest division, accounting for 31 replies. IAQ/Occupant Sensitivity/Perceived IAQ represents the second popular area of research with 29 replies.

1.2.2 Theoretical Analysis:

Theoretical and Numerical Studies covered 17 broad categories which fall into three main groups; Modelling/Simulation, Surveys/Databases and Ventilation and Heating Systems.

The largest category in the former section includes Air Quality/Pollution and Thermal Comfort Models with 40 replies. Thermal Modelling has 36 replies and Airflow Modelling (General/Multi Zone and Single Zone) has a combined total of 53 replies. The second group can be divided into three subject areas, the largest being the use of Surveys/and Questionnaires etc., having a total of 47 replies. Studies contributing to the development of Standards and Guidelines account for 38 replies, 10 replies are using or developing Databases or Expert Systems. Two hundred and ten replies covering eleven ventilation and heating system combinations are outlined in the third section. The largest of these classifications is mechanical ventilation and HVAC systems in general, with a total of 79 replies. Other specific mechanical ventilation systems included Demand Controlled Ventilation with 7 replies and Displacement Systems with 12 replies. Research into Natural Ventilation Systems were identified by 28 replies.

Table 1.2.1 Project Details

Measurement Analysis

Tracer Gas Techniques (38 replies)

Belgium	6,8,9
Canada	10,12,13,26
Finland	5,11
France	18
Germany	2,5,6,7,9,14
New Zealand	2
Norway	1,3
Switzerland	16
United Kingdom	13,19,20,22,33,35, 36,37,38,39,46,55, 62,63,67
USA	9,21
Poland	1

Passive Tracer Techniques (PFT's) (5 replies)

Canada	5,7
France	20
Germany	6
Sweden	5

Pressurisation/Depressurisation (20 replies)

Canada	3,6,22,29
France	20
Germany	9,16
Sweden	5
Switzerland	16
United Kingdom	2,3,4,14,35,38,46, 47,62,63
Poland	1

Airflow Measurements General (29 replies)

Belgium	6,7,8
Canada	24
Denmark	4
Finland	3,5,11
France	2,4,22
Germany	4,6
Norway	1
Sweden	5,7
Switzerland	1,7,10
United Kingdom	2,9,18,32
USA	21,22,32,33
Taiwan	1

Energy Consumption/Heat loss/ Airtightness (54 replies)

Belgium	2,4,5,6
Canada	19,23,29,30,31,32
Denmark	2
Finland	8,9
France	12
Germany	16
Netherlands	3
New Zealand	1,3
Norway	1
Sweden	5,9,10
Switzerland	3,4,6,12
United Kingdom	2,3,9,16,27,31,41, 44,45,46,47,48,49, 52,54,55,59,62,64, 69
USA	1,5,8,16,17,22,24

Internal/External Pressure Differences (9 replies)

Belgium	9
Canada	10,11
Finland	11
Germany	9
United Kingdom	14,52
USA	1,25

Flow Visualisation (9 replies)

Canada	6,18
Switzerland	10
United Kingdom	35,38,40,46,48
Poland	1

Thermography (3 replies)

USA	6,8
Poland	1

Wind Tunnel Models (3 replies)

Canada	27
United Kingdom	37,61

Environmental Assessment (1 reply)

United Kingdom	1

Test Method - Validation (1 reply)

Canada	3

Laboratory Test Facilities (17 replies)

Belgium	6
Canada	18
Denmark	5,6,7
Finland	6,8
France	18,22
Switzerland	14
United Kingdom	2,4,16,74
USA	1,27
Taiwan	1

Thermal Stratification (4 replies)

Canada	24
Denmark	4
Switzerland	7

Indoor Air Quality (IAQ) (37 replies)

Canada	30,32
Denmark	3,6
France	12,13,14,15,16,17, 18,19,23,24
Sweden	2,5,6
Switzerland	2,4
United Kingdom	23,29,55,59,65,69, 73,74
USA	1,7,8,14,21,25,26, 29,32
Australia	1

Thermal Comfort (20 replies)

Germany	1,4
Canada	25,28
Denmark	3
Finland	1,2
France	12,17
Germany	2
Sweden	5
Switzerland	4,7,15
United Kingdom	41,45,55
USA	8,9,33

Comfort (2 replies)

Belgium	1
France	4

Moisture (6 replies)

France	20
Switzerland	15
United Kingdom	33,66,67,73

Outdoor Temperature (5 replies)

Canada	5
France	18,20
United Kingdom	73,74

Indoor Temperature (6 replies)

France	18,20
Switzerland	15
United Kingdom	65,73,74

Ventilation Sytstems (5 replies)

Canada	32
Finland	10
France	18,22
Sweden	15

Ventilation Systems Cleaning (1 reply)

Finland	10

Analysis of Indoor Climate

Carbon Dioxide (CO_2) (21 replies)

Belgium	8
Canada	4,6,7
Finland	3
France	1,12,17
Germany	16
Norway	1,3
Sweden	2,5
United Kingdom	9,19,41,43,55
USA	9,21
Australia	1

CO/Combustion (11 replies)

Canada	4,6,13
France	12,17
Norway	1
United Kingdom	19,23
USA	9,13
Australia	1

Formaldehyde/HCHO (6 replies)

Canada	4,7,30,32
United Kingdom	29
USA	25

Nitric Oxide / Nitrgen Dioxide (NOx) (2 replies)

United Kingdom	23,29

Moisture/Condensation (20 replies)

Belgium	3,8
Canada	4,6,7,14,16
Finland	3
Netherlands	4
Sweden	6
United Kingdom	14,19,28,39,56,73,74
USA	1,9,14

Relative Humidity (13 replies)

Canada	4,6,7
Finland	3
New Zealand	1
Sweden	5,6
Switzerland	15
United Kingdom	19,51,65,74
USA	15

Odour (6 replies)

Finland	3
France	16
Sweden	2
Switzerland	17
United Kingdom	48,55

Radon (3 replies)

Belgium	9
Canada	7
Denmark	1
Finland	11
Germany	16
Netherlands	2
United Kingdom	14
USA	3,21,22,25,27,28

Soil Gases inc. Petroleum Hydrocarbons/Methane/VOC's (2 replies)

Canada	15
United Kingdom	57

Tobacco Smoke (ETS) (2 replies)

United Kingdom	8
USA	9

Particles/Particulates (9 replies)

Canada	7
France	12,19
Sweden	5,2
USA	2,9,25,29

Thermal Comfort/Draught (31 replies)

Belgium	1,4
Canada	1,3,25
Denmark	3
Finland	1,2,8
France	2,4,5,12,17
Germany	2
Sweden	5,12
Switzerland	4,6,7,9
Netherlands	1
United Kingdom	10,11,18,41,44,55
USA	6,8,9

IAQ/Occupant Sensitivity/Perceived IAQ (29 replies)

Canada	2,4,20
Denmark	6
Finland	3,5,10
France	9,12,13,17,19
Norway	1
Sweden	4,8,11
Switzerland	7
United Kingdom	11,24,25,27,65,73
USA	9,25,26,29,32
Australia	1

VOC/TVOC's (24 replies)

Canada	4,7,15,32
Finland	3
France	1,12,14,15,16
Germany	16
Norway	1
Sweden	2,4,6
Switzerland	2
United Kingdom	29,65
USA	7,9,10,25,29
Australia	1

Spores/Bacteria/Moulds/Fungi (11 replies)

Canada	4,6,8,14,16
Finland	10
France	19
Germany	16
United Kingdom	29
USA	10,15

B16. Dust (14 replies)

Canada	4,8
Finland	10
Germany	16
Norway	1
New Zealand	1,3
United Kingdom	26,29,33,51,65,73, 74

Indoor Temperature (1 reply)

United Kingdom	65

SO_2 (1 reply)

Australia	1

Ozone (O_3) (1 reply)

Australia	1

Theoretical Analysis

Airflow Modelling General (27 replies)

Belgium	6
Canada	16,18
Denmark	7,9,11
France	4,10,22
Germany	7,10
Netherlands	1
Sweden	1
Switzerland	1,9
United Kingdom	5,8,17,30,40,43
USA	12,18,22,30,33
Poland	1

Multi zoneModellig (23 replies)

Belgium	8
Finland	4,7
France	18,20,21
Germany	6,8
Sweden	15
Switzerland	5,8,11,12
United Kingdom	21,34,39,50
USA	9,11,17,22,24
Poland	1

Single Zone (3 replies)

United Kingdom	21,35,39

Air Quality/ Pollution Models/Thermal Comfort (40 replies)

Belgium	8
Canada	16,28,29
Denmark	1,8
Finland	2,4,7
France	8,9,10,13,17,18,20, 21
Sweden	7
Switzerland	4,12,15
United Kingdom	8,21,23,30,35,37, 60,66,67,74
USA	9,13,16,19,22,23, 24,25,33

Climate Modelling (1 reply)

United Kingdom	49

Computational Fluid Dynamics (CFD) (27 replies)

Denmark	10
France	5,8,10,18
Germany	15
Netherlands	1
United Kingdom	5,10,11,12,20,21,30, 34,35,36,37,38,39, 50,53,55,58,64
USA	18,30

Model Validation (20 replies)

Denmark	7,8,11
Finland	7
France	10,13
Germany	6,8
Switzerland	5,8
United Kingdom	10,18,34,62,66
USA	1,9,12
Poland	1
Taiwan	1

Scale Models (3 replies)

Denmark	11
Switzerland	9
United Kingdom	40

Building Energy Simulation (1 reply)

Switzerland	12

Ventilation System Modelling 16 replies)

France	10
Netherlands	5
Sweden	1,14,15
Switzerland	13,14
United Kingdom	16,17,63,68
USA	19,20,23,25,31

Thermal Modelling (26 replies)

Belgium	6
Canada	1,29
Denmark	4,10,11
Finland	2,7
France	5,6,7
Germany	3,6,8,10,11,12
Sweden	12
Switzerland	3,6,7,9,16
United Kingdom	7,12,15,16,18,34, 50,53
USA	1,6,9

Expert Systems Development (2 replies)

Canada	27
United Kingdom	40

Develop/Use Databases (8 replies)

Canada	1,11
France	12
Switzerland	4
United Kingdom	3,12,47
USA	5

Literature Search / Survey (11 replies)

Canada	3
France	2
Sweden	6
United Kingdom	58,61,63,68,70
USA	2,10,23

Questionnaire (26 replies)

Belgium	1
Canada	1,2,3,6,19,20,25,29
Finland	3,5,9,10
France	12,17
Norway	1
Sweden	4,5,6
United Kingdom	18,23,29,41
USA	3,20

Survey (General) (10 replies)

Belgium	1
Canada	6,15,21
France	4,12
Switzerland	4
Netherlands	5
USA	17,20

Guidelines/Standards (28 replies)

Canada	9,13,14,20,21,22, 27,32
New Zealand	3
Sweden	9,14
Switzerland	4,9
United Kingdom	3,11,19,24,35,43, 51,58,59,60,63,70, 71,72,74
USA	1,17,20,24,25,26, 29,33
Austria	1

Heating and Ventilation Systems.

Ventilation Systems General (14 replies)

Belgium	2
Canada	31
Finland	9
Germany	14
Netherlands	5
New Zealand	1
Sweden	3,4
Switzerland	4
United Kingdom	13,14,21,28
USA	33

Natural Ventilation (28 replies)

Canada	7,26
Finland	11
France	11,21
Germany	6,15
Netherlands	1
New Zealand	3
Norway	2
United Kingdom	8,9,10,11,19,22,31, 35,41,46,53,56,58, 59,61,70,74
USA	17

Mechanical Ventilation (54 replies)

Belgium	5
Canada	2,9,10,11,17,18,19, 21,22
Finland	5,8,10,11
France	10,11,18,20,21
Germany	13,15
Netherlands	2
New Zealand	2,3
Norway	1,2
Sweden	9,10,13
Switzerland	7
United Kingdom	2,6,10,14,16,17,18, 19,26,32,33,35,38, 46,47,48,51,68,74
USA	4,9,17,31,32

Air Conditioning Systems (HVAC) (25 replies)

Canada	2,6,17,18
France	1,10,19,23
Germany	10,12
Sweden	9,14
United Kingdom	17,32,35,36,45,47 72
USA	8,9,10,17,23,32

Heat Recovery Devices (17 replies)

Belgium	2,4
Canada	18,19,21
Finland	8
Germany	13,16
Norway	2
New Zealand	1
Sweden	4,6
Switzerland	1,13
United Kingdom	16,18,31

Occupant Interaction/Behaviour (5 replies)

Belgium	5
France	17
Switzerland	5
United Kingdom	9
USA	33

Demand Controlled Ventilation (DCV) (7 replies)

Denmark	3
Finland	6,9
France	1,3
Germany	6
Sweden	13

Displacement Ventilation System (12 replies)

Denmark	9
Finland	1
France	5
Germany	2,3,7,12
Sweden	8
Switzerland	7
United Kingdom	17,20
USA	9

Bulding Energy Management Systems (BEMS) (1 reply)

United Kingdom	68

Heating Systems (30 replies)

Belgium	2
Canada	6,11,15,21
Finland	1,7,8
France	5,18
Germany	16
Netherlands	1
New Zealand	1
Norway	1
Sweden	3,5,12
United Kingdom	15,16,19,21,38,35, 41,42,46,47,53,55
USA	7

Cooling (17 replies)

Finland	2
France	5,6
Germany	2,3,6,10,12
Netherlands	1
Switzerland	3,7,13
United Kingdom	7,11,43,49,54

1.3 Parameters to which Air Change and IAQ will be Related

Parameters which are related to either Air Change or Indoor Air Quality include, for example, weather variables, the performance of building components, the behaviour of occupants or sources of pollution. Two tables have been collated from the survey replies received. Table 1.3.1 outlines those parameters related to Indoor Air Quality and Table 1.3.2 outlines those related to Air Change.

An examination of Table 1.3.1 revealed three main categories; Weather and Climate Variables, Physical Parameters and Pollutants. Each section has been subivided into specific variables, for example, the Weather and Climate Section has 10 sub-sections including wind speed (11 replies), wind direction (9 replies), indoor temperature (17 replies), outdoor temperature (8 replies) etc.

The Physical Parameters category contains 13 sub-sections, including the Performance of Building Components (Building Construction and Design and Air Tightness) (34 replies) and Air Movement/Ventilation rate (21 replies).

The final category in Table 1.3.1 is the Pollutants Section, consisting of 26 sub-sections. The most popular variables include Pollution Concentration/Source with 28 replies and Indoor Air Quality in general with 21 replies. Also included are some specific pollutants, for example, Volatile Organic Compounds with 11 replies, Carbon Dioxide with 10 replies and Radon with 8 replies.

Table 1.3.2 focuses on the Parameters to which air change will be related. This table can also be divided into three sections; Weather and Climate, Physical Parameters and Building Characteristics and Performance. Again the Weather and Climate section contains similar categories as those outlined in Table 1.3.1. Nine sub-sections are detailed in this category. In the Physical Parameters section 22 sub-sections have been identified. These include Ventilation Systems (37 replies), IAQ (23 replies) and Pollution Sources and Occupant Behaviour both with 17 replies each. Ten sub-divisions covering Building Characteristics and Performance have been identified, the largest of which is Building Envelope Performance/Openings/Leakage Distribution and Airtightness with 32 replies and Building Component Performance 21 replies.

A full break down of all the sub-divisions can be seen by referring directly to Tables 1.3.1 and 1.3.2

Table 1.3.1 Parameters to which IAQ will be related

Weather and Climate Variables

Weather (General) (16 replies)

Belgium	8
Canada	27,30,31
Finland	7
France	17,21
Sweden	5
Switzerland	1,5,16
United Kingdom	14,18,56
USA	16,26

Wind Speed (11 replies)

France	10
Germany	6,8,16
Netherlands	1
United Kingdom	11,13,14,17,55
Poland	1

Wind Direction (9 replies)

France	10
Germany	8,16
United Kingdom	11,13,14,17,55
Poland	1

Wind Pressure (5 replies)

France	10
United Kingdom	11,14,17
Poland	1

Indoor temperature (17 replies)

Canada	4,7,25
France	6,10,14,15,16
Switzerland	2,15
United Kingdom	13,18,41,55
USA	9,15
Poland	1

Outdoor Temperature (8 replies)

Germany	8,16
Netherlands	1
United Kingdom	11,13,14,17,55

Temperature differences (Indoor Vs Outdoor) (1 reply)

Germany	6

SubSurface Temperature (1 reply)

United Kingdom	13

Relative Humidity (Indoor) (17 replies)

Canada	4,25
France	6,10,14,15,16
Sweden	5,6
Switzerland	15
United Kingdom	14,18,55,73,74
USA	9,15

Design Parameters for ventilation Systems (8 replies)

Belgium	8
Canada	27
Finland	10
Switzerland	1,4,5,8
USA	23

Physical Parameters

Air Movement (10 replies)

Denmark	7
Finland	7
United Kingdom	38,41,55
USA	8,17,11,29,33

Air Change Rate/Ventilation Rate (21 replies)

Belgium	5
Canada	2,6
Finland	3,5,11
France	7,14,15,16
Germany	5
Norway	1,3
United Kingdom	23,41,55,60
USA	16,17,18,21

Air Recirculation (1 reply)

Sweden	4

Contaminant Removal Effectiveness (2 replies)

USA	9,33

Perfomance of Building Components (Building Construction and Design and Air-tightness) (34 replies)

Belgium	4,5,8
Canada	7,30,31
Finland	7,11
France	9,10,12,13,21
Germany	8
Norway	3
Sweden	15
Switzerland	5,16
United Kingdom	9,17,23,48,55,70,71
USA	5,16,18,21,22,23,26, 33
Poland	1

Energy Conservation/Consumption (10 replies)

Canada	7,30
Sweden	4
Switzerland	9,16
United Kingdom	9,27,60,70
USA	26

Occupant Behaviour (20 replies)

Belgium	4
Canada	25
Denmark	6
Finland	7,11
France	9,11,13,17,21
Germany	6
Netherlands	1
Sweden	5,8,15
Switzerland	1,4
United Kingdom	1,18
Poland	1

Level of Occupancy (2 replies)

Norway	3
United Kingdom	18

Ventilation Systems (General) (25 replies)

Belgium	4,8
Canada	7
Finland	3,5,10
France	9,12,13,17,18
Germany	2,3
Switzerland	16
Sweden	2,3,5,8,15
United Kingdom	6,17,23,68
USA	15,17

Natural Ventilation Systems (7 replies)

Canada	7
France	11
New Zealand	3
United Kingdom	9,13,56,74

Mechanical Ventilation Systems (6 replies)

Belgium	5
Canada	6
Germany	1
United Kingdom	73,74
USA	10

Heating and Cooling Systems. (2 replies)

Germany	2,3

Illumination (1 reply)

Switzerland	15

Pollutants

IAQ (General) (21 replies)

Belgium	4,5,7
Canada	29
Denmark	6
Norway	1
Sweden	11,13
Switzerland	4
United Kingdom	24,25,65,68,70,71,72
USA	8,21,23,25
Australia	1

Pollution Concentration/Sources (28 replies)

Canada	7,8,27,30,31
Denmark	8
Finland	7
France	9,10,11,13,14,15,16, 18,19,21
Germany	2
Sweden	8
Switzerland	2,4,16
United Kingdom	1,10,11,69
USA	29,33

Pollution Diffusion. (2 replies)

France	8
United Kingdom	69

Bioaerosols (3 replies)

France	19
USA	10,29

Bacteria/Mould/Fungi (1 reply)

United Kingdom	29

Carbon Dioxide (10 replies)

Canada	4,6
France	1
Sweden	5
United Kingdom	9,41,55
USA	9
Australia	1
Poland	1

Combustion Emissions/Hydrocarbons (3 replies)

Canada	4,15
United Kingdom	23

Dust Concentration (3 replies)

New Zealand	3
United Kingdom	29,73

Formaldehyde Releases (2 replies)

Canada	4
United Kingdom	29

Moisture (5 replies)

Canada	20
Sweden	5
United Kingdom	73,74
USA	17

Sorption by Indoor Surfaces (1 reply)

United Kingdom	23

NOx (1 reply)

United Kingdom	29

Noise (1 reply)

USA	8

Odour (1 reply)

USA	48

Man Made Mineral Fibres (Fibre Glass) (1 reply)

USA	2

Occupant Health and Comfort. (6 replies)

Finland	3
France	3,19
Switzerland	4
United Kingdom	26,27

Particles (1 reply)

Sweden	5

Radon (8 replies)

Belgium	8
Denmark	1
Finland	11
United Kingdom	14
USA	21,22,27,28

Tobacco Smoke (1 reply)

United Kingdom	8

Passive Smoking (1 reply)

United Kingdom	1

Thermal Comfort (7 replies)

Canada	2
Finland	7
Switzerland	9
United Kingdom	55,60
USA	8,9

Volatile Organic Compounds (VOC's) (11 replies)

Canada	4,15
France	1
Sweden	4,6
United Kingdom	29
USA	7,9,10,29
Australia	1

Methane (1 reply)

Canada	15

SO_2 (1 reply)

Australia	1

Ozone (O_3) (1 reply)

Australia	1

Room Partitions (1 reply)

USA	33

Table 1.3.2 Parameters to which Air Change will be related

Weather and Climate

Weather (General)(33 replies)

Belgium	4,5,6
Canada	1,11,16,27,28,30,31
Finland	7,8
France	20
Sweden	5,9,12
United Kingdom	5,16,19,20,31,33, 37,40,46,49,50,51, 63,64
USA	1,13,26

Wind Speed (12 replies)

Canada	12,13
Germany	8,9,16
United Kingdom	17,34,37,50,62
Austria	1
Poland	1

Wind Direction (10 replies)

Canada	11,12,13
Germany	8,9
Netherlands	2
United Kingdom	31,34,50,62

Wind Velocity (10 replies)

Canada	12
Germany	8,9,16
United Kingdom	17,34,37,50
Austria	1
Poland	1

Indoor Temperature (9 replies)

Canada	10
Denmark	9
United Kingdom	34,35,39,50
USA	1
Austria	1
Poland	1

Outdoor Temperature (10 replies)

Canada	5,10
Germany	8
Sweden	12
United Kingdom	17,34,37,50,62
Austria	1

Indoor /Outdoor Temperature Difference (7 replies)

Canada	11,12,13
France	5
Germany	9,16
USA	30

Indoor Humidity (7 replies)

New Zealand	3
Sweden	5
United Kingdom	26,35,39
USA	1
Austria	1

Outdoor Humidity (1 reply)

Austria	1

Physical Parameters

Pollution Sources (17 replies)

Canada	5,7,27,28,30,31
Finland	4,7,11
Germany	14
Netherlands	3,4
Sweden	7
United Kingdom	21,48,57
Poland	1

Pollutant levels/transport (10 replies)

Finland	11
Germany	14
New Zealand	1
Sweden	7
Switzerland	11
United Kingdom	30,47,48,61
USA	3

IAQ (23 replies)

Canada	4,6,27,29,30,31
Finland	11
New Zealand	3
Sweden	5,14
United Kingdom	16,21,25,35,37,46, 51,59,61
USA	3,26
Australia	1
Taiwan	1

Occupant Behaviour (17 replies)

Belgium	4,5
Canada	1
Finland	1,2,7,9,11
France	20
Germany	14
Sweden	5,9
Switzerland	11
United Kingdom	35,37
USA	3
Poland	1

Moisture Transfer (12 replies)

Belgium	3
Canada	14,16
New Zealand	1
Sweden	5
United Kingdom	26,28,33,66,67
USA	14,17

Thermal Comfort/Draught (10 replies)

Belgium	1
Canada	24
Finland	1,2
Switzerland	6,7
United Kingdom	7,44
USA	6,30

Comfort (3 replies)

Switzerland	12
United Kingdom	45,46

Ventilation Systems (37 replies)

Belgium	2,4,5
Canada	7,17,18,19,21,22,26
Finland	4,6,9
France	11
Germany	4,10
Netherlands	2
New Zealand	3
Norway	2
Sweden	9,10
Switzerland	7
United Kingdom	5,7,17,19,26,28,33, 45,51,58,59
USA	4,17,20,31

Filtration (1 reply)

Finland	4,6

Terminal Devices (6 replies)

France	22
New Zealand	2
Sweden	1
United Kingdom	32
USA	30,31

Sensors and Control Devices (2 replies)

Canada	28
Finland	6

Heating and Cooling Systems (7 replies)

Finland	8
Germany	12
United Kingdom	7,40,42,43,54

Energy consumption and usage (25 replies)

Belgium	2
Canada	19,30
Finland	6,9
Germany	10,13
Netherlands	3
Sweden	10,14
Switzerland	6,7,12
United Kingdom	2,7,16,45,46,47, 49,59,61
USA	13,24,26

Heat Recovery (4 replies)

Finland	8
Germany	13
Norway	2
United Kingdom	16

Heat Transfer (17 replies)

Belgium	3
Denmark	9
Finland	7
France	5
Germany	10,13
Netherlands	3
Switzerland	3,12
United Kingdom	12,15,20,34,52,53
USA	6,24

Thermal Insulation (1 reply)

France	5

Ventilation and Air Change Rate (14 replies)

Canada	10,16,26,30
Finland	4,7,11
France	7
Switzerland	11
United Kingdom	5,22
USA	17,24,31

Ventilation Effectiveness/Efficiency (5 replies)

Germany	5,7,15
New Zealand	2
Switzerland	11

Combustion Appliances (1 reply)

United Kingdom	35

Fire Security (2 replies)

Netherlands	3
United Kingdom	47

Development of standards and guidelines (6 replies)

Canada	9,19
United Kingdom	31,32
USA	3,20

Sound Attenuation (2 replies)

Finland	8
United Kingdom	61

Building Characteristics and Performance

Building Design (General) (5 replies)

Canada	8,27
United Kingdom	30,39,49

Building Envelope Performance/Openings/Leakage Distribution and Airtightness (32 replies)

Canada	3,5,6,7,8,10,11,23, 27,30,31
Finland	4,9
Germany	8
New Zealand	1
Norway	2
United Kingdom	2,4,16,48,35,37,47, 49,50,57,61,64
USA	1,13,26
Austria	1

Building Component Performance (21 replies)

Canada	12,13,28
Finland	7,9
France	22
Sweden	9
United Kingdom	3,4,5,17,19,20,31, 35,37,40,50
USA	1,31
Poland	1

Building Construction Type (2 replies)

Germany	4
United Kingdom	30

Building Exposure (1 reply)

United Kingdom	34

Internal Airflow (10 replies)

Canada	1
Denmark	10,11
Germany	4,15
Switzerland	7,8,11
United Kingdom	34
Taiwan	1

Internal Air Velocities (6 replies)

Belgium	1
Denmark	9
France	5
Germany	7,11
Switzerland	10

Turbulent Airflows (3 replies)

France	2,4
USA	12

Internal Pressure (2 replies)

Canada	6
United Kingdom	52

Air Distribution Patterns (8 replies)

Canada	10,18,24,26
France	4
United Kingdom	34,52
USA	31

1.4 Building Type

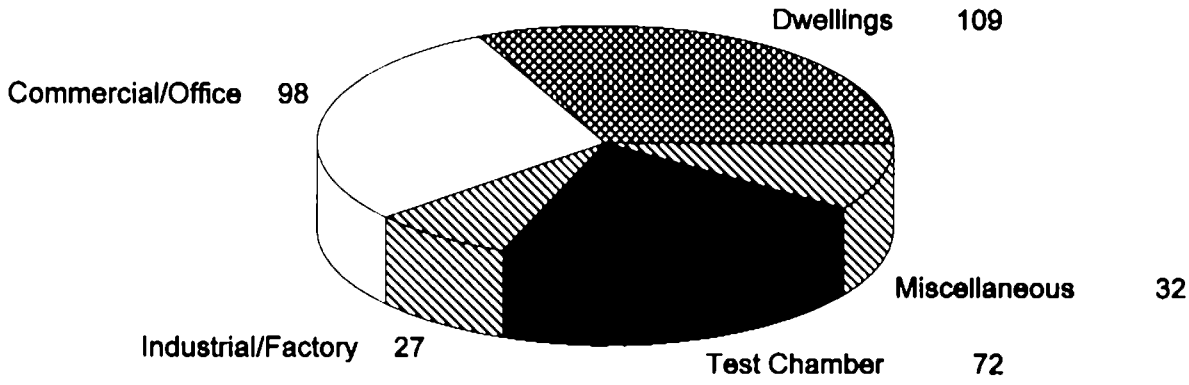

Figure 1.4.1 Classification of Building Types

Dwellings represent the greatest area of interest with 109 replies. The Commercial/Office sector also attracted a good deal of interest with 98 replies. Test chamber studies attracted 72 replies and the industrial/factory sector 27 replies. Miscellaneous buildings included Atria, Hospitals and School/Lecture Theatres. A complete list is given in Table 1.4.1.

Table 1.4.1 Building Type

Building Type	
Dwellings (109 replies)	
Belgium	2,4,8,9
Canada	4,5,6,7,8,10,11,12,13,14,15,16,17,18,19,20,21,22,26, 29,30,31,32
Denmark	1
Finland	4,6,8,9,10
France	4,5,8,9,10,11,20,21
Germany	5,8,11
New Zealand	1,3
Netherlands	2
Norway	1,2,3,4,5
Sweden	3,5,10,11,12,13,14,15
Switzerland	1,3,5,9
United Kingdom	2,4,8,13,14,16,17,18,19,23,24,26,28,29,31,33,34,35,38,39,4 0,49,50,51,52,56, 57,66,67,73
USA	1,2,3,4,5,6,7,13,15,16,17,26,27,28
Poland	1
Commercial/Office (98 replies)	
Belgium	1,5,7
Canada	1,2,9,23,25
Denmark	9,11
Finland	1,2,5,11,19
France	1,2,3,4,7,9,10,12,23
Germany	4,5,6,10,11,12,13
New Zealand	2,3,
Netherlands	1
Sweden	4,6,9,10,11,13,14
Switzerland	3,4,5,7,8,9,13,14,16
United Kingdom	1,5,7,9,10,11,12,17,20,24,25,27,30,31,32,34,35,36,38,40,41,45,46,48,49,50, 53,55,58,59,61,65,68,70,71,72
USA	2,6,7,9,10,15,21,26,29,32,33
Australia	1
Industial/Factory (27 replies)	
Canada	24
Denmark	9
Finland	1,2,11
France	6,10
Germany	4,11
Sweden	6,14
Switzerland	5,9
United Kingdom	4,6,10,11,30,31,34,49,50,60,62,63
USA	2
Taiwan	1

Test Chamber or Test Structure (72 replies)

Belgium	3,6
Canada	3,10,11,32
Denmark	1,5,6,7,8,9,10,11
Finland	1,2,7
France	4,5,8,10,13,14,15,16,18,23
Germany	1,2,3,4,7,10,11,12,14,16
Netherlands	1
Sweden	8
Switzerland	2,5,7,15
United Kingdom	2,3,4,12,20,31,32,34,35,36,38,47,49,50,51,52,57,64,74
USA	1,2,8,9,15,18,27,30,31,33

Miscellaneous (32 replies)

Aircraft Cabins	USA 7
Airplane Hangers	Switzerland 6
Animal Barns and Green Houses	Canada 27,28, USA12,
Atria	Switzerland 9; United Kingdom 40
Auditoria/Stadia/Gymnasium	Germany15, Norway3, Switzerland 9
Garages	Germany 4
Hospitals/Day Care Centre	Australia1, Finland 3, France 23
Laboratory	Canada 18
Library	Australia1
Market and Storage	United Kingdom 48
New Design	Belgium 2
Railway Station	France 24, United Kingdom 54,
Schools/Lecture Theaters	Australia 1, France7, 17, Sweden 2,12, United Kingdom 22,42
Underground Workplaces	Finland11
Various Building Types	Austria1, Switzerland11,12, United Kingdom24

1.5 Building Occupancy

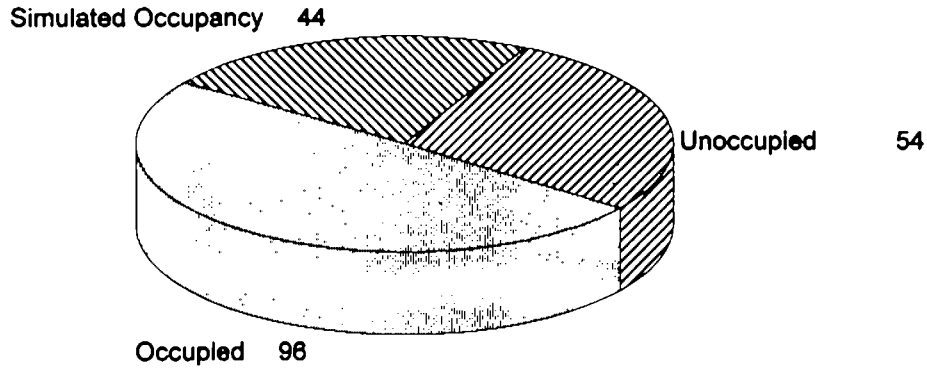

Figure 1.5.1 Classification of Building Occupancy

Over 50% of the building related studies are being undertaken in occupied premises. Simulated occupancy accounts for 23% while studies in unoccupied buildings account for 26%. A detailed breakdown of projects is outlined in Table 1.5.1.

Table 1.5.1 Building Occupancy

Unoccupied (54 replies)	
Belgium	4,5,8
Canada	4,10,11,12,13,23,26,27,32
France	5,7,8,10,18,20,22
Denmark	9,10,11
Germany	4,8,15
Sweden	1,8
Switzerland	5,15
United Kingdom	3,4,5,11,19,20,21,31,35,49,50,52,56,62,63,66,67
USA	2,4,18,26,27,29,30
Poland	1

Simulated Occupancy (44 replies)	
Denmark	6,7,9,10
France	10,13
Germany	2,3,10,12,14
Netherlands	1,3
Sweden	7,9
United Kingdom	4,7,8,9,11,13,14,16,17,20,21,26,31,33,35,49,50,51,74
USA	1,2,4,9,17,26,29,31,33
Poland	1

Occupied (96 replies)	
Belgium	1,2
Canada	1,2,4,5,6,7,8,23,24,25,29,30,32
Denmark	6,7,11
Finland	3,5,10,11
France	1,2,6,9,10,11,12,17,19,20,21
Germany	5,6,11,16
Netherlands	2,4
New Zealand	1,2,3
Norway	1,2,3
Sweden	2,3,4,5,6,8,9,12
Switzerland	1,3,4,5,6,7,8,9,16
United Kingdom	1,9,17,18,22,23,24,25,26,27,28,29,31,32,49,50,51,52,53,54, 55,56,65,73
USA	2,3,4,5,10,15,17,26,32
Poland	1

1.6 Component Type

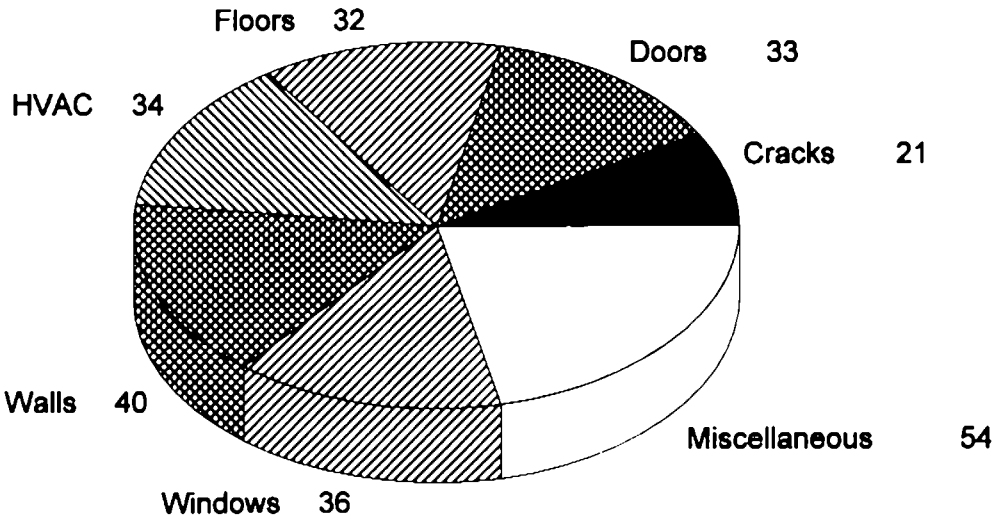

Figure 1.6.1 Classification of Component Type

Components being studied are summerised in Figure 1.6.1. Six main divisions have been identified these include main building components such as Walls (40 replies), Windows (36 replies), Doors (33 replies), Floors (32 replies) and Cracks (21 replies). HVAC systems also represent an important area of study with 34 replies. The Miscellaneous category with 54 replies, is by far the biggest division, and consists of 17 different sub-divisions, including HVAC components, Building Materials, Passive Stack Ventilation, and Carpets. A full list of components under investigation is presented in Table 1.6.1.

Table 1.6.1 Building Component Type

Windows (36 replies)

Belgium	6
Canada	23,27
Denmark	10
France	4,9,11,17
Germany	6,8,16
Netherlands	1
New Zealand	1
Sweden	9
Switzerland	9
United Kingdom	2,3,4,5,7,8,9,17,20, 21,22,31,35,37,46, 47,55,58,61
USA	9
Poland	1

Doors (33 replies)

Belgium	6
Canada	23
Finland	11
France	9,11,17
Germany	8,16
Netherlands	1
New Zealand	1
Switzerland	6
United Kingdom	3,4,5,7,8,17,19,20, 21,22,31,35,38,46, 47,55,58,61,63,66
USA	9
Poland	1

Walls (40 replies)

Canada	3,12,13,23
Finland	11
France	8,9,13,14,15,16
Germany	3,10,12,13,16
Netherlands	1,2
New Zealand	1
United Kingdom	2,3,4,5,7,17,20,21, 22,31,35,37,46,47, 48,55,66
USA	9,18,29
Poland	1

Floors (32 replies)

Canada	23
Denmark	1
Finland	11
France	8,9,13,14,15,16
Germany	16
Netherlands	1,2
New Zealand	1
United Kingdom	2,3,4,7,13,14,17, 20,21,22,31,35,27, 48,55,57
USA	9,18,29

Cracks (21 replies)

Canada	23,27,28
Denmark	1
Finland	11
France	9,11
New Zealand	1
United Kingdom	3,4,17,22,31,35, 37,38,48,57,64
USA	1
Poland	1

Air Conditioning Systems (HVAC) (34 replies)

Canada	6,12,13,17,18,19, 21,22
Finland	7,10
France	9,10,11,12,19
Norway	2
Sweden	9,13,14
Switzerland	7
United Kingdom	3,4,17,31,36,37, 45,49,51,61
USA	2,10,22,31

Miscellaneous (54 replies)

Atria	Netherlands 3
Basements	Canada 14
Building Materials	Switzerland 2, France 12,13,14,15,16
Building Shell	United Kingdom 16,42,46,47,USA5
Carpets	United Kingdom 35,37, USA9, France 15,16,14
Ceilings	Germany 2,3,10
Components of HVAC Systems	Canada 28, France 11, Denmark 9 Netherlands 4, Sweden 1, Switzerland 13,14,United Kingdom 61,63 USA 2,15,18,30
Crawlspace	Netherlands 2
Evaporative cooling	Switzerland13
Insulation	France 16,14,15
Occupant behaviour	France 12
Passive Stack Ventilation	Germany 6, New Zealand3, United Kingdom19,22,56, Poland 1
Roofs	Belgium 3, Canada 16, United Kingdom 63
Soil	United Kingdom 57
Stairwells and Liftshafts	United Kingdom 38
Total Impact	Canada 1
Weather	Germany 13

1.7 Allocation of Staff Time

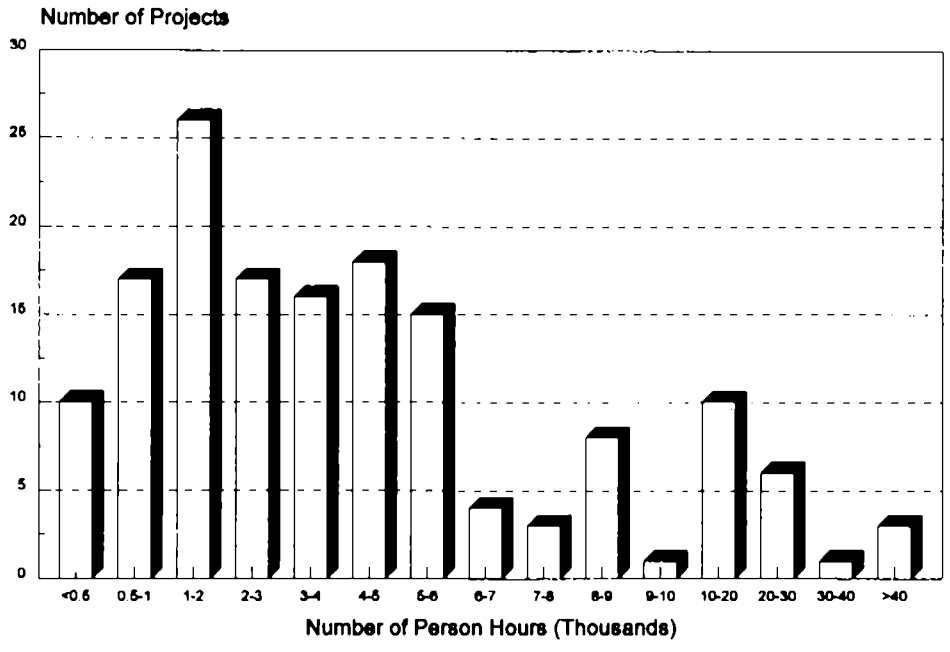

Figure 1.7.1 Allocation of Staff Time

Information regarding the staff time allocated to each project was stated in 61% of survey replies. The results are summarised in figure 1.7.1. It can be seen that time allocation for 70% of those replies where the amount of research time was stated, is between 1000 and 6000 person hours (which equates to approximately 6 man-months to 3 man-years worth of research effort). Thirty six projects have longer staff allocation times, with 3 long term projects having over 40,000 person hours of staff time each. This is equivalent to 22 person years worth of research effort. These projects are often general ventilation/Indoor air quality programmes spanning several years of research effort.

Over one million person hours of research effort in the field of Ventilation, Infiltration, Indoor Air Quality and Energy within buildings has been documentated by this Survey.

1.8 Concluding Remarks

Response to this survey has once again been very promising, with even more survey replies being received than in previous years. The project summaries from 17 countries are contained within this report covering all aspects of ventilation and indoor air quality research.

This Survey of Current Research, based on the replies outlined in Section 2, reveals that projects focusing on indoor air quality and the energy impact of ventilation have increased since the last survey. However, it is interesting to note that the replies relating to tracer gas and air flow modelling studies are less than in previous surveys. Research in occupied buildings remains popular, while greater interest is being shown towards simulated occupancy and unoccupied studies. Research in Dwellings, Commercial/Office and Industrial buildings has remained stable

since the last survey, however, the use of test chambers has notably risen by 32%. There has also been an increase in studies focusing on HVAC systems and their associated components.

The number of survey replies should be looked upon as an overview, rather than an exact picture of the level of research in any particular area, since response to the survey is entirely voluntary and therefore does not necessarily provide a complete picture.

It is intended that the Survey of Current Research should be an ongoing venture, and that it should appear alongside the AIVC's Bibliographic Database "AIRBASE". The SURVEY94 database contains the replies outlined in Section Two of this publication and will be continually updated.

SECTION TWO

SURVEY REPLIES

2.1 BELGIUM

REF BE01
TITLE OF PROJECT: Comfort problems in department stores.
PRINCIPAL RESEARCHER: Girst Verbeeck
ORGANISATION: KV-Leuven
ADDRESS: Laboratory of building physics
Celestijnenlaan, 131 3001 Leuven, Belgium.
TELE: +32 16 22 09 37 FAX: +32 16 22 00 06
E-Mail Address:
SPECIFIC OBJECTIVES: Studying thermal comfort in department stores, Indoor air movement, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Commercial Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Relation between draught and thermal comfort complaints.
PROJECT DETAILS: Analysis of the thermal comfort problems in 6 large department stores.
Step 1 - Enquiry between all employees (+/- 2000 responses).
Step 2 - Analysing different employee workplace situations by measuring the comfort parameters.
Step 3 - Comparing measurements with enquiry results and comfort prediction. Searching for strategies to improve comfort situations.
STARTDATE: 01:06:1993
EXPECTED TERMINATION DATE: 01:09:1994
ESTIMATED NUMBER OF PERSON HOURS: 20 Man Months
SELECTED BIBLIOGRAPHY: Only internal reports have been released. The work will be presented to the International Audience after finishing the Work.

REF BE02
TITLE OF PROJECT: The low energy k20+ House
PRINCIPAL RESEARCHER: Hugo Hens
ORGANISATION: KV-Leuven
ADDRESS: Laboratory of building physics
Celestijnenlaan, 131 3001 Leuven, Belgium
TELE: +32 16 22 09 31 FAX: +32 16 29 00 06
E-Mail Address:
SPECIFIC OBJECTIVES: Development of a new generation of prefab low energy houses Energy Impact of ventilation Airtightness air leakage of buildings Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied Dwellings +New design
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS:
* Evaluation of the energy consumption in 50 low energy, Prefabricated K 30 houses.
* Intensive audit in 3 of the 50 houses, measuring indoor and outdoor climate, logging energy consumption, analysing the efficiency of the ventilation system and heat recovery unit, checking thermal insulation.
* Initiating new design for a next generation of K20+ houses. Predicting the energy economy potential of different choices (better insulation, optimised passive solar, transparent insulation, high efficiency heating and ventilation systems for very low peak power supply.
* Elaboration of performance specifications.
* Judgment of designs for the K20+ system, introduced by invited architects.
STARTDATE: 00:07:1994
EXPECTED TERMINATION DATE: 00:07:1997
ESTIMATED NUMBER OF PERSON HOURS: 6 person years
SELECTED BIBLIOGRAPHY: (None at this time)

REF BE03
TITLE OF PROJECT: Heat air and moisture transfer in and through pitched roofs with insulation between rafters.
PRINCIPAL RESEARCHER: Arnold Janssens, Hugo Hens
ORGANISATION: KV-Leuven
ADDRESS: Laboratory of building physics
Celestijnenlaan, 131 3001 Leuven, Belgium
TELE: 32 16 22 09 31 FAX: 32 16 29 00 06
E-Mail Address:
SPECIFIC OBJECTIVES: Establish performance criteria for pitched roofs Airtightness/ air leakage of buildings Analysing interstitial condensation by convective vapour flow
BUILDING TYPE: Test chamber or test structure.
COMPONENT TYPE: Roofs
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Testing different roof lay outs in hot box-cold box under temperature , vapour pressure and air pressure gradients. Analyses of influence of internal lining choice and type of underlay on condensation response. Effects of increase of air pressure gradients on condensation rate.
STARTDATE: 00:00:1991
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 2 person years
SELECTED BIBLIOGRAPHY: (None Stated).

REF BE04
TITLE OF PROJECT: Belgian participation at IEA Task XIII: The Pleiade dwelling.
PRINCIPAL RESEARCHER: A De. Herde (Univer. de Louvain) Peter Wouters (BBRI)
ORGANISATION: UCL-Unite Architecture

ADDRESS: Place de Levant 1, B-1348 Louvain La Neuve, Belgium
TELE: +32 10 47 22 23 FAX: 32 10 47 45 44
E-Mail Address: deherde@arch.ucl.ac.be
SPECIFIC OBJECTIVES: Indoor air movement IAQ Energy impact of buildings Moisture / leakage of buildings Heating and ventilation systems and strategies. Thermal comfort in summer time - Night time ventilation.
BUILDING TYPE: Unoccupied,Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather Performance of building components Behaviour of occupants Operation ventilation system
PROJECT DETAILS: The PLEIADE dwelling is the Belgian contribution in the framework of the IEA Task XIII. The aim is to build a low energy high performance row house which should be realistic for wide scale application in the period 2000-2005. Specific points of interest are: good indoor air quality, good thermal comfort in summer, low energy consumption, air to air heat recovery, very good building airtightness. The building will be terminated in spring 1994. During about 1 year measurements are planned without occupancy, afterwards the measurement will be continued with occupants.
STARTDATE: 00:00:1990
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: approx. 10,000 person hours.
SELECTED BIBLIOGRAPHY:
1. The PLEIADE dwelling: an IEA Task XIII low energy dwelling with emphasis on IAQ and thermal comfort, P wouters D L'Hereux, (BBRI), A De Herde, Gratia (UCL), 14th AIVC Conference, Copenhagen, September 1994.
2. CIB : exacte referntie toe te voegen.

REF BE05
TITLE OF PROJECT: Evaluation of mechanical ventilation for offices with Infrared control
PRINCIPAL RESEARCHER: Peter Wouters
ORGANISATION: Belgian Building Research Institute (WTCB-CSTC)
ADDRESS: Violetstraat 21-23, B-1000 Brussels, Belgium
TELE: +32 2 653 88 01 FAX: +32 3 653 07 29
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ Energy Impact of ventilation Airtightness/leakage of buildings Heating and ventilation systems and strategies.
BUILDING TYPE: Unoccupied, Commercial / Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather Performance of building components Behaviour of occupants Operation ventilation system Building airtightness
PROJECT DETAILS: In one of the office buildings of BBRI, a mechanical ventilation system will be installed. The specific features of the installation are:
* Mechanical supply in all offices (about 35 offices).
* Supply grills have a built - in infrared controller. The ventilation openings are automatically closed if no movement is observed during the last 15 minutes.
* The supply air is filtered. The aim of the study is to evaluate the energy consumption, indoor air quality, interaction with the building airtightness and the reaction of the building users.
STARTDATE: 00:00:1993
EXPECTED TERMINATION DATE: 00:00:1994
ESTIMATED NUMBER OF PERSON HOURS: 1000 hours
SELECTED BIBLIOGRAPHY: (None Stated)

REF BE06
TITLE OF PROJECT:Belgian participation to the EC project PASCOOL (Passive Cooling for Buildings)
PRINCIPAL RESEARCHER: Luk Vandaele
ORGANISATION: Belgian Building Research Institute
ADDRESS: Rue de la violette 21-23, B-100 Brussels, BELGIUM
TELE: +32 2 653 88 01 FAX +32 2 653 07 29
E-MAIL Address:
SPECIFIC OBJECTIVES: Indoor air movement, Energy impact of ventilation, Passive cooling for buildings
BUILDING TYPE: Test cell
COMPONENT TYPE: Windows, Doors
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather
PROJECT DETAILS: BBRI is involved in the ventilation subtask of the Model Development Subgroup as well as the Experimental Testing Subgroup. Experiments regarding air flows through large openings were carried out in a PASSYS test cell equipped with the Pseudo Adiabatic Shell (PAS). Heat balance and tracer gas appliances were used to determine air flows rates. Both methods showed a good agreement.
STARTDATE: 01:11:1992
EXPECTED TERMINATION DATE: 21:01:1995
ESTIMATED NUMBER OF PERSON HOURS: 1300
SELECTED BIBLIOGRAPHY: (None Stated)

REF BE07
TITLE OF PROJECT: Belgian participation to the EC project EC Indoor Air Quality Audit Project
PRINCIPAL RESEARCHER: David Ducarme
ORGANISATION: Belgian Building Research Institute
ADDRESS: Rue de la violette 21-23, B-100 Brussels, BELGIUM
TELE: +32 2 653 88 01 FAX +32 2 653 07 29

E-MAIL Address:
SPECIFIC OBJECTIVES: IAQ, Energy impact of ventilation
BUILDING TYPE: Office Building
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS The other participating countries investigated six buildings with a common audit method. Detailed ventilation studies are carried out by BBRI in two of those office buildings. The objectives are to complete and enhance the general ventilation measurements and also to demonstrate their limitation and validity.
STARTDATE: 12:12:1992
EXPECTED TERMINATION DATE: 00:01:1995
ESTIMATED NUMBER OF PERSON HOURS: 900
SELECTED BIBLIOGRAPHY: (None Stated)

REF BE08
TITLE OF PROJECT: IEA annex 13: Measurements at a flat in Numar: air flows and pollutant spreading
PRINCIPAL RESEARCHER: Alain Boosaer
ORGANISATION: Belgian Building Research Institute
ADDRESS: Rue de la violette 21-23, B-100 Brussels, BELGIUM
TELE: +32 2 653 88 01 FAX +32 2 653 07 29
E-MAIL Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ
BUILDING TYPE: Unoccupied, Apartment at ground level and enclosed at both sides by other apartments.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Internal parameters : Position of the doors, the air-outlets and the air inlets External parameters : weather conditions.
PROJECT DETAILS Examination of the air flows and the spreading of contaminants (CO2 and water vapour in the apartment, with tracer gas). Use this data set to do simulations with COMIS 1,2 and to evaluate this program with regard to the contaminant spreading.
Perform a sensitivity analysis with MISA (Multitum Interface for sensitivity Analysis).
STARTDATE: 00:00:1990
EXPECTED TERMINATION DATE: 00:00:1995
ESTIMATED NUMBER OF PERSON HOURS: 2880 (72 person weeks)
SELECTED BIBLIOGRAPHY: (None Stated)

REF BE09
TITLE OF PROJECT: Belgian contribution to the EC Project: Radon sources, models and counter measures.
PRINCIPAL RESEARCHER: David Ducarme
ORGANISATION: Belgian Building Research Institute
ADDRESS: Rue de la violette 21-23, B-100 Brussels, BELGIUM
TELE: +32 2 653 88 01 FAX +32 2 653 07 29
E-MAIL Address:
SPECIFIC OBJECTIVES: IAQ, Radon transport
BUILDING TYPE: Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS BBRI studies the role of the ventilation and the air flow patterns on the radon transport in dwellings from the theoretical and experimental point of view. Radon and tracer gas measurements were carried in parallel in a dwelling in Vise, Belgium (in collaboration with the University of Ghent). The anaylsis shows that radon concentrations in the rooms of the dwelling can be estimated from the radon concentration in the basement and tracer gas concentration in the basement and in the rooms. A soil depressurisation technique was applied and evaluated. Three-dimensional simulations (finite differences) will be performed in order to obtain a better understanding of the radon transport inside the ground.
STARTDATE: 01:09:1992
EXPECTED TERMINATION DATE: 31:06:1995
ESTIMATED NUMBER OF PERSON HOURS: 2000
SELECTED BIBLIOGRAPHY:
1. P Cohilis, P Wouters and D L'Heureux, BBRI, Use of finite differences code for the prediction of the ability of subfloor ventilation strategies to reduce indoor radon concentration. 5th International symposium on the natural radiation environment (NBRE-V),Salzburg, Austria, 22-28 September 1991.
2. P Cohilis, P Wouters and Voordecker, Radon reduction in buildings: the case of two Belgian schools. Inter. Conference on Building Design , Technology and Occupants Well Being in Temperate Climates, Brussels, Belgium, Feb 1993.

2.2 CANADA

REF CA01
TITLE OF PROJECT: Field study of occupant comfort and office thermal environments in a cold climate.
PRINCIPAL RESEARCHER: Giovanna Donnini.
ORGANISATION: ADN Inc.
ADDRESS: 2020 University, #2450 Montreal, Quebec, Canada. H3A 2A5.
TELE +1 (514) 842-6880
FAX +1 (514) 842-6865
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement.
To provide information on office thermal environments and occupant response in a severe cold climate.

BUILDING TYPE: Occupied, Commercial/office.
COMPONENT TYPE: Total impact.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Air movement, Behaviour of occupants, Weather.
PROJECT DETAILS:
1. A database will be developed of the thermal environments and subjective responses of occupants in existing office buildings in this climate region.
2. Collect data from 10 office buildings within a 100 mile radius.
3. Both old and new buildings.
4. Both individual and open plan offices in the buildings' core and perimeter.
5. In each office studied, physical and subjective measurements will be performed at approximately 40 places of work, both summer and winter.
6. Determine both the referred thermal conditions for occupancy and the range of conditions found thermally acceptable by the occupants.
7. Investigate the influence of clothing and gender.
8. Investigate potential acclimation effects by correlating occupant responses with prevailing outdoor conditions.
STARTDATE: 00:04:1994
EXPECTED TERMINATION DATE: 00:03:1995
ESTIMATED NUMBER OF PERSON HOURS: 1760
SELECTED BIBLIOGRAPHY:
1. Schiller G E et al, 1988. "A Field Study of Thermal Environments and Comfort in Office Buildings." Final report, ASHRAE 462-RP, ASHRAE, Inc., Atlanta.
2. Schiller G E et al, 1988. "A Field Study of Thermal Environments and Comfort in Office Buildings." ASHRAE Transactions, Vol 96, Part 1.
3. Schiller G E, 1990, "A Comparison of Measured and Predicted Comfort in Office Buildings." ASHRAE Transaction, Vol 96, Part 1. 4. Benton C C, Bauman F, and Fountain M, 1990. "A Field Measurement System for the Study of Thermal Comfort." ASHRAE Transactions, Vol. 96, Part 1.

REF CA02
TITLE OF PROJECT: The Quality of Ventilation: Main cause of sick building syndrome.
PRINCIPAL RESEARCHER: Van Hiep Nguyen
ORGANISATION: McGill University, Department of Occupational Health,
ADDRESS: Faculty of Medicine, 1130 Pine Avenue West, Montreal, Quebec, Canada, H3A 1A3.
TELE+1 (514) 842-6880
FAX +1 (514) 842-6865
E-Mail Address:
SPECIFIC OBJECTIVES: To demonstrate that SBS is caused by the quality of ventilation. Indoor air movement. IAQ. Heating and ventilation systems and strategies.
BUILDING TYPE Occupied, Commercial/office.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Fresh air, total air, air performance diffusion index, ventilation efficiency, PMV, PPD.
PROJECT DETAILS: Individuals in a given building who are reportedly affected by SBS are paired with persons in the same and different exposure zones who display similar or none of the of the well known symptoms of SBS. The immediate work environment of each participant is characterise in depth by measuring the performance of the ventilation system serving the area occupied by them. A detailed statistical comparison of the ventilation parameters measured is then made to ascertain which, if any, of these can be the causes of SBS. Buildings with VAV, CAV, Dual Duct, Induction and 100% Fresh air ventilation systems will be selected. These buildings will not necessarily be known for the incidence of SBS. The performance of the ventilation system is one of the main determinants of the quality of the given work environment. Assuming all possible known local sources of air contamination have been identified. Participants will include office workers and administrators in buildings in Quebec. Questionnaires will be used to identify participants in the specified exposure zones.
STARTDATE: 00:12:1993
EXPECTED TERMINATION DATE 00:06:1995
ESTIMATED NUMBER OF PERSON HOURS: 1.5 person-year.
SELECTED BIBLIOGRAPHY:
1. World health Organisation. 1978. Air quality in selected urban areas 1975-1976. Geneva: WHO offset publication no. 41.
2. Spengler, J D and Samet, J. M "Indoor air pollution : a health perspective", The John Hopkins University Press, Baltimore, 1991.
3. Ganier, M et al 1980. Humidifier lung: an outbreak in office workers. Chest 77:183-87. 4. McDonald, J C Investigation of employee health complaints at Les Terrasses de las Chaudiere, Final report to the Treasury Board of Canada, July 1984.
5. Hodgson MJ et al, 1987. Vibration as a cause of tight building syndrome symptoms. Proceedings of the 4th international conference on indoor air quality and climate. Ed B. Seifert et al 449-53 Berlin: Institute for Water, Soil and Air Hygiene.
6. Molhave L, et al 1986 Human reactions to low Concentrations of Volatile organic compounds. Environ Int, 12: 169-75
7. Samet JM and Nero AV 1989, Indoor radon and lung cancer: a strategy to control. N Engl.J.Med 320:591-94.
8. Spengler J D et al 1989. Exposures to acidic aerosols. Environ. Health Perspect. 79: 43-51
9. Smith K 1987 , Biofuels, air pollution and health, New York: Plenum

backdraughting and the possible effects the exhaust equipment might have on the basement depressurisation monitoring.
4. Wall temperatures were measured for each level and each orientation to see if wall temperatures would correlate with areas of mould or condensation. No moisture problems were encountered in the survey.
5. The wood moisture level was measured at one central framing member (in the basement where possible), to determine if wood moisture can be used as a good indicator of long term relative humidity in the house.
6. The neutral pressure plane was determined using smoke pencils. The information was gathered to determine if high basement depressurisation (from one week monitoring test) could be related to a high neutral pressure plane.
7. The thermostat and furnace operation was studied.
8. Room pressurisation due to the furnace fan operation was measured in rooms with doors that could be closed off from the rest of the house.
9. Forced air heating system duct leakage through the building envelope was studied.
10. Carbon dioxide (CO2) levels were measured in the master bedroom to acquire further data on CO2 levels in Canadian houses.
11. Basement depressurisation was monitored to determine the range that can be expected in Canada in winter. To measure the largest depressurisation, teams attempted to measure the cross envelope pressure as low as possible in the house (ie as far as possible below the neutral pressure plane).
In addition a homeowner questionnaire was completed to gather information on the house operations and performance. This information could help to interpret the results of the tests performed.
52 houses were chosen for this project. On the following criteria:
1. contractor built tract houses or houses representative of the housing stock
2. forced air heating systems
3. single family detached houses.
4. representative examples of pre-war, late 40', 50s'/60s/70s/80s/ and new homes.
5. willingness of home owners to participate and record CO2 and basement depressurisation data for a week.
STARTDATE: 00:11:1992
EXPECTED TERMINATION DATE: Report submitted 00:10:1993
ESTIMATED NUMBER OF PERSON HOURS: 1000
SELECTED BIBLIOGRAPHY:
1. Field Testing of House Characteristics by Scanada Consultants Ltd for CMHC (to be released late spring 1994).

REF CA07

TITLE OF PROJECT: Experimental Investigation of Ventilation and Air Quality in Housing.
PRINCIPAL RESEARCHER: Don Fugler (Project Manager)
ORGANISATION: CMHC Research Division
ADDRESS: 700 Montreal Road, Ottawa, Ontario, K1A OP7. Canada.
TELE 613-748-2658 Fax 613-748-2402
E-Mail ADDRESS:
SPECIFIC OBJECTIVES: IAQ. Energy impact of ventilation. Airtightness/leakage of buildings. Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Dwellings,
COMPONENT TYPE: None Stated
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Passive ventilation systems, temperature-controlled exhaust devices, house source emissions, airtightness.
PROJECT DETAILS: 30 houses tested for one week (PFT) air change.
1 indoor air particulates, total VOC's HCHO, radon for one week.
2 flow rates of existing exhaust devices.
3 flow rates on passive (wind-drawn turbine) systems.
4 occupant habits.
For eight of the thirty houses:
1 CO2, RH, Temperature on continuous recorder (and particulates).
2 weather conditions, energy use, etc continuous then a ventilation system will be installed and the houses will be re-tested for a week.
STARTDATE: 00:11:1993
EXPECTED TERMINATION DATE: 00:05:1994
ESTIMATED NUMBER OF PERSON HOURS: 500-1000
SELECTED BIBLIOGRAPHY: Report will be published. Project being done in conjunction with Hydro Quebec so timing, report title, etc. are currently unknown.

REF CA08
TITLE OF PROJECT: Wallaceburg Biological Contaminate Survey.
PRINCIPAL RESEARCHER: Jim White (Project Manager)
ORGANISATION: CMHC Research Division
ADDRESS: 700 Montreal Road, Ottawa, Ontario, K1A OP7. Canada.
TELE: +1 613-748-2309 Fax +1 613-748-2402
E-Mail ADDRESS:
SPECIFIC OBJECTIVES: Indoor air movement. IAQ. Airtightness/air leakage of buildings. Moisture mould generation and prevalence.
BUILDING TYPE: Occupied, Dwellings,
COMPONENT TYPE: None Stated
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: For next phase, many

house characteristics will be determined. The exact list has not been set yet.
PROJECT DETAILS: Determine the bacterial endotoxin, dust miteontigen, and mould (species and total mass) in air and settled dust in 500 houses. Follow up project will investigate housing performance characteristics of 50 most and 50 least contaminated houses, to determine what makes a house prone to contamination.
STARTDATE: 00:11:1993
EXPECTED TERMINATION DATE: 00:11:1994
ESTIMATED NUMBER OF PERSON HOURS: 5000 to 10000 hours
SELECTED BIBLIOGRAPHY: To be announced

REF CA09
TITLE OF PROJECT: Building Codes Designed For Ensuring Good Indoor Air Quality.
PRINCIPAL RESEARCHER: Ferahian, R H
ORGANISATION: Consulting Engineer
ADDRESS: 4998 de Maisonneuve, 1416 Westmount, Quebec, H3Z 1N2. CANADA.
TELE: +1 (514)-484-5492 FAX:
E-MAIL Address:
SPECIFIC OBJECTIVES To attain objective of the title and have up-to-date building codes with incorporated maintenance bylaws.
BUILDING TYPE: Apartment, Office buildings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (Not Stated)
PROJECT DETAILS To incorporate in codes and by-laws the most up-to-date research results not only at the design and construction stages of buildings but also for the maintenance of the building systems essential for the health and safety of the occupants to ensure good indoor air quality throughout the useful life of the building. Ongoing representations at the local municipal level (City of Westmount) provincial and federal levels together with appeals to ASHRAE and National Research Council to effect the necessary changes in codes, standards and bylaws. Details in author's papers published in Proceedings of the "Healthy Buildings '88" Conference held in Stockholm in September 1988 and AIVC's 10th annual conference, 1989 held in Espoo, Finland. At present (April 1994), The City of Westmount in updating its Bylaws prohibited smoking even in private offices and will possibly by May 1994 Council meeting - make mandatory the periodic certified cleaning of ventilation air ducts.
STARTDATE: 00:00:1981
EXPECTED TERMINATION DATE: Ongoing till goal reached
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: See references in author's paper in proceedings of 10th AIVC Conference, 1989 Espoo, Finland.

REF CA10
TITLE OF PROJECT: Ventilation Systems for New and Existing Houses with Baseboard Heating.
PRINCIPAL RESEARCHER: James T. Reardon
ORGANISATION: National Research Council of Canada, Institute for Research in Construction
ADDRESS: Montreal Road Campus Ottawa, Ontario, Canada K1A 0R6
TELE: +1 (613)993-9700 FAX: +1 (613)954-3733
E-Mail Address: Reardon@IRC.LAN.NRC.CA
SPECIFIC OBJECTIVES: To identify designs of simple ventilation systems that are suitable for new and existing houses with electric baseboard heating. (Experimentally compare their air distribution performance with the requirements of the CAN/CSA-F326-M91 Standard "Residential Mechanical Ventilation Systems" Relevant to : Indoor air movement, air tightness/air leakage of buildings, heating and ventilation systems and strategies, indoor air quality.
BUILDING TYPE: Dwellings, unoccupied, Test Structure, Two-storey house.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Indoor temperatures, Outdoor temperature, Air distribution patterns, air change rates, ventilation flow rates, envelope pressure differences.
PROJECT DETAILS: Five simple ventilation systems were installed in the NRC two-storey research house. System A consists of exhaust fans in the kitchen, powder room and 2nd storey bathroom, with make-up air provided by accidental leakage. System B has the same fans but deliberate make-up air passive vents in each of the three bedrooms, and in the living and dining rooms. System C has the kitchen and powder room fans and a partial central exhaust system for the second storey with pick-up grilles in each bedroom. The 2nd storey bathroom fan operates at a reduced flow rate. Accidental leakage provides the make-up air. System D has the same fans as System C, but includes a single, deliberate make-up air vent. System E is a "minimal ducted supply system" with supply grilles in each occupiable room, and includes all three exhaust fans from System A. Single and multiple tracer gas test methods are used to measure the fresh air distribution provided by these various systems. Comparison measurements are made in the house with no purpose provided ventilation (purely air infiltration and exfiltration), and with the forced air electric furnace in operation. Temperature distributions throughout the house and flow rates through the various supply and exhaust ducts and devices are monitored and recorded by an automated

data acquisition system. Some envelope pressure differences and weather condition parameters are also monitored.
STARTDATE: 00:05:1993
EXPECTED TERMINATION DATE: 00:01:1995
ESTIMATED NUMBER OF PERSON HOURS: 2,000
SELECTED BIBLIOGRAPHY: (None to-date)

REF CA11
TITLE OF PROJECT: House Ventilation
PRINCIPAL RESEARCHER: James T. Reardon
ORGANISATION: National Research Council of Canada, Institute for Research in Construction
ADDRESS: Montreal Road Campus Ottawa, Ontario, Canada K1A 0R6
TELE: +1 (613)993-9700 Fax: +1 (613)954-3733
E-Mail ADDRESS: Reardon@IRC.LAN.NRC.CA
SPECIFIC OBJECTIVES:
(1) Develop a realistic database of measured pressure differences across the building envelope created by wind, temperature difference and operation of residential mechanical systems and household appliances
(2) Develop relationships between weather factors and equipment operation and the envelope pressure differences they create.
Relevant to : Indoor air movement, air tightness/air leakage of buildings, heating and ventilation systems and strategies.
BUILDING TYPE: Dwellings, unoccupied, Test Structure, Two-storey house.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: A two-storey house was built for research purposes. It is of standard wood frame construction, with 150 mm stud walls insulated with glass fibre batts and polyethylene vapour barrier on the warm side. All windows are tight sealing double pane casement style units. Forced air electric furnace provides heating. Three metal flues typical of gas furnaces and two basement vents of the type used with clothes dryers are provided with electrically actuated dampers. 22 pressure taps in the four walls each have a pressure transducer mounted to measure pressure differences across the exterior envelope. Transducer output signals are recorded with an automated data acquisition system based on an IBM AT (286) microcomputer. Weather parameters including inside and outside dry bulb temperature, barometric pressure, wind speed and direction are also measured and recorded by the DAS.
Minute-by-minute average pressures and weather parameters were recorded from December 1991 to April 1993, providing a database of pressures and weather for all four seasons of the year. Daily appliance simulation tests were performed using a variable flow rate exhaust fan whose flow rate was also monitored and recorded by the DAS. Analysis of this database has so far produced statistically sound "measured" neutral pressure levels for four leakage configurations in the house, created by opening and closing one flue and one vent. Further analysis has examined the influence of mechanical exhaust and temperature difference on the pressure distributions around the exterior envelope. The data should also yield a statistical basis for projecting wind pressure coefficients for the building, and an understanding of the typical envelope pressures with which a mechanical or passive ventilation system can be expected to contend.
STARTDATE: 00:08:1991
EXPECTED TERMINATION DATE: 00:08:1993
ESTIMATED NUMBER OF PERSON HOURS: 4,500
SELECTED BIBLIOGRAPHY:
1. Neutral Pressure Levels in a Two-Storey Wood Frame House, J.T. Reardon and C.Y. Shaw, 14th AIVC Conference Proceedings (Supplement), September 1993.
2. Residential Mechanical Ventilation Systems: Impact of CSA F326 Standard on the Building Envelope, Final Contract Report CR6450.8, National Research Council Canada for Energy, Mines and Resources Canada, March 1994.

REF CA12
TITLE OF PROJECT: The Effect of local Wind Shelter on Ventilation Openings.
PRINCIPAL RESEARCHER: David J Wilson
ORGANISATION: University of Alberta
ADDRESS: 4-9 Mechanical Engineering Building, Edmonton Alberta Canada T6G 2G8
TELE: +1 (403) 492-3598 FAX: +1 (403) 492-2200
E-Mail Address: wayne@frodo.mece.ualberta.ca
SPECIFIC OBJECTIVES: Airtightness/air leakage of buildings
BUILDING TYPE: Unoccupied, Dwellings
COMPONENT TYPE: Ventilation holes in exterior walls, Ventilation fans in exterior walls.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Wind speed, wind direction, variability, temperature difference, shelter, exterior fan vent, passive exterior vents
PROJECT DETAILS:
The objective of this project is to develop a design procedure that would allow local wind shielding factors to be applied to portions of buildings and parts of building walls to estimate the effect of nearby obstacles and structures on air intake flows. Measurements of air infiltration through large openings are being carried out at the University Home Heating Research Facility. This facility consists of six unoccupied test houses in a tightly spaced row with an open rural setting. These houses incorporate: continuous infiltration measurement using sulphur

hexaflouride tracer gas, and local meteorological measurements (wind speed, wind direction and ambient temperature). Flow visualization of building wakes which shelter downwind walls will be carried out in a water channel flow. Flow visualization is carried out using fluorescent dye, sheets of laser light with digital imaging. A computer model will be developed that predicts local wind shelter patterns on building walls, taking into account variations in wind direction along with the location and shape of nearby buildings and obstacles.
STARTDATE: 00:01:1993
EXPECTED TERMINATION DATE: 00:01:1995.
SELECTED BIBLIOGRAPHY: (None Stated)

REF CA13
TITLE OF PROJECT: Design Guidelines for Combustion Air Openings in Cold Climates.
PRINCIPAL RESEARCHER: Mark Ackerman
ORGANISATION: University of Alberta
ADDRESS: 4-9 Mechanical Engineering Building, Edmonton Alberta Canada T6G 2G8
TELE: +1 (403) 492-3598 FAX: +1 (403) 492-2200
E-Mail Address: Ackerman@frodo.mece.ualberta.ca
SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies
BUILDING TYPE: Unoccupied, Dwellings
COMPONENT TYPE: Ventilation holes in exterior walls, Ventilation fans in exterior walls.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Wind speed, wind direction, variability, temperature difference, shelter, exterior fan vents, passive exterior vents
PROJECT DETAILS: The objective of this project is to develop design guidelines for combustion air supply based on the size and type of combustion appliance served, the type of enclosure and the local climate. Over ventilation through combustion air openings in extreme winter weather conditions are a serious problem in northern climates, usually resulting in burst water pipes in boiler rooms. This problem is not correctly addressed by current codes in North America. Prototype combustion air systems are being evaluated at the University of Alberta Dept of Mechanical Engineering Home Heating Research Facility. This facility consists of six unoccupied test houses in a tightly spaced row with an open rural setting. These houses incorporate: continuous infiltration measurement using sulphur hexaflouride tracer gas, and local meteorological measurements (wind speed, wind direction and ambient temperature).
STARTDATE: 00:01:1993
EXPECTED TERMINATION DATE: 00:06:1994.
ESTIMATED NUMBER OF PERSON HOURS: (None stated)
SELECTED BIBLIOGRAPHY:
1. Walker, I.S. and Wilson, D.J. (1993) "Evaluating Models for Superposition of Wind and Stack Effect in Air Infiltration", Building and Environment, 28, pp. 201-210.
2. Walker, I.S. and Wilson, D.J.(1990) "Including Furnace Flue Leakage in a Simple Air Infiltration Model", Air Infiltration Review 11, No. 4, pp. 4-8.
3. Wilson, D.J. and Kiel, D.E. (1990) " Gravity Driven Counterflow Through an Open Door in a Sealed Room", Building and Environment 25, pp. 379-388.
4. Kiel, D.E. and Wilson, D.J. (1989) "Combining Door Swing Pumping with Density Driven Flow", ASHRAE Transactions 95 part 2 , pp. 590-599.
5. Kiel, D.E. and Wilson, D.J. (1987) "Influence of Natural Infiltration on Total Building Ventilation Dominated by Strong Fan Exhaust", ASHRAE Transactions 93 part 2, pp. 1286-1299.
6. Wilson, D.J. and Walker, I.S. (1991) "Wind Shelter Effects on Air Infiltration for a Row of Houses", Proceedings 12th AIVC Conference on Air Movement and Ventilation Control Within Buildings, Ottawa, September 22-27, 12 pages.
7. Wilson, D.J. and Walker, I.S. (1990) "Combining Air Infiltration and Exhaust Ventilation", Proceedings 5th International Conference on Indoor Air Quality and Climate, Toronto, July 28 - August 3, pp. 467-472.

REF CA14
TITLE OF PROJECT: Investigating, diagnosing and treating your damp basement.
PRINCIPAL RESEARCHER: Don Fugler
ORGANISATION: The Canadian Mortgage and Housing Information Centre CMHC
ADDRESS: 700 Montreal Road Ottawa, Ontario K1A OP7 CANADA
TELE: +1 613 748 2367 FAX: +1 613 748 2098
E-Mail Address:
SPECIFIC OBJECTIVES: Moisture mould generation and prevalence
BUILDING TYPE: Dwellings
COMPONENT TYPE: Basements
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Moisture
PROJECT DETAILS: Basements have increasingly become part of the living space in Canadian houses. Basements are plagued with moisture problems, particularly as they get older. Dampness and moisture problems are responsible for musty basement air: mildew on stored items; humidity problems and structural, wall floor and furniture decay. The causes of basement moisture problems are numerous. It is often confusing and costly to try to remiate the situation before isolating the exact cause. The research Division of CMHC has gathered the best advice on basement moisture problems in an easy to read guide for householders. It will help diagnose moisture problems and identify their sources. Interim and long term solutions to each problem type are

included. The guide is broken down into a number of easy to use sections.
* The SYMPTOMS section describes the main symptoms likely to be found in a house with a damp basement and lists probable sources and causes.
* The SOURCES and CAUSES section lists a series of tests to confirm the sources or cause, and offers some solutions. A SOLUTIONS section gives an indication of the price range for solutions in terms of low medium or high. The guide can often provide sufficient information to allow householders to make their own repairs.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Fugler (1992), Investigating, diagnosing and treating your damp basement. NHA 6541

REF CA15
TITLE OF PROJECT: Study of Houses Affected by Hazardous Lands.
PRINCIPAL RESEARCHER: Don Fugler
ORGANISATION: The Canadian Mortgage and Housing Information Centre CMHC
ADDRESS: 700 Montreal Road Ottawa, Ontario K1A OP7 CANADA
TELE: +1 613 748 2367 FAX: +1 613 748 2098
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ Occupant safety and health; and To give a qualitative breakdown of the incidence of soil gas infiltration problems in housing in Canada today.
BUILDING TYPE: Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Soil Gases - Petroleum hydrocarbons, methane, and miscellaneous VOC's
PROJECT DETAILS: A Canada-wide survey was undertaken to identify:
* incidents of soil gas contamination into housing
* the types of these soil gas contaminants found;
* the effect of these soil gases on indoor air quality, occupant safety and health; and
* the remedial measures taken and the relative success of these measures. The main sources of information regarding soil gas infiltration comes from government organisations, media reports, and engineering contractors who specialise in soil gas remediation. As a large body of research into radon gas already exists, this study expressly focussed on other types of soil gas contaminants. Three major types of soil gases were identified as causing the majority of incidents in Canada.
1. Petroleum hydrocarbons were identified as the most common soil gas problem, as a result of the number of leaking underground storage tanks and the spillage of home heating fuel and gasoline. These incidents were readily identifiable due to the characteristic odours. Typically, remedial measures were implemented quickly and log-term high dose exposures were extremely rare.
2. Methane gas infiltration was the next most frequent occurrence. Sources for methane included natural sites, such as swamps and peat bogs, as well as industrial sources and landfill sites. Methane gas, even at low concentrations, is recognised as a safety hazard and as such many well documented studies exist.
3 Miscellaneous volatile organic compounds (VOC's) was the least frequent documented problem. Sources of VOC s included the offgassing of contaminated groundwater, local spills, illegal activities, and the migration to trace gases from landfill sites. Remediation techniques were defined as either house-based or source-based. House based remediation included sub-slab venting, pressurised air curtains, liners, sealing and caulking and plumbing corrections. Sourced based control included soil vacuum extraction, passive venting, liners, pressurised air curtain, and soil excavation.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Fugler (1992), Study of Houses Affected by Hazardous Lands.
2. Fugler (1993), Soil gases for housing : A guide for Municipalities. NHA 6728

REF CA16
TITLE OF PROJECT: Attic ventilation and moisture.
PRINCIPAL RESEARCHER: Don Fugler
ORGANISATION: The Canadian Mortgage and Housing Information Centre CMHC
ADDRESS: 700 Montreal Road Ottawa, Ontario K1A OP7 CANADA
TELE: +1 613 748 2367 FAX: +1 613 748 2098
E-Mail Address:
SPECIFIC OBJECTIVES: Moisture mould generation and prevalence. To use the continuous monitoring data to find out the relationships between outside conditions (wind, temperature, humidity) and attic performance (ventilation rate, wood moisture levels), and To develop an accurate attic venting model that could be extended to different attic designs, climates, venting systems, etc.
BUILDING TYPE: Dwellings
COMPONENT TYPE: Attics/roof spaces
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Outside conditions : (wind, temperature, humidity)
Attic performance : (ventilation rate, wood moisture levels),

PROJECT DETAILS: The field studies were built around two similar test houses: one with no intentional attic ventilation openings and one with traditional soffit and roof venting. These buildings were monitored over two winters. Measurements included attic wood moisture levels, attic air humidity levels, continuous air change testing, and environmental conditions. In addition to passive venting, one attic was retrofitted with a fan to force the ventilation rate. The fan was operated both as an air supply and as an exhaust to the attic during different periods. The researchers developed the computer model from both programs and new original research. The model was verified using the test house data. The research explains attic behaviour in a comprehensive fashion, and continued use of the model will expand this knowledge. Some preliminary conclusions include: * Attic ventilation rates are dominated by wind speed and can easily vary by a factor of ten, depending on the wind conditions at the time of measurement.
* When there is significant air movement into attics from the house below, ,an unventilated attic will result in a higher wood moisture content than a vented attic.
* Conversely, if the attic-house junction is nearly airtight, increasing attic ventilation will result in higher wood moisture levels due to reduced attic temperatures.
* The use of fans to ventilate an attic did not offer significant advantages over passive ventilation in the cases modelled for this report.
* The attic simulation program allows for the extension of the research findings to different climatic zones and ventilation strategies.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Fugler (1993), Attic ventilation and moisture.

REF CA17
TITLE OF PROJECT: Efficient and effective air handling devices.
PRINCIPAL RESEARCHER: Jim White
ORGANISATION: The Canadian Mortgage and Housing Information Centre CMHC
ADDRESS: 700 Montreal Road Ottawa, Ontario K1A OP7 CANADA
TELE: +1 613 748 2367 FAX: +1 613 748 2098
E-Mail Address:
SPECIFIC OBJECTIVES: Energy impact of ventilation, Heating and ventilation systems and strategies
BUILDING TYPE: Dwellings
COMPONENT TYPE: HVAC
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: HVAC
PROJECT DETAILS: Individual devices, including controllers, motors fans and cabinets, were studied in the context of the more common air handling operations in a house. Use was compared with flow power requirements, and projections were made as to what minimum, typical, near term maximum and future potential efficiencies were, and could be. Reduction of flow power requirements, through optimisation of the ducting components for instance, was left for a future study, when better component performance information will be available. For comparison, some larger building devices and systems were also investigated. Findings:
* Current residential air handling devices and systems are one tenth as efficient than they could be, and major improvements should be cost effective even with present costs for electricity. Their commercial counterparts are presently that efficient (but could also benefit from further upgrades, because of the scale of the waste involved).
* Although some furnace motor-fan sets are about 20% efficient, poor installation make them only 7% efficient as air handling devices. Individual exhaust devices are typically less than 2% efficient. The spread between poor and best can be in the order of ten to one, even without major new developments in technology or production. The potential for energy efficiency improvements in small air handling devices is vast! A phased approach to increasing required efficiency may have many benefits to all involved, especially if this opens the marketplace in the USA to devices developed here in Canada, for leading-edge technologies. Little time can be wasted , however or external suppliers will have the whole marketplace. Soon after devices are available to the new house market, a major demand can be expected in houses as the benefits of mechanical ventilation at low electrical operating cost, become evident.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. White J (1993), Efficient and effective air handling devices.CMHC

REF CA18
TITLE OF PROJECT: Testing of fresh air mixing devices
PRINCIPAL RESEARCHER: Jim White
ORGANISATION: The Canadian Mortgage and Housing Information Centre CMHC
ADDRESS: 700 Montreal Road Ottawa, Ontario K1A OP7 CANADA
TELE: +1 613 748 2367 FAX: +1 613 748 2098
E-Mail Address:

SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies
BUILDING TYPE: Dwellings Laboratory
COMPONENT TYPE: HVAC
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: When fresh air is introduced into the return air ducts of forced air furnaces, it may pool and hit the heat exchanger of the furnace in a localised cold flow. This in turn can initiate local corrosion and stress cracking of the heat exchanger. A few instances have also been reported of cold air coming out of supply registers, when the heat is off but the furnace fan is running. There are many causes for all these problems, but ducting was thought to be too badly built to allow such problems to occur in houses. The 1995 National Building Code of Canada to reduce the possibility of such problems, a test project was undertaken to develop mixing devices of adequate performance. In the absence of a local test house with sufficiently well-designed and built forced air duct to create the pooling problem, a laboratory duct set up was constructed, to study both streamline flow and mixing device performance. Conditions of cold stream flow were produced, then the flow was mixed by means of several devices of varying complexity. Very accurate temperature profiles were measured, and the flow was visualised with smoke.
Findings:
* Ducting with sharp corners and leaky connections will not support streamline flow. When ducts are built to HRAI guidelines, however, for reduced pressure drop and flow noise reduction, a cold steam can be created and its dispersion delayed. Although some care must be taken to introduce the cold air and avoid mixing, unmixed flow can and does happen.
* Several mixing devices were built, and located in different parts of the duct to determine temperature mixing distances and patterns.Most worked well enough to be located within a few metres of the furnace inlet, and yet introduce small temperature distortions in the flow field.
* The simplest device workable was a flush intake just downstream of the horizontal to vertical corner, where a separation vortex would be expected to occur.

* A simple taper cut off at either 45 degrees or 60 degrees produced reasonable mixing. The short (45 degree) cylindrical section worked best at the inside corner, where the flush intake worked best.
* The most complex mixing cone, distorted to form a series of slots across the diagonals of the duct, was by far the best mixing device.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:

1. White J (1993), Testing of fresh air mixing devices CMHC.

REF CA19
TITLE OF PROJECT: Barriers to the use of energy efficient residential ventilation devices.
PRINCIPAL RESEARCHER: Jim White
ORGANISATION: The Canadian Mortgage and Housing Information Centre CMHC
ADDRESS: 700 Montreal Road Ottawa, Ontario K1A OP7 CANADA
TELE: +1 613 748 2367 FAX: +1 613 748 2098
E-Mail Address:
SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies Energy impact of ventilation
BUILDING TYPE: Dwellings
COMPONENT TYPE: HVAC
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Changes to the building codes are likely to result in an increase in the number of mechanical ventilation devices and systems in housing and in their frequency of use. Because present equipment is woefully inefficient much higher operating costs result for electrical input energy that are actually required for ventilation. The longevity and other operating characteristics (noise and vibration levels) of most devices are also inappropriate. Industry opinion was sampled by means of an open-ended telephone questionnaire, delivered to 31 individuals representing a cross-section of the industry. The responses were summarised and analysed, to better understand the barriers to change. A number of suggested strategies were developed, based on consideration of those barriers, to increase the energy efficiency of residential ventilation devices in new and existing houses. Strongly held and frequently voiced opinions were also summerised, even when they are at variance with known science or facts. A separate study investigated the present and likely future efficiencies in much greater detail. * Although all respondents claimed to be aware that most residential ventilation devices are extremely inefficient, only a few displayed a real understanding of the science or the implications of those inefficiencies. Several respondents strongly argued points that are at variance with currently held scientific opinion. Others argued that energy efficiency per se, is irrelevant, maintaining that concern should rather be directed towards functional design, total energy consumption or heat recovery losses. Those factors are important, of course but not to the exclusion of energy efficiency.
* Air moving efficiency (how much power it takes to move air, compared to how much is used to perform the task) was frequently confused with heat recovery efficiency (how much power it takes to heat or cool

the air,compared to how much is available in exhaust or intake flows).
* Opinions about the potential for technical improvements varied in the extreme. Apparently no common understanding exists in regards to the kinds of technical changes that are possible., desirable or effective. Responses tended to focus on particular types of devices (bathroom fans, range hood fans, heat recovery ventilators, forced air circulation motor blowers, or central exhaust fans etc.) rather than controller, motor and fan sets themselves. The most frequently cited improvement was a change to a permanent split capacitor motor from the present shaded pole variety used in bathroom and range hoods, and to higher efficiency motors for forced air systems.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. White J (1992), Barriers to the use of energy efficient residential ventilation devices. CMHC.

REF CA20
TITLE OF PROJECT: The Clean air Guide: How to identify and correct indoor air problems in your home.
PRINCIPAL RESEARCHER: Virginia Salares.
ORGANISATION: The Canadian Mortgage and Housing Information Centre CMHC
ADDRESS: 700 Montreal Road Ottawa, Ontario K1A OP7 CANADA
TELE: +1 613 748 2367 FAX: +1 613 748 2098
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Moisture mould generation and prevalence
BUILDING TYPE: Dwelling
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Recent statistics indicate that we now spend up to 90% of our time indoors. Accordingly, our health is affected by the indoor air quality in our housing. People affected by indoor air contamination can be broken down into three categories: 1) those who are minimally affected, 2) those who suffer from allergies or respiratory ailments due to indoor air quality, and 3) those who are hypersensitive and react adversely to extremely low levels of contaminant exposure. Indoor air quality is affected by a host of agents ranging from moulds and mildews found in damp areas of the house to chemical vapours emanating from modern building materials. This study gives information on the effects of contaminants on house occupants, methods of contaminant detection and possible corrective measures. The guide is broken down into six sections, following the six steps to a cleaner environment.
These steps include:
* Assessing of the situation - entails a family profile and air quality questionnaire to give the reader a better perspective on the situation and the potential impact of air quality on each occupants health.
* Evaluating the house location,- involves an examination of the area where the house is located. A location audit and house history is included here.
* Evaluating the house, - this step uses a detailed assessment checklist of the house based on chemical and biological contamination, giving the reader a greater knowledge of potential sources and problems.A number of corrective measures are also listed.
* Deciding on a plan of action, - this sections describes numerous strategies to correct the source problems. These can be categorised as ventilation, elimination, and separation.
* Taking action, advice is given on how to find professionals who will take into account indoor air issues when renovating, building or remodelling. * Assessing the situation after action has been taken. This section examines the importance of evaluating the effects of measures taken to improve indoor air quality. These evaluation techniques assist in finding out where improvements helped. Further information is given on other issues such as relocating, apartment complexes and buying and building a home. A list of other organisations in the fields of indoor air quality and health is appended.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Salares V (1993), The Clean air Guide: How to identify and correct indoor air problems in your home. NHA 6695

REF CA21
TITLE OF PROJECT: Study of residential mechanical ventilation
PRINCIPAL RESEARCHER: (None Stated)
ORGANISATION: Ontario new home warranty program client and technical services.
ADDRESS: North York City Centre 6th Floor 5160 Younge Street North York, Ontario M2N 6L9 CANADA
TELE: (None Stated) FAX: +1 416 229 3845
E-Mail Address:
SPECIFIC OBJECTIVES: Heating and Ventilation systems and strategies
BUILDING TYPE: Dwellings
COMPONENT TYPE: HVAC
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: HVAC

PROJECT DETAILS: Report prepared by : Habitechnica This survey proposed that ventilation requirements from part of the Ontario Building Code. Technologies proposed within the Code should be widely available, and where new approaches were recommended, they would have to be extensively tested in the field. Ventilation rates need to be sensitive to occupancy, and bedroom counts were proposed as more representative of occupancy than house volume of total room count. The base system proposed for any dwelling is a packaged ventilator (eg heat recovery ventilator) operating in a balanced pressure mode. For dwellings with forced air heating system, a balanced system consisting of a central exhaust fan interlocked to a dampered supply duct which is hard connected to the furnace return, is proposed as an alternative to the base system.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF CA22
TITLE OF PROJECT: Ontario Building Code Part 9 . Mechanical ventilation demonstration
PRINCIPAL RESEARCHER: (None Stated)
ORGANISATION: Ontario new home warranty program client and technical services.
ADDRESS: North York City Centre 6th Floor 5160 Younge Street North York, Ontario M2N 6L9, CANADA
TELE: (None Stated) FAX: +1 416 229 3845
E-Mail Address:
SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies
BUILDING TYPE: Dwellings
COMPONENT TYPE: HVAC
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: HVAC
PROJECT DETAILS: Report prepared by: Buchan, Lawton, Parent Ltd, May 1993 This final report presents findings of a ventilation demonstration project, conducted by Buchan, Lawton, Parent Ltd,in 1992. This project involved testing new tract-built homes which incorporated ventilation systems built to the proposed methods and comparing them to current code requirements. Seven new homes where constructed and tested based on proposed requirements for air tightness and pressurisation potential, air exchange and ventilation air, flow measurements limited air quality and more. This project provided useful feedback on the workability of the code proposals. Identified observations include the difficulty experienced by builders in attempting to interpret the proposed code requirements, difficulty in attempting to achieve the interlocks for fan operation, difficulty in achieving a working system in balanced airflow mode, and system problems resulting in depressurisation of the home by using an exhaust only method. Based on the project observations, changes to the proposed revisions were recommended by an industry-government task group organised by the Ontario Ministry of Housing. This report suggests that a more broad based monitoring program should be undertaken in concert with implementation of the 1993 Ontario Building Code.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated).

REF CA23
TITLE OF PROJECT: Effectiveness of Air Tightening Measures
PRINCIPAL RESEARCHER: C Y Shaw
ORGANISATION: IRC/NRC.
ADDRESS: Building Performance Laboratory Ottawa Ontario CANADA K1A OR6
TELE: +1 613 993 9702 FAX: +1 613 954 3733
E-Mail Address:
SPECIFIC OBJECTIVES: Airtightness/air leakage of buildings, Retrofit measures
BUILDING TYPE: Occupied, Unoccupied, Commercial/Office
COMPONENT TYPE: Windows, Doors, Walls, Floors, Cracks
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: This project is to determine the effect of various air tightening retrofit measures on the building envelope of office buildings.
STARTDATE: 00:00:1992
EXPECTED TERMINATION DATE: 00:00:1994
ESTIMATED NUMBER OF PERSON HOURS: 1 person year
SELECTED BIBLIOGRAPHY:
1. C Y Shaw, J T Readon, and M S Cheang (1993), Changes in airleakage levels of six Canadian office buildings. ASHRAE Journal, Feb 1993.

REF CA24
TITLE OF PROJECT: Air distribution and energy efficiency in large space industrial / Commercial Buildings.
PRINCIPAL RESEARCHER: M N Said
ORGANISATION: IRC/NRC.
ADDRESS: Building Performance Laboratory Ottawa Ontario CANADA K1A OR6
TELE: +1 613 993 5938 FAX: +1 613 954 3733
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Thermal Stratification
BUILDING TYPE: Occupied, Industrial Factory
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)

PROJECT DETAILS: This project is to investigate the air distribution characteristics and the factors contributing to thermal stratification in large space buildings. Measurements of airflow patterns and temperature distributions in 10 aircraft hangers have been conducted.
STARTDATE: 00:00:1992
EXPECTED TERMINATION DATE: 00:00:1994
ESTIMATED NUMBER OF PERSON HOURS: 2 person years
SELECTED BIBLIOGRAPHY: (None Stated)

REF CA25
TITLE OF PROJECT: Validation of occupant survey Questionnaires.
PRINCIPAL RESEARCHER: J A Veitch
ORGANISATION: IRC/NRC.
ADDRESS: Bldg M-24 IRC/NRC Montreal Road, Ottawa, Ontario CANADA K1A OR6
TELE: +1 613 993 9671 FAX: +1 613 954 3733
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Occupant reactions to the indoor environment
BUILDING TYPE: Occupied, Commercial/Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Temperatures Relative Humidity Clothing Gender Occupation Age Office layout etc.
PROJECT DETAILS: This project is aimed to investigate the impact of indoor environment measures on the occupants of office buildings by relating occupant reactions to measurable parameters of the indoor environment such as ventilation rate, and thermal comfort and lighting conditions. Phase 1 will examine the equivalence of French translations of a set of occupant survey questionnaires were developed in English only.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: 1.5 person years
SELECTED BIBLIOGRAPHY: (None Stated)

REF CA26
TITLE OF PROJECT: House ventilation
PRINCIPAL RESEARCHER: J T Reardon
ORGANISATION: IRC/NRC.
ADDRESS: Building Performance Laboratory, Ottawa, Ontario CANADA. K1A OR6.
TELE: +1 613 993 9700 FAX: +1 613 954 3733
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Heating and ventilation systems and strategies
BUILDING TYPE: Unoccupied, Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: This project is to examine the efficacy of low cost alternatives to completely ducted ventilation systems suitable for houses with no air distribution systems. Six different ventilation systems which are suitable for both existing and new houses are examined. Single and multiple tracer gas tests to measure the air change rate of the house, the distribution of the ventilation rate (outdoor air) within the house, and the ventilation air supply rate to a closed bedroom began in late fall 1993 and will continue until early summer 1994.
STARTDATE: 00:10:1993
EXPECTED TERMINATION DATE: 00:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 2.5 person years
SELECTED BIBLIOGRAPHY: (None Stated)

REF CA27
TITLE OF PROJECT: Natural ventilation for Livestock Housing
PRINCIPAL RESEARCHER: Yves Choiniere
ORGANISATION: Ontario Ministry of Agriculture and Food
ADDRESS: Alfred College, 31 St-Paul Street, Alfred, Ontario, Canada, KOB 1AO
TELE: +1 613 679 2218 FAX: +1 613 679 4296
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Airtightness/air leakage of buildings, Moisture mould generation and prevalence, Heating and ventilation systems and strategies.
BUILDING TYPE: Unoccupied, Livestock-Agricultural
COMPONENT TYPE: Windows, Cracks
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: 1. Weather
2. Sidewall and chimney openings
3 Animals heat, moisture and gases production.
PROJECT DETAILS In barn experiments, design and test the control strategies for temperature and moisture, develop control systems and mechanical hardware for natural ventilation.
Wind tunnel tests pressure coefficients to obtain a wind tunnel induced production model.
Design computer software to size positive sidewalk, ridge and end wall openings for livestock barns.
Expert systems on natural ventilation for livestock housing
Canadian design code for naturally ventilated Swine, Dairy, Poultry and Beef barns
Wind tunnel tests on effects of up wind buildings, addition of wing walls and inside ceiling slope on natural ventilation efficiency.
STARTDATE: 00:00:1984
EXPECTED TERMINATION DATE: 00:00:1995
ESTIMATED NUMBER OF PERSON HOURS: about 13 person years
SELECTED BIBLIOGRAPHY: (None Stated)

REF CA28
TITLE OF PROJECT: Mechanical ventilation for swine nursery barns.
PRINCIPAL RESEARCHER: Yves Choiniere
ORGANISATION: Ontario Ministry of Agriculture and Food
ADDRESS: Alfred College, 31 St-Paul Street, Alfred, Ontario, Canada, KOB 1AO
TELE: +1 613 679 2218 FAX: +1 613 679 4296
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Energy Impact of ventilation, Heating and ventilation systems and strategies
BUILDING TYPE: Agricultural livestock Building
COMPONENT TYPE: Cracks, Air inlets
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED:
1. Weather
2. Performance of building components
3 Source of Pollution
4. Control System.
PROJECT DETAILS:
Evaluation of control strategies based on temperature to control
1.Moisture temperature
2. Minimise positive heating cost
3. Stabilise positive air flow patterns.
Methods : Environmental control chamber; data recording systems; test various control strategies.
STARTDATE: 00:00:1993
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 1.5 person years
SELECTED BIBLIOGRAPHY: (None Stated)

REF CA29
TITLE OF PROJECT: Survey of 180 older existing Canadian Houses
PRINCIPAL RESEARCHER: Robin Sinha
ORGANISATION: Natural Resources Canada
ADDRESS: 580 Booth Street, Ottawa, Ontario, Canada.
TELE: (613) 943 2260 FAX: (613) 996 9416
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ Airtightness / air leakage of buildings
BUILDING TYPE: Occupied, Dwellings,
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS Survey of about 180 houses of various ages to improve existing datasets and develop and evaluate analysis procedures and tools for house auditing. Airtightness tests were performed . Thermal descriptions for energy modelling obtained and a subset tested for IAQ.
STARTDATE: (Not Stated)
EXPECTED TERMINATION DATE: (Not Stated)
ESTIMATED NUMBER OF PERSON HOURS: (Not Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF CA30
TITLE OF PROJECT: Airtightness, Thermal Integrity and IAQ in new constructions and R2000 houses
PRINCIPAL RESEARCHER: Tom Hamlin
ORGANISATION: Natural Resources Canada
ADDRESS: 580 Booth Street, Ottawa, Ontario, Canada
TELE: +1 (613) 943 2260 FAX: +1 (613) 996 9416
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Energy Impact of Ventilation, Airtightness/ air leakage of buildings
BUILDING TYPE: Occupied, Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: n50, weather, pollutant sources, ventilation, energy meter readings
PROJECT DETAILS 200 new conventional houses and 50 new R2000 houses will be tested to example relative performance and opportunities for improvement. Hot 2000 thermal performance descriptions and other info phase will be used to charaterise performance.
STARTDATE: 00:08:1994
EXPECTED TERMINATION DATE: 00:08:1996
ESTIMATED NUMBER OF PERSON HOURS: (Not Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF CA31
TITLE OF PROJECT: R2000 Long term Monitoring
PRINCIPAL RESEARCHER: Tom Hamlin
ORGANISATION: Natural Resources Canada
ADDRESS: 580 Booth Street, Ottawa, Ontario, Canada.
TELE +1 (613) 947 1959 FAX: +1 (613) 996 9416
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Energy impact of ventilation, Airtightness / air leakage of buildings.
BUILDING TYPE: Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: n50, weather, pollutant sources, age
PROJECT DETAILS About 150 early R2000 energy efficient houses will have repeat tests of airtightness, formaldehyde concentrations and ventilation system performance to evaluate longevity and persistence of performance.
STARTDATE: 00:08:1994
EXPECTED TERMINATION DATE: 00:05:1996
ESTIMATED NUMBER OF PERSON HOURS:
SELECTED BIBLIOGRAPHY: (None Stated)

REF CA32
TITLE OF PROJECT: Building Materials - Volatile Organic Chemical Emission Characterisation and Database Development
PRINCIPAL RESEARCHER: Robert S Dummont
ORGANISATION: Saskatchewan Research Council (SRC)
ADDRESS: 15 Innovation Boulevard, Saskatoon, SK, Canada, S7N 2XB
TELE: +1 306 933 6138 FAX: +1 306 933 6431
E-Mail Address:
SPECIFIC OBJECTIVES: Assess VOC emssions from commonly used building materials and examine their impact on the indoor environment of houses. IAQ
BUILDING TYPE: Dwellings (Samples from) Tested in Test chambers
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Samples were taken from homes in the Advanced Home Program in which indoor environment studies were performed (Unoccupied and Occupied)
PROJECT DETAILS: Natural Resources Canada sponsored a national project to construct and monitor the next generation of low energy houses. The Advanced Houses Program built ten houses. These are being extensively monitored for energy use and indoor air quality as well as ventilation.
Building material samples were collected during the construction phases and stored in Tedlar samples bags. These samples are being tested in SRC test chambers for VOC's and formaldehyde emissions. A test method was developed and written for the project. A report is due by March 1995, including a handbook providing guidance to builders for the selection of building materials with regards to VOC emission potential.
STARTDATE: 00:08:1994
EXPECTED TERMINATION DATE: 00:03:1995
ESTIMATED NUMBER OF PERSON HOURS: 800
SELECTED BIBLIOGRAPHY:
1. Efficency of Post Manufacture Surface Coatings to reduce Formaldhyde emissions from composite wood products.

2.3 DENMARK

REF DK01
TITLE OF PROJECT: Modelling of radon entry and related experimental studies.
PRINCIPAL RESEARCHER: Claus E Anderson / Benny Majborn
ORGANISATION: Risoe National Laboratory
ADDRESS: Dept. of Nuclear Safety Research, DK - 40000 Roskilde, Denmark.
TELE: +45 46774677 FAX: +45 46753533
E-Mail ADDRESS: claus@risoe.dk
SPECIFIC OBJECTIVES: IAQ.
BUILDING TYPE: Test chamber or test structure.
COMPONENT TYPE: Floors, Cracks.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Soil parameters.
PROJECT DETAILS: Motivation and background
The objective of this project if to obtain a better understanding of radon transport in soil and of radon entry from soil into houses. To this end we have developed a numerical model of radon transport and entry, and constructed a test structure at a field site at Roso where radon transport in soil can be studied experimentally. The numerical model solves the equations for steady-state soil-gas and radon transport including radon emanation, decay, diffusion, advection, and partitioning of radon between gas and liquid phases. The model is flexible, and problems related to houses, to our test structure, or to soil probes ban be modelled in detail. The heart of the test structure is a 40 litre, stainless-steel cylinder which is placed in a small excavation. The excavation is lined with an airtight membrane, and soil gas enters the cylinder through a changeable interface in the bottom. The (de)pressurization of the cylinder is controlled by a mass-flow controller, and the pressure and radon fields can be monitored in the soil at a number of probe locations. Initial steady-state experiments and model calculations have shown a reasonable agreement between measured and calculated values of the pressure couplings and of the normalized radon concentration fields under diffusive and advective conditions. However, discrepancies were found between measured and calculated absolute values of soul-gas entry rates and radon concentrations
STARTDATE: 00:06:1992
EXPECTED TERMINATION DATE: 00:06:1995
ESTIMATED NUMBER OF PERSON HOURS: 1000
SELECTED BIBLIOGRAPHY:
1. Claus E. Andersen Entry of Soil Gas and Radon into Houses. Report Ris0-R-623 (EN), Riso National Laboratory,DK-4000 Roskilde, Denmark.

REF DK02
TITLE OF PROJECT: Measurement in houses with low energy, mechanical ventilation systems.
PRINCIPAL RESEARCHER: Peder Veisig Pedersen
ORGANISATION: Cenergia ApS.
ADDRESS: Sct. Jacobsuej 4, DK 2750 Ballerup, Denmark
TELE: +45 44 66 00 99 FAX + 45 44 66 01 36
E-Mail Address:
SPECIFIC OBJECTIVES: (Not Stated)
BUILDING TYPE: (Not Stated)
COMPONENT TYPE: (Not Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (Not Stated)

PROJECT DETAILS A monitoring programme for 43 new low energy houses at Egebjerggard in Ballerup will be realised from 1994 to 1996. The low energy houses will be shown at an international building exhibition in Bellerup. Energy design has been made by Canergia Energy Consultants and comprises extra insulation, super low energy windows (U-value of 0.95 W/m2 degree C for the whole window) air heating systems in combination with heat recovery on ventilation air. Besides solar heating for DHW, energy meters, low temperature district heating from a CHP-plant, EMS survey and control, water- and electricity savings.
STARTDATE: 00:00:1994
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 2000
SELECTED BIBLIOGRAPHY: (None Stated)

REF DK03
TITLE OF PROJECT: Demand Controlled Mechanical Ventilation with Humidity as a Regulator
PRINCIPAL RESEARCHER: Esbensen, T
ORGANISATION: Esbensen Consultants
ADDRESS: Mollegade 54-56, DK 6400 Sonderborg, Denmark
TELE: +45 74 42 22 50 FAX +45 74 42 26 74
E-Mail Address:
SPECIFIC OBJECTIVES: (None Stated)
BUILDING TYPE: (None Stated)
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS The purpose of the project is to demonstrate if demand controlled mechanical ventilation with humidity as a regulator can assume:
* The maintenance of an indoor climate with satisfactory physical health conditions.
* A reduction of the ventilation needs with 20-30% throughout the majority of the year compared to those recommended in Danish Building Code. The elimination of the need to adjust the mechanical ventilation system during and after installation.
The demonstration is carried out in a new 3-story housing project with 48 flats situated in Sonderborg, Denmark. 16 of the flats have traditional exhaust ventilation systems, 16 have mechanical heat recovery ventilation systems and 16 flats have the new humidity controlled ventilation system.
In 1993 measurements of the indoor climate took place. In this project a study will be carried out concerning the satisfactory level of the occupiers in the dwellings.
STARTDATE: 00:00:1994
EXPECTED TERMINATION DATE: 00:00:1995
ESTIMATED NUMBER OF PERSON HOURS: 400
SELECTED BIBLIOGRAPHY: (None Stated)

REF DK04
TITLE OF PROJECT: Effective ventilation of large enclosures. IEA Annex 26.
PRINCIPAL RESEARCHER: Peter Nielsen
ORGANISATION: Alborg University Centre
ADDRESS: Sohngaardsholmsveg 57, DK 9000 Aalborg, Denmark
TELE: +45 98 15 85 22
E-Mail Address:
SPECIFIC OBJECTIVES: (None Stated)
BUILDING TYPE: (None Stated)
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS IEA has established an Annex 26 with the aim to increase the understanding of energy and air flow, of thermal stratification and of contamination dispersion in large enclosures and to develop methods for minimizing the energy consumption in the provision of air quality and comfort. The existing tools for analysis of energy and air flow conditions in buildings are suitable for small rooms where the conditions are controlled by the ventilation system but in the design of large enclosures where the conditions are controlled by the convective flows they are inadequate. The present project is part of this work.
The aim of the project is to develop a mathematical model for convective flows along vertical, sloping and horizontal surfaces based on experimental investigations in both full scale and scale models. Measurement of velocities and temperatures in the boundary layer flow along plane surfaces will be parts of the project. The influence of the convective flows on the flow conditions in the room in general will be determined by tests in scale models.
The mathematical model should result in easy to use terms to be used for determination of substantial parameters of convective flows in the primary design stage. In addition to that sub routines are to be constructed which are able to handle the conditions at cold and warm surfaces. A method where profiles for velocity and temperature in the convective flow are used as boundary values to the numerical method which calculates the flow conditions in the room in general could be used. The goal is to describe the convective flows in an efficient way, that is with a limited use of space and CPU time.
STARTDATE: 00:00:1993
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 4 years
SELECTED BIBLIOGRAPHY:
1. Nielsen PV (1991), Models for the prediction of room air distribution . Proc. AIVC 12th Annual Conference.
2. Heiselberg P and Bergsoe N C (1993), Measurements of Contaminant Dispersion in Ventilated Rooms by a Passive Tracer Gas Technique.

Room Air Convection and Ventilation Effectiveness. ASHRAE 1993.
3. Nielsen P V (1993),Model experiments for the determination of airflow in large spaces. Proc of the International Conf. Indoor air '93, Helsinki 1993.
4. Nielsen P V (1983), Air Diffusion in rooms with ceiling mounted obstacles and two dimensional isothermal flow. Proc of the 16th Int. Confere. on Refrigeration.
5. Fox S G and Nielsen P V (1993), Model experiments in 1990 and on-site validation in 1992 of air movement in the Danish Pavilion in Seville. Proc. of the Int. Confer. Indoor Air '93, Helsinki, 1993.
6. Heiselberg P (1994), Stratified flow in rooms with a cold vertical wall. ASHRAE TRansaction, V 100 Pt 1, 1994.

REF DK05
TITLE OF PROJECT: Design and characterisation of the CLIMPAQ, Chamber of Laboratory Investigations of Materials, Pollution and Air Quality.
PRINCIPAL RESEARCHER: Lars Gunnarsen and Peter V Nielsen
ORGANISATION: Danish Building Research Institute
ADDRESS: PO BOX 119, DK-2970 Horsholm, Denmark
TELE: +45 42 86 55 33 FAX +45 42 86 75 35
E-Mail Address:
SPECIFIC OBJECTIVES: (None Stated)
BUILDING TYPE: Test chamber or test structure
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS Typical shortcomings in available full size testing facilities concerning emissions are their lack of test capacity. This has lead to the development of several smaller facilities. They suffer from unrealistic limitations to the parameters that influence emission rates.
The CLIMPAQ is a test chamber which has been developed in order to provide a small, simple but well documented emission testing facility capable of exposing construction products to a climate were the important climatic parameters may be varied independently around values found in typical buildings.
The CLIMPAQ is made of panes of window glass put together with low emitting two component epoxy glue. Only other main surface materials are stainless steel and eloxated aluminum. Testing of up to four material specimens of 0.80 m x 0.20m may be done. Temperatures up to 50 degree C are allowed. Outdoor air flow may be varied continuously from the leak rate of 0.0003 l/s up to 2.5 l/s. Mean air velocities in the chamber are equally distributed and may be varied independently of outdoor air supply rate from close to 0.1 m/s up to 0.5 m/s.
Qualification of emissions may be done by a variety of methods. In this investigation human subjects acted as air pollution judges, and chemical characterisation of air pollution was done. Results of comparative emission testing of carpet, linoleum, wall paint and sealant are presented. Tests were performed in the CLIMPAQ and in four other facilities ranging from a full scale chamber of 28m3 to a field and laboratory emission cell of 3.5.10^-5 m3. Results are seen to be the result of different exposures and sink properties in the different chambers.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF DK06
TITLE OF PROJECT: Interaction between man and the indoor environment.
PRINCIPAL RESEARCHER: Peter V. Nielsen, Henrik Brohus and C E Hyldgaard
ORGANISATION: Aalborg University
ADDRESS: Dept. of Building Technology and structural Engineering, Sohngaardsholmsvej 57, DK-9000 Aalborg, Denmark.
TELE: +45 98 15 85 22 FAX +45 98 14 82 43
E-Mail Address: i6hb@civil.auc.dk
SPECIFIC OBJECTIVES: Indoor air movement, IAQ
BUILDING TYPE: Occupied, Simulated Occupancy, Test Chamber or test structure
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Persons' impact on IAQ, personal exposure
PROJECT DETAILS The project is divided into two parts:
1. Persons' effect on the surroundings in the form of heat and contaminant emission.
2. Personal exposure and transport of contaminants and fresh air in the vicinity of a person. The project includes measurements with a breathing thermal manikin in a full scale test room.
STARTDATE: 00:00:1993
EXPECTED TERMINATION DATE:00:00:1997
ESTIMATED NUMBER OF PERSON HOURS: Two persons per year
SELECTED BIBLIOGRAPHY:
1. Brohus, H and Nielsen, PV (1994), Contaminant Distribution around in rooms ventilated by displacement ventilation, Proc. Roomvent '94, Air Distribution in rooms, 4th Inter. Confer. Cracow, Poland, June 15-17, 1994.
2. Brohus, H and Nielsen, PV (1994),Personal exposure in a ventilated room with concentration

gradients, Proc. Healthy Buildings Confer. '94. 22-25 August, Budapest, Hungary, 1994
3. Hyldgaard C E (1994) Humans as a source of heat and air pollution. Proc. Roomvent '94, Air Distribution in rooms, 4th Inter. Confer. Cracow, Poland, June 15-17, 1994.

REF DK07
TITLE OF PROJECT: Numerical Prediction of Air Flow in Livestock Buildings.
PRINCIPAL RESEARCHER: Kjeld Svidt
ORGANISATION: Aalborg University
ADDRESS: Dept. of Building Technology and structural Engineering. Sohngaardsholmsvej 57, DK-9000 Aalborg, Denmark.
TELE: +45 98 15 85 22 FAX +45 98 14 82 43
E-Mail Address: i6ks@civil.auc.dk
SPECIFIC OBJECTIVES: Indoor air movement, IAQ
BUILDING TYPE: Simulated Occupancy, Test chamber or test structure.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Inlet air velocity, room geometry
PROJECT DETAILS The project deals with numerical prediction of air flow in livestock buildings. Simulations are compared with full scale laboratory measurements.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF DK08
TITLE OF PROJECT: Simulation of Indoor Air Quality in Ventilated Rooms
PRINCIPAL RESEARCHER: Peter V. Nielsen, G P Jensen
ORGANISATION: Aalborg University
ADDRESS: Dept. of Building Technology and structural Engineering. Sohngaardsholmsvej 57, DK-9000 Aalborg, Denmark
TELE: +45 98 15 85 22 FAX +45 98 14 82 43
E-Mail Address: i6gpj@civil.auc.dk
SPECIFIC OBJECTIVES: Indoor air movement, IAQ
BUILDING TYPE: Test Chamber or test structure.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Contaminant emission
PROJECT DETAILS The project can be divided into two parts:
1. Simulation of contaminant transport in ventilated rooms.
2. Simulation of pollutant emission. Full scale measurements are compared with numerical predictions.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF DK09
TITLE OF PROJECT: Velocity distribution in a room with displacement ventilation and low level diffusers.
PRINCIPAL RESEARCHER: Peter V. Nielsen
ORGANISATION: Aalborg University
ADDRESS: Dept. of Building Technology and structural Engineering. Sohngaardsholmsvej 57, DK-9000 Aalborg, Denmark
TELE: +45 98 15 85 22 FAX +45 98 14 82 43
E-Mail Address: i6hb@civil.auc.dk
SPECIFIC OBJECTIVES: Indoor air movement, Energy Impact of ventilation, Heating and ventilation systems and strategies
BUILDING TYPE: Simulated Occupancy, Unoccupied, Dwellings, Commercial/Office, Industrial/Factory, Test chamber or test structure
COMPONENT TYPE: Low velocity diffuser
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Velocity distribution in occupied zone, temperature distribution in occupied zone.
PROJECT DETAILS The aim of this project is to develop a semi-analytical expression for the velocity in the vicinity of the floor in a room with displacement ventilation and low level diffusers.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Nielsen P V (1994) Velocity distribution in the flow from a wall-mounted diffuser in rooms with displacement ventilation. Roomvent'94. Conf. in Aalborg, 1994.
2. Nielsen P V (1994) Velocity distribution in a room with displacement ventilation and low level diffusers. IEA Energy Conservation in Buildings and Community Systems, Annex 20.

REF DK10
TITLE OF PROJECT: Modelling of boundary layer flows
PRINCIPAL RESEARCHER: Per Heiselberg and Heine Overby
ORGANISATION: Aalborg University
ADDRESS: Dept. of Building Technology and structural Engineering. Sohngaardsholmsvej 57, DK-9000 Aalborg, Denmark
TELE: +45 98 15 85 22 FAX +45 98 14 82 43
E-Mail Address:

Per Heiselberg = i6per@civil.auc.dk
Heine Overby = i6ho@civil.auc.dk
SPECIFIC OBJECTIVES: Indoor air movement
BUILDING TYPE: Simulated Occupancy, Unoccupied, Test chamber or test structure
COMPONENT TYPE: Windows
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS The aim of this project is to develop a mathematical model for free convective flows along vertical, sloping and horizontal surfaces based on experimental investigations in both full-scale and scale models. Both plane surfaces and surfaces with obstacles will be considered. Measurements of velocities and temperatures in the boundary layer flow will be part of the project. Airflows above the floor area induced by cold boundary layer flow will be investigated by measurements of velocities and temperatures in the flow.
The mathematical model should result in easy to use terms to be used for determination of substantial parameters of convective flows in the primary design stage. In addition to that subroutines for CFD-programmes are to be constructed which are able to handle the conditions at cold and warm surfaces. The goal is to describe the convective flows in an efficient way, that is with a limited use of space and CPU-time.
STARTDATE: 01:10:1993
EXPECTED TERMINATION DATE: 31:12:1995
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Heielberg P, Kuldenedfald of traek (in Danish). VVS Denmark, Vol.30. No. 8June 1994, pp6-8.
2. Heielberg P, Stratified flow in rooms with a cold vertical wall .ASHRAE Trans. vol 100 pt 1 1994
3. Heielberg P,Draught risk from cold vertical surface. Building and Environment, Special Issue. 29, 3 1994.

REF DK11
TITLE OF PROJECT: Convective air flow and air temperature models for building simulation programmes
PRINCIPAL RESEARCHER: Overby, H
ORGANISATION: Aalborg University
ADDRESS: Dept. of Building Technology and structural Engineering. Sohngaardsholmsvej 57, DK-9000 Aalborg, Denmark
TELE: +45 98 15 85 22 FAX +45 98 14 82 43
E-Mail Address: i6ho@civil.auc.dk
SPECIFIC OBJECTIVES: Indoor air Movement
BUILDING TYPE: Occupied, Unoccupied, Commercial/Office, Test chamber or test structure
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: To develop simplified models for vertical air flows, downstream air velocity and vertical air temperature profiles in zones with convective flows. The models are to be used in building simulation programmes for determination of the energy consumption, vertical air temperature profile and air velocity above the floor near cold surfaces.
The simplified models will be based on theoretical and experimental examination of the convective air flow and vertical temperature profile in rooms. The simulation results will be compared with laboratory measurements an will be demonstrated at the IEA Annex 26 case study building.
STARTDATE: 01:10:1993
EXPECTED TERMINATION DATE: 30:04:1995
ESTIMATED NUMBER OF PERSON HOURS: 500
SELECTED BIBLIOGRAPHY:
1. Overby H, Vertical temperature gradients in rooms with convective flows. (in Danish) Ph.D. Thesis. Aalborg University. Dept of Building Tech. and Struct.Eng. 1992.
2. Overby H and Steen-Thode M, Calculation of vertical temperature gradients in heated rooms. ISBN 0902 7513 R9046
3. Overby H, Measurement and calculation of vertical temperature gradients in rooms with convective flows. presented at Roomvent '94, Air Distribution in rooms, 4th Inter. Confer. Cracow, Poland, June 15-17, 1994.

2.4 FINLAND

REF SF01
TITLE OF PROJECT: Local heating systems
PRINCIPAL RESEARCHER: Jari Palonen
ORGANISATION: Helsinki University of Technology, HVAC-laboratory
ADDRESS: 02150 Espoo, Finland.
TELE:358-0-4513593 FAX: 358-0-4513611
E-Mail ADDRESS:
SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies
BUILDING TYPE: Commercial/office, Industrial/factory, Test chamber.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Thermal comfort; occupants behaviour.
PROJECT DETAILS:
Introduction.
The thermal climate in Finnish office and shops fulfill the requirements of ISO 7730 during heating period very well. Despite that a large percentage of office workers are complaining of drafts when the room temperature is 22oC or less. We have measured over 40% of office workers voting the room temperature too low at 20oC. Among office buildings in the Helsinki area nearly 60% were found that too low

room temperature was being a problem and 45% had problems with draft.
Objective.
The aim of this study was to determine the possibilities to adjust microclimate in workplaces by means of the local heating systems.
Methods. Measurements were made with a seated thermal manikin built and designed in Helsinki University of Technology. The room temperature was adjusted to 18-20oC and the manikin wore indoor winter clothing with clo-value of 1.0. Several small electrically heated surfaces were installed on the underside of the desk or on the floor under the manikin's feet. The effects of the local heater on the manikin's thermal balance was judged with equivalent homogeneous temperature.
Results and conclusions.
It was possibly to maintain the mean heat loss of the manikin at the comfort level of 45W/m2 even when the room temperature was decreased to 17-18oC. With a very small heated surface (0.2m-0.5m) very compact local heater can be designed but this will lead to relatively high surface temperature (60oC) and uneven radiation field under the desk. This can cause discomfort if worker's thighs are nearby the heated surface or he moves his position during sitting. A large heater under the desk allows lower surface temperature and more uniform thermal radiation. The use of a heated carpet (1m-1m) under feet with surface temperature about 30oC was tested with displacement ventilation. It caused some convective currents upwards (the mean velocities at ankle level were increased) but the local heat losses from feet, ankles and calves were decreased which is a sign of better thermal comfort. The power need of the local heaters 100-150 W is about 1/3-1/10 of that used in traditional electric heaters for individual room temperature control by the means of heating.
STARTDATE: 01:02:1993
EXPECTED TERMINATION DATE: 01:03:1994
ESTIMATED NUMBER OF PERSON HOURS 1000
SELECTED BIBLIOGRAPHY Under preparation.

REF SF02
TITLE OF PROJECT: Performance of convective spot cooling; measurements with thermal manikin.
PRINCIPAL RESEARCHER: Ulla Parvio
ORGANISATION: Helsinki University of Technology, HVAC-laboratory
ADDRESS: 12150 Espoo, Finland.
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SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies.
BUILDING TYPE: Commercial/office, Industrial/factory, Test chamber.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Thermal comfort; occupants behaviour.
PROJECT DETAILS: The principle of spot cooling is to influence on the thermal micro-climate in close proximity to a person. Cooling is thus directed to the spot where it is needed. Spot cooling enables a flexible and individual control of thermal climate to meet personal needs and preferences. controlling and the micro-climate of a working place instead of a large space may also lead to energy savings.
The cooling potentials of systems based on increasing air velocity (convective cooling) were studied experimentally.
Measurements were carried out with a thermal manikin consisting of 25 separately controlled sections in a climatic chamber. The manikin was exposed to vertical downward air stream, which was either isothermal or below ambient temperature. The effects of the air stream on thermal comfort in prevailing circumstances were evaluated from the total and sectional heat losses of the manikin using a physiological model and comfort criteria.
Skin wettedness is the major factor governing discomfort in hot climates and it was used as criteria defining upper comfort limit for ambient temperature for different cooling cases. For this purpose a model was developed to evaluate evaporative heat transfer through clothing at varying air velocities based on dry heat transfer measurements.
The results show that increasing air velocity from stagnant conditions to 0.45 m/s raised the upper limit of comfort zone from 25oC to 28.5oC for a sedentary person.
STARTDATE: 01:04:1993
EXPECTED TERMINATION DATE: 01:03:1994
ESTIMATED NUMBER OF PERSON HOURS 1000
SELECTED BIBLIOGRAPHY Under preparation.

REF SF03
TITLE OF PROJECT: The Finnish day-care environment and health study.
PRINCIPAL RESEARCHER: Olli Seppanen
ORGANISATION: Helsinki University of Technology and University of Helsinki.
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TELE:+358-0-451 3600 FAX: +358-0-451 3611
E-Mail ADDRESS:
SPECIFIC OBJECTIVES: IAQ.
BUILDING TYPE: Occupied, Day-care centers.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Ventilation system, ventilation rate, human health and comfort.
PROJECT DETAILS: The aim of the study have been to assess the occurrence of SBS symptoms among day-care workers and children in relation to ventilation and indoor air quality. A random sample

of 30 day-care centres in city of Espoo was selected for the study. The study population consisted of 268 female nursing workers and 1091 children. Also, a random sample of 2568 pre-school children was included in the study. The measurements consisted of airflows, temperature, relative humidity, concentrations of CO2, VOC and odour intensity. Questionnaires were distributed to the workers and children's parents.
STARTDATE: 00:00:1990
EXPECTED TERMINATION DATE: 00:00:1995
ESTIMATED NUMBER OF PERSON YEARS: 12 Person years.
SELECTED BIBLIOGRAPHY
1. Ventilation and indoor air quality in Finnish day-care Centers. Ruotsalainen R, Jaakkola N, Jaakkola JJK. Env Int 19, 2109-19.1993.
2. Home dampness and molds as determinants of respiratory symptoms and asthma in pre-school children.Jaakkola JJK, Jaakkola N, Ruotsalainen R. J Exp Anal Env Epid 3, 1129- 42. 1993.
3. What are the determinants of children's exposure to environmental tobacco smoke at home? Jaakkola N, Ruotsalainen R, Jaakkola JJK.Scand J Soc Med. 1994.
4. Ventilation rate as a determinant of symptoms and unpleasant odours among workers in day-care centers. Ruotsalainen R, Jaakkola N, Jaakkola JJK. Proceedings of Indoor Air '93, Vol.5127-32.1993.
5. Water damage and moisture problems as determinants of respiratory symptoms among workers in day-care centers. Ruotsalainen R, Jaakkola N, Jaakkola JJK. Proceedings of Indoor Air '93, Vol.4317-22.1993.

REF SF04
TITLE OF PROJECT: An Active Sheltering from Outdoor Pollutants in a one-family house.
PRINCIPAL RESEARCHER: Jukka Paalanen.
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E-Mail ADDRESS:
SPECIFIC OBJECTIVES: Coping with external pollutions.
BUILDING TYPE: Dwellings.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Supply air rate, airtightness of the envelope filtration efficiency, dose inside the shelter.
PROJECT DETAILS: The protection ability of a one-family house has been studied by computational methods. Shelter given by building envelope alone/siren 1993/ and by over pressurized building / Paalanen 1994 / have already been reported. Computer programs MOVECOMP and MULTIE have been used to calculate airflows, concentrations and doses in the shelter. The weather statistics was based on the long term measurements of the Finnish Meteorological Institute at the Helsinki airport. The next step is to study other sheltering measures for instance the effects of filtrated recirculated air inside the building.
STARTDATE: 00:00:1992
EXPECTED TERMINATION DATE: 00:00:1995
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Siren K., A Computational Approach to the Penetration of Gaseous Pollutants Into Buildings, Part I single family house. Helsinki University of Technology, Faculty of Mechanical Engineering, Department of Energy Engineering. Report 45, May 1992.
2. Paalanen J. and Siren K. An Active Sheltering from Gaseous Outdoor Pollutants in a one-family house (in Finnish with English abstract). Helsinki University of Technology, HVAC-laboratory. Report B34, 1994.

REF SF05
TITLE OF PROJECT: The Helsinki Office Environment Study.
PRINCIPAL RESEARCHER: Jouni J.K. Jaakkola
ORGANISATION: University of Technology, HVAC-laboratory.
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E-Mail ADDRESS:
SPECIFIC OBJECTIVES: IAQ, Heating ventilation systems and strategies.
BUILDING TYPE: Occupied, Commercial/office.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Ventilation system, ventilation rate.
PROJECT DETAILS: The goals of the Helsinki office environment study have been
1) to estimate the prevalence of SBS-symptoms and perceptions among Finnish office workers.
2) to recognize and estimate the frequency of technical solutions or operational errors that are a cause of SBS-symptoms.
3) to establish a link between ventilation systems and rates and SBS-symptoms.
4) to create an evaluation method to estimate indoor air quality in buildings.
This study supplements the work that has been done at the HVAC-laboratory of the University of Technology in the field of indoor air quality since 1983. Adjoining studies have been or are currently carried out in residential buildings and day-care centers. The effects of air recirculation and humidification have been studied earlier in office environment. The symptom prevalences in this study

were recorded with a questionnaire that was sent to the workers of the 41 randomly selected buildings. The questionnaire was returned by 2678 persons, which gave a response rate of 80.7%. During the study the exhaust air flows of the offices of 1782 persons were measured from the exhaust valves with a hot- wire anemometer. The maximum air recirculation rates were measured with tracer gas technique. The results were analysed statistically with the SAS-program. All those confounding factors that are significant according to the researchers' prior knowledge, were taken into account. An evaluation method to estimate the indoor air quality in buildings was developed, but no link could be established between the estimates obtained from the evaluation and actual measured symptom prevalences.
STARTDATE: 01:01:1990
EXPECTED TERMINATION DATE: 31:05:1994
ESTIMATED NUMBER OF PERSON HOURS: 10 800
SELECTED BIBLIOGRAPHY:
1. Jaakkola JJK, Miettinen P, Tuomaala P, Seppanen O The Helsinki office environment study The type of ventilation system and the sick building syndrome. in The proceedings of Indoor Air '93.
2. Teijonsalo J, Jaakkola JJK, Seppanen O The Helsinki office environment study Air change in mechanically ventilated buildings. in The proceedings of Indoor Air '93.
3. Puputte T, Seppanen O Experience of SBS-investigations on three levels. An abstract that has been accepted to Health Buildings '94.
4. Jaakkola JJK et al. The amount of ventilation and the sick building syndrome. An article to be published in a peer-reviewed journal.
5. Jaakkola JJK, Teijonsalo J, Miettinen P, Tuomaala P, Seppanen O The use of air recirculation as a determinant of symptoms and perceived air quality among office workers. In Finnish with English abstract. Ministry of trade and commerce, department of energy, LVIS-2000 research program. Report 20. Espoo 1993.
Additional material has been published in Finnish and will be published later in peer-reviewed journals under the title of the Helsinki office environment study.

REF SF06
TITLE OF PROJECT: Innovated Ventilation System for Houses.
PRINCIPAL RESEARCHER: Olli Seppanen, Jarmo Heinonen.
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SPECIFIC OBJECTIVES: Indoor air quality. Energy impact of ventilation. Heating and ventilation system and strategies. Filtration of outdoor air.
BUILDING TYPE: Dwelling.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Demand controlled ventilation, sensors and control devices, energy economy, local exhaust ventilation, kitchen range hood, filtration of outdoor air, materials of ducts.
PROJECT DETAILS: The aim of this research is to develop and demonstrate the new type of ventilation system for houses. Above mentioned parameters will be taken account in the research.The ventilation system for houses should be designed to operate so that it removes pollutants and moisture and provides thermal comfort in an energy efficient way. That's why the Demand Controlled Ventilation (DCV) system would be a good solution for houses, because there the pollutant loads are usually highly variable and unpredictable. The presence and the functions of humans may depend both on time and location in the house.Therefore in this research will be focused to improve the indoor air quality and the energy economy simultaneously.
The ventilation system includes CO2-controlled ventilation of one or more zones, humidity controlled bathroom ventilation and efficient adjustable range hood for kitchen ventilation. The concentration level of CO2 in bedrooms and the moisture level in bathrooms will control both the supply and exhaust airflow and the pressure level of the supply and exhaust fan. Calculations with TFCD simulation program have showed that the supply and exhaust airflow of the specific room can be controlled in the wide range with ratio one to four without decreasing the supply and exhaust airflow significantly in other rooms. The maximum deviation of the supply and exhaust airflow was only 30% of from the initial value.
The problem in designing and developing the DCV system has been how to carry it out with minimum cost in small buildings or houses. One solution for this problem is to construct the DVC system according to the modular principle. Then it might be possible to add components to the existing system with minimum cost. Important part of the research is to give to HVAC-consults and - industries information about planning and building the DVC system. All new components and the new residential ventilation system will be tested in the laboratory. Because this research is the product development project, there will be paid a great deal of attention to the working re-ability and the ease of function of the ventilation system.
The filter research will be carried out during this project. There will be tested five kinds of filter. Filters are fibre filter, electric fibre filter, electric fibre filter with corona wire, electret filter and electret filter

with corona wire. The filter research is an experimental research and it will be carried out in the field testing the removal efficiency and the long time stability of the filters.
STARTDATE: 1.April 1993
EXPECTED TERMINATION DATE: 31.September 1994
ESTIMATED NUMBER OF PERSON HOURS: 2500 hours
SELECTED BIBLIOGRAPHY:
1. Calculations of airflows, temperatures and contaminant concentrations in multi-zone buildings.
2. Klobut, Krzysztof. Licentiate's thesis, helsinki University of technology. Espoo 1991.
3. The Demand Controlled Ventilation system for Houses, Jarmo Heinonen, Olli Seppanen. Healthy Building' 94 Conference Budapest. (Paper will be published in August 1994)

REF SF07
TITLE OF PROJECT: Development of a Building Simulation Program to Study Ventilation Process and Thermal Behaviour of Building Structures.
PRINCIPAL RESEARCHER: Mr. P. Tuomaala
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SPECIFIC OBJECTIVES: Simulation of building behaviour, Indoor air movement, IAQ, Energy Impact of Ventilation, Airtightness/air leakage of buildings, Moisture mould generation and prevalence, Heating and Ventilation Systems and Strategies.
BUILDING TYPE: (simulated occupancy), Test chamber or test structure, artificial test case
COMPONENT TYPE: Air flow characteristics of all air flow elements are needed and defined for simulations, and thermal properties are also needed.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather (temperature, wind, Humidity etc)., Performance of building components, Behaviour of occupants. Sources of pollution, Also air flow characteristics and thermal properties are included.
PROJECT DETAILS: This new building simulation program BUS (version 4.1) is based on a network assumption, and it includes simulation of air flow, heat transfer, and indoor air quality processes. Also an effective sparse matrix solution algorithm for linear set of equations is introduced.
For single air nodes of networks, complete and instant mixing of air is assumed. Ventilation fans, external wind and thermal buoyancy are included as driving forces. An improved SIMPLE -algorithm is selected for air flow simulation. This algorithm is based on simultaneous iterative solution of both the mass balance equation of each node in the network, and the momentum equation of every flow element. A thermal balance method (lumped capacitance method) is selected to assessment of temperature levels at building network nodes. Indoor air quality simulation has been included to the model in order to evaluate indoor air humidity and quality in different parts of buildings. Contaminant balances of particles and gases together with moisture content are evaluated by implicitly discretised equations.
There is certain analogy and synergy in formulation of mass, heat, and contaminant balance equations. All of them have to be discretised for a numerical solution, and in all cases problem is to solve, more or less sparse, linear set of equations. In this study an iterative solution method, preconditioned conjugate gradient method, is chosen. The conjugate gradient method works for symmetric positive definite matrices, as all coefficient matrices in this program are.
In this building simulation program BUS, simulation of air flow and heat transfer processes are combined, and the program is capable of solving mass balance, momentum, and heat balance equations. This makes it possible to take into consideration the interaction between ventilation and heat transfer processes, obtain more reliable simulation results than earlier, and simulate time-dependent processes. The completed building simulation program BUS can be applied to pre-construction testing, indoor air quality prediction, energy efficient heating and ventilation design, and design validation - as a tool for both research work and practical applications.
STARTDATE: 01:01:1993
EXPECTED TERMINATION DATE: 31:12:1995
ESTIMATED NUMBER OF PERSON HOURS: 5000
SELECTED BIBLIOGRAPHY:
1. The theoretical basis of a new building air flow simulation model.(Building Services Engineering Research and Technology, Vol 14, No 4)
2. A thermal analysis program for a new building simulator. (Sent on September 1993 to be published in Energy and Buildings)
3. Measurements and parameter definition of ventilation flow elements.(Measurement arrangements are completed, and the actual measurements will be started in February 1994; planned to be published in ASHRAE Transactions)
4. Combined air flow simulation and thermal analysis of a building. (Sent on January 1994 to be published in Building and Environment)
5. Validation of a simulation program to study ventilation processes and thermal behaviour of building structures. (Planned to be sent in Dec 1994 to be published in Building and Environment)

REF SF08

TITLE OF PROJECT: EBES - Residential Building

PRINCIPAL RESEARCHER: Laine, Juhani
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SPECIFIC OBJECTIVES: The aim is to study whether or not it is possible to achieve a better indoor climate with low building and maintenance costs, by integrating the building elements and heating and ventilation systems developed in the EBES-project.
BUILDING TYPE: Residential building.
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Mechanical sound attenuated ventilation heating system with heat recovery, cold climate.
PROJECT DETAILS: The operation of the systems selected and of the heating and ventilating equipment are simulated, theoretically an experimentally before the construction phase. The functionality of the contract limits, the success of the installations, the work methods and costs are studied during construction. The functionality of the systems, the indoor climate, the energy consumption, and the function of the building elements as an energy store, are followed in the finished building.
In EBES apartment houses, the heating, piping, ventilation and the structures in an open BES-element building system of an apartment house have been integrated into an energy-economic overall EBES system. When using an EBES apartment house in an experimental building project in the Vuosaari district in the city of Helsinki, the design and installation instructions as well as components involved in this building practice proved to be useful also in a real building project.
The accumulating ventilation heating system functioned well during the monitoring of the EBES residential building. Residents were very satisfied. Also with regard to indoor air quality and thermal comfort, the mechanical supply and exhaust air ventilation system functioned well. The use of hollow spaces in concrete structures as supply air ducts was a good solution and reduced the need for heating of the supply air. The experience gained in this project indicated the ventilation unit should be as simple as possible in residential buildings. Consumption of night-time electricity was 70 % of total heating energy. It was lower than the target value of 85 % owing to dimensioning inaccuracy.
The consumption of heating energy was 27% lower in the EBES building than in the reference building, although in the EBES building the ventilation rate was almost 50% higher than in the reference building. The normalized heating energy consumption per building volume was 40 kWh/m3, which was 33% lower than the average consumption in Helsinki. Already in test measurements performed both in the laboratory and on the building site before starting to use the EBES system, EBES components and EBES building system sections were usually found to meet their desired and design values. Only the air ductwork of hollow-core slabs did not meet its desired air tightness class C because of the incorrect punching of the webs of the hollow-core slabs used to construct the ductwork.
On the building site both erecting the bearing floor and wall structures as well as sewage and electrical installation were generally carried out well. Problems were met when constructing the air ductwork of hollows in the hollow-core slabs of the bearing floor and wall structures and when installing heat-insulated water pipe elements into the hollows in the hollow-core slabs of the bearing wall structures. The prototype nature of the EBES components delivered to the building and the incompatibility of different designs caused problems.
The most important development need for the EBES building system is to develop a suitable wall element with hollows for the system. Improving ease of construction and installation work sets further development needs for other EBES components. The ease of work is promoted by the principle of the manufacturer of components also installing them at the building site.
STARTDATE: 01:03:1988
EXPECTED TERMINATION DATE: 31:05.1993
ESTIMATED NUMBER OF PERSON-HOURS: 4000 person-hours
SELECTED BIBLIOGRAPHY:

1. Korhonen, P, Laine, J., Muro, O. & Virtanen, M. EBES - integroitu LVIS- ja rakennejrjestelm. Espoo: Valtion teknillinen tutkimuskeskus, 1988. 83s. + liitt. 2 s. (VTT Tutkimuksia 537).
2. Laine, J. EBES-rakenteiden ja LVIS-tekniikan yhteistoimintaa. LVI-lehti,1988. Vol. 40, nro 4, s. 24 - 31.
3. Laine, J. Control of indoor climate by an integrated HVAC and building system. 13th IABSE Congress, Helsinki, 6
International Association for Bridge and Structural Engineering, 1989. S. 190 - 191.
4. Laine, J. & Korhonen, P. Rakenteiden ja LVIS-tekniikan yhteensovitus EBES-asuinkerrostalossa. Rakennus ja yhdyskunta, 1990. S. 7 - 8.
5. Laine, J. & Korhonen, P. EBES-asuinkerrostalo - kantavien betonirakentei-den ja laitetekniikan yhteistoimintaa. Kunnallisrakentaminen, 1990. Nro 1, s. 10 - 12.
6. Luoma, M., Laine, J. & Kohonen, R. Demand controlled ventilation in three Finnish demonstration dwelling houses. International CIB W67 Symposium on Energy, Moisture and Climate in Buildings,

Rotterdam, 3 - 6 September 1990. Rotterdam, Netherlands: CIB, International Council for Building Research, Studies & Documentation, 1990. 6 s.
7. Laine, J. & Saari, M. EBES - energy-efficient residential buildings. Teoksessa: Ventilation For Energy Efficiency and Optimum Indoor Air Quality. 13th AIVC Conference, Nice, 15 - 18. September 1992. Coventry: IEA Energy Conservation in Buildings and Community Systems Programme, 1992. S. 359 - 367.
8. Laine, J. & Saari, M. Itsestnstyv ilmakanavisto takaa hyvn sisilmaston asuinkerrostalossa. Teoksessa: Saari, M. (toim.) LVIS-2000 sisilmastoseminaari 4.6.1992. Espoo: Valtion teknillinen tutkimuskeskus, LVI-tekniikan laboratorio, 1992. S. 110 - 116. (LVIS-2000-tutkimusohjelma, Raportti 14).
9. Laine, J. & Saari, M. Hyv sisilmasto ymprist ystvllisesti. Good indoor climate in environmentfriendly office building. (In Finnish). Sisilmastoseminaari 14.2.1994, DIPOLI, Espoo, Finland. (Conference Paper). SIY Report 2, pages. 43-48.
10. Laine J. & Saari, M. Advanced HVAC-systems in energy-efficient experimental buildings. Proceedings of International Conference on HVAC in Cold Climate (COLD CLIMATE HVAC '94) in Rovaniemi, Finland, March 15-18, 1994. pages 313-322.
11. Kaitamaa, A., Laine, J. & Saari, M. EBES-asuinkerrostalo. Espoo: Valtion teknillinen tutkimuskeskus 1993. 62 s. + liitt. 17 s. (VTT Tiedotteita 1515).

REF SF09

TITLE OF PROJECT: Retrofitting of Residential Ventilation Systems

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SPECIFIC OBJECTIVES: Energy impact of ventilation, Airtightness/air leakage of buildings, Heating and ventilation system and strategies.
BUILDING TYPE: Dwellings.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Building airtightness, ventilation system, energy economy, demand controlled ventilation, leakage of air ducts
PROJECT DETAILS: The aim of the project is to develop methods for improving ventilation systems in existing residential buildings, especially in multi storey buildings.
In the completed part of project three multi storey buildings were selected for investigation. According to the questionnaire survey the occupants felt that the kitchen ventilation worked unsatisfactorily, smells from neighbouring flats were disturbing and also that they had to use airing too often. There were no substantial differences between mechanical exhaust and passive stack ventilation systems. Different renovation strategies were planned in the project for improving existing systems and also for shifting into a balanced ventilation system. The designs were verified by simulations in different climatic conditions. The passive stack system can perform satisfactorily if new air flow control equipments will be taken into use. To improve the performance of the ventilation system it is often necessary to seal the building envelope, internal cracks and the air ducts. Demand controlled ventilation systems should be preferred.
In the next part of the project methods will be developed to calculate energy saving due to heat recovery systems. The effect of air tightness of the building envelope on energy saving will be taken into account. The concepts for different heat recovery systems will be defined. The methods to seal and to prove the air tightness of air ducts will be clarified as well.
STARTDATE: 01:04:1993
EXPECTED TERMINATION DATE: 31:12:1996
ESTIMATED NUMBER OF PERSON HOURS: 4000 hours
SELECTED BIBLIOGRAPHY:
1. Heikkinen, J. Pallari, M-L. Improvement of Domestic Ventilation Systems. A paper to be presented at the 15th AIVC Conference, September 1994, Buxton, UK.

REF SF10

TITLE OF PROJECT: The effect of cleaning of ventilation system of air flow rates and or stratification of occupants in single family houses.

PRINCIPAL RESEARCHER: Pertti Pasanen
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SPECIFIC OBJECTIVES: IAQ, Dirtiness of ventilation system
BUILDING TYPE: Occupied, Dwellings
COMPONENT TYPE: Air handling system
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Cleaniness of ventilation system, re-adjustment of the air delivery to different rooms.
PROJECT DETAILS The objects are chosen among single family houses and detached houses in which cleaning of ventilation system is ordered by the occupants. The half of the objects are equipped with supply and exhaust ventilation systems with filtered

and heating units, and the second half of the houses have central air heating system. The whole dust samples are collected separately from supply and exhaust air systems. The amount of dust, proportion inorganic fractions and organic fractions in the dust and concentrations of viable and nonviable fungal spores will be analysed to characterise the cleaniness of the system. The total air flow rate and air distribution between the rooms are measured before the cleaning and after the cleaning and readjustment and balancing the ventilation. The effect of cleaning and readjustment of the ventilation system on the satisfaction of occupants is followed by questionnaire filled in by adults in the dwelling. The questionnaire is asked to fill before the cleaning and three months after the cleaning.
STARTDATE: 00:06:1994
EXPECTED TERMINATION DATE: 00:03:1995
ESTIMATED NUMBER OF PERSON HOURS: 1100
SELECTED BIBLIOGRAPHY:
1. Luoma M et al Duct cleaning - a literature survey. Air Infiltration Review. Vol 14, No 4 pp1-5, 1993.
2. Pasanen Pertti et al (1993), Residues of lubricant oils as a source of impurities in ventilation ducts. In Proceedings of the 6th International Conference on Indoor Air Quality and Climate. Vol6 pp 273-277 Eds:O Seppanen, Helsinki 1993.
3. Pasanen P et al (1994), Increase of perceived odour emissions with loading of ventilation filters. Indoor Air Vol 4, no 2, 1994.
4. Pasanen P et al (1993), Filters of air supply units as sources of contaminants. In Proc. of the 6th International Conference on Indoor Air Quality and Climate. Vol 6 533-538. Eds. O Sepanen, Helsinki 1993.

REF SF11
TITLE OF PROJECT: Detection and mitigation of occupational radon exposure in underground workplaces
PRINCIPAL RESEARCHER: Pirjo Korhonen
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SPECIFIC OBJECTIVES: IAQ, Airtightness/air leakage of buildings, Heating and ventilation systems and strategies, Radon
BUILDING TYPE: Occupied, Commercial/Office, Industrial/Factory, Underground workplaces
COMPONENT TYPE: Doors, Walls, Floors, Cracks
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Occupants, Radon, air exchange rate and operation time, pressurisation
PROJECT DETAILS Construction type: concrete, bricks, wood, steel, cave. Ventilation: natural and mechanical supply and exhaust. Measurements: radon (alpha track etch film and Pylon AB-5) pressure differences (monometer-datatader-PC), air flows (tracer gas measurements with freon 12, Miran 1A)
STARTDATE:01:11:1992
EXPECTED TERMINATION DATE: 31:12:1994
ESTIMATED NUMBER OF PERSON HOURS: about 6460 hours
SELECTED BIBLIOGRAPHY:
1. Kokotti H et al Radon problems in under ground workplaces. IN Building Design Tech, and Occup. well being in cold and temperate climates. ED. Sterling E. Bieva C and Collett, Atlanta, ASHRAEpp 298-301, 1993.
2. Kokotti H et al (1993), Radon problems in underground spaces. In Proc. of Indoor Air'93. Helsinki, 1993,4 593-598.
3. Kokotti H et al (1994), Effect of ventilation on radon levels in underground workplaces. Received 15th March 1994, in Occupational Hgygiene - Risk Management of Occupational Hazzards.
4. Korhonen P et al (1994), Detection and mitigation of occupational radon exposure in underground workplaces. Submitted in 15th AIVC Conf. Buxton, England, 27-30.of Sept. 1994.

2.5 FRANCE

REF FR01
TITLE OF PROJECT: Air Quality Sensors - A Field Evaluation.
PRINCIPAL RESEARCHER: M H Huze.
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SPECIFIC OBJECTIVES; IAQ, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Commercial/office, HVAC controls
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: VOC, CO2
PROJECT DETAILS: Air quality sensors, based on measurements of CO2 or volatile organic compound concentrations, are becoming increasingly popular for the control of ventilation and air conditioning systems. Although the physical reactions of the sensors are well known, it appeared necessary to check how well they can influence the control of real air conditioning systems.
In a first part of the project, and after being tested in the laboratory, various sensors were placed in the field and their response was recorded under typical conditions met in commercial buildings of offices with intermittent occupancy.

A second stage involved an analysis of some commercial sites (schools, offices, auditoria, hotels, restaurants) where air quality sensors are being used for ventilation control. The way of inserting the sensor into the control logic is examined, and the impact on operational savings and maintenance procedures assessed, as well as eventual problems faced. The satisfaction of users is evaluated as well. Two of these sites (an auditorium and a conference room) were fitted with comprehensive measuring equipment in order to record operational parameter during a few weeks.
STARTDATE: 00:01:1993
EXPECTED TERMINATION DATE: 00:14:1994
ESTIMATED NUMBER OF PERSON HOURS: 10 months
SELECTED BIBLIOGRAPHY:
1. M H Huze (CoSTIC),La Regulation de la ventilation par la mesure de CO2 PROMOCLIM - Tome 24 - no3 - Mai/Juin 1993

REF FR02
TITLE OF PROJECT: Effects of air turbulence on comfort..
PRINCIPAL RESEARCHER: Jean Baptise Hoffmann, Didier Humbert.
ORGANISATION: CoSTIC
ADDRESS: Domaine de St.Paul, B.P.66, F - 78470 St Remy-les-Chevreuse, FRANCE.
TELE: +33.1.30.85.20.28 FAX: +33.1.30.85.20.38
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Commercial/office.
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Air turbulence
PROJECT DETAILS: The project comprises 3 stages:
1. Measurements of turbulence: which type of turbulence has an impact on convective heat transfer coefficient on skins and consequently on feeling of draught?
How fine should be the measurement in time intervals, how quick should be the sensor?. Review of commercial instruments.
2. Review of published work and determination of areas for further research.
3. Field measurement campaign in occupied offices: investigation of sensitivity threshold verses physical parameters.
STARTDATE: 01:01:1994
EXPECTED TERMINATION DATE: 01:06:1994
ESTIMATED NUMBER OF PERSON HOURS: 900
SELECTED BIBLIOGRAPHY: (Work will be published by COSTIC at some future date).

REF FR03
TITLE OF PROJECT: CO2 Controlled Ventilation.
PRINCIPAL RESEARCHER: Fleury, B
ORGANISATION: ABB VIM
ADDRESS: BP 120, 79400 St Maixent L'Ecole, FRANCE.
TELE: +33.49.06.60.00 FAX: +33.49.06.60.26
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Heating and ventilation systems and strategies.
BUILDING TYPE: Commercial/office.
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Evaluate after 1 to 3 years of running 20 buildings with CO2 controlled ventilation, feedback and occupants' satisfaction.
STARTDATE: 00:06:1993
EXPECTED TERMINATION DATE: 00:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 500
SELECTED BIBLIOGRAPHY: (NONE STATED)

REF FR04
TITLE OF PROJECT: Self Regulated Air Inlets.
PRINCIPAL RESEARCHER: B Fleury
ORGANISATION: ABB VIM
ADDRESS: BP 120, 79400 St Maixent L'Ecole, FRANCE.
TELE: +33.49.06.60.00 FAX: +33.49.06.60.26
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement.
BUILDING TYPE: Dwellings, Commercial/office, Test chamber or test structure.
COMPONENT TYPE: Windows.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)
PROJECT DETAILS: Evaluate the behaviour of air inlet devices in a test chamber under non isothermal conditions air flow, jet, draught, comfort on site survey. Develop new components.
STARTDATE: 00:05:1992
EXPECTED TERMINATION DATE: 00:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 3000
SELECTED BIBLIOGRAPHY:
1. "Comparison of Various Air Inlets Air Diffusion and Comfort" Indoor Air '93.

REF FR05
TITLE OF PROJECT: Air Diffusing Ceiling.
PRINCIPAL RESEARCHER: Triboix
ORGANISATION: Ensais
ADDRESS: 24 Boulevard de la Victoire, 67084 - Strasbourg, FRANCE
TELE: +33.88.14.47.46 FAX: +33.88.24.14.90
E-Mail Address:

SPECIFIC OBJECTIVES: Indoor air movement, Heating and ventilation systems and strategies, Including radiation model in CFD codes.
BUILDING TYPE: Unoccupied, Dwellings, Test chamber or test structure.
COMPONENT TYPE:
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Velocities, Air Temperatures, Heat fluxes at wall, Wall Temperatures.
PROJECT DETAILS: The studies are both experimental and numerical.
A real size test room (5m x 3m x 2.6m) has been constructed. Air and wall temperatures as well as heat fluxes at walls are measured. Velocities lower than 5 cm/s are measured using a hot wire anemometer.
A numerical model utilizing the finite volume method of solution has been constructed in HVAC problem solving. The so-called method of fictitious enclosure has been extended to take into account wall to wall radiation. Convective heat fluxes are derived from the low Reynolds turbulence model of Lam and Bremhoist working on an optimized near wall grid (only seven grid points are necessary inside the boundary layer).
The PHOENIC code was extended to include this new model. This model is applied to a new patented system of heating and cooling which diffuses air through knitted fabric stretched in suspended ceiling. Comparison with experimental data show good agreement.
It has been proved that this new system works fairly well from a thermal comfort point of view.
STARTDATE: 00:12:1991
EXPECTED TERMINATION DATE: 00:12:1993
ESTIMATED NUMBER OF PERSON HOURS: 5000
SELECTED BIBLIOGRAPHY:
1. Triboix-Levat "A wall to wall radiation model for use inside a computational fluid dynamics code. Application for a new process of heating and cooling which supplies air through knitted fabric which is installed to create a suspended ceiling." To be submitted to "Building and Environment"
2. Triboix-Levat Coupling Conduction - Convection - Radiation inside a CFD code. First Part Turbulence and convective exchange modelling. To be published by "Revue generale de thermique" during April-May 1994 (in French)
3. Triboix-Levat Coupling Conduction - Convection - Radiation inside a CFD code. Second Part Radiation modelling Application for a new process of heating and cooling. "Air Diffusing Ceiling".

REF FR06
TITLE OF PROJECT: Conception of Methodological and Technical Tools for Buildings Cooling by evaporative systems.

PRINCIPAL RESEARCHER: Rafik Belarbi, M Speranojo.
ORGANISATION: LEPTAB,
ADDRESS: Universite de la Rochelle, Departement Genie civil et Mecanique, Avenue Marillac, 17000 La Rochello, France.
TELE: +33 46 45 82 03 FAX: +33 46 45 82 41
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Cooling systems and strategies.
BUILDING TYPE: Occupied, Industrial/factory.
COMPONENT TYPE: (NONE STATED)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Temperature, Relative Humidity.
PROJECT DETAILS: This work is carried out in collaboration with MICROLIDE company. The aim of our work is
1. To characterize the performances of evaporative systems by a detailed study of adiabatic evaporation phenomenon.
2. To evaluate the potentialities of such systems, i.e. to define the using fields and the theoretical performances of these systems according to the building type and climatic conditions. Experiments will confirm these potentialities.
3. To provide building designers installation design tools that will account for economic and energetic performances as well as the indoor air quality.
STARTDATE: 0110:1993
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 1 Phd student full time
SELECTED BIBLIOGRAPHY: (NONE STATED)

REF FR07
TITLE OF PROJECT: Ventilation as a tool for indoor air quality improvement and energy saving in summer.

PRINCIPAL RESEARCHER: P Blondeau, M Sperandio, F Allard.
ORGANISATION: LEPTAB
ADDRESS: Dept de Genie Civil et Mecanique, Batiment des Sciences et Techniques, Avenue Mavillac, 17000 La Rochello, France.
TELE: +33 46 45 82 03 FAX: +33 46 45 82 41
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy impact of ventilation, Airtightness/air leakage of buildings.
BUILDING TYPE: Unoccupied, Commercial/office, University building.
COMPONENT TYPE: (NONE STATED)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Ventilation rates.
PROJECT DETAILS: The main objective of the study is to show the potential of ventilation in the fields of energy saving and indoor air quality, and to

provide building designers a general method to predict the building behaviour.
To reach these objectives, the study will mainly be based on the development of simulation tools which will be able to predict both the thermal behaviour and the air flow rates through the zones of a building equipped with various ventilation systems, and submitted to European typical climatic loads. The parameters will be the thermal state of the building, the air quality and the comfort physical parameters. Moreover, in order to validate the numerical results, an experiment on a real building equipped with an accelerated ventilation system, will be realized. Finally, the last part of the study will consist in defining global indices to evaluate indoor air quality and ventilation effectiveness.
STARTDATE: 00:10:1993
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 1 PhD student full time
SELECTED BIBLIOGRAPHY: (NONE STATED)

REF FR08
TITLE OF PROJECT: Numerical Prediction of Pollutant Diffusion in a Room.
PRINCIPAL RESEARCHER: P Joubert, C Beghein. F Allard.
ORGANISATION: LEPTAB
ADDRESS: Departement de Genie Civil et Mecanique, Batiment des Sciences et Techniques, Avenue Mavillac, 17000 La Rochello, France.
Tel +33 46 45 82 03 FAX: +33 46 45 82 41
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ
BUILDING TYPE: Unoccupied, Dwellings, Test Chamber or test structure.
COMPONENT TYPE: Walls, Floors.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)
PROJECT DETAILS: The aim of this study is to numerically predict pollutant diffusion in a ventilated or non ventilated room. For this study, the CFD technique is used. The governing equations of turbulent natural, mixed or forced convection are therefore solved in each point of a single room. Two kinds of studies will be performed. The objective of the first study is to improve the treatment of boundary conditions. In most thermosolutal convection studies developed until now , temperatures or heat fluxes and pollutant transfers within these walls may significantly affect the way a pollutant species is diffused within a room. The computational domain should thus be enlarged and include the walls themselves (intrinsic characteristics of walls such as conductivity or porosity should be accounted for). The second study deals with turbulence modelling. Air flows in dwellings are usually turbulent. Most turbulent models developed for air flow simulation in buildings based on time decomposition of variables are two-equation k-e models. Wall laws are used for forced convection flows, low-Reynolds modellings is employed for mixed or natural convection flows. For k-e models, turbulence is assumed to be isotropic, which does not really correspond to turbulent flows encountered in buildings. This study will thus be devoted on the one hand on the improvement of such models based on time decomposition. On the other hand, we will start with the large Eddy Simulation approach which will enable us to take non stationary turbulent flows into consideration.
STARTDATE: 00:04:1994
EXPECTED TERMINATION DATE: 00:04:1997
ESTIMATED NUMBER OF PERSON HOURS: months approx 30 mm
SELECTED BIBLIOGRAPHY:
1. F Allard, "Effects of thermal boundary conditions on natural convection in thermally driven cavities", invited conference, EUROTHERM/ERCOFTAC Workshop, Delft, The Netherlands, March 25-27, 1992.
2. F Allard, P Joubert, M Sperandie, "Prediction of Indoor Air Motion in Naturally Ventilated Buildings. A Review", CCE PASCOOL Seminar, Glasgow, February 15-17, 1993.
3. C Beghein, F Haghighat, F Allard, "numerical study of double diffusive natural convection in a square cavity". International Journal of Heat and Mass Transfer, 1992, Vol. 35, No. 4, pp 833-846.
4. C Beghein, F Allard, P Depecker, "Numerical analysis of themosolutal convection by a control volume method". Proceedings of the 2nd Symposium on High Performance Computing, Montpellier, France, October 7-9, 1991. AmsterdamNorth Holland. pp 597-608.
5. C Beghein, F Allard, A Draoui, "Numerical modelling of turbulent convection in a thermally driven square cavity".
6. Proceedings of the EUROTHERM Seminar No22 Turbulent natural Convection in Enclosures, A Computational And Experimental Benchmark Study, Delft, The Netherlands, March 25-27, 1992. Paris, France Editions Europeennes Thermique et Industrie, 1992. 12p.
7. C Beghein, F Allard, C Inard, "Numerical analysis of the influence of thermal and solutal diffusion processes on turbulent thermosolutal convection in a thermally driven square cavity". Proceedings of Indoor Air 93, Helsinki, Finland, July 4-8, 1993.
8. C Beghein, F Allard, P Depecker, "Numerical modelling of turbulent thermosolutal convection in t two-dimensional ventilated enclosure". Proceedings of Indoor Air 93, Helsinki, finland, July 4-8, 1993, 6p.
9. C Beghein, F Penot, S Mergui, F Allard, "Numerical and experimental evaluation of turbulent models for natural convection simulation in a thermally driven square cavity". ASME Paper 93-WA/HT-46 presented at the ASME Winter Annual

Meeting, New Orleans, Louisiana, November 28 to December 3, 1993. 12 p.
10. C Beghein,"Contribution a l'etude numerique de le convection naturelle themosolutale en cavite. application a la diffusion de polluants dans les pieces d'habitation".
These de Doctorat; Institut National des Sciences Appliquees de Lyon, 1992. 250 p.
11. P Joubert, "Convection naturelle instationnaire en milieu confine stratifie", These de Seme cycle, University de Poitiers, 1985.
12. P Joubert, P Lequere, "Numerical study of thermal coupling between conductive walls and a Boussinesq stratified fluid", Numerical Heat Transfer, Part A, Vol 16, 1989, pp 489-506.
13. K Limam, "Contribution a l'etude des transferts de chaleur et de masse dans les cavites partitionnees. Application a la caracterisation des transfers aerauliques dans les batiments a travers les grandes ouvertures verueales, These de Doctorat, Institut National des Sciences Appliquees de Lyon, 1993.
13. K Limam, C Berghein, F Allard, "Etude numerique de la convection naturelle dans des celluies partitionnees", Revue Generale de Thermique, No 377, pp 246-252, mai 1993

REF FR09
TITLE OF PROJECT: Indoor Environment quality project
PRINCIPAL RESEARCHER: Jean Robert Millet
ORGANISATION: CSTB
ADDRESS: 84 avenue Jean Jaures, BP 02 - 77421, Marne le Vallee, Cedex 2, France
TELE: +33 64 68 83 23 FAX: +33 64 68 83 50
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Overal comfort
BUILDING TYPE: Occupied, Dwellings, Commercial/ Office
COMPONENT TYPE: Every room component with regard to comfort and IAQ
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Performance of building components and systems (HVAC, lighting etc, sources of pollution, behaviour of occupants.
PROJECT DETAILS: Development of methodology and tool for assessing the overall perceived comfort and IAQ in indoor environment (thermal, visual, acoustic and olfactive comfort).
* simplified computer method for predicting thermal comfort.
* Definition of perceived IAQ criteria with regard type of rooms and analysis of IAQ sensors.
* IAQ audit in office buildings (Joule II European Project)
* Indoor environment comfort: development of the Ambiometre: apparatus composed of a data logger, various sensors for recording simultaneously the parameters of comfort, a key board to know the perception of the occupant. Definition of the analysis methodology of the different parameters and their reciprocal actions.
STARTDATE: 00:00:1992
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 8000
SELECTED BIBLIOGRAPHY:
1. Millet JR and Villenave JG (1993), Assessment of the overall comfort in the indoor environment. INDOOR AIR '93. The 6th International Conference of Indoor Air Quality and Climate. Helsinki, July 4-8 1993.
2. Millet JR and Villenave JG (1993), Assessment of the overall comfort in the indoor environment. CIB TG8. First International Conference on "Buildings and Environment". BRE Garston , May 16-20 , 1994.

REF FR10
TITLE OF PROJECT: Performance of ventilation and air conditioning systems.
PRINCIPAL RESEARCHER: Jean Robert Millet
ORGANISATION: CSTB
ADDRESS: 84 avenue Jean Jaures, BP 02 - 77421, Marne le Vallee, Cedex 2, France
TELE: +33 64 68 83 23 FAX: +33 64 68 83 50
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy Impact of ventilation, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Simulated Occupancy,Unoccupied, Dwellings, Commercial/Office, Industry/Factory, Test Chamber or test structure.
COMPONENT TYPE: HVAC systems
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Temperature, wind, humidity, performance of building components, sources of pollution.
PROJECT DETAILS: Development of methods for evaluating the overall performance of ventilation and air conditioning systems with regards to energy consumption and IAQ. Enhancement of knowledge of air insufflation systems.
* modification of design computer codes for ventilation systems in orders to take into account IAQ criteria and management systems.
* Field investigations and modelling study of air conditioning systems (especially VAV systems in office buildings).
* Method of dimensioning and calculation of energy for air conditioning systems.
* Study of management systems for air conditioning.
* Study of internal heat and mass transfers within air conditioned rooms and large enclosures. Numerical prediction of air flow patterns in rooms using CFD code and experimental validation using a full scale test cell. Theoretical and numerical study of

downward cold or warm air jets for large enclosures aiming in particular to know the establishment of air stratification.
STARTDATE: 00:00:1992
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 8000
SELECTED BIBLIOGRAPHY:
1. Fleury E, Millet JR (1992), Etude des methods manuelles de dimensionement des installations de climatisation individuelle. Cahiers du CSTB no. 2611.
2. Fleury E, Millet JR O'Kelly P (1993), Suivi de maisons individuelles equipees de climatiseurs reversibles. Revue QUALITA no. 33.
3. Millet JR, Vota C (1992), Guide de choix et d'installation de climatiseurs antonomes individuels. GIE Climatisation et Developpement.
4. Villenave JG, Millet JR, Riberon J (1993), Theoretical basis for assessment of air quality and heat losses for domestic ventilation systems in France. 14th AIVC Conference.
5. Buchmann P, Riberon J, Millet JR (1994), Numerical predictions of airflows patterns in large enclosures with supply air jet system. RoomVent'94.
6. Kherrouf S , Riberon J (1994), Etude du comportement thermoaeraulique d'un climatise. Congres SFT 94.

REF FR11
TITLE OF PROJECT: Refurbishment of passive stack ventilation systems for multi storey buildings.
PRINCIPAL RESEARCHER: Jean Robert Millet
ORGANISATION: CSTB
ADDRESS: 84 avenue Jean Jaures, BP 02 - 77421, Marne le Vallee, Cedex 2, France
TELE: +33 64 68 83 23 FAX: +33 64 68 83 50
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Airtightness/air leakage of buildings, Moisture mould generation and prevalence, Overall comfort
BUILDING TYPE: Occupied, Dwellings
COMPONENT TYPE: Windows, Doors, Cracks, Components of ventilation system
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Development of methodology and computer assisted design tools applied to passive stack ventilation for existing buildings.
PROJECT DETAILS:
When renovating existing buildings, air leakage of the envelope is often reduced; this can lead to an insufficient ventilation if ventilation system is non existent or inadequate. A new system - be it of the natural or of the mechanical kind - is then to be designed. In case of passive stack for multi storey buildings, the proper dimensioning of system is a critical matter which can be solved using computer models.

* Overview of actual types of natural ventilation and exhaust smokes systems according to the age of the building.
* Development of a two zone model for predicting passive stack ventilation in multi storey dwellings.
* Development of a methodology to design and achieve ventilation system when retrofitting buildings.
STARTDATE: 00:00:1993
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 2500
SELECTED BIBLIOGRAPHY: (None Stated)

REF FR12
TITLE OF PROJECT: European audit project to optimize indoor air quality and energy consumption in office buildings. (JOULE II program).
PRINCIPAL RESEARCHER: Christian Cochet
ORGANISATION: CSTB
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TELE: +33 64 68 82 66 FAX: +33 64 68 84 73
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy Impact of ventilation, Heating and ventilation systems and strategies
BUILDING TYPE: Occupied, Office buildings
COMPONENT TYPE: Ventilation system, building materials, human activities.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Performance of building components and systems (HVAC, lighting...), sources of pollution, behaviour of occupants
PROJECT DETAILS: Development of a common agreed European wide method to investigate indoor air quality in office buildings based on pluridisciplinarity approach:
* Walk through survey
* Questionnaires survey
* Noise and thermal comfort measurements
* Indoor air quality measurements (VOC, CO, CO2, particles)
* Perceived air quality (Decipol)
* Ventilation study (ventilation rate and performance)
* Energy consumption
IAQ investigation of 6 office buildings from January to April.
Analysis of the results enclosed:
* Correlation between complaints/symptoms of occupants and perceived air quality , IAQ and indoor climate measurements.
* Pollution load data of the buildings with a list of identified pollution sources.
* Ventilation performance of the buildings
* Energy consumption data
* Contribution to cause-effect complaints database
STARTDATE: 00:00:1993
EXPECTED TERMINATION DATE: 00:00:1995

ESTIMATED NUMBER OF PERSON HOURS: 4,000
SELECTED BIBLIOGRAPHY: (None Stated)

REF FR13
TITLE OF PROJECT: Indoor air quality project
PRINCIPAL RESEARCHER: Christian Cochet
ORGANISATION: CSTB
ADDRESS: 84, avenue Jean Jaures, BP 02 77421, Marne la Vallee, Cedex 2, France
TELE: +33 64 68 82 66 FAX: +33 64 68 84 73
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Building Hygiene, source control
BUILDING TYPE: Simulated Occupancy, Test chamber or test structure.
COMPONENT TYPE: Floors, Walls, Building materials and construction products.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Performance of building components and systems (HVAC, lighting....), sources of pollution, behaviour of occupants.
PROJECT DETAILS: The project concerns the development at CSTB of new facilities for IAQ experimental research. The following fields are covered:
* Pollutants measurements.
* Characterisation of sources (chemical and sensory)
* Model validations for pollutions transfer
* Indoor exposures
* Health effects
This project will develop in connection with medical research.
STARTDATE:00:00:1993
EXPECTED TERMINATION DATE: 00:00:1997
ESTIMATED NUMBER OF PERSON HOURS: 5,000
SELECTED BIBLIOGRAPHY:
1. Kirchner S and Cochet C, Characterisation of volatile organic compounds emission from construction products, Conference "Building Design, Technology and Occupant well being in temperate climates", Bruxelles, 17-19 February 1993.
2. Kirchner S, Caracterisation des composes organiques volatils emis a partir des produits de construction, Symposium satellite "Qualite de l'air ambient: un apercu de l'experience francaise", SOFRAB, Bruxelles 17-19 February, 1993.
3. Kirchner S Karpe Ph and Cochet C Characterisation of Volatile Organic Compounds emissions from floor coverings . Proceedings de la conference indoor air '93, Helsinki Vol 2 pp 455-460, Juillet 1993.
4. Kirchner S Materiaux : les pollutants sous haute surveillance, lettre mensuelle sur la recherhe - No 12 Juillet-aout 1993.
5. Kichner S and Cochet Ch, Produits de construction et qualite de l'air interieur: cas des composes organiques volatils, Proceedings of the 9th World Clean Air Congress and Exhibition, Montreal, Canada, August 30 - September 4 1992.
6. Kirchner S and Cochet Ch. Building materials and volatile organic compounds (in french), Semaine des Hopitaux de Paris, 67 No 26-27, 1233-1237, 1991.

REF FR14
TITLE OF PROJECT: Volatile Compounds emissions from building materials
PRINCIPAL RESEARCHER: Severine Kirchner
ORGANISATION: CSTB
ADDRESS: 84, avenue Jean Jaures, BP 02 77421, Marne la Vallee, Cedex 2, France
TELE: +33 64 68 82 66 FAX: +33 64 68 84 73
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Pollutants sources control
BUILDING TYPE: Test chamber or test structure
COMPONENT TYPE: Walls, Floors, Insulation, paints, seals, floor and wall coverings.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Temperatures, humidity, air exchange rate, other sources of pollution
PROJECT DETAILS: Determination of Volatile Organic Compounds (VOC) emissions from building materials and construction products.
Experimental procedure: Environmental test chambers, air sampling on solid sorbents, Thermal Desporption/ Gas Chromatography/Mass Spectrometry/ Flame Ionisation (TD/GC/MS/FID)
STARTDATE: 00:00:1993
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 4000
SELECTED BIBLIOGRAPHY:
1. Kirchner S and Cochet C, Characterisation of volatile organic coumpounds emission from construction products, Conference "Building Design, Technology and Occupant well being in temperate climates", Bruxelles, 17-19 February 1993.
2. Kirchner S, Caracterisation des composes organiques volatils emis a partir des produits de construction, Symposium satellite "Qualite de l'air ambient: un apercu de l'experience francaise", SOFRAB, Bruxelles 17-19 February, 1993.
3. Kirchner S Karpe Ph and Cochet C Characterisation of Volatile Organic Compounds emissions from floor coverings. Proceedings de la conference indoor air '93, Helsinki Vol 2 pp 455-460, Juillet 1993.
4. Kirchner S Materiaux : les pollutants sous haute surveillance, lettre mensuelle sur la recherhe - No 12 Juillet-aout 1993.

REF FR15

TITLE OF PROJECT: Adsorption/Desorption of Volatile Organic Compounds from building materials.
PRINCIPAL RESEARCHER: Severine Kirchner
ORGANISATION: CSTB
ADDRESS: 84, avenue Jean Jaures, BP 02 77421, Marne la Vallee, Cedex 2, France
TELE: +33 64 68 82 66 FAX: +33 64 68 84 73
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Pollutant Sources control
BUILDING TYPE: Test chamber or test structure
COMPONENT TYPE: Walls, Floors, Insulation, paints, seals, floor and wall coverings
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Temperature, humidity , air exchange rate, other sources of pollution.
PROJECT DETAILS: Study of VOC sink effects on building materials via experimental analysis and modelling.
Experimental procedure: Environmental test chamber, diffusion tubes, air sampling on solid sorbents, Thermal desorption/Gas Chromatography/Mass Spectrometrey / Flame Ionisation (TD/GC/MS/FID).
STARTDATE: 00:00:1993
EXPECTED TERMINATION DATE: 00:00:1994
ESTIMATED NUMBER OF PERSON HOURS: 3 000
SELECTED BIBLIOGRAPHY:
1. Kirchner S and Cochet C, Characterisation of volatile organic coumpounds emission from construction products, Conference "Building Design, Technology and Occupant well being in temperate climates", Bruxelles, 17-19 February 1993.
2. Kirchner S, Caracterisation des composes organiques volatils emis a partir des produits de construction, Symposium satellite "Qualite de l'air ambient: un apercu de l'experience francaise", SOFRAB, Bruxelles 17-19 February, 1993.
3. Kirchner S Karpe Ph and Cochet C Characterisation of Volatile Organic Compounds emissions from floor coverings. Proceedings de la conference indoor air '93, Helsinki Vol 2 pp 455-460, Juillet 1993.
4. Kirchner S Materiaux : les pollutants sous haute surveillance, lettre mensuelle sur la recherhe - No 12 Juillet-aout 1993.

REF FR16
TITLE OF PROJECT: Sensory and chemical evaluation of building materials and construction products.
PRINCIPAL RESEARCHER: Severine Kirchner
ORGANISATION: CSTB
ADDRESS: 84, avenue Jean Jaures, BP 02 77421, Marne la Vallee, Cedex 2, France
TELE: +33 64 68 82 66 FAX: +33 64 68 84 73
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Pollutant sources control, sensory evaluation
BUILDING TYPE: Test chamber or test structure
COMPONENT TYPE: Walls, Floors, Insulation, Paints, seals, floor and wall coverings.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Temperature, humidity air exchange, other sources of pollution.
PROJECT DETAILS: Sensory and chemical complementary evaluation of building including:
* Development of sensory evaluation protocol for intensity and acceptability of odour measurements.
* Determination of VOC emissions from building materials
* Relation chemistry\olfactometry
Experimental Procedure:
* Chemical evaluation : Environmental test chambers, diffusion tubes, air sampling on solid sorbents, Thermal Desorption/Gas Chromatography/Mass Spectrometry/Flame ionisation (TD/GC/MS/FID)
STARTDATE: 00:00:1993
EXPECTED TERMINATION DATE: 00:00:1995
ESTIMATED NUMBER OF PERSON HOURS: 3 000
SELECTED BIBLIOGRAPHY: (None Stated)

REF FR17
TITLE OF PROJECT: Air Quality inside classrooms
PRINCIPAL RESEARCHER: Richalet, V
ORGANISATION: LASH - Ecole Nationale des Travaux Publics Etat
ADDRESS: Rue H Audin, 69518 Vaulx en Velin, Cedex, France
TELE: +33 72 04 70 37 FAX:+33 72 04 70 41
E-Mail Address:
SPECIFIC OBJECTIVES: Interaction between air quality and occupants behaviour Towards windows, IAQ, Heating and ventilation strategies and systems, Occupants behaviour
BUILDING TYPE: Occupied, Classrooms of secondary schools
COMPONENT TYPE: Windows, Doors
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Behaviour of occupants (real), Weather, Occupancy patterns, Natural or mechanical ventilation system
PROJECT DETAILS: Objectives: Analyse air quality inside classrooms and thermal comfort both during winter and spring time. Study behaviour of the occupants towards doors and windows. Relate first 2 points with type of ventilation
Teams are: LASH/ENTPE plus CETE de Lyon plus Laboratoire d'Hygiene de la Ville de Lyon.
Support for Study: 2 classrooms around Lyon. One school has a mechanical ventilation System, the other

is supposed to be ventilated by opening of the windows.
Measurements Include: Indoor temperature plus relative humidity (every 3 min.), CO, CO2 levels (every 4 min), Duration of openings (every 2 min), Weather (every 5 min at ENTPE), Aerobiological sampling (3 times a week) and are completed with interviews and questionnaires to the teachers.
Main Conclusions: Very poor IAQ was recorded (high CO2 levels, forming colonies units), especially in the school without any ventilation system. The teachers often open windows but usually during breaks between classes, so that bad IAQ's reached at the end of classes. Interviews show that some troubles often prevent them to open windows (noise, wind, temperature or student concentration).
Calculations: of air change rate in both schools were done using equation of CO2 mass concentration.
STARTDATE: 01:01:1993
EXPECTED TERMINATION DATE: 30:09:1994
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Demand Controlled ventilation Systems - State of the Art Review. IEA Annex 18, 1990
2. Qualite des ambiances atmosphere en milieu scolaire. F Souinaz Laboratoire d'Hygiene de la Ville de Paris. Contrat No. 89-83/03

REF FR18
TITLE OF PROJECT: Indoor air quality in buildings
PRINCIPAL RESEARCHER: Christian Inard, Sophie Casianei
ORGANISATION: CETHIL
ADDRESS: INSA Bat 307, 20 Av Albert Einstein, 69621 Villeurbanne CEDEX, FRANCE
TELE: +33 72 43 83 62 FAX: +33 72 43 85 22
E-Mail Address: inard@cethil.insa.lyon.fr
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy impact of ventilation, Heating and ventilation systems and strategies
BUILDING TYPE: Unoccupied, Test chamber or test structure
COMPONENT TYPE:
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Type of heating and ventilation systems, Type of source of pollution (location)
PROJECT DETAILS: The aim of this project is to study the heating and ventilation strategies with respect to indoor air quality. In that way we plan to make measurements in a test chamber and to use different types of models.
Measurements:
1. real scale test chamber : two zones (3.10x3.10x2.5m each) separated by a door (0.8x2.10m).
2. facade in contact with a climatic box (-5degC, +35degC) and other walls in contact with a thermal guard.
3. Mechanical ventilation (0, 75m3/h/ 0, 30 degreeC) with various supply and exhaust locations.
4. Electrical heating systems.
5. Metrology: external and internal surface temperatures; indoor air temperatures; tracer gas concentration.
Model calculations. 1. CFD model (Fluent) 2. Zonal model
STARTDATE: 00:10:1994
EXPECTED TERMINATION DATE: 00:10:1997
ESTIMATED NUMBER OF PERSON HOURS: a PhD Student over 3 years
SELECTED BIBLIOGRAPHY: (None Stated)

REF FR19
TITLE OF PROJECT: Relationship between airborne micro organisms and allergic symptomatology in air conditioned buildings.
PRINCIPAL RESEARCHER: Sylvie Parat
ORGANISATION: Institute Universitaire de Medecine du Travail de Grenoble
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TELE: +33 76 76 54 42 FAX: +33 76 76 55 59
E-Mail Address:
SPECIFIC OBJECTIVES: Airborne micro organisms and allergy in air conditioned buildings.
BUILDING TYPE: Occupied, Commercial/Office
COMPONENT TYPE: Air Conditioning Systems (HVAC)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Allergic symptoms among exposed people
PROJECT DETAILS: The study is based on a double survey: the measurement of airborne micro-organisms in an office and the evaluation of the symptomatology of the people working in this office. "Case" people will be selected as they usually develop symptoms when exposed to an air conditioned ambience. For every "Case" person, a "control" person will be selected in the same office (not ill). Ten case people will be surveyed one week, every hour. The aerobiological measurements will be carried out by Andersen one stage impactor. On two culture media (bacteria and fungi) colonies will be numbered and indentified after 5 days incubation at 27degree C. Every hour, air samples will be collected while at the same frequency, the subject will have to complete a short questionnaire for the evaluation of his symptoms and intensity. A peak-flow measurement will be associated every hour at the workplace and at home. This study will allow the detection of a possible variation in aerobiocontamination and the detection of all variation in symptomatology.

This way it will be possible to study the possible relationship between airborne micro-organisms and symptoms.
STARTDATE: 00:10:1994
EXPECTED TERMINATION DATE: 00:10:1996
ESTIMATED NUMBER OF PERSON HOURS: 4 000
SELECTED BIBLIOGRAPHY: (None Stated)

REF FR20
TITLE OF PROJECT: Ventilation by mechanical insufflation - Ventila:Resc system.
PRINCIPAL RESEARCHER: Alain Grelat
ORGANISATION: C E B T P
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TELE: +33 1 30 85 31 81 FAX: +33 1 30 85 23 24
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Airtightness/air leakage of buildings, Heating and Ventilation Systems and Strategies
BUILDING TYPE: Occupied, Unoccupied, Dwelling
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather, Behaviour of occupants
PROJECT DETAILS: The project aims to examine the performances of a ventilation system by mechanical insufflation, used for retrofit of humid ancient buildings, an to define suitable using conditions for this type of system.
The study consisted in:
(a) Field measurements in 7 dwellings. Occupied or unoccupied in the north and east of France, including
* Tracer gas measurements by PFT technique (3 zones).
* Temperature and humidity measurements,
* Site weather
Comparing the situations for each dwelling between
* Natural ventilation (M.I.V off)
* M.I.V in function
Duration: 2 weeks for each situation.
(b) Comparison with hygrothermal and ventilation simulation using CEBTP program BILGA.
Results: Air exchange routes between rooms and outside, flow patterns, internal humidity evolutions, criteria for system installation..
Further studies: Generated air pressure. Fire, Gas, safety - optimisation.
STARTDATE: 00:01:1993
EXPECTED TERMINATION DATE: 00:02:1995
ESTIMATED NUMBER OF PERSON HOURS: 500
SELECTED BIBLIOGRAPHY: Reports
1. Ministere de l'equipement, du logement et ds transport, January 1994.

REF FR21
TITLE OF PROJECT: Air quality in dwellings.
PRINCIPAL RESEARCHER: M Cohas, A Grelat
ORGANISATION: C E B T P
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E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Moisture mould generation and prevalence , Heating and ventilation systems and strategies
BUILDING TYPE: Occupied, Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather, Performance of building components, Behaviour of occupants, source of pollution
PROJECT DETAILS: The research scope is to improve an hygro thermal simulation program, BILGA, towards prediction of air quality in dwellings, in order to help for design of suitable heating and ventilation solutions for retrofit of existing buildings. It is a part of a larger research program involving EDF - GDF and ENB which includes a national survey on health and dissatisfaction of occupants of locative dwellings.
The numerical simulation includes algorithum for:
* ventilation (natural or mechanical) based on pressure fields (zonal model)
* Humidity exchange between air, occupants, walls , furniture, processes.
* pollutant production and transfer from occupants (CO2, smoke etc), from cooking (CO2, CO, NOx etc..), from building materials.
* Modes of transfer, convection, diffusion, gravity (experimental work on gravity effects, allowing also for gas leakage simulation was performed) definition of multi gas air quality index.
The model was widely used to evaluate degraded ventilation conditions in typical dwellings and propose related solutions.
STARTDATE: 00:00:1990
EXPECTED TERMINATION DATE: 00:06:1994
ESTIMATED NUMBER OF PERSON HOURS:
SELECTED BIBLIOGRAPHY:
1. M Cohas, Contribution a l'amelioration de la qualite de l'ain interiour ds locoux d'habitation. Thesis University Paris VI 21: 06:1994

REF FR22
TITLE OF PROJECT: Experimental Study of 3d rectangular vertical and horizontal buoyant free air jets.
PRINCIPAL RESEARCHER: Blay, D
ORGANISATION: Laboratoire d'Etudes Thermiques
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E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Heating and ventilation systems and strategies
BUILDING TYPE: Unoccupied, Test chamber or test structure
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: No direct relation
PROJECT DETAILS: This project deals with the experimental study of 3D bouyant free air jets. Two types of jets will be studied:
* Horizontal rectangular jet (5x20cm)
* Vertical rectangular jet (5x20cm)
For each type of jet, cases with positive and negative buoyancy will be investigated.
The main objectives of this study are to determine velocity and temperature profiles, velocity and temperature deficit decay laws, entrainment rate laws for different values of the jet Reynolds and Archimede numbers which correspond to a mean jet velocity varying from 0 up to 3m/s and a delta T varying from -20 degree C up to +20 degree C.
This experiment will be performed in a test chamber (approx. 3mx3mx3m) specifically devoted for this purpose.
Velocity and turbulence measurements will be made with a laser doppler velocimeter and temperature measurements witll be made with thermocouples.
STARTDATE: 00:01:1995
EXPECTED TERMINATION DATE: 00:06:1996
ESTIMATED NUMBER OF PERSON HOURS: 1500
SELECTED BIBLIOGRAPHY: (None Stated)

REF FR23
TITLE OF PROJECT: Air and Surface quality of the Underground Railway Station
PRINCIPAL RESEARCHER: Festy B, Parfait C
ORGANISATION: Laboratorie d'Hygiene de la Ville de Paris
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TELE: +33 1 48 04 12 45
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ
BUILDING TYPE: Railway Station
COMPONENT TYPE:
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Project Includes: traffic related, underground, climate, pollution, concentrations, air surface, biological, bacteria, diurnal variations, spatial variations.
STARTDATE: 00:00:1982
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF FR24
TITLE OF PROJECT: Air and Water quality in Buildings with Air Conditioning Systems
PRINCIPAL RESEARCHER: Festy, B ; Squinazi, F ; Mouilleseaux A
ORGANISATION: Laboratoire d'Hygiene de la Ville de Paris (LHVP)
ADDRESS: 11, Rue George Eastman, F 75013 Paris. France
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E-Mail Address:
SPECIFIC OBJECTIVES: IAQ
BUILDING TYPE: Commercial/Office, Hospitals
COMPONENT TYPE: HVAC
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: HVAC
PROJECT DETAILS: Project relates to air and water quality in buildings with Air Conditioning Systems. Including Offices and Hospitals, climate control, SBS, Ventilation, ACS
STARTDATE: 00:00:00
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (none Stated)

2.6 GERMANY

REF D01
TITLE OF PROJECT: Improved Air Quality through better Air Handling units.
PRINCIPAL RESEARCHER: Prof. Dr.-Ing. Klaus Fitzner
ORGANISATION: Technical University of Berlin, Hermann-Rietschel-Institut
ADDRESS: Marchstr. 4, 10587 Berlin, Germany.
TELE: +49 30 314-22618
FAX: +49 30 314-21141
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ
BUILDING TYPE: Test chamber or test structure.
COMPONENT TYPE: (NONE STATED)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)
PROJECT DETAILS: Construction of a test chamber to evaluate air quality. Investigation of different components of HVAC-Systems. Also investigation of different materials.
STARTDATE: 01:01:1993
EXPECTED TERMINATION DATE: 31:12:1994
ESTIMATED NUMBER OF PERSON HOURS: (NONE STATED)
SELECTED BIBLIOGRAPHY: (NONE STATED)

REF D02

TITLE OF PROJECT: The Influence of Cooling Ceilings on Thermal Comfort and Indoor Air Quality.
PRINCIPAL RESEARCHER: Dipl.-Ing. Martin Behne.
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FAX: +4930 314-21141
E-Mail Address: holi2130@w206 zrz.zrz.tu-berlin.de
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Heating and ventilation systems and strategies, Thermal comfort.
BUILDING TYPE: Simulated occupancy, Test chamber or test structure.
COMPONENT TYPE: Ceiling.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Arrangement of cooling ceiling area and heat source locations.
PROJECT DETAILS: The aim of this investigation is to find out whether cooling ceiling can offer best thermal comfort and good indoor air quality even if there are asymmetrical arrangements of cooled area and heat source location. Measurements of temperatures, air velocities and tracer gas concentrations were no made in a full scale test room (7,0mx6, 5mx2,9m). The testroom is built of insulated wooden chipboards and is equipped with a cooled ceiling, a displacement ventilation system, several heat sources and usual bureau equipment. The heat sources can be located at different places so that this influence on thermal comfort and indoor air quality can be monitored. The cooled ceiling is a nearly closed type and is divided in two equal areas. This arrangement is necessary to investigate the influence of different combinations of cooled ceiling area and heat source locations. The data is registered with a computer controlled data logger.
STARTDATE: 00:08:1992
EXPECTED TERMINATION DATE: 00:12:1994
ESTIMATED NUMBER OF PERSON HOURS: (NONE STATED)
SELECTED BIBLIOGRAPHY:
1. The influence of the arrangement of cooling ceiling areas on thermal comfort Martin Behne Indoor air - congress 1993 Helsinki Published in the proceedings.
2. The influence of the arrangement of cooling ceiling areas of the air movement Martin Behne Clima 2000 - conference 1993 London Published in the proceedings (CD-Rom)

REF D03
TITLE OF PROJECT: Investigation of Displacement Flow with and without cooled ceilings.
PRINCIPAL RESEARCHER: Holger Kruhne.
ORGANISATION: Hermann-Rietschel-Institute of Heating and Air Conditioning.
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E-Mail Address: holi2130@w206zrz.zrz.tu-berlin.de
SPECIFIC OBJECTIVES: Indoor air movement, IAQ.
BUILDING TYPE: Simulated occupancy, Test chamber or test structure.
COMPONENT TYPE: Walls, Ceiling.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Cooling ceiling performance.
PROJECT DETAILS: Investigation of the influence of the cooling ceiling at the displacement flow pattern, especially at the air quality in the occupation zone. Variation of the cooling ceiling performance and measurement of the ventilation effectiveness for different heat loads in the room.
Thermographic measurements of the wall temperature - distribution to determine the influence of wall flows at the displacement flow.
STARTDATE: 00:09:1991
EXPECTED TERMINATION DATE: 00:12:1994
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Effect of cooled ceilings in rooms with displacement ventilation on the air quality Hoger Kruhne Indoor Air Congress Helsinki 1993 published in the proceedings.
2. Influence of buoyant wall flows in rooms with displacement ventilation. Holger Kruhne Clima 2000 Conference London 1993 published in the proceedings (CD-ROM)
3. Stromungsuntersuchungen am Klimasystem Ouelluftung und Deckenkuhlung Holger Kruhne, Klaus Fitzner Ki - Klima Kalte Heizung 11/93, p 450-453.

REF D04
TITLE OF PROJECT: Model investigation in deep garages for optimal ventilation.
PRINCIPAL RESEARCHER: Liepsch
ORGANISATION: Fachhochschmle Muenchen, Institut of Biotechnik
ADDRESS: Lothstr. 34, 80335 Muenchen, Germany
TELE: 089 1265 1533 FAX: 089 1265 1502
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement Heating and ventilation systems and strategies
BUILDING TYPE: Unoccupied, Commercial/ Office, Industrial/Factory, Test chamber or structure, Garage
COMPONENT TYPE: (None stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Model studies, Ventilation

PROJECT DETAILS: It will make the means for modelling air flow visible and as a result will enable optimal ventilation.
STARTDATE: 00:10:1993
EXPECTED TERMINATION DATE: 00:04:1994
ESTIMATED NUMBER OF PERSON HOURS: 720
SELECTED BIBLIOGRAPHY:
1. Liepsch D: Laser-Doppler-Sondenmessungen der Stroemungsprofile an einer 90 Deg-Verzweigung mit kleinen Rohrdurchmessen. DLR Mitt. 73-21 Teil 2 (1973)
2. Liepsch D: Bestimmung der Rohrrauhigkeit und der Verlust =Ziffern von Formstuecken und Ventilen an Rohsteckungen ans Borosi Borosicherteit-Glass. Chemie Zug. Technik 49, 5:437,1977
3. Liepsch D: Geschwindigkeitsmessungen mittels eine Laser-Doppler-Anemometers an einem Modell eines Grosswasser = speichers Z.bbr 8:278-280, 1978
4. Huber G, Kaufer H, Liepsch D, Fahr R Experimentelle Stroemungsuntersuchung zur Be- und Entlueftung einer oeffentlichen Tiefgarage an Hand eines modells. Z. TAB 9/91 687-694

REF D05
TITLE OF PROJECT: Cheap and simple method to measure air exchange rate in room/building.
PRINCIPAL RESEARCHER: Willigert Raatschen
ORGANISATION: TracerTech GmbH
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E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air Movement, IAQ, Energy Impact of ventilation, Airtightness / air leakage of buildings
BUILDING TYPE: Occupied, Dwellings, Commercial/office
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Air change rate, age of air
PROJECT DETAILS: Research and testing procedures have been completed.
ACR measurements eases the decay method consisting of 6 syringes of 50cc. One syringe is filled with pure SF6 or a mixture of SF6 in air, depending on the zone volume. The other 5 syringes are empty. The 6 syringes are shipped by mail to the customer. He injects according to a description form the SF6 syringe into the room/building air. After waiting for 15 minutes the customer takes 5 samples of room, air in time steps of 15 - 20 minutes. He caps the syringes, marks the labels with the sampling time and sends them back to the laboratory for analysis. He obtains the air change rate of his measurement and a detailed report with error analysis.
The developed measurement is simple, chap and easy to handle also for untrained personnel.
STARTDATE: 00:04:1994
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF D06
TITLE OF PROJECT: Double Facade Buildings
PRINCIPAL RESEARCHER: Willigert Raatschen
ORGANISATION: Dornier GmbH,
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E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy impact of ventilation, Heating and ventilation strategies, night cooling
BUILDING TYPE: Occupied, Commercial/Office
COMPONENT TYPE: Windows - In double facades, Passive vents in the outer facade
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Temperature differences, wind speed, inhabitant behaviour on window opening
PROJECT DETAILS: A new office building in Berlin with a double facade has just been constructed.It will be equipped with a complete data acquisition system, to measure continuously over a period of more than one year all relevant parameters to understand and improve the potential of the facade with regard to : air exchange rates; ventilation efficiency; air flow through shafts, vents and vented hot windows; temperatures between the two facades; influence on building interia on passive night cooling; efficiency of sun screen models.
The building has no mechanical ventilation system. Data acquistion consists of: recording of window opening with hall sensors of every window, temperature in rooms and various places in the facade, indoor air quality with CO2 and mixed gas sensors, air change rates by PFT technique and Constant concentration with SF6. The main goal of the project is to validate a coupled thermal and multi zone infiltration model to reduce the uncertainty in the design of new buildings.
STARTDATE: 00:01:1994
EXPECTED TERMINATION DATE: 00:12:1995
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: Restricted reports only.

REF D07
TITLE OF PROJECT: Design of tracer gas system to measure ventilation efficiency.
PRINCIPAL RESEARCHER: Willigert Raatschen
ORGANISATION: Dornier GmbH

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E-Mail Address:
SPECIFIC OBJECTIVES: (None Stated)
BUILDING TYPE: Laboratory tests
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: airflow pattern, ventilation efficiency
PROJECT DETAILS Development of tracer gas measurement system to measure ventilation efficiency parameters with different tracer gas techniques. Hardware consists of IR-analyser and multiplexer from Bruel & Kjaer (Denmark). Complete software is developed in this project. Laboratory tests will be conducted with different ventilation systems. Step-up, step-down and pulse method will be compared. Influence of infiltration on efficiency parameters are investigated. Evaluation and assessment of efficiency parameters according to the airflow pattern with special emphasis to displacement flow.
STARTDATE: 00:09:1990
EXPECTED TERMINATION DATE: (Not Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Raatschen W (1988), Was ist Lueftungseffektivitaet? Klima Kaelte Heizung, Heft 5/6/7-8:1988, inlgerman.
2. Raatschen, W; Walker R.R. (1991), Measuring Air Exchange Efficiency in a Mechanically Ventilated Industrial Hall, ASHRAE Conference June 1991, Indianapolis.

REF D08
TITLE OF PROJECT: Building thermal analysis for European and tropical climates: Combining COMIS and SUNCODE.
PRINCIPAL RESEARCHER: Heidt F D and Nayak J K
ORGANISATION: University of Siegen
ADDRESS: Dept. of Physics, Adolf - Reichwein - StraBe 57068 Siegen, Germany
TELE: +49 271 740 4181 FAX +49 271 740 2379
E-Mail Address: Heidt@physik.uni-siegen.d400.de
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy impact of ventilation, Airtightness /air leakage of buildings
BUILDING TYPE: Unoccupied, Dwellings
COMPONENT TYPE: Windows, Doors
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Wind velocity and direction, outdoor temperature, flow coefficients of leakages.
PROJECT DETAILS: Investigations on the COMIS multizone model for the estimation of air infiltration into typical Indian dwelling are performed. The effects of various parameters influencing the air infiltration have been discussed and their applicability in the design of buildings has been examined. The usefulness of the calculations for airflows in the simulation of building thermal performance is demonstrated. An integrated method incorporating both air infiltration (by COMIS) and thermal simulation of the building (by SUNCODE) is proposed.
STARTDATE: 00:10:1992
EXPECTED TERMINATION DATE: 00:04:1994
ESTIMATED NUMBER OF PERSON HOURS: 2000
SELECTED BIBLIOGRAPHY:
1. Heidt F.D. and Nayak J.K. (1993), Simulation of air infiltration and thermal performance of buildings. Report for European and Tropical Climates. University of Siegen, Germany, September 1993.
2. Heidt F.D. and Nayak J.K. (1994), Estimation of Air Infiltration and Building Thermal Performance. Submitted for publication in Air Infiltration Review, Feb 1994.
3. Heidt F.D. and Nayak J.K. (1994), Simuiltane Berechnuug des luft wechscels und des Gebaudewarmehaushalts. Proceedings of the 9th International Solar Forum. 28.6 Gis 1.7, 1994 Stuttgart, DGS, Verlag, Munchen, 1994.

REF D09
TITLE OF PROJECT: Development of Methods for the Measurement of the Air Change Rate in Rooms and Buildings.
PRINCIPAL RESEARCHER: Heidt, F.D.
ORGANISATION: University of Siegen
ADDRESS: FB 7/Dept.of Physics, Adolf-Reichwein-Str., 57068 Siegen, GERMANY
TELE: +49 271 740 4181
FAX: +49 271 740 2379
E-Mail Address: heidt@physik.uni-siegen.d400.de
SPECIFIC OBJECTIVES: (None Stated)
BUILDING TYPE: (None Stated)
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Temperature and pressure differences between single rooms and the outside, wind speed and direction.
PROJECT DETAILS Construction of a mobile measurement system for tracer gas measurements. measurement methods:
* initial injection (decay method)
* constant injection;
* constant concentration (1 channel); Tracer gas: N20 or SF6; gas analyzer principle: infrared absorption. Eight independent channels can be used to:
* sample simultaneously at various locations in a single room or building;
* subsequent measurements in different rooms of a building without change of measurement setup;

* subsequent measurements at different locations in a mechanically ventilated room to obtain local mean age, room mean age and air exchange efficiency.
STARTDATE: 02:02:1988
EXPECTED DATE OF TERMINATION: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: (Not Stated)
SELECTED BIBLIOGRAPHY:
1. Heidt F D & Werner H (1986), Microcomputer Aided Measurement of Air Change Rates. Energy and Buildings, Vol.9, No.4, 1986, pp 313-320.
2. Heidt F D & Werner H (1987), Advantages of Microcomputer Support for Air Change Measurements. In: Air Infiltration Centre (Hrsg).: Proceedings of the 8th AIVC Conference, Sept 21-24 1987 Uberlingen, FRG, 1987, S 17.1 17.11.
3. Heidt F D (1987), Zur Messung des Luftwechsels mit Spurengasmethoden Bauphysik, Bd.9, Nr.6, 1987, Verlag, Ernst und Sohn, Berlin, pp.272-278.
4. Heidt F D & Rabenstein R (1988), MULTI-CAT Dokumentation report Univ of Siegen, FRG, Nov 1988.
5. Rabenstein R (1990) Weiterentwicklung und Erprobung von Methoden der Luftwechselmessung in Raeumen und Gebuden (Further development and application of air exchange measuring methods for rooms and buildings). Internal Report (in German) Dept of Physics University of Siegen, Germany.
6. Heidt F D , Rabenstein R, Schepers G (1990), Comparison of Tracer-Gas Methods for Measuring Air Flows in Two-Zone Buildings, In: Air Infiltration Centre (ed.): Proceedings of the 11th AIVC Conference Sept 18-21 1990 Belgirate, Italy pp.171-192.
7. Rabenstein R., Heidt F.D., (1990), The Man-Machine-Interface for the Air Exchange Measurement System Multi-Cat, In: Air Infiltration Centre (ed.) Proceedings of the 11th AIVC Conference Sept 18-21, 1990, Belgirate, Italy, pp.131-147.
8. Heidt F.D., Rabenstein R. (1990), Die Messung des externenund interzonalen Luftaustauschs (The measurement of the external and interzonal air exchange), In: DGS-German Section of the International Solar Energy Society (ISES) (ed.): Proceedings of the 7. Internationales Sonnenforum, October 9-12, 1990, Frankfurt, Germany, pp.450.455.
9. Rabenstein R und Heidt F D : Standardised air exchange measurements by computer controlled instrumentation. International Symposium on ventilation efficiency at ASHRAE meeting, June 23-26 1991, Indianapolis, USA ASHRAE Trans. Volume 97, pt 2 pp1073-1077.
10.Heidt F D and Rabenstein R : Measuring airborne heat flows in passive solar buildings with tracer gas methods. In Arden, M E et al (Hrsg): Proceedings Solar World Congress, August 19-23 1991, Denver USA,Pergamon Press, New York

REF D10
TITLE OF PROJECT: Reduction of energy consumption of air conditioning systems by using alternative systems in office buildings
PRINCIPAL RESEARCHER:
1. Laabs, K -D.
2. Steimle F
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2. Universtatsstr Essen
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FAX: +49 (0) 40/5585458
TELE: 2. +49 (0) 201 183 2600
FAX: +49 (0) 201 183 2584
E-Mail Address:
SPECIFIC OBJECTIVES: Design tools for "silent cooling" elements with heat transfer forced by natural ventilation Cooling and ventilation systems and Strategies
BUILDING TYPE: Simulated occupancy, Commercial/office, Test chamber or test structure
COMPONENT TYPE: Walls, Chilled ceilings, TRY
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: One important aim for the development of new air conditioning systems is the reduction of the total energy consumption. This can be reached by separation of cooling and ventilation in air conditioning system, because it is more effective to transport energy by using water systems instead of air to deliver cooling energy to the consumers. This strategy was the base for the development of several "silent cooling" systems, which can be characterised by heat transfer forced by natural convection at the cooling elements.
PROJECT DETAILS: The aim of this project is to develop design tools to calculate the cooling performance of these elements during the planning period. It is planned to fix charateristic data to describe the heat transfer at these elements on different conditions. The investigation will be done, under clearly defined boundary conditions, related to national guidelines to guarantee standardised measurements.
By using tools to calculate the cooling performance of "silent cooling"elements and additional elements to calculate the energy consumption for dehumification and production of cold water in combination with a building energy analysis to describe the thermal dynamic behaviour of a building it is possible to calculate the energy consumption of these during variable periods. By using this tool it is possible to fix operating parameters and system design during the planning period, with guarantees a suitable minimum of energy consumption.
STARTDATE: 01:07:1993
EXPECTED DATE OF TERMINATION: 30:06:1996

ESTIMATED NUMBER OF PERSON HOURS: 25,000 person hours
SELECTED BIBLIOGRAPHY: (None Stated)

REF D11
TITLE OF PROJECT: Determination of flow direction by a globe sensor
PRINCIPAL RESEARCHER: Steimle F
ORGANISATION: Universtatsstr Essen
ADDRESS: Institute Fur Angewaudle Thermodynamic und klimatechnik, Universtatsstr 15, 45141 Essen, Germany
TELE: +49 (0) 201 183 2600
FAX: +49 (0) 201 183 2584
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Development of new measurement system
BUILDING TYPE: Occupied, Dwellings, Commercial/office, Industrial/factory, Test chamber or test structure
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS Conventially used thermal anemometers are able to measure the value of the velocity , but not the direction. Now a new type of thermal anemometer is developed which consists of a ball with 12 sides constant temperature - anemometers on its surface which take measurements of a local heat transfer. The calibration of the sensor is taken by 325 different directions for 5 velocities.
The simultaneous measurements of the 12 anemometers are compared with the dates of the calibration and so the values and the angles of the airflow are determined. The range of measurements is from 0.1 m/s up to 1.5 m/s over the whole room angle of 360 degrees. One measurement takes about 3 - 4 seconds.
STARTDATE: 01:06:1990
EXPECTED DATE OF TERMINATION: 30:11:1993
ESTIMATED NUMBER OF PERSON HOURS: (None stated)
SELECTED BIBLIOGRAPHY:
1. Steimle F et al (1991), Determination of flow direction by a globe sensor containing thermal anemometers. 12th AIVC Conference, Ottawa, Canada. 24-27 September 1991.

REF D12
TITLE OF PROJECT: Dynamic reaction of air conditioning systems
PRINCIPAL RESEARCHER: Franzke, Uwe
ORGANISATION: Institut fur Luft und Kaltetechnik Gemeinnutzige GmbH
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E-Mail Address:
SPECIFIC OBJECTIVES: Development of mathematical models
BUILDING TYPE: Simulated occupancy, Commercial/office, Test chamber or test structure
COMPONENT TYPE: Walls, Weather
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS Ventilation systems have a driving performance in the field between kilowatts and a few megawatts. In practice determines instationary extent of the influence the efficiency of ventilation systems. In cooperation with the University if Dresden a mathematical model, which describes a dynamic reaction of
1. Chilled ceilings
2. Peak of cooling load
3. integration of walls in ventilation systems was generated.
STARTDATE: 01:07:1991
EXPECTED DATE OF TERMINATION: 31:12:1993
ESTIMATED NUMBER OF PERSON HOURS: 20,000
SELECTED BIBLIOGRAPHY: (None Stated)

REF D13
TITLE OF PROJECT: Ventilation Systems for low energy buildings.
PRINCIPAL RESEARCHER: Franzke, Uwe
ORGANISATION: Institut fur Luft und Kaltetechnik Gemeinnutzige GmbH
ADDRESS: Bertolt Brecht Allee 20, 01309 Dresden, Germany
TELE: +49 (0) 0351 4081651
FAX: +49 (0) 0351 4081655
E-Mail Address:
SPECIFIC OBJECTIVES: Energy Impact of ventilation, Heating and ventilation systems and strategies
BUILDING TYPE: Commercial/office
COMPONENT TYPE: Walls, Weather
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Energy consumption of new buildings is normally determined by the ventilation system. The reason is the low heat flow through the wall. A new ventilation system was created. Its based on the principal of heat pipe. The location of the equipment is the outdoor wall, where the air change through the heat recovery system. The results of different tests shows a high efficiency.
STARTDATE: 01:01:1993
EXPECTED DATE OF TERMINATION: 31:12:1993

ESTIMATED NUMBER OF PERSON HOURS: 4,800
SELECTED BIBLIOGRAPHY: (None Stated)

REF D14
TITLE OF PROJECT: Characterisation of Ventilation Systems by means of Air Exchange Efficiency and Ventilation Effectiveness.
PRINCIPAL RESEARCHER: M Zeller, A Jung
ORGANISATION: Lehrstuhl fur Warmeubertragung und Klimatechnik; RWTH Aachen
ADDRESS: EilfschornsteinstraBe 18, 52056 Aachen, Germany
TELE: +49 241 80 54 00 FAX: +49 241 8888 143
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Heating and ventilation systems and strategies
BUILDING TYPE: Simulated Occupancy, Test Chamber or test structure
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Behaviour of occupants, Sources of pollution, arrangement of heat loads and exhaust grills
PROJECT DETAILS The performance of four ventilation systems will be investigated by means of different tracer gas methods under laboratory conditions. Parameters are the type and position of different contamination sources in the room, the air exchange rate, the heat load, the arrangement and shape of heat sources, the position and number of exhaust grills. The overall scope of the study is the development of a reliable tracer gas measurement and evaluation strategy in order to utilize the concepts of the air exchange efficiency and ventilation effectiveness for general practical applications. Field measurements in Annex 26 case study building (Gymnasium in Munich) are also planned.
STARTDATE: 01:01:1992
EXPECTED DATE OF TERMINATION: 31:12:1995
ESTIMATED NUMBER OF PERSON HOURS: 8000
SELECTED BIBLIOGRAPHY:
1. Jung et al (1992) An improved method to determine the age of air from tracer gas measurements. Proc. Roomvent 92. Pt 3, pp231-244 Aalborg, Denmark, 1992.
2. Jung A (1993), Messung der Luftungseffektivitat im LabormaBstab mit Spurengasen. Heizung Luftung Haustechnik HLH ed. 44 919930 Nr 7,s, 434-437
3. Jung A et al (1993), Bestimmungder Luftungseffekivitat und der Luftungswirksamkeit mit Spurengasen - Gegenubertellung anhand von Laboruntersuchungen an einem Quelluftungssystem, 20 Jahrestagung des Deutschen Kalteund Klimatechnischen Vereins DKV, Ed, 4 S 187-201, Numberg, 1993.
4. Jung et al (1994), An analysis of different tracer gas techniques to determine the air exchange efficiency in a mechanically ventilaed room. Paper to be presented Roomvent 94, Krakow, Poland, June 1994.

REF D15
TITLE OF PROJECT: Room air flow in single rooms and large enclosures (supported within a IEA Annex 20 (26 project)
PRINCIPAL RESEARCHER: Renz, U
ORGANISATION: Lehrstuhl fur Warmeubertragung und Klimatechnik; RWTH Aachen
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TELE: +49 241 80 54 00 FAX: +49 241 8888 143
E-Mail Address:
SPECIFIC OBJECTIVES: Measurements and simulations with CFD of room air flow Indoor air movement, Measurement technique (LDA, PIV)
BUILDING TYPE: Unoccupied, Gymnasium
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS Measurements : (velocities, turbulence parameters) Laser-Doppler-Anemometer (LDA) and Particle Image- Velocimetry (PIV) measurements in a test chamber (3mx4.8mx2.5m). Test conditions:
1. Mechanical ventilation, isothermal
2. Natural ventilation, cold and warm walls PIV measurement at a mechanically ventilated gymnasium (15mx27mx7m)
CFD calculations: The FLUENT code is used for numerical simulations. Main fields of interest are the definition of boundary conditions of air inlets, turbulence models and wall functions for nonisothermal flow, Calculations are carried out for the test chamber and the gymnasium (s.a)
STARTDATE: 01:10:1989
EXPECTED DATE OF TERMINATION: 31:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 8000
SELECTED BIBLIOGRAPHY:
1. Ewert M and Zeller M (1991), Turbulence parameters at supply Opening (measurements) IEA Annx 20 Report, Research Item 1.43,1991.
2. Ewert M et al Definitions of flow parameters at room inlet device - measurements and calculations. 12 th AIVC Conference, Otttawa, Canada, September 1991.
3. Ewert M. Zum Problem der Randbedingungen bei der numerischen simulation von Raumstromungen. Heizung Luftung/Klima Haustechnik, Heft 7, Juli 1993.
4. Ewert M. Simulation der Randbedingungen bei der numerischen Berechnung der Luftstromung in Raumen.Dissertation RWTH Aachen 1993
5. Ewert M. Messung von Raumluftstromungen mit der Particle-Image-Velocimetry (PIV). Heizung Luftung/Klima Haustechnik, 1994.

6. Vogl N Comaprison of numerically predicted air flow pattern using low Renolds Turbulence models with Laser Doppler Velocimeter Measurements in a room with heated walls . Roomvent, 1994, Krakow, Poland, June 1994.

REF D16
TITLE OF PROJECT: Passive House Darmstadt Kranichstein.
PRINCIPAL RESEARCHER: Wolfgang Feist
ORGANISATION: Institute Housing and Environment (IWU)
ADDRESS: Annastr. 15, D-64285 Darmstadt. Germany
TELE: +49-6151 29040 FAX: +49-6151 290497
E-mail Address:
SPECIFIC OBJECTIVES: Energy balance, indoor air quality, ventilation strategies. Indoor air movement, IAQ. Energy impact of ventilation. Airtightness/air leakage of buildings, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Dwellings.
COMPONENT TYPE: Windows, Doors, Walls, Floors,
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Temperature difference and wind direction and velocity.
PROJECT DETAILS: Passive House Darmstadt Kranichstein:
4-unit terrace house
extremely low consumption of heating energy less than 11 kWh/(m2a) (kWh per m2 living area and year) superinsulation the u-values (inW/m2K) are roof 0.1; wall 0.13; floor 0.12; and window 0.7
very airtight house nl50-pressurization-test 0.2 to 0.4 h-1 VAV ventilation system with efficiency 80%.
Subsoil heat exchanger. related research projects
1. Pressurization tests (nl50 = 0.2 to 0.4 h-1)
2. Thermographic detection of leakages under pressurization.
3. Tracer-gas-measurements.
4. Energy balance of the houses and of the ventilation systems.
5. Air flows, temperatures and rel. humidity in the ventilation system.
6. Rel. Humidity and CO2- concentration in the occupied rooms.
7. Indoor air quality analysis Radon; dust; VOC; airborne microorganisms.
STARTDATE: 00:10:1991
EXPECTED TERMINATION DATE: 31:05:1995
ESTIMATED NUMBER OF PERSON HOURS: 5000
SELECTED BIBLIOGRAPHY: 1. Forschungsprojekt Passive Hauser. Wolfgang Feist; Institut Wohnen und Umwelt DA; Novem. 1988
2. Passivhaus Darmstadt Kranichstein. Hessisches Ministerium fur Umwelt, Energie und Bundesangelegenheiten, Dokumentation, Wiesbadenh, 1.Aufl. 2/91; 3.Aufl. 3/94 Passivhaus Darmstadt Kranichstein. Feist, Wolfgang; Bundesbaublatt, Februar 1992
3. Bauvorbereitendes Forschungsprojekt Passive hauser; Feist, W; Institut Wohnen u.U., DA 1992
4. passivhauser in Mitteleuropa. Wolfgang Feist; Dessertation Gesamthochschule Kassel 1993;
5. Die Zukunft des energiesparenden Bauens Das Passivhaus. Feist, W.& Ebel,W Baumakt 91 (1992),H.4,S.310-316
6. Zwischenbericht "Wissenschaftliche Auswertung Passivhaus Darmstadt kranichstein". Wolfgang Feist; 1.Aufl.Darmstadt Institut Wohnen und Umwelt, 1993
7. Erste MeBergebnisse aus dem Passivhaus Darmstadt kranichstein. Feist, W und Werner j Gesundheitingenieur 114 (1993), H5, S.240-249
8. Nutzerhandbuch fur das passivhaus Darmstadt Kranichstein. Fest W; Darmstadt IWU, 1993
9. Passivhauser in Mitteleuropa - Planungshinweise und Umsetzung. Feist w; Bauphysik 1994
10. passivhaus Darmstadt Gesamtenergiekennwert 32kWh/(m2a). 11. Feist, W; Bundesbaublatt, 1994; S.106-110.

2.7 THE NETHERLANDS

REF NL01
TITLE OF PROJECT: Rule-based indoor climate control.
PRINCIPAL RESEARCHER: X Peng, A H C van Paassen, Q Chen.
ORGANISATION: Department of Mechanical Engineering, Delft University of Tech.
ADDRESS: Mekelweg 2, 2628 CD Delft, The Netherlands.
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FAX: +31 (0) 15-782947
E-mail Address: chen@dutwg.tudelt.nl
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy impact of ventilation. Heating and ventilation systems and strategies.
BUILDING TYPE: Simulated occupancy, Commercial/office, Test chamber or test structure.
COMPONENT TYPE: Windows, Doors, Walls, Floors.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Outdoor temperature, wind speed, window opening.
PROJECT DETAILS: In recent years, there is an ever increasing concern with the indoor thermal comfort and energy saving among HVAC specialists. This concern motivates people to take closer investigations on the indoor temperature distributions, the air flow patterns and how to take the advantage of outdoor climatic conditions for ventilation and heating. This is especially important in the control of passive indoor climate buildings where natural ventilation is used is a cooling source and varying

wind conditions may change the indoor temperature distributions and air flows dramatically.
When the rule-based control strategy is employed for the passive indoor climate control system, various useful human knowledge is designed as control rules. As the indoor air flows may bring draught due to the use of natural ventilation, systematic investigation must be carried out on them. As an alternative of experimental method, the widely recognized CFD (Computational Fluid Dynamics) codes are used to study the air flow patterns and the sensation of draught.
Nonetheless, since the energy, mass and especially momentum balance equations of thousands of grid points need to be solved iteratively, and the iterations have to be continued long enough until all variables converge to some satisfactory extent, the CFD codes take so much computing time that they are quite costly for the study of the dynamic temperature responses and the dynamic air flow patterns. Obviously, they can not be used for the dynamic simulations of the indoor climate control systems. For some typical heating and cooling situations, although the indoor air flow patterns may vary with time because of the existence of turbulence, the prevailing airflow patterns which have dominant effects on the air temperature distributions and the sensation of draught almost do not change. These air flow patterns and the corresponding air velocity datafiles can be pre-calculated with CFD codes and used for temperature response calculations further. With reference to these fixed air flow patterns, the grids used in the CFD calculations, and the pre-calculated air velocity datafiles, the heat balance equations of all air grid cells, walls, windows and heating devices can be solved simultaneously. The dynamic temperature responses are calculated quickly. The calculations are validated with measurements under different heating and cooling situations.
With this simulation strategy, various control schemes such as the rule-based fuzzy control are tested under different outdoor weather conditions. The indoor thermal comfort indexes relating indoor temperature distributions and draughts are also studied.
STARTDATE: 00:07:1992
EXPECTED TERMINATION DATE: 00:07:1996
ESTIMATED NUMBER OF PERSON HOURS: 2000/year (8000 in total)
SELECTED BIBLIOGRAPHY:
1. State-of-art of Modelling and Control of Indoor Climate Systems. (X Peng, Oct 1994. TUDelft)
2. Prediction of room thermal response by CFD technique with conjugate heat transfer and radiation models. (Q Cheng, X Peng, AHC van Paassen, to be published.)

REF NL02

TITLE OF PROJECT: Air Lock Floor. Fieldtest. Radon protection.
PRINCIPAL RESEARCHER: Hans Phaff
ORGANISATION: TNO Building & Construction
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TELE: +31 (0) 15 608 608
FAX: +31 (0) 15 608 432
E-mail ADDRESS: Phaff@bil-5.bouw.tno.nl
SPECIFIC OBJECTIVES: Radon/soil gasses/protection, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Dwellings.
COMPONENT TYPE: Walls, Floor/crawlspace.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED:
Meteorological, Wind pressures, Mechanical extract ventilation.
PROJECT DETAILS: A horizontal foil separates the crawlspace in two layers. A mechanical exhaust fan (the fan used in normal mechanical extract systems) produces -10 to -20 Pa in the upper layer, just below the floor. An over pressure of 2--5 Pa is generated in the lower layer. The air through the fan is the extract ventilation of the dwelling. Its normal mechanical ventilation ducts are now mounted through the ground floor into the upper layer.
1. The low pressure under the ground floor prevents entrance of any crawlspace gasses in the dwelling.
2. The IOX increased crawlspace ventilation dilutes any sources to lower concentrations.
3. The over pressure on the soil of the crawlspace presses Radon away from the foundation.
4. The warmer exhausted air lowers energy loss through the floor.
5. The fan operates at low pressure and replaces the normal extract fan.
STARTDATE: 00:10:1993
EXPECTED TERMINATION DATE: 00:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 400
SELECTED BIBLIOGRAPHY:
1. Annex 23 note spring 1993 (available from TNO)
Healthy buildings Hungary 1994.

REF NL03
TITLE OF PROJECT: Collective glass roofed indoor spaces in house building
PRINCIPAL RESEARCHER: Donze GJ, Vrins E, Hoiting H
ORGANISATION: Woon/Energie
ADDRESS: PO BOX 733, NL 2800 AS Gouda, Netherlands
TELE: +31 1820 24233 FAX: +31 1820 11296
E-Mail Address:
SPECIFIC OBJECTIVES: Energy Impact of ventilation, Heating and Ventilation systems and strategies
BUILDING TYPE: Simulated Occupancy, Dwellings
COMPONENT TYPE: Glass roofed indoor spaces

PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Energy, Overheating, Fire security, air purity
PROJECT DETAILS: Aim of this study was to provide insight into the application possibilities of collective glass roofed spaces in house building. Three types have been observed in this study Atrim, Indoor street and sunroom. Special Attention has been paid to energy consumption and comfort aspects.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF NL04
TITLE OF PROJECT: Study to possible causes of yellow brown colouring complex Josephlaan in Utrecht NL
PRINCIPAL RESEARCHER: Vrins E,
ORGANISATION: Woon/Energie
ADDRESS: PO BOX 733, NL 2800 AS Gouda, Netherlands
TELE: +31 1820 24233 FAX: +31 1820 11296
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Heating and Ventilation systems and strategies
BUILDING TYPE: Occupied, Dwellings
COMPONENT TYPE: Air exhaust grids
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Yellow/brown colouring
PROJECT DETAILS: Aim of this study was to get insight into the yellow colouring problems.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF NL05
TITLE OF PROJECT: Desk study house ventilation
PRINCIPAL RESEARCHER: Vrins E, Rijn van J D
ORGANISATION: Woon/Energie
ADDRESS: PO BOX 733, NL 2800 AS Gouda, Netherlands.
TELE: +31 1820 24233 FAX: +31 1820 11296
E-Mail Address:
SPECIFIC OBJECTIVES: Listing of dutch research and research programmes in the field of ventilation
BUILDING TYPE: Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS:
*Investigating the possibilities to improve coordination and integration of studies in the field of housing ventilation.
* Indicating bottle necks and conflicting interests from different angles in relation to housing ventilation.
In the Netherlands elaborated researchers and research programs have been listed with which ventilation aspects play a role. The aims of the program and the contents of the researches have been observed herewith. The aims of the various program have been compared and aspects as to contents of the researches have been compared to one another.
With the latter subject use has been made of a model in which aspects and parts of buildings can be named. Results of this analysis have been represented in a matter of matrices. Based on these matrices a survey of white spots and doubles has been a result.
A number of researches and interested parties have been asked which type of knowledge will be of interest in the future. The results of this have been compared to the contents of existing researchers.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

2.8 NEW ZEALAND

REF NZ01
TITLE OF PROJECT: Retrofit Airtightness of Old Houses
PRINCIPAL RESEARCHER: Mark Bassett
ORGANISATION: Building Research Association of New Zealand
ADDRESS: Private Bag, 50908 Pirua, New Zealand
TELE: +64 (0)4 2357600
FAX +64 (0) 4 235 6070
E-Mail Address:
SPECIFIC OBJECTIVES: Airtightness air leakage of buildings, Moisture mould generation and prevalence
BUILDING TYPE: Occupied, Dwellings
COMPONENT TYPE: Windows, Doors, Walls, Floors, Cracks,
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)
PROJECT DETAILS Project is part of a wider study of dust mite population and the strategies (ventilation included) that reduce these. This part will improve the airtightness of the houses and reduce indoor RH levels with a mixture of heat recovery ventilation, heating and dehumidification. Other contributions to this extended project are the Wellington Medical School, ECNZ (Electricity Confederation of NZ).
STARTDATE: 00:03:1994
EXPECTED TERMINATION DATE: 00:12:1995
ESTIMATED NUMBER OF PERSON HOURS: (NOT STATED)

SELECTED BIBLIOGRAPHY
1. Cunningham M J and Trethawen H A (1993), Microclimates in New Zealand homes. Proc. Mites Asthma and Domestic Design. Sydney.

REF NZ02
TITLE OF PROJECT: Ventilation Effectiveness in Mechanically Ventilated Buildings
PRINCIPAL RESEARCHER: Mark Bassett
ORGANISATION: Building Research Association of New Zealand
ADDRESS: Private Bag, 50908 Pirua, New Zealand
TELE: +64 (0)4 2357600
FAX + 64 (0) 4 235 6070
E-Mail Address:
SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies
BUILDING TYPE: Occupied, Commercial Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Ventilation effectiveness as a function of compartmentalisation. Location of inlets and extracts etc.
PROJECT DETAILS This project aims to identify generic poor practice in mechanically ventilated buildings using tracer gas methods to measure ventilation effectiveness.
STARTDATE: 00:00:1993
EXPECTED TERMINATION DATE: 00:00:1995
ESTIMATED NUMBER OF PERSON HOURS: 1/2 person year
SELECTED BIBLIOGRAPHY: No published material at present.

REF NZ03
TITLE OF PROJECT: Ventilation and Indoor Air Quality
PRINCIPAL RESEARCHER: Mark Bassett
ORGANISATION: Building Research Association of New Zealand
ADDRESS: Private Bag, 50908 Pirua, New Zealand
TELE: +64 (0) 4 2357600 FAX +64 (0) 4 235 6070
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Moisture Dust mites, Energy Impact of ventilation, Airtightness/air leakage of buildings, Moisture mould generation and prevalence
BUILDING TYPE: Occupied, Dwellings, Commercial Office
COMPONENT TYPE: Passive Vents
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS Passive ventilation in residential buildings. Further trials of passive ventilation systems and development of appropriate codes.
Dust mite control. Development of measures needed to control duct mites. This will consist of building airtightness requirements, insulation, and perhaps dehumidification.
Ventilation effectiveness of mechanical systems, local mean age and ventilation effectiveness parameters are being measured to see if results can be used to modify selection and installation practices.
STARTDATE (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

2.9 NORWAY

REF NO1
TITLE OF PROJECT: (NO TITLE GIVEN).
PRINCIPAL RESEARCHER: Peter Blom
ORGANISATION: Norwegian Building Research Institute
ADDRESS: Forskningsveien 3b, PO BOX 123 Blindern, N-0314 OSLO, NORWAY
TELE: +47 2 96 55 00 FAX + 47 2 96 55 42
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ
BUILDING TYPE: Occupied, Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS A questionnaire was distributed by post to around 1000 low-rise dwellings in a suburb near Oslo. The houses are relatively new (built around 1990), and they all have a variant of mechanical ventilation system. The questionnaire included questions about user habits and user satisfaction, especially regarding ventilation, heating and cleaning. The respondents were also asked for complaints on indoor climate factors and complaints on IAQ related health symptoms.
Field measurements were accomplished in 27 dwellings. The measurements included air change (constant concentration tracer gas), noise, house dust mites, air flows in the ventilation system and various gases (TVOC, CO2, CO). The gas detection was performed with B&K 1302, an instrument based on photo-acoustic spectroscopy. The project is financed by the Nordic Committee of Building Regulations.
STARTDATE: 00:02:1993
EXPECTED TERMINATION DATE: 00:06:1994
ESTIMATED NUMBER OF PERSON HOURS: 300 person-hours
SELECTED BIBLIOGRAPHY (None Stated)

REF NO2
TITLE OF PROJECT: (NO TITLE GIVEN).
PRINCIPAL RESEARCHER: Trygve Hestad

ORGANISATION: Norwegian Building Research Institute
ADDRESS: Forskningsveien 3b, PO BOX 123 Blindern, N-0314 OSLO, NORWAY
TELE: +47 2 96 55 00 FAX + 47 2 96 55 42
E-Mail Address:
SPECIFIC OBJECTIVES: Energy Impact of ventilation, Heating and ventilation systems and strategies
BUILDING TYPE: Occupied, Dwellings
COMPONENT TYPE: Ventilation systems
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: The ventilation system assumes an airtight building because of the heat exchanger and air flow controller. The system uses electronic filtration.
PROJECT DETAILS: The aim is to develop a new ventilation system for dwellings that is energy efficient, has low noise level, good filtration, draught free air supply and combines natural and mechanical ventilation forces.
Wind forces will help to supply and extract air through a specially designed hood on the roof. When the wind is too weak a low velocity fan will keep the air flow through the system on designed rate, approx, 0.7 ach. When the wind is too strong, the same fane will be used as a flow regulator and reduce the air flow. The ventilation system has low flow resistance, about 20-30 Pa at designed flow rates. One or more prototypes will be installed in new dwellings that will be flowed up with measurements over one year in a new project.
STARTDATE: 00:06:1993
EXPECTED TERMINATION DATE: 00:07:1994
ESTIMATED NUMBER OF PERSON HOURS: 1200 person-hours
SELECTED BIBLIOGRAPHY: Project report will be ready at termination date.

REF NO3
TITLE OF PROJECT: Research program: Rock Cavern Stadium.
PRINCIPAL RESEARCHER: Hans Martin Mathisen
ORGANISATION: SINTEF Applied Thermodynamics
ADDRESS: 7034 - Trondheim, NORWAY
TELE: +47 73 59 38 70 FAX + 47 73 59 38 59
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy Impact of ventilation, Moisture mould generation and prevalence, Heating and ventilation systems and strategies
BUILDING TYPE: Occupied, Ice hockey rink, 5800 seats, rock cavern
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: IAQ will be related to occupancy, air flow rate and type of use (Ice hockey, concert)
PROJECT DETAILS The rock cavern is 62m wide, 91m long 24m high. Entrance is through a 100m long tunnel. It is a multi purpose room, ice hockey, hand ball, concerts, exhibitions etc. For ice hockey it has a capacity of 5800 persons.
The ceiling has a lining of thin corregated steel sheets. Measurements have been done for a concert situation and an ice hockey situation :
Tracer gas - measurements air exchange, efficiency and local efficiency
CO2
Velocity in the room
Temperatures in the room and surfaces
STARTDATE: 00:06:1993
EXPECTED TERMINATION DATE: 00:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 1200 person-hours
SELECTED BIBLIOGRAPHY:
1. Mathisen et al (1993), Verification of tool for energy calculations in rock caverns. Underground openings for public use. The EUREKA Technology Conference in Lillhammer, 13-17 June, 1993, Norway.

2.10 SWEDEN

REF SE01
TITLE OF PROJECT: Low Velocity Air Jets.
PRINCIPAL RESEARCHER: Tor-Gorum Malmstrom.
ORGANISATION: Royal Inst. of Technology
ADDRESS: Div. Bldg Services Engineering, S-100 44 Stockholm, Sweden
TELE: +46-8790 7836 FAX: +46-84118432
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement
BUILDING TYPE: Unoccupied.
COMPONENT TYPE: Air supply terminal device.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)
PROJECT DETAILS: The characteristics of low velocity air jets are studied. The studies include dependence on Reynolds number and other characteristics of the supply device.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1 Low velocity air jets from round muzzles. Report no.26, Div of Building Services Eng, KTH, 10044 Stockholm, Sweden (1992).
2 Use of constant momentum for supply of cold air. Roomvent 92, Aalborg, Denmark (1992)

REF SE02

TITLE OF PROJECT: Air quality in schools.
PRINCIPAL RESEARCHER: Jan Gusten.
ORGANISATION: Dept. of Building Services Engineering.
ADDRESS: Chalmers University of Technology, S-41296 Gothenburg, Sweden.
TELE: +46 31 772 10 00 FAX: +46 31 772 1152
E-Mail Address:
SPECIFIC OBJECTIVES:; IAQ, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Schools.
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: A comprehensive measurement programme has been accomplished in order to quantify the indoor air quality before and after the reconstruction of the ventilation systems. The measurements include registration of the contents of CO2, volatile organic compounds and the content of airborne particles. It is possible to discern pollution load relating to:
* activity from educational activities and cleaning.
* emissions from building materials and furnishings.
* the influence of outdoor air, traffic-generated air pollution.
STARTDATE: 00:00:1992
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF SE03
TITLE OF PROJECT: IEA - Annex 27, Evaluation and Demonstration of Domestic Ventilation Systems.
PRINCIPAL RESEARCHER: Lars-Goran Mansson.
ORGANISATION: LGM CONSULT AB
ADDRESS: Alder Salvius Vag 87, S-14653 TULLINGE, Sweden
TELE: +46-8 7785006 FAX: +46 8 7788125
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ and energy strategies and consequently for above.
BUILDING TYPE: Occupied, Dwellings.
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Operating Agent for Annex 27.
Objectives
1. Develop methods for evaluating domestic ventilation systems.
2. Validate the methods with data obtained from the measurements. 3. Demonstrate and evaluate domestic ventilation systems for different climates, building types, and use of dwelling application in future and existing domestic buildings that require heating.
1. State of the Art
a) Give and overview of system solutions.
b) Identify most frequently used systems.
c) Give reasons behind the solutions.
d) Review existing evaluation methods.
2. Development and Validation of Evaluation Methods
a) Define evaluation parameters.
b) Select methods.
c) Develop new methods where appropriate.
d) Validate.
3. Evaluation, Demonstration and Application of Currents and Innovative Ventilation Systems
a) Use the methods developed to evaluate ventilation systems for a set of variables.
b) Demonstrate good performance of principally different ventilation systems.
c) Demo innovative systems for future buildings.
STARTDATE: 00:04:1993
EXPECTED TERMINATION DATE: 00:04:1998
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF SE04
TITLE OF PROJECT: High quality ventilation systems - a tool to reduce SBS-symptoms
PRINCIPAL RESEARCHER: Anders Kumlin, Jan Drakfors.
ORGANISATION: AK-konsult Indoor Air.
ADDRESS: Box 86, S-162 12 Vallingby, Sweden.
TELE: +46 8373072 FAX: +46 8875223
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Energy impact of ventilation, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Commercial/office.
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: TVOC, air recirculation, energy cost.
PROJECT DETAILS: The employees in a large administration building stated to experience SBS-symptoms 3-4 years after it had been built.
A questionnaire was used to investigate the health situation among employees, showing complaints mainly concerning fatigue and headaches.
The analysis of the indoor air quality showed unusually high TVOC concentrations including 2 ethyl-1-hexanol. The floors showed relatively high concentrations of ammonia under the PVC-coating, due to self leveling compounds containing case in.
The TVOC concentration varied with time and it was concluded that the main VOC source was due to printing works located in the building. The concrete framed floors were found to be dry and it was suggested that no increasing problems would arise from the floors.

The ventilation system was redesigned. The device for recirculating the air was removed and a heat recovery system based on fluids was installed.
After the reconstruction of the ventilation system the complaints of the indoor air quality decreased to a level close to a "healthy building".
This present study shows that measurements taken had clear positive effects on the health situation, in spite of remaining defects from the floors.
STARTDATE: 00:00:1990
EXPECTED TERMINATION DATE: 00:00:1992
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF SE05
TITLE OF PROJECT: Indoor climate and energy use in houses with warm air heating or radiator heating.
PRINCIPAL RESEARCHER: Ake Blomsterberg.
ORGANISATION: Swedish National Testing and Research Institute.
ADDRESS: Box 857, S-501 15 Boras, Sweden.
TELE: +46 33165505 FAX: +46 33131979
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movements, IAQ, Airtightness/air leakage of buildings, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Dwellings.
COMPONENT TYPE:
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather, behaviour of occupants, ventilation system, moisture, CO2, particles, relative humidity.
PROJECT DETAILS: The aim of the project is to evaluate and compare thermal comfort, ventilation, indoor air quality and energy use in modern Swedish one-family houses with warm air heating (incorporating balanced ventilation) respectively radiator heating (combined with extract ventilation). Improvements will be proposed. The first step in the project is to select 450 one-family houses. All of them will receive indoor climate questionnaires. Using the results from the questionnaires and knowing the energy use, 50 houses will be chosen for a visit. Mainly houses with indoor climate problems according to the questionnaires will be chosen. During the visit the status of the heating and ventilation system will be documented. Pressurization tests of the building envelope will be performed. Thermal comfort and sound level will be monitored. Airflows in the ventilation system will be measured. The particle content in the outside air, in a couple of rooms and in the supply duct will be monitored using passive techniques air temperature, relative humidity, outdoor air flows (using two different PFT-tracer gases). The indoor climate questionnaire also includes questions concerning operating and maintenance instructions etc. The CO2 content will be monitored for one night in the master bedroom.
STARTDATE: 00:03:1993
EXPECTED TERMINATION DATE: 00:06:1994
ESTIMATED NUMBER OF PERSON HOURS: 1600
SELECTED BIBLIOGRAPHY:
1. Norlen U, Andersson K. The indoor climate in the Swedish Housing Stock. Swedish Institute of Building Research, Gavle, Sweden, 1993, TN30(in Swedish)
2. Engvall K, Norrby C. Perceived indoor climate in the housing stock of Stockholm. USK (Investigation and Statistical Office), Stockholm, Sweden, Nr 19924, 1992 (in Swedish)

REF SE06
TITLE OF PROJECT: Investigation of rotary heat exchangers.
PRINCIPAL RESEARCHER: Thomas Carlsson.
ORGANISATION: Swedish National Testing and Research Institute.
ADDRESS: Box 857, S-50115 Boras, Sweden.
TELE: +46 33 165149 FAX: +46 33 131979
E-Mail Address:
SPECIFIC OBJECTIVES:; IAQ, Energy impact of ventilation, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Commercial/office, Industrial/factory.
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: VOC, relative humidity.
PROJECT DETAILS: The aim of the project is to make a "state of the art" investigation of rotary heat exchangers. In the study will be determined how many of the heat exchangers which are correctly installed and whether there is a correlation with the perceived indoor air quality. The project will start with an inventory of delivered/installed rotary heat exchangers in Sweden. For 80 of these the drawings and technical descriptions will scrutinized. Later 17 systems will be investigated by field measurements and indoor climate questionnaires. The following measurements will be taken; VOC, relative humidity, transfer between supply and exhaust air.
STARTDATE: 00:10:1993
EXPECTED TERMINATION DATE: 00:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 1500
SELECTED BIBLIOGRAPHY:
1. Ruud S. Transfer of pollutants in Rotary Air-to-air Heat exchangers - A Literature Survey/State of the Art Review. Swedish National Testing and Research Institute, Boras, Sweden, SP RAPPORT 199303, 1993.

REF SE07
TITLE OF PROJECT: Safety Ventilation
PRINCIPAL RESEARCHER: Bengt Ljungsvist
ORGANISATION: Royal Inst.of Technology
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E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Airtightness/air leakage of buildings, Contamination, occupational health.
BUILDING TYPE: (None Stated)
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: To study the aerodynamics governing the dispersion of pollutants from one source into ambient air. The control of such processes, both regarding human safety and production safety, and measurement methods necessary for such studies.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Ljungqvist B Ventilated Benches and Enclosures in Laboratories. The Safety and Health Practitioner. Vol 10, No 9, September 1992.
2. Ljungqvist B, Hillerbrant B Downward Parallel Flow Systems for Operating Rooms with Moderate Air Volume Flows. ROOMVENT -92, Ahus Denmark, September 1992.
3. Ljungqvist B Some Observations on Aerodynamic Types of Laboratory Fume Hoods, In Ventilation-91. Huges et al, ed), American Conference of Governmental Industrial Hygienists Inc, Cincinnati, OH, 1993.
4. Ljungqvist B, Reinmuller B Interaction between Air Movements and the Dispersion of Contaminants. Clean Zones with Unidirectional Air Flow, Journal of Parenteral Science & Technology, Vol 47, No 2, March-April, 1993.

REF SE08
TITLE OF PROJECT: Air movement and contamination distribution in comfort ventilation.
PRINCIPAL RESEARCHER: Elisabeth Mundt.
ORGANISATION: Royal Institute of Technology, Division of Building Services Engineering,
ADDRESS: S-100 44 Stockholm, SWEDEN.
Tel +468 790 78 34 FAX: +468 411 84 32
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movements, IAQ.
BUILDING TYPE: Occupied, Simulated occupancy, Test chamber or test structure.
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Type of contamination source, ventilation, behaviour of occupants.
PROJECT DETAILS: To study the contamination distribution especially in the breathing zone and the dependence of the air flow and position of the contamination sources on the distribution. In displacement ventilation pollutants can be locked in at different levels depending on how they are produced, temperature gradients and ventilation air flow versus convective air flows. The distribution is very sensitive to disturbances, opening and closing of a door can cause a great decrease in the local ventilation effectiveness at a point.
STARTDATE: 01:07:1993
EXPECTED TERMINATION DATE: 30:6:1996
ESTIMATED NUMBER OF PERSON HOURS:
SELECTED BIBLIOGRAPHY:
1. Mundt E. Convection flows above common heat sources in rooms with displacement ventilation. Proc Room-Vent 90. Oslo 1990.
2. Mundt E. Convection flows in rooms with temperature gradients - theory and measurements. Proc Room-Vent 92. Aalborg 1992.
3. Mundt E. Displacement ventilation - Convection flows and temperature gradients. Accepted for publication in Building and Environment.
4. Mundt E. Contamination distribution in displacement ventilation - Influence of disturbances. Proc Indoor Air '93. Helsingfors, 1993.
5. Mundt E. Displacement ventilation - Contamination distribution. Submitted for publication in Building and Environment.

REF SE09
TITLE OF PROJECT: Energy Efficient HVAC Systems for Commercial and Institutional Buildings.
PRINCIPAL RESEARCHER: Lennart Jagemar
ORGANISATION: Department of Building Services Engineering
ADDRESS: Chalmers University of Technology, S-41296 Gothenburg, SWEDEN.
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E-Mail Address: hvac@vsect.chalmers.se
SPECIFIC OBJECTIVES: Energy impact of ventilation, Heating and ventilation systems and strategies, Interactions between HVAC system and building.
BUILDING TYPE: Occupied, Simulated occupancy, Commercial/office.
COMPONENT TYPE: Windows, HVAC system, fans, ducts etc.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather, Performance of building components, Behaviour of

occupants, Air distribution system incl. air handling units.
PROJECT DETAILS: The project shall result in design guidance on how to achieve energy efficient HVAC systems. One main point is to develop key-numbers to characterize the energy usage for the HVAC system, its subsystems as well as HVAC equipment. For the building and the HVAC system as an entity the well-known key-number [hwh/year]/[treated m2] is used. With help of monitored data from demonstration projects and through simulations with the building simulation program DOE-2.1S numerical values on the key-number are acquired for different designs of HVAC systems (and building) world wide.
Economics are included as the profitability of marginal improvements, resulting in from a base case are analysed. These changes may be with a higher efficiency or decreasing the pressure drops in the unit handling unit. The maximum permissible investment (= present value of annual energy savings) as well as the internal rate of returning methods are used in the marginal cost analysis.
STARTDATE: 01:07:1989
EXPECTED TERMINATION DATE: 31:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 5000
SELECTED BIBLIOGRAPHY:
1. Jagemar K, (1991). ENERGY ECONOMICS - Selection of Fans and Duct Design for Air Distribution systems in Commercial and Industrial Buildings. (In Swedish, thesis for the Licentiate of Engineering Degree)
Document D101991; April 1991 Dept. of Building Services Engineering, Chalmers University of Technology, Gothenburg, SWEDEN.
2. Jagemar L, (1991). Classification, with Regard to the Electricity usage, of Air Conditioning Systems for Commercial Buildings. (In Swedish).
Document D111991; December 1991. Dept. of Building Services Engineering, Chalmers University of Technology, Gothenburg, SWEDEN.
3. Jagemar L, Nilsson P-E, Abel E, Aronsson S, (1994). Learning from experiences with Energy Efficient HVAC Systems for Non-Residential Buildings.
CADDET Analyses Series No ?, CADDET Analysis Support Unit. To be published in spring 1994. Centre for the Analysis and Dissemination of Demonstrated Energy Technologies, IEA CADDET Sittard, the Netherlands.
4. Jagemar L, (1994). Energy Efficient HVAC Systems for Commercial Buildings. Document D?1994 (Planned PhD thesis). Dept. of Building Services Engineering, Chalmers University of Technology, Gothenburg, SWEDEN.
5. Jagemar L and Rengholt U, (1992). Guidelines for the Classification of Indoor Climate and of Air Distribution Systems. ACEEE 1992 Summer Study on Energy Efficiency in Buildings, Pacific Grove, CA, USA; 1992-08-30--09-05
Proceedings Panel 1; Commercial Technologies Design and Operation, pp 1.133 - 1.135. American Council for an Energy-Efficient Economy. Washington DC, USA.
6. Jagemar L (1992). Economic Margin for Electricity Conservation Measures in Air Distribution Systems for Commercial Buildings. Workshop Energy Efficiency and Ventilation, Manchester, UK; 1992-09-21--22 CIB Working Commission W67 Energy Conservation in the Built Environment Forthcoming CIB publication, 8 pages.
7. Jagemar L and Rengholt U, (1992). Guidelines for the Classification of Indoor Climate and of Air Distribution Systems. International Symposium Innovations in Management, Maintenance and Modernization of Buildings, Rotterdam, the Netherlands; 1992-10-28--30
Proceedings Volume 7;9. Managing the Indoor Environment, Paper 9.4, 9 pages. CIB Working Commission W70 Management, Maintenance and Modernization of Building Facilities.
8. Jagemar L (1993). Key-Values for Design of HVAC Systems in Commercial Buildings. International Symposium Energy Efficient Buildings, Leinfelden-Echterdingen (Stuttgart), Germany; 1993-03-09--11 Proceedings Kapitel IV Innovative Materials, Components and Systems, pp463-468. CIB Proceedings Publication 152, IRB-Verlag, Stuttgart. CIB Working Commission W67 Energy Conservation in the Built Environment and IEA Solar Heating and Cooling Programme Task 13 Low Energy Buildings.
9. Jagemar L.(1993). Economic Margin for Decreasing Installation Effects for Centrifugal Fans in HVAC Systems. IMechE Seminar Installation Effects in Fan Systems, London; 1993-09-28 IMechE Seminar 1993-9, pp 17- 25 Institution of Mechanical Engineers, London, UK.

REF SE10
TITLE OF PROJECT: Classified Air Distribution Systems - Guidelines And Specifications.
PRINCIPAL RESEARCHER: Rengholt, Ulf
OGRANISATION: SCANVAC & The Swedish Indoor Climate Institute,
ADDRESS: Hantverkaratan 8, S-11221 Stockholm, SWEDEN.
TELE: +46 8 65 40 830 FAX +46 865 49 683
E-Mail Address:
SPECIFIC OBJECTIVES: Classification as to energy efficiency and other requirements.
BUILDING TYPE: Commercial buildings and Dwellings (Houses & Residences)
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Specific fan power

PROJECT DETAILS: Three different classes are suggested. The main parameter is the specific fan power in Kilo Watts divided with the ventilation air flow in m3/s. Class limits are 1.5, 2.5 and 4.0 kw/m3/s.
STARTDATE: 01:01:1990
EXPECTED TERMINATION DATE: 30:06:1991
ESTIMATED NUMBER OF PERSON HOURS: 1200 person-hours
SELECTED BIBLIOGRAPHY: (None Stated)

REF SE11
TITLE OF PROJECT: Classified indoor climate systems V.2
PRINCIPAL RESEARCHER: Rengholt, Ulf
OGRANISATION: The Swedish Indoor Climate Institute,
ADDRESS: Hantverkaratan 8, S-11221 Stockholm, SWEDEN.
TELE: +46 8 65 40 830 FAX +46 865 49 683
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ
BUILDING TYPE: Dwellings, Commercial/Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Classification of indoor climate quality and Specification of quality parameters. Revision of first project from 1990.
STARTDATE: 01:09:1994
EXPECTED TERMINATION DATE: 30:06:1995
ESTIMATED NUMBER OF PERSON HOURS: 600
SELECTED BIBLIOGRAPHY: (None Stated)

REF SE12
TITLE OF PROJECT: Evaluation of indoor climate when remodelling with superinsulated windows and new heating systems.
PRINCIPAL RESEARCHER: Levin, Per
ORGANISATION: Royal Institute of Technology
ADDRESS: Building Technology, S-100 44 Stockholm, Sweden
TELE: +46-8-790 86 66 Fax: +46-8-20 51 35
E-mail Address: perlev@ce.kth.se
SPECIFIC OBJECTIVES: Indoor air movements, Air leakage, Energy impact of ventilation (and heating), Heating and ventilation systems, Temperatures (surfaces, gradients, comfort)
BUILDING TYPE: Occupied dwellings and class rooms.
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather (season - mainly outdoor temperatures)
PROJECT DETAILS To investigate the indoor thermal environment in two demonstration buildings remodelled with superinsulated windows (U-1.0 W/m2K) and new heating systems. Two types of thermal distribution systems are used: radiant floor heating and forced air heating.
STARTDATE: 01:12:1993
EXPECTED DATE OF TERMINATION: 30:09:1995
ESTIMATED NUMBER OF PERSON HOURS: 600 person-hours
SELECTED BIBLIOGRAPHY: planned Project report - end of project, Conference paper/article

REF SE13
TITLE OF PROJECT: Flexible ventilation systems
PRINCIPAL RESEARCHER: Anders Svensson
ORGANISATION: Stifab AB
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TELE: +46 0417 11600 FAX +46 0417 14183
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Heating and ventilation systems and strategies.
BUILDING TYPE: Dwellings, Commercial/Office
COMPONENT TYPE: DCV - systems
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS The purpose of the project is to develop products and systems suitable for simple demand controlled ventilation. The project includes:
* Development of a satisfactory pressure regulator
* Examples of how to design a system based on constant pressures in different branches of the system.
Specification of the demands:
General:
* Adjustable supply and extract air flows
* Guaranteed minimum air flows in different rooms.
* Guaranteed balance between supply and exhaust air flows.
* Easy balanced and commissioned
Specific demands for the constant pros. regulator:
* Working range: 1.5-8 m/s air velocity
* Constant pressure range: 0-20 Pa
* Constant pressure tolerances: less than / equal to 18%
* Time constant = less than /equal to 30 sec.
STARTDATE: 01:01:1988
EXPECTED TERMINATION DATE: 30:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 5000
SELECTED BIBLIOGRAPHY: (None Stated)

REF SE14
TITLE OF PROJECT: Design tool for optimising the selection of ventilation plants.
PRINCIPAL RESEARCHER: Gunnar Wernstedt
ORGANISATION: Stockholm Konsult
ADDRESS: BOX 8318, 104 20 Stockholm, Sweden
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E-Mail Address:

SPECIFIC OBJECTIVES: Energy Impact of ventilation, Life cycle cost evaluations of ventilation plants
BUILDING TYPE: Dwellings, Commercial/Office, Industrial/Factory
COMPONENT TYPE: Ventilation plants
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS:
The main goals for this design tool are:
* A powerful, but simple to use, technical and economic tool for selecting a ventilation plant.
* Guide and control the consultants in accordance with the owner's economic preferences.
* The long run extra cost, if one is forced not to follow the guidelines of the method is calculated in order to get the economic backgrounds for a decision.
* Creating a key-value for the cost of ventilation that can be understood by engineers and people with economic education.
The 3 most important parts of the selection of this design tool are:
1. The representative or equivalent parameters called "the equivalent working condition". This operating condition has the same electric energy consumption as the sum of all running condition of the selected ventilation plant will run at. VAV system is transformed to a CAV system running at a fixed air flow rate.
2. Selecting key-values are presented, for the pressure drop in the plant, fan efficiency and the efficiency of the heat recovery equipment and optional specific fan power, to guide the designer.
3. When selection is made the "specific total cost" of the selected plant is calculated and compared with optimal cost. This "Specific total cost" describes the cost for operation, maintenance and capital cost for the ventilation function.
* The kernel of this design tool (selection method) is "the database of performance and investment cost for manufactured ventilation plants", "The general economic evaluation key value stipulated by the owner " and "the equivalent conditions". This kernel make it possible to find the best set of performance key values similar to the ventilation plants that have the lowest life cycle cost in the database. The performance sets with the lowest life cycle cost in the database, modified to suite "the equivalent working condition"; are chosen to derive performance key values diagrams.
STARTDATE: 00:01:1990
EXPECTED TERMINATION DATE: 00:05:1994
ESTIMATED NUMBER OF PERSON HOURS: 1800
SELECTED BIBLIOGRAPHY: (None Stated)

REF SE15
TITLE OF PROJECT: Reliability of Domestic Ventilation - An evaluation tool.

PRINCIPAL RESEARCHER: Ake Blomsterberg (1) and Johnny Kronvall (2)
ORGANISATION:
(1) Swedish Testing and Research Institute.
(2) Technergo AB
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(2) Ideon Research Park, S-223 70 Lund, Sweden
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TELE (2) +46 46 1688 80
FAX (2) +46 46 16 88 81
E-Mail Address:
SPECIFIC OBJECTIVES: Heating and Ventilation systems and strategies
BUILDING TYPE: Dwellings
COMPONENT TYPE:
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Ventilation system, Airtightness, User behaviour
PROJECT DETAILS: This project is a part of the IEA ANNEX 27 work (evaluation and domestic ventilation systems) The objecvtive of the total annex-work is to develop an evalutaion tool for determining the optimum ventilation strategy for dwellings of different kinds, in different countries.
The objective of the Swedish Project is to:
1. Develop a method for evaluating the reliablity of different ventilation systems for dwellings of different kinds and in different climates.
2. To test and evaluate the methods by field measurements in houses and blocks of flats in Swedish Climate.
The main means of the project work are multi zone computer simulations and field ventilation measurements.
STARTDATE: 00:07:1994
EXPECTED TERMINATION DATE: 00:12:1996
ESTIMATED NUMBER OF PERSON HOURS: 3000
SELECTED BIBLIOGRAPHY:
1. Kronvall J, Ventilation Reliablity in a dussion paper, report to 3rd working meeting of IEA Annex 27, Feb. 1994, Technergo AB, Lund, Sweden.
2. Mansson L G et al Evaluation and demonstration of domestic ventilation systems, state of the art report. To be published late 1994

2.11 SWITZERLAND

REF CH01
TITLE OF PROJECT: Demonstration Project "HAVSACKER".

PRINCIPAL RESEARCHER: Peter Hartmann
ORGANISATION: (NONE STATED)
ADDRESS: Lindenstr 62, CH 8307 Effretikon, Switzerland.
TELE: +41 52 32 70 96 FAX: (NONE STATED)
E-mail Address:
SPECIFIC OBJECTIVES: * Check of function of a new type of controlled ventilation system.
* Indoor air movement.
* IAQ.
* Energy impact of ventilation.
* Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Dwellings, multifamily.
COMPONENT TYPE: (NONE STATED)
PARAMETERS TO WHICH INFILTRATION AND INDOOR AIR QUALITY WILL BE RELATED: 1 outdoor climate; system control parameters.
2 user influence
PROJECT DETAILS: This project is not an indepth research project, but a so called "success - control" of a demonstration project. Nevertheless the project "controls" a number of new design details as
1 high efficiency counterflow heat exchanger.
2 a relatively cheap typed of collector (earth/ground collector for incoming airtight plastic tubes)
3 a new concept of room air inlet (low velocity)
4 a well designed air transfer from room to room (acoustic provisions)
The unmeasured concept includes a number of experienced researchers for the different aspects of "control" as 1 Prof. H.V. Wanner (uses information and inquiry),
2 EMPA (V.Dorer) (IAQ; ventilation concept),
3 Technikun Winterthur (Prof. Juzij Couzett, Kriez), (Efficiency of head recovery; acoustics),
4 Peter Hartmann (energy ventilation system, overall reporting),
STARTDATE: 00:01:1995
EXPECTED TERMINATION DATE: 00:08:1996
ESTIMATED NUMBER OF PERSON HOURS: 1000
SELECTED BIBLIOGRAPHY: (NONE STATED)

REF CH02
TITLE OF PROJECT: Emissions from building materials
PRINCIPAL RESEARCHER: Gehrig,R
ORGANISATION: Swiss Federal Laboratories for Materials Testing and Research
ADDRESS: Ueberlandstr. 129, CH 8600 Dubendorf, Switzerland.
TELE: +411 823 5511 FAX: +411 821 6244
E-mail ADDRESS: (NONE STATED)
SPECIFIC OBJECTIVES: IAQ
BUILDING TYPE: Test chamber or test structure and strategies.
COMPONENT TYPE: Building materials.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Emissions from building materials, temperature.
PROJECT DETAILS: Scope of the project
1 Test chamber studies to characterize the emissions of VOC from building materials used in Switzerland.
2 Influence of temperature on emissions.
3 Relation between test chamber measurements and measurements in real rooms.
4 Relation between emissions from building materials and other indoor sources.
STARTDATE:00:00:1992
EXPECTED TERMINATION DATE: 00:00:1995
ESTIMATED NUMBER OF PERSON HOURS: 8000
SELECTED BIBLIOGRAPHY:
1. R. Gehrig, M. Hill, C.Zellweger and Pittofer. VOC-Emissions from Wall Paints - A Test Chamber Study Proceedings Indoor Air '93, Vol 2, p 431-436.

REF CH03
TITLE OF PROJECT: Joule II - Pascool (Swiss contribution)
PRINCIPAL RESEARCHERS J. Van der Maas, C.-A. Roulet
ORGANISATION: Solar Energy and Building Physics Research Laboratory Swiss Federal Institute of Technology
ADDRESS: LESO-PB, EPFL, CH 1015 Lausanne, Switzerland
TELE: +41 21 693 45 57 FAX: +41 21 693 27 22
E-mail ADDRESS: roulet@eldp.epfl.ch
SPECIFIC OBJECTIVES: Energy impact of ventilation HV systems and strategies
Other passive ventilation cooling
BUILDING TYPE: Occupied, Dwellings, Commercial/office
COMPONENT TYPE: (NONE STATED)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Heat transfer from air to structure and back.
PROJECT DETAILS: The intention is to promote passive cooling in Mediterranean countries, in order to save energy (mainly electricity). The projects results will however also be useful for temperate climates in summer. To reach that scope, various building models are evaluated, using measurements on real buildings. Planning tools, using these models, are under development. One of these tools will allow one to size the openings and/or the fans required to eliminate a given amount of energy.
STARTDATE: 01:09:1992
EXPECTED TERMINATION DATE: 31:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 8000 (for CH only)
SELECTED BIBLIOGRAPHY Project Reports will be issued by CEC

REF CH04
TITLE OF PROJECT: Joule II - Indoor Air Quality Audit (Swiss contribution)
PRINCIPAL RESEARCHER: Roulet Claude-Alain

ORGANISATION: Solar Energy and Building Physics Research Laboratory, Swiss Federal Institute of Technology
ADDRESS: LESO-PB, EPFL, CH 1015 Lausanne, Switzerland.
TELE: +41 21 693 45 57 FAX: +41 21 693 27 22
E-mail Address: roulet@eldp.epfl.ch
SPECIFIC OBJECTIVES: IAQ
Energy impact of ventilation
HV systems and strategies
Other sources of contaminants
BUILDING TYPE: Occupied, Commercial/office
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED:
Perceived air quality, opinion of occupants, comfort conditions
PROJECT DETAILS: The research project was initiated by the Commission of European Communities. Its general objective is to improve the knowledge on indoor air quality in relationship with energy consumption in large office buildings. Seven countries of the European Community and three EFTA countries participate to this project. To gain knowledge, it is planned to investigate 6 buildings in each country, that is a total of about 54 buildings in Europe. The audited buildings are in any case not selected because they have problems. The following results are expected from that research project
1. A common European method to investigate indoor air quality in office buildings ;
2. A database containing measurement results and statistical interpretation, and which will present an image of the present state of indoor air quality and comfort conditions in office buildings; 3. Guidance for planning and maintenance of ventilation systems and buildings, for obtaining an efficient ventilation and a good control of contaminant sources. The audit will concern the building itself and its technical equipment, in particular its ventilation system, the option of the occupants on the comfort and health condition, the thermal comfort, the lighting and noise level in some office rooms. The indoor air quality will be examined as well for its olfactive or sensory aspect as for its chemical composition. All this audit will be performed in less than a day, in order to obtain synchronous information all concerning the same working conditions, without perturbing too much the work in the visited firm.
STARTDATE: 01:11:1993
EXPECTED TERMINATION DATE: 31:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 4000
SELECTED BIBLIOGRAPHY:
1. Clausen, Pjetersen, Bluyssen (ed) Research manual of European Audit Project to Optimise IAQ and Energy Consumption in Office Buildings. Draft for internal use, not yet published.

REF CH05
TITLE OF PROJECT: IEA-ECB Annex 23 Multizone Airflow Modelling (Swiss contribution)
PRINCIPAL RESEARCHER: Roulet Claude-Alain
ORGANISATION: Solar Energy and Building Physics Research Laboratory
Swiss Federal Institute of Technology
ADDRESS: LESO-PB, EPFL, CH 1015, Lausanne, Switzerland
TELE: +41 21 693 45 57
FAX: +41 21 693 27 22
E-mail Address: roulet@eldp.epfl.ch
SPECIFIC OBJECTIVES: Indoor Air movement, IAQ
BUILDING TYPE: Occupied and unoccupied, Dwellings, Industry/(factory, Commercial/office, Test chamber or structure, COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Meteorological conditions and building parameters
PROJECT DETAILS: The result of Annex 23 will be a reliable, practical and user-friendly code for Multizone Air Flow modelling. The project is organised in two tasks program development and program evaluation. Swiss contribution to program development include addition of new modules, such as models of large openings and of occupant behaviour; and improvement of the man-code interface for input and output. The goals of the evaluation task are to ensure that the program performs as it should, to determine its domain of application and, by a feedback effect, to improve its performances. The evaluation procedure is divided into the following tasks or steps The Module Evaluation will control that each module of the code fulfils the requirements. The Sensitivity Study gives the possible error on the result when there are realistic errors on the input data. Comparison with experiments knowing the accuracy of the experimental data gathered for evaluation and the propagation of errors through the computer code, the results of the calculation based on measured input data can effectively be compared with the measured output data. Performance of program / User feedback Important limits of the application domain come from the interaction between the user and the code. In order to evaluate these limits and to enlarge the application domain by improving the user-friendliness, the program was distributed to interested users, together with a test case. The users treat the case with the program and note the problems encountered together with comments on the user-friendliness. These comments were collected together with the input files and the results obtained by the users. This information will be used to improve the man-code interface.
STARTDATE: 01:03:1992
EXPECTED TERMINATION DATE: 31:12:1995
ESTIMATED NUMBER OF PERSON HOURS: 10000

SELECTED BIBLIOGRAPHY:
1. H. Feustel et al COMIS Users Guide, draft available by the AIVC.
2. H. Feustel et al Fundamentals of COMIS, AIVC TN 29. J.-M. Furbringer Evaluation Procedures Using Sensitivity Analysis of Model and Measurements. International Symposium on Air Flow in Multizone Structures, Budapest, Sept. 9, 1992.
3. Roulet, C.-A.; Furbringer, J.-M. IEA-ECB Annex 23, Sub task 3 The Evaluation of a Multizone Infiltration Computer Code. International Symposium on Air Flow in Multizone Structures, Budapest, 1992.

REF CH06
TITLE OF PROJECT: Air flow occurring by hangar door openings
PRINCIPAL RESEARCHER: Claude-Alain Roulet
ORGANISATION: Solar Energy and Building Physics Research Laboratory
Swiss Federal Institute of Technology
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TELE: +41 21 693 45 57
FAX: +41 21 693 27 22
E-mail Address: roulet@eldp.epfl.ch
SPECIFIC OBJECTIVES: Indoor Air movement, Air tightness of buildings, Energy impact of ventilation, Other comfort problems and drafts
BUILDING TYPE: Occupied
Other hangars (e.g. airplane hangars)
COMPONENT TYPE: Doors
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Drafts, comfort of occupants, energy use.
PROJECT DETAILS: In winter, a gravity-driven cold air wave runs into large hangars when the door is open. This destroys the comfort conditions of people working in this hangar (e.g. for maintenance). The scope of the preliminary project is to examine the feasibility of various systems avoiding this wave while letting large objects (planes, trucks) enter the hangar.
STARTDATE: 01:05:1993
EXPECTED TERMINATION DATE: 31:05:1994
ESTIMATED NUMBER OF PERSON HOURS: 1000
SELECTED BIBLIOGRAPHY (NONE STATED)

REF CH07
TITLE OF PROJECT: Thermally induced ventilation - experiments, simulation and design insights.
PRINCIPAL RESEARCHER: Charles H Filleux
ORGANISATION: Basler and Hofmann, Consulting Engineers
ADDRESS: Forchstrasse 395, CH-8029 ZURICH. Switzerland
TELE: +41-1-387 11 22 FAX: +41-1-387 1101
E-mail ADDRESS:
SPECIFIC OBJECTIVES: Energy impact of ventilation, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Commercial/office, Test chamber or test structure,
COMPONENT TYPE: Mechanical ventilation.
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (See Project Details)
PROJECT DETAILS: The following design parameters for thermally induced ventilation in office buildings have been investigated at the Sulzer Infra test site in Winterthur room height, air flow rate, internal load intensities and the fraction of convective heat transfer from the internal loads. The parameters have been varied over a wide range and their influence on air flow patterns, thermal comfort and air quality dosing criteria were carefully analyzed. Systems' choice did also include cooling ceilings. A polynom representation of the room air temperature gradient between 1.1 m and 0.1 m as a function of air flow rate and internal load could be obtained from data reduction. In a similar way the warming up of the room air at 0.1 m above the floor has been deduced. Using this model and by linearization of the equation a nomogram for designers has been developed. The nomogram also applies for thermally induced ventilation combined with cooled ceilings, although the effect of the cooled ceiling on the warming up of the room air near the floor could not be taken into account in a satisfactory way. The design guide is published in German and is one of the major outputs from the Swiss research program on energy efficiency of ventilation systems.
STARTDATE: 00:01:1992
EXPECTED TERMINATION DATE: 00:03:1994
ESTIMATED NUMBER OF PERSON HOURS: 2000
SELECTED BIBLIOGRAPHY: 1. Zeitgemasse Luftungssysteme - Aktuelles Wissen und Leitfaden, St. Krummenacher, Ch. Filleux, D Aiulfi und P Chuard, 1994.
Distributed by VSHL, Olgastrasse 6, Postfach 73, CH8024 Zurich.

REF CH08
TITLE OF PROJECT: Annex 23 - Multizone air flow modelling, (subtask 3: Sensitivity analysis of COMIS).
PRINCIPAL RESEARCHER: Frbringer Jean Marie, Claude Alain Roulet
ORGANISATION: Laboratoire d'energie solaire et de Physique du batiment,
ADDRESS: LESO - EPFL, CH-1015 Lausanne, Switzerland,
TELE: + 41-21-693 45 45 FAX: +41-21 693 27 22
E-mail Address: Furbringer@eldp.epfl.ch
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Airtightness/Air leakage of buildings, validation and sensitivity analysis of air flow model

BUILDING TYPE: Occupied, Commercial/Office
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Confidence interval of input and output parameters
PROJECT DETAILS: Analysis of error transmission from input to output parameters. This is dine using factorial design and monte-carlo method fro estimating confidence interval. A suitable procedure for comparing measured and simulated data has also been developed. The aim is the sensitivity analysis of COMIS an air flow multizone nodel model.
STARTDATE: 00:00:1992
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 5000
SELECTED BIBLIOGRAPHY:
1. Furbringer J -M and Borchiellini R (1993), Technique of sensitivity analysis applied to an air infiltration multi-zone model, ASHRAE trans of Denver Conf, June 1993.
2. Dorer V, et al (1992), Evaluation of COMERL with the LESO data set. Final report to BEW, project ERL B4, EMPA, Dubendorf, CH dec 1992.
3. Furbringer J -M , Dorer V (1993), Air flow simulation of the LESO building including comparison with measurements and sensitivity analysis. Proc Indoor Air '93, Finland, 1993.
4. Furbringer J -M (1994), Sensibite de modeles et de mesures en aeraulique de batiment a l'aide de plans d'exeriences. These No 1217, EPFL, Lausanne, 1994.

REF CH09
TITLE OF PROJECT: Energy efficient ventilation of large enclosures, IEA - BCS Annex 26
PRINCIPAL RESEARCHER: Alfred Moser (Operating Agent)
ORGANISATION: Energy Systems Lab, ETH
ADDRESS: Energietechnik les, ETH-Zentrum ML, CH-8092, Zurich, Switzerland
TELE: +41-1-63 23 641 FAX: +41-1-261 42 51
E-mail Address: Alfred.Moser@IET.ETHZ.CH
SPECIFIC OBJECTIVES: Energy optimised ventilation of large spaces, Indoor air movement, IAQ, Energy impact of ventilation, Heating and ventilation systems and strategies, Applied to large enclosures.
BUILDING TYPE: Occupied, Dwellings, Commercial / Office, Industrial/factory, Atria, auditoria, stadia, ice rinks
COMPONENT TYPE: Glazings
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Energy consumption by ventilation, thermal comfort, draught risk
PROJECT DETAILS: Three - year project with 12 countries.
Subtask 1: Measurement techniques and case studies.
Subtask 2: Models
Products:
(1) Measurement and modelling techniques.
(2) Guidelines for designer
(3) Case studies of IEA Annex 26
Parameters and performance of various ventilation concepts in existing case study buildings are measured, occupant surveyed.
The air flow, temperature distribution , and thermal performance of the buildings are compared with numerical simulation and scale model tests.
Results are interpreted, conclusions drawn and guidelines formulated.
STARTDATE: 01:04:1993
EXPECTED TERMINATION DATE: 31:03:1996
ESTIMATED NUMBER OF PERSON HOURS: 432 person months plus
SELECTED BIBLIOGRAPHY: (None Stated)

REF CH10
TITLE OF PROJECT: Lite sheet velocimeter (Eureka project EU 921)
PRINCIPAL RESEARCHER: Alfred Moser
ORGANISATION: Energy Systems Lab, ETH
ADDRESS: Energietechnik les, ETH-Zentrum ML, CH-8092, Zurich, Switzerland
TELE: +41-1-63 23 641 FAX: +41-1-261 42 51
E-mail Address: Alfred.Moser@IET.ETHZ.CH
SPECIFIC OBJECTIVES: Measurement of velocity field in room, Indoor air movement, Quantitative flow visualisation,
BUILDING TYPE: (Not a specific Building type)
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Instantaneous air velocity in plane section (light sheet)
PROJECT DETAILS: Partners in international collaboration are:
* RWTH AACHEN, GERMANY, Principal Investigator: Prof U. Renz
* KTH STOCKHOLM, SWEDEN, Principal Investigator: Prof M Sandberg
Objective: An instrument, together with measurement procedures is developed fro the diagnostic flow visulatisation and quantitative determination of the instantaneous velocity field in a ventilated room of different types of buildings. Laser - illuminated tracer exposure (LITE) is applied.
This is a PIV Method extended to large sections (eg 2m*2m)
Measurement principle:
* Tracer, such as Soap bubbles, are released into air.
* A light sheet is generated to illuminate tracers within a slab of air space.
* Photographic pictures (digital orin film are analysed by image processing
* velocity vectors are computed.

STARTDATE: 01:01:1993
EXPECTED TERMINATION DATE: 31:12:1995
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF CH11
TITLE OF PROJECT: Multizone Air Flow model COMERL
PRINCIPAL RESEARCHER: Viktor Dorer
ORGANISATION: EMPA
ADDRESS: 175 Building Equipment, CH-8600 Duebendorf, Switzerland
TEL: +41-1-823 55 11 FAX: +41-1 821 62 44
E-Mail Address: dorer@empa.ch
SPECIFIC OBJECTIVES To develop a multizone air flow and contaminant transport model in the and to build up and integrate the respective data base for input data.
Indoor Air Movement
BUILDING TYPE:
Naturally and combined naturally and mechanically ventilated buildings
COMPONENT TYPE:
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: With this computer program air flows and pollutant concentrations can be calculated, together with parameters derived from these basic results, such as multizone ventilation efficiencies, occupant exposures, ventilation losses.
PROJECT DETAILS: The project is a part of the national research program ERL 'Energy relevant air flows in buildings'. The programme development and evaluation work has been conducted in the frame of the COMIS workshop and the IEA-ECB Annex 23 'Multizone Air Flow Modelling'.
For the simulation code COMVEN, a PC based shell program, named COMERL, has been developed.
The project is funded by the NEFF (National energy research fund) and the BEW (Swiss federal department of energy)
STARTDATE: 00:00:1989
EXPECTED TERMINATION DATE: 00:07:1994
SELECTED BIBLIOGRAPHY:
1. COMERL Rechenprogramm zur Bestimmung des Luft- und Verunreinigungstransportes in mehrzonigen Gebaeuden , Handbuch (in German), EMPA Duebendorf 1994
2. COMIS User Guide, Lawrence Berkeley Laboratory , USA

REF CH12
TITLE OF PROJECT: Integration of Building Simulation Computer Programs for Energy, Air Transport and Daylighting
PRINCIPAL RESEARCHER: Viktor Dorer, Gerhard Zweifel
ORGANISATION: EMPA
ADDRESS: 175 CH-8600, Duebendorf, Switzerland
TELE: +41-1-823 55 11 FAX: +41-1 821 62 44
E-Mail Address: dorer@empa.ch, zweifel@empa.ch
SPECIFIC OBJECTIVES: To further develop and to integrate existing building computer simulation models for energy, air transport and daylighting in order to provide to the planner and practitioner better tools for the evaluation of buildings in regard to energy and comfort.
BUILDING TYPE All No restrictions
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: The codes consider all relevant parameters in regard to energy and comfort.
PROJECT DETAILS: For the integral planning of buildings, tools are necessary which combine the existing programmes for
* building energy simulation
* building systems simulation
* daylighting
* air and contaminant transport in buildings
The project is split into several tasks, some of which still have to be defined in more detail. Work items are among others:
* To develop better interfaces between the daylighting programs, building energy and building systems programs
* To develop DOE-2 for surface temperature output which is necessary for thermal comfort evaluations
* To implement a multizone air and contaminant transport module in both DOE-2 and TRNSYS
* To link DOE-2 and SUPERLITE by integrating DOE- 2 into ADELINE.
STARTDATE: 00:07:1994
EXPECTED TERMINATION DATE: 00:10:1996
ESTIMATED NUMBER OF PERSON HOURS: approx. 4800
SELECTED BIBLIOGRAPHY: (None Stated)

REF CH13
TITLE OF PROJECT: Electrical energy savings in mechanical ventilation systems by adiabatic cooling
PRINCIPAL RESEARCHER:
1. HP Kruettli
2. Gerhard Zweifel
ORGANISATION:
1. Air Comfort AG
2. EMPA
ADDRESS:
1. P.O. Box 1219, CH-8401 Winterthur, Switzerland
2. EMPA 175, CH-8600 Duebendorf, Switzerland
TELE 1. +41 52 213 95 20 FAX: 1.
TELE 2. +41-1-823 55 11
FAX: 2. +41-1-821 62 44
EMAIL: 2. zweifel@empa.ch

SPECIFIC OBJECTIVES: Energy impact, heating and ventilation systems and strategies
BUILDING TYPE: Commercial/office
COMPONENT TYPE: Ventilation, evaporative cooling
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: This project aims to provide the basics for the preparation of guidelines on the design and the operation of adiabatic cooling systems. In the first part of the project simulation with an extended version of DOE-2 are made. Several different ventilation systems, evaporators and heat recovery units are studied together with several respective control strategies. In the second phase, long term measurements in an office building of a Swiss bank are made.
STARTDATE: 00:05:1993
EXPECTED TERMINATION DATE: 00:12:1994
SELECTED BIBLIOGRAPHY: (None Stated)

REF CH14
TITLE OF PROJECT: Optimal operation of radiant cooling ceilings in combination with displacement ventilation
PRINCIPAL RESEARCHER:
1. B. Gasser
2. Markus Koschenz
ORGANISATION:
1. Sulzer Infra AG (Schweiz)
2. EMPA
1. SIL, Postfach, 8400- Winterthur, Switzerland
2.EMPA 175, CH-8600 Duebendorf, Switzerland
TELE: +41-1-823 55 11 FAX: +41-1-821 62 44
E-Mail Address:
SPECIFIC OBJECTIVES: Ventilation and cooling, Energy consumption, thermal comfort, IAQ, control
BUILDING TYPE: Commercial/office
COMPONENT TYPE: Displacement ventilation, evaporators, heat recovery units
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Extensive simulation are made with a specifically developed model for the building systems simulation code TRNSYS. The results are compared with results from specific measurements in laboratory test cell as well as in a real building.
STARTDATE: 00:07:1992
EXPECTED TERMINATION DATE: 00:12:1994
SELECTED BIBLIOGRAPHY:
1. M. Koschenz: Simulation of displacement ventilation and radiative cooling, 14th AIVC Conference, Copenhagen, 1993

REF CH15
TITLE OF PROJECT: Water evaporation of 5 common indoor plants under various climate conditions.
PRINCIPAL RESEARCHER: Beat Strickler
ORGANISATION: ETH
ADDRESS: Swiss Federal Inst.of Tech., Group of Building Services, PO BOX 49, CH 8093, Zurich, Switzerland
TELE: +41 1 633 36 18 FAX: +41 1 371 03 20
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Moisture mould generation and prevalence
BUILDING TYPE: Unoccupied, Test chamber and test structure
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Air temperature, humidity and illumination.
PROJECT DETAILS In recent years plants have increasingly become an intregral part of the interior design of buildings. Greened office space and large enclosures can provide a better human environment not only because of psychological reasons. Due to photosynthesis, plants interact with the "aerial" environment. Water evaporation effects room air humidity and temperature. Water uptake rates of five common plants as are "False aralie", "Warneckeii dracaena", "Ficus", English Ivy" and "Philodendron"under various climate conditions have been studied. During the measuring campaign, air temperature, humidity and illumination were varied in order to obtain results for common thermal indoor conditions. Water evaporation of these plants can now be predicted in design studies. Simulation of a typical office room in summer and winter show that intensive planting can highly increase air humidity. As a conclusion, this extra humidity should be removed by natural ventilation in summer while in winter it helps enhancing room air comfort. The study shows also that the effect of indoor plant's water evaporation on air temperature is very low.
STARTDATE: 00:03:1993
EXPECTED TERMINATION DATE: 00:09:1993
ESTIMATED NUMBER OF PERSON HOURS: 400
SELECTED BIBLIOGRAPHY:
1. Pflanreu in Buroaumen:Messuug des Wasservunstunug ron 5 typisdeen Zimmerpttanren uuter veschiedenen Raumklimata, B, Strickler, ETHZ, 4 January 1994.
2. Strickler B (1994), Water evaporation of 5 common indoor plants under various climate conditions. 14th AIVC Conference. 27-30 September 1994

REF CH16
TITLE OF PROJECT: Air flows in large enclosures (IEA-ECB&C Annex 26)
PRINCIPAL RESEARCHER: C.-A. Roulet
ORGANISATION: Solar Energy and Building Physics Research Laboratory, Swiss Federal Institute of Technology
ADDRESS: LESO-PB, EPFL, CH 1015 Lausanne, Switzerland.
TELE: +41 21 693 45 57 FAX: +41 21 693 27 22

E-Mail Address: roulet@eldp.epfl.ch
SPECIFIC OBJECTIVES: Indoor Air movement, IAQ, Energy impact of ventilation,
BUILDING TYPE: Occupied, Industry/(factory), Commercial/office
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: Ventilation strategy, energy consumption, climatic conditions, contaminant sources, envelope tightness
PROJECT DETAILS: Within the frame of IEA-ECB&C Annex 26, the LESO will contribute to four tasks:
1. Develop pressurisation technique for large enclosures
2. Develop tracer gas techniques for large enclosures
3. Use these techniques in Swiss large enclosures
4. Apply a simple aerothermal model to large enclosures in order to predict time evolution of temperature.
STARTDATE: 00:04:1992
EXPECTED TERMINATION DATE: 00:04:1996
ESTIMATED NUMBER OF PERSON HOURS: 3000 at LESO
SELECTED BIBLIOGRAPHY:
1. Roulet,C.-A.,van der Maas,J.: Measurement of Air Flow Patterns and Temperatures on a 60000 m Industrial Hall. Roomvent '94, Krakow, Poland June 15-17, 1994

2.12 UNITED KINGDOM

REF UK01
TITLE OF PROJECT: Indoor Air Quality in Public Houses.
PRINCIPAL RESEARCHER: John I Currie and Graham Capper.
ORGANISATION: Building Performance Centre
ADDRESS: 18 Blantyre Terrace, Edinburgh, EH10 5AE. Scotland, United Kingdom
TELE: +44 (0)131 455 2320
FAX: +44 (0) 131 447 9900
E-Mail Address: BU07@CSU.napier.ac.UK
SPECIFIC OBJECTIVES: IAQ, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Commercial/office.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Behaviour of occupants, pollution source, primarily passive smoking.
PROJECT DETAILS: Environmental assessment of public houses.
STARTDATE: 00:05:1993
EXPECTED TERMINATION DATE: 00:04:1996
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. "Environmental Assessments in Public Houses", Capper Graham, and Currie John I, Interim Report, Building Performance Centre, Napier University, Edinburgh, September 1993.
2. "The performance of intelligent public houses" Capper G, and Currie J I, to be presented at 1st International Congress on Intelligent Buildings, Tel Aviv, February 1995.

REF UK02
TITLE OF PROJECT: Energy and Air Tightness in Masonry Dwellings.
PRINCIPAL RESEARCHER: Robert Lowe
ORGANISATION: Leeds Metropolitan University, School of the Environment
ADDRESS: Brunswick Building, Leeds, LS2 8BU, United Kingdom
TELE: +44 (0) 1132 832600
FAX: +44 (0) 1132 833190
E-Mail Address:
SPECIFIC OBJECTIVES: Energy impact of ventilation, Airtightness/air leakage.
BUILDING TYPE: Dwellings, Test chamber or test structure.
COMPONENT TYPE: Windows, Walls, Floors.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Primary Aims To investigate the factors that affect air-tightness and energy consumption in masonry superinsulated buildings, through a programme of laboratory and field work, involving pressurisation testing of building elements and whole buildings.
Relationship to other work The project is related to on-going work on Energy and Environmental Performance of Mechanical Ventilation Heat Recovery Systems, and to York Energy Demonstration Project.
Laboratory measurements involve test pieces approx 2m x 2m. Test pieces are pressurized using plywood plenum. Air flow is measured using Furness Controls laminar flow sensor and micromanometer.Work on full scale buildings involved fan-pressurisation using a Minneapolis blower door.
STARTDATE: 01:04:1988
EXPECTED TERMINATION DATE: Approx 01:04:1994
ESTIMATED NUMBER OF PERSON HOURS: approx 4500
SELECTED BIBLIOGRAPHY:
1. Lowe R J, Curwell S R, Bell M, & Ahmad A. Laboratory and Field Experience with Air Tightness in Masonry Dwellings. paper presented to the BRE Workshop on Airtightness in Dwellings, Garston, 26th October 1993.

REF UK03

TITLE OF PROJECT: Air Infiltration in Dwellings
PRINCIPAL RESEARCHER: Paul Bell, Tracy Panioty
ORGANISATION: Wimpey Environmental
ADDRESS: Beaconsfield Road, Hayes, Middlesex. UB4 0LS. United Kingdom
TELE: +44 (0) 181 573 7744 FAX: +44 (0) 181 848 1554
E-Mail Address:
SPECIFIC OBJECTIVES: Airtightness/air leakage of buildings.
BUILDING TYPE: Unoccupied, Test chamber or test structure.
COMPONENT TYPE: Not interested in the values of the components themselves but in the effects of fitting them and unnatural leakage paths. Windows, Doors, Walls, Floors, Cracks, Services.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: We are as you must appreciate, in the very early stages of this research project. But our main objectives are
1. To review current building practise, detailing and construction methods and identify critical areas of air leakage.
2. To design/suggest possible design alternatives.
3. To test both stages, assess improvements.
4. Test practicability in general building.
5. Produce reports and design guides for use by architects, designers and builders.
We will be using a test rig, built in Controlled Conditions to normal building regulations under supervision form us. It will be built as a masonry structure. Including all service entries and exits, windows, roof, 1st floor.
At this time, we are only considering pressurisation but this may change during the course of the experiments.
We have reviewed the information from the database and done additional calculations to prioritize leakage areas but our main research and developments will hopefully come from the experimental data produced from the tasks.
STARTDATE: 00:01:1994
EXPECTED TERMINATION DATE: 00:01:1996
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. NHBC good practice guide, Thermal Insulation and ventilation Energy Efficiency office Nov 1991.
2. Component Leakage values and their Relationship to Air Infiltration by Donald L Carr and Peter A Kayes (provided by AIVC)
3. Cataloging Air Leakage Components in Houses D T Harrje and G J Born. Princetown University. Center for energy and Environmental Studies.
4. Wimpey Environmentals own work on component testing.
But obviously we are still researching the project so this list is not final.

REF UK04
TITLE OF PROJECT: Development of a System to Measure the Airtightness of Buildings at Low Pressure Differences.
PRINCIPAL RESEARCHER: J Dewsbury
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E-Mail Address:
SPECIFIC OBJECTIVES: Airtightness/leakage of buildings.
BUILDING TYPE: ALL.
COMPONENT TYPE: ALL.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: The purpose of the project is to construct an apparatus to measure the airtightness of a building using AC pressurisation, to calibrate the method and apparatus using artificial leaks and other elements connected to a very stiff and airtight chamber, and to use the calibrated method to measure the airtightness of some buildings. Results from the laboratory and field trials will be compared with results from fan pressurisations.
STARTDATE: 01:06:1987
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: 10 000 +
SELECTED BIBLIOGRAPHY:
1. R M AlKhaddar, J Dewsbury, R Orlowski (Univ of Salford) (1990) The design and testing of a calibration chamber used in the development of A C pressurisation apparatus. AIVC, march 1990.
2. J Dewsbury, R M AlKhaddar, R J Orlowski (1990) AC pressurisation calibration. CIB W-67 symposium on Energy, moisture and climate in buildings, Rotterdam, Netherlands,September.
3. J Dewsbury (1992) Theories of AC pressurisation. CIB W-67, Manchester.
4. J Dewsbury, R M AlKhaddar, R J Orlowski (1992) A calibration chamber for the A C pressurisation method of measuring building airtightness. CIB W-17, Utrecht, Netherlands, February.

REF UK05
TITLE OF PROJECT: Investigation of the Application of Computational Fluid Dynamics Methodology to Air Flow in Buildings.
PRINCIPAL RESEARCHER: Fan Li
ORGANISATION: University of Westminster
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FAX: +44 (0) 171 580 4319
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement. Heating and ventilation systems and strategies.
BUILDING TYPE: Unoccupied, Commercial/office.
COMPONENT TYPE: Windows, Doors, Walls,
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Doors; weather; air vents; ventilation systems.
PROJECT DETAILS: To perform numerical experiments for air flow in a modern commercial office-type building using CFD codes, primarily FLOW 3D.
Comparisons with experimented date and predictions of other CFD codes will be made where appropriate. It is hoped to synthesize the results into a criteria list for use during building design phases.
Project is funded by a scholarship from Quintin Hogg Trust.
STARTDATE: 00:01:1992
EXPECTED TERMINATION DATE: 00:01:1995
ESTIMATED NUMBER OF PERSON HOURS: 9000
SELECTED BIBLIOGRAPHY:
1. H V Awbi, Application of Computational Fluid Dynamics in Room Ventilation, Building and Environment, Vol. 24, No 1, 73-84, 1989.
2. M W Liddament, A Review of Building Air Flow Simulation, AIC-TN-33-1991.

REF UK06
TITLE OF PROJECT: General Data Gathering For A Major Research Project on Industrial Ventilation
PRINCIPAL RESEARCHER: Eric F Curo
ORGANISATION: Liverpool John Moores University
ADDRESS: School of the Built Environment, Clarence Street, Liverpool. L3 5UG. United Kingdom
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FAX: +44 (0) 151 709 4957
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy impact of ventilation, Heating and ventilation systems and strategies, The above related to Industrial Ventilation.
BUILDING TYPE: Industrial/factory.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Research in to effectiveness of industrial ventilation systems. UK expert on CEN 156 WG.1.
Projects with
CHINA University of Beijing.
JAPAN Muroran Institute of Technology Hokkaido.
ESTONIA Tallinn Technical University.
FINLAND Consulting Engineers & Research Laboratory.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: ISO work/CEN work/BS work

REF UK07
TITLE OF PROJECT: Night Cooling - Design and Control.
PRINCIPAL RESEARCHER: Maria Kolokotroni and Earle Perera.
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FAX: +44 (0) 1923 664010
E-Mail Address: Kolokotronim@uk.co.bre
SPECIFIC OBJECTIVES: Indoor air movements, Energy impact of ventilation. Heating and ventilation systems and strategies.
BUILDING TYPE: Simulated occupancy, Commercial/office.
COMPONENT TYPE: Windows, Doors, Walls, Floors.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Energy demand to avoid overheating, nightime ventilation, thermal comfort.
PROJECT DETAILS: The aim of this project is to investigate the design and control of night cooling as a means to minimise or avoid the use of air conditioning in the UK. to achieve this, the objectives are to:
a) develop a simple calculation method to estimate night cooling requirements for a given internal architecture and heat gains.
b) link the above to a quantified review of night cooling options to ensure that, for a given cooling requirements, the solution with the minimum CO2 overhead is selected.
STARTDATE: 00:04:1993
EXPECTED TERMINATION DATE: 00:04:1995
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK08
TITLE OF PROJECT: Passive Smoking in Homes.
PRINCIPAL RESEARCHER: Maria Kolokotroni and Earle Perera.
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E-Mail Address: Kolokotronim @ uk.co.bre
SPECIFIC OBJECTIVES: IAQ.
BUILDING TYPE: Simulated occupancy, Dwellings.
COMPONENT TYPE: Windows, Doors.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: ETS in homes.
PROJECT DETAILS: The airflow and pollutant prediction model BREEZE is used to determine the movement of tobacco smoke from living rooms to bedrooms (especially those of children) with a view to evaluating the effectiveness of various natural ventilation strategies to minimize contamination in the bedrooms.
Three types of dwellings have been analysed for a range of ventilation strategies over a typical range of wind speeds, temperatures and wind directions.
STARTDATE: 00:04:1993
EXPECTED TERMINATION DATE: 00:04:1994
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: BREEZE 6.0, User manual, BRE, 1993

REF UK09
TITLE OF PROJECT: Trickle Ventilators in Naturally Ventilated Non-Domestic Buildings.
PRINCIPAL RESEARCHER: Earle Perera and Maria Kolokotroni.
ORGANISATION: Building Research Establishment
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FAX: +44 (0) 1923 664010
E-Mail Address: Kolokotronim@uk.co.bre
SPECIFIC OBJECTIVES: IAQ, Energy impact of ventilation.
BUILDING TYPE: Occupied, Simulated occupancy, Commercial/office.
COMPONENT TYPE: Windows.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Trickle ventilators, energy consumption, airtightness,CO2 concentrations.
PROJECT DETAILS: Field measurements will be carried out to assess the effectiveness of trickle ventilators to provide adequate and controlled background ventilation in office buildings.
The first stage of the project involves measurements of temperature, CO2 concentrations, internal air velocity and air change rates in an instrumented office room with simulated occupancy to study the effect of various arrangements of trickle ventilators. Measurements in an identical control office room (but without the trickle ventilators) will be also performed to compare the environments.
In the second stage, measurements in occupied offices will be made which will examine additionally the effect of occupant behaviour on the ventilation demands.
STARTDATE: 00:04:1993
EXPECTED TERMINATION DATE: 00:04:1995
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. MDAES PERERA, S G MARSHALL and E W SOLOMON, "Controlled background ventilation for large commercial buildings" Building Serv. Eng. Res Technol. 14(3) 81-86 (1993)

REF UK10
TITLE OF PROJECT: Further Development of a CFD Program for Air Flow Simulation in Buildings.
PRINCIPAL RESEARCHER: H B Awbi
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FAX: +44 (0) 1734 313856
E-Mail Address: kcsawbi@reading.ac.uk
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy impact of ventilation, Heating and ventilation systems and strategies.
BUILDING TYPE: Commercial/office, Industrial/factory.
COMPONENT TYPE:
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Indoor Pollution Sources.
PROJECT DETAILS: This project is a continuation of the development of the CFD program VORTEX for predicting room air movement, thermal comfort indices (PMV and PPD), ventilation effectiveness, contaminant diffusion, age of air, etc... for naturally and mechanically ventilated enclosures. Validation is also undertaken using experimental data.
STARTDATE: 00:00:1986
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: 10,000+
SELECTED BIBLIOGRAPHY:
1. Awbi H B and Gan G, computational fluid dynamics in ventilation, Proc of CFD for Environmental and Building Services Engineer, I Mech E, London, pp 67-79, 1992.
2. Gan G, Croome D J and Awbi H B, Numerical Prediction of Contaminant distribution in ventilated rooms, Proc. Ventilation '91, Cincinnati, USA, pp 359-366, 1993.
3. Gan G, Awbi H B and Croome D J, CFD Simulation of the indoor environment for ventilation design, ASME 1993 inter Meeting, Transport Phenomena in Indoor Environments, New Orleans, USA.
4. Gan G and Awbi H B, Numerical Simulations of the indoor environment, Building and Environment, 1994 (to be published)

5. Awbi H B, and Gan G, Predicting air flow and thermal comfort in offices, ASHRAE Journal, February 1994.

REF UK11
TITLE OF PROJECT: Comfort and IAQ Assessment of Naturally Ventilated Buildings.
PRINCIPAL RESEARCHER: H B Awbi
ORGANISATION: University of Reading
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FAX: +44 (0) 1734 313856
E-Mail Address: kcsawbi@reading.ac.uk
SPECIFIC OBJECTIVES: Indoor air movements, IAQ, Energy impact of ventilation.
BUILDING TYPE: Simulated occupancy, Unoccupied, Commercial/office, Industrial/factory.
COMPONENT TYPE:
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Wind and outdoor temperature. Indoor pollution sources.
PROJECT DETAILS: The aim is to provide guidelines for designing natural ventilation openings. Analytical and numerical (CFD) methods are used to optimize the size and position of ventilation openings. The application is for summer cooling and winter outdoor air supply. The thermal comfort and air quality indoors are used as criteria for evaluating the performance of natural ventilation systems.
STARTDATE: 00:00:1992
EXPECTED TERMINATION DATE: 00:00:1995
ESTIMATED NUMBER OF PERSON HOURS: 2000
SELECTED BIBLIOGRAPHY:
1. Croome K J, Gan G, and Awbi H B, Air flow and thermal comfort in naturally ventilated offices, Proc, ROOMVENT '92. Aalborg, Denmark, pp 401-417.
2. Awbi H B, and Gan G, Simulation of solar-induced ventilation, Proc. Second World Renewable Energy Congress, Reading, UK, Vol.4, pp 2016-2030, 1992.

REF UK12
TITLE OF PROJECT: Heat Transfer Mechanisms in Enclosures.
PRINCIPAL RESEARCHER: H B Awbi
ORGANISATION: University of Reading
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TELE:+44 (0) 1734 318201
FAX: +44 (0) 1734 313856
E-Mail Address: kcsawbi@reading.ac.uk
SPECIFIC OBJECTIVES: Energy impact of ventilation, Heating and ventilation systems and strategies, Heat transfer within rooms.
BUILDING TYPE: Commercial/office, Test chamber or test structure.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: None
PROJECT DETAILS: The project involves accurate measurements of convective and radiant heat transfer coefficiency of internal room surfaces. The measurements are performed in test chambers. The aim is to provide a data-base of heat transfer coefficients for use in heat transfer calculations in buildings, particularly in building thermal models and CFD programs. The new data will be compared with existing data using parametric buildings.
STARTDATE: 00:00:1994
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 7 000
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK13
TITLE OF PROJECT: Measurement of Subfloor Ventilation Rates.
PRINCIPAL RESEARCHER: Richard Hartless.
ORGANISATION: Building Research Establishment (BRE)
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TELE: +44 (0) 1923 664143
FAX: +44 (0) 1923 664088
E-Mail Address:
SPECIFIC OBJECTIVES: Continuous measurement of subfloor ventilation, IAQ, Control of hazardous soil gases.
BUILDING TYPE: Simulated occupancy, Dwellings.
COMPONENT TYPE: Floors.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Wind speed; wind direction; internal, external and subfloor temperatures; air brick area and location.
PROJECT DETAILS: Using continuous emission technique to measure ventilation rate in a void beneath a suspended timber floor of a BRE test house. Sulphur hexafluoride is tracer gas and mixing fans are used. IR analyser and flow controller.
Preliminary measurements taken in summer '93 with follow up programme in 94/95.
STARTDATE: 00:04:1993
EXPECTED TERMINATION DATE: 00:04:1995
ESTIMATED NUMBER OF PERSON HOURS: 0.2 person years.
SELECTED BIBLIOGRAPHY:
1. Edwards R, Hartless R, & Graze A. "Measurement of subfloor ventilation rates - comparison with

BREVENT predictions". AIVC conference, September 1990.

REF UK14
TITLE OF PROJECT: The Remediation of Radon Affected Dwellings.
PRINCIPAL RESEARCHER: Paul Walsh
ORGANISATION: Building Research Establishment (BRE)
ADDRESS: Bucknall's Lane, Garston, Watford. Herts. WD2 7JR.
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FAX: +44 (0)1923 664088
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ (RADON).
BUILDING TYPE: Simulated occupancy - heating only (gas central), Dwellings.
COMPONENT TYPE: Floors.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather (temperature, humidity, wind speed & direction), press differences across walls and floors, type of floor, type of radon remedy technique.
PROJECT DETAILS: Aim to observe the effectiveness of different remedy techniques at reducing indoor radon levels. Tests conducted at house with high indoor radon level.
Stage 1. House has a suspended timber floor.
Monitor effectiveness of natural underfloor ventilation, mechanical extract ventilation, mechanical supply ventilation. Monitor changes in moisture beneath floor as well as the usual parameters.
Stage 2. Lay a concrete oversite over soil beneath floor.
Monitor effect of this then alter the underfloor ventilation as in stage 1.
Stage 3. Replace suspended timber floor with insitu slab.
Monitor effect of this and passive driven sumps, mechanical sumps and possibly positive pressurisation of house.
Throughout these tests the following parameters are monitored 1) Radon levels in house.(and under floor when appropriate). (continuous monitoring and long term averages.)
2) Pressures across floors and walls.
3) Humidities in house and beneath suspended floor.
4) Temperatures in house and beneath suspended floor and outside.
5) Wind speed and direction.
6) Atmospheric pressure.
The results from this study will go towards updating guidance available from the building research establishment (and possibly towards building regulations).
STARTDATE: 00:03:1994
EXPECTED TERMINATION DATE: 00:00:1999
ESTIMATED NUMBER OF PERSON HOURS: 2000-3000 hours
SELECTED BIBLIOGRAPHY: Existing reports on guidance for treating existing dwellings.
1. Radon sumps A BRE guide to radon remedial measures in existing dwellings. ref BR227
2. Sealing cracks in solid floors A BRE guide to radon remedial measures in existing dwelling by P W Pye. ref BR239
Future guidance. (Exact title no available) Treating dwelling with suspended timber floors A BRE guide to radon remedial measures in existing dwellings by Paul Welsh.

REF UK15
TITLE OF PROJECT: Ventilation and conduction driven heat losses.
PRINCIPAL RESEARCHER: M G Davies.
ORGANISATION: The University of Liverpool
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SPECIFIC OBJECTIVES: Energy impact of ventilation, Heating and ventilation systems and strategies.
BUILDING TYPE: (None Stated)
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Following an examination of the roles of convective and radiative heat exchange in a room, an expression has been found for the heat load in a room needed to maintain some comfort temperature which includes explicit mention of the losses of heat by conduction and ventilation together with consideration of the radiant/convective characteristics of the heating unit. The project is now completed.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. M G Davies, The basis for a room global temperature, Phil. Trans. Royal Society, London, A339, 153-192, 1992.
2. M G Davies, Definitions of room temperature, Building and Environment, 28, 383-398, 1993.

REF UK16
TITLE OF PROJECT: Energy Efficiency And Environmental Impact of Domestic Mechanical Heat Recovery Ventilation.
PRINCIPAL RESEARCHER: Kevin Broughton
ORGANISATION: Leeds Metropolitan University

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FAX: +44 (0) 1132 833190
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SPECIFIC OBJECTIVES: Energy impact of ventilation, Heating and ventilation systems and strategies.
BUILDING TYPE: Simulated occupancy, Dwellings.
COMPONENT TYPE: Whole house.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Climate, Airtightness, Energy, Carbon Emissions.
PROJECT DETAILS: This project concentrates on energy transfers within Mechanical Ventilation Heat Recovery (MVHR) systems and considers the operating conditions required to ensure atmospheric carbon emission abatement from domestic space heating. A model is developed that identifies useful performance parameters that can be determined by measurement.
Conventional MVHR systems use electrically driven fans to force air though a heat exchanger and along networks of supply an extract ducts. The effectiveness of the type of MVHR system in providing atmospheric carbon emission abatement is determined by the electrical power demand of the system, the reduction in space heating power demand resulting from ventilation heat recovery and the carbon intensities of electricity and the fuel used by the space heating system.
The condition of ensuring carbon abatement sets an upper bound to the electrical power demand of the MVHR system. An analysis of manufacturer's data suggests that installing conventional MVHR systems in dwellings does not guarantee a reduction in carbon emissions. Comparison of the energy required to move the ventilation air and system electrical power demand suggests that the energy transfer efficiency is poor and can be improved using currently available technology. A significant improvement in energy efficiency could ensure a net reduction in carbon emissions from space heating in a dwelling fitted with a MVHR system.
An investigation to determine energy transfer efficiencies of domestic MVHR systems that are currently marketed in the UK has begun at Leeds Metropolitan University. The laboratory study involves the measurement of electrical power demand and air mass flow rates. The power loss coefficient associated with different designs of ductwork is also being investigated by comparing energy losses in MVHR systems supplied by several manufacturers to a standardized house specification. The results of the laboratory studies are being used to develop a prototype advanced MVHR system, for use in the UK climate, that exhibits a significant improvement in energy efficiency.
STARTDATE: 00:09:1992
EXPECTED TERMINATION DATE: 00:09:1995
ESTIMATED NUMBER OF PERSON HOURS: 4600
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK17
TITLE OF PROJECT: Thermal Interaction of Building and HVAC system.
PRINCIPAL RESEARCHER: Jan Hensen
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ADDRESS: Energy Systems Division, 75 Montrose Street, Glasgow. G1 1XJ. United Kingdom
TELE: +44 (0) 141 552 4400 x2042
FAX: +44 (0) 141 552 8513
E-Mail Address: jan@esru.strath.ac.uk
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy impact of ventilation, Airtightness/air leakage of buildings, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Simulated occupancy, Dwellings, Commercial/office.
COMPONENT TYPE: Windows, Doors, Walls, Floors, Cracks, HVAC components.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Outside temperature, wind, performance of building components and of HVAC components.
PROJECT DETAILS: The dynamic thermal interaction - under the influence of occupant behaviour and outdoor climate - between building structure and environmental control (energy) systems is difficult to predict in terms of the resulting indoor climate (IAQ) and energy consumption.
In our approach we try to approach the whole of the building form and fabric, HVAC and control systems as an integrated, dynamic system. For this we use computer modelling and simulation.
The overall project comprises of two main subjects
1. domain specific problems like, for example, displacement ventilation (energy impact) and air flow in imperfectly mixed zones.
2. application and development of computer modelling and simulation, for instance in the area of imperfectly mixed building zones.
In both cases we try to concentrate on the interaction area between building and plant, because that is where in practice most problems occur, and where new/better tools/knowledge are needed most.
STARTDATE: Ongoing
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Hensen J L M, "On the thermal interaction of building structure and heating and ventilating system" Doctoral Dissertation, Eindhousen University of Technology, 1991.

2. Henson J L M, "An integrated building systems simulation approach to energy conservation", Proc. 5th I.Contier Conference, University of Concordia, Montreal, 1992.
3. Henson J L M, "Towards an integral approach of building and HVAC system", Energy and Buildings, (19) No. 4, pp 197-302, 1993.
4. Henson J L M, Ivan du Maas, A Roos "Air and heat flow through large vertical openings", Proc. 3rd IBPSA Congress Building Simulation '93, Adelaide, 1993.

REF UK18

TITLE OF PROJECT: Monitoring Thermal Performance and Social acceptance of an air-to-air heat pump in well insulated and well sealed domestic dwellings.

PRINCIPAL RESEARCHER: Lawrence Hughes.
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E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy Impact of Ventilation, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Dwellings.
COMPONENT TYPE:
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather; Ambient temperature/humidity; Number of people and their behaviour patterns.
PROJECT DETAILS: The project is sponsored by Northern Electric Plc and aims to be an independent study of the overall performance of a newly developed air-to-air heat pump combined with a cross flow heat exchanger; after installation in to nine occupied test houses in the North Eastern region. The houses involved vary in detail and construction from an old Tyneside Flat, refurbished to reduce infiltration and heat loss to mostly consisting of new build housing association properties for small families. These houses are constructed with traditional brick cavity walls and partial fill insulation, the floors are solid concrete with insulation, the windows are double glazed with the internal pane having a low emmisivity coating and finally the doors are steel with an insulation filled cavity.
The heat pump units are installed in the loft space and are entirely electrical in operation. They supply heated air to the lounge, kitchen and bedrooms with extract points in the kitchen and bathrooms. Measurements are recorded of air temperature in all rooms, external conditions and electrical demand for the units by a data logger which is interrogated remotely via a modem on the university's premises. Social monitoring is also to take place in the form of a 6 monthly interview with the occupants of each house during which they will be questioned about perceived thermal comfort and any respiratal health problems that have occurred.
The thermal performance of the building has been modelled on APACHE part of the FACET suite of programs, further validation of this work is on going using the modular public domain package TRNSYS. Further on site testing will be limited to air flow distribution.
STARTDATE: 00:02:1993
EXPECTED TERMINATION DATE: 00:02:1996
ESTIMATED NUMBER OF PERSON HOURS: 660-900
SELECTED BIBLIOGRAPHY:
1. McIntyre D A. Domestic Ventilation Heat Recovery using Heat Pumps, ECRO / M2065 1986.
2. Electrical Review, Heat Pumps Heading for Home? Electrical Review 21 February - 5 March 1992.
3. Electrical Review A breath of FRESH AIR, Electrical Review 31 July - 20 August 1992.
4. McIntyre D A, Mechanical Ventilation House Dust Mites and Asthma, EA Technology (Year Unknown).
5. Clarke G, Heat Pumps Systems Promises Relief For Asthma Sufferers, H & V Engineer, Volume 65 No. 712P.15 - 16.
6. Kew J, Heat Pumps for Building Services, BSRIA, Technical Note TN 8/85, November 1985.

REF UK19

TITLE OF PROJECT: Domestic Combustion Appliances.

PRINCIPAL RESEARCHER: Tom Shepherd / Lynn Parkins
ORGANISATION: Building Research Establishment
ADDRESS: Garston, Watford, Herts. WD2 7JR. United Kingdom
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SPECIFIC OBJECTIVES: Indoor air movement, Moisture mould generation and prevalence, Heating and ventilation systems and strategies.
BUILDING TYPE: Unoccupied, Dwellings.
COMPONENT TYPE: Flues, Doors, Air Bricks/vents.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather, performance of doors, extract fans, flues, psv.
PROJECT DETAILS:
Part 1. Interaction of open-flued combustion appliances with mechanical extract ventilation.
Aim to develop guidance on safe practice where open-flued combustion appliances are in the same room or dwelling as mechanical extract ventilation,

for Building Regulations. To ensure that spillage of combustion products is kept to a minimum by safe design.
(a). Measurements.
House semi-detached test house. Built mid 1970's. Timber frame, vol 196 m3. Highly insulated. Gas and oil boilers tested in house, (solid fuel appliances in lab and other test house). Underfloor heating system. Mechanical extract ventilation from room with combustion appliance in - variable extract rate to determine point of spillage.
Measurements PRT's in room and external, thermocouples and pressure tappings in boilers and flues, internal/external DP. Core of CO and CO2 in room. Scorpio Schlanberger Data logger, B+K gas analyser. Also weather conditions.
Part 2. Effectiveness of extract fan, passive stack vent and open flued boiler at removing moisture from a kitchen.
Aim to establish relative effectiveness at moisture removal of various ventilation measures to advise Building Regulations Division on suitable ventilation for kitchens.
a). Measurements. House as part 1. Heating system Tests with boiler (gas) central heating rads. Tests with other ventilation systems - electric panel rads. Ventilation measures Extract fan on or off; psv open or closed; air brick open or closed; trickle vent open or closed; kitchen door open or closed; open-flued boiler on or off; flue open or closed.
Measurements PRTs in all rooms and external; RH in all rooms and external monitored house ventilation rate using SF6 as constant conc. tracer. Monitored moisture movement about house under different ventilation regimes. Moisture input into kitchen over 2 hrs.
Equipment Schlumberger Scorpio date logger, B+K gas analyser and sampler/doser unit.
STARTDATE: Part 1 00:07:1990; Part 2 00:10:1992
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: to date 4500?
SELECTED BIBLIOGRAPHY:
1. J Timusk et al. Chimney Venting performance study. Journal of Testing and Evaluation Vol 16, No 2, March '88, pp 158-177.
2. Scanada - Sheltair Consortium Inc. Residential Combustion Venting Failure - A systems Approach Monitoring Combustion Gas Spillage Frequency and Duration in 20 Problem Prone Houses - A Find Report.
3. M C Swinton et al. Residential Combustion Venting Failure - A Systems Approach Symposium on Air Infiltration, Ventilation and Moisture. Fort Worth, Texas, December 1986.
4. Littler J, Kolokotoni M. A Study of Moisture Movement and its Effects on Condensation Risk. SERC Find Report, September 1993.
5. T Shepherd. Spillage of Flue Gases from Open-flued Combustion Appliances. BRE Information Paper IP21/92. December 1992.
6. T Shepherd. Extract Fan Flow Rates Resulting in Spillage. To be printed in BSERT vol 14/4.
7. T Shepherd, L Parkins and A Cripps. Effects of Passive and Mechanical Ventilation on Kitchen Moisture Levels. To be published in 1994 - place unknown as yet.

REF UK20
TITLE OF PROJECT: An Evaluation of Computational Fluid Dynamics for Predicting Airflows in Naturally Ventilated Buildings.
PRINCIPAL RESEARCHER: Malcolm Cook, Prof A T Howarth, DR K J Lomas.
ORGANISATION: De Montfort University
ADDRESS: ECADAP Group, School of the Built Environment, The Gateway, Leicester. LE1 9BH. United Kingdom
TELE: +44 (0) 1162 577 417
FAX: +44 (0) 1162 577 449
E-Mail Address: edu@uk.ac.dmu
SPECIFIC OBJECTIVES: Indoor air movement, Heating and ventilation systems and strategies, CFD Evaluation.
BUILDING TYPE: Simulated occupancy, Unoccupied, Commercial/office, Test chamber or test structure.
COMPONENT TYPE: Windowsm, Doors, Walls, Floors.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Performance of building components. Internal sources of buoyancy.
PROJECT DETAILS: The theory of displacement ventilation has been explained by UNDEN et al. (1989) in which perspex models were submerged in water, and brine used to simulate the effects of internal sources of buoyancy. The CFD code, CFDS-FLOW 3D is to be used to model these flows and the results compared with those measured. In doing this it is hoped to determine the sensitivity of the CFD results to the choice of turbulence model, boundary conditions, solution method, etc.
The code will then be applied to real rooms in which displacement ventilation has been utilized. The auditoria in the new Engineering Building at De Montfort University will be a possible focus of attention. It is intended that tracer gas experiments will be carried out in this building via another research project, the results of which will enable interesting comparisons with the CFD code.
STARTDATE: 18:01:1993
EXPECTED TERMINATION DATE: 17:01:1996
ESTIMATED NUMBER OF PERSON HOURS: 6210
SELECTED BIBLIOGRAPHY:

1. Linden P F, Lane-serf G F, and Smeed D A. "Emptying Filling Boxes The Fluid Mechanics of Natural Ventilation ". Journal of Fluid Mechanics, Vol 212, pp 309-335, 1990.

REF UK21
TITLE OF PROJECT: CFD Modelling of Distribution and Deposition of Particles in Buildings.
PRINCIPAL RESEARCHER: Weizhen Lu and A T Howarth.
ORGANISATION: De Montfort University
ADDRESS: Department of Building Studies, Leicester. LE1 9BH. United Kingdom
TELE: +44 (0) 1162 577 417
FAX: +44 (0) 1162 577 449
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, particle tracking in heating, ventilated buildings. CFD modelling.
BUILDING TYPE: Simulated occupancy, Unoccupied.
COMPONENT TYPE: Windows, Doors, Walls, Floors.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Indoor air quality, Particle distribution and deposition. Particle tracking.
PROJECT DETAILS: 1. To analyze the distribution, deposition and migration of particles in single and two zone areas by CFD modelling, compare the numerical solution with measurement data obtained from experiment.
2. To model air flow and particle distribution in heating, ventilated system.
3. To provide a method for CFD modelling of particles in buildings and ventilation systems.
STARTDATE: 20:10:1993
EXPECTED TERMINATION DATE: 20:10:1995
ESTIMATED NUMBER OF PERSON HOURS: 4160
SELECTED BIBLIOGRAPHY:
1. Clift R, Grace J R, and Webber M E."Bubbles, Drops and Particles", Academie Press, Inc. London, 1978.
2. Warsi Z U A."Fluid Dynamics - Theoretical and Computational Approaches" CRC Press, Inc. 1993.

REF UK22
TITLE OF PROJECT: The Performance of Passively Ventilated Auditorium in De Monfort University.
PRINCIPAL RESEARCHER: Eoin Clancy, Prof A T Howarth.
ORGANISATION: De Montfort University,
ADDRESS: Department of Building Studies, The Gateway, Leicester. LE1 9BH. United Kingdom
TELE: +44 (0) 1162 577 417 FAX: +44 (0) 1162 577 449
E-Mail Address:
SPECIFIC OBJECTIVES: To examine environment of theatres. Indoor air movement. Energy impact of ventilation. Airtightness/air leakage of buildings. Heating and ventilation systems and strategies. Ventilation effectiveness in theatres.
BUILDING TYPE: Occupied, Lecture theatres.
COMPONENT TYPE: Windows, Doors, Walls, Floors. Cracks, Stack openings, inlets.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Minimum air change rates for given occupancy levels.
PROJECT DETAILS: Air change rates will be measured by using tracer gas injection techniques (decay and/or constant concentration). Air velocities in stacks and in regions in the spaces, together with air temperatures will also be measured. Experiments will be carried out for a number of conditions, e.g. damper closed/open/half open; unoccupied, occupied (simulated occupancy with a heat load of up to 13 kw). Experiments will also be performed for a range of out door conditions (during winter, spring and summer). Data will probably have to be gathered at weekends as the lecture theatres are heavily used during the week. The spaces themselves use natural ventilation, i.e. the stack and/or wind effects are used to drive air through the theatres.
STARTDATE: 00:01:1994
EXPECTED TERMINATION DATE: 00:10:1996
ESTIMATED NUMBER OF PERSON HOURS: approx 51 520.
SELECTED BIBLIOGRAPHY:
1. Perera M, Walker M, "Strategy for Measuring Infiltration Rates in Large, Multicelled and Naturally Ventilated Buildings using a Single Tracer Gas", Nov 1984. Building Services Engineering, Research and Technology, V.6, No 2, pp82-88 (1985).
2. Perera M, Tull R, "Envelope Leakage of Large, Naturally Ventilated Buildings", July 1989, 10th AIVC Conference on "Progress and Trends in Air Infiltration and Ventilation Research".
3. l'Anson, Irwin C, Howarth A, "Air Flow Measurement using Three Tracer Gases", Building And Environment, Vol. 17, No 4, pp 245-252, 1982.
4. Riffat S, "Air Flows Between Two Zones Accuracy of Single - Tracer Gas Measurements for Estimation" "Building Services Engineering Research and Technology" Vol 10, No 2, pp 85-88, 1989, UK.

REF UK23
TITLE OF PROJECT: Continuous Monitoring and Modelling of NO2 and CO in UK Homes.
PRINCIPAL RESEARCHER: David Ross.
ORGANISATION: Building Research Establishment
ADDRESS: Garston, Watford, Herts. WD2 7JR. United Kingdom

TELE: +44 (0) 1923 894 040
FAX: +44 (0) 1923 664 088
E-Mail ADDRESS: RossD@BRE.co.uk (EUNET)
SPECIFIC OBJECTIVES: IAQ.
BUILDING TYPE: Occupied, Dwellings.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: IAQ will relate to indoor combustion sources (gas cookers, heaters etc.), sorption by indoor surfaces, ventilation to outside and infiltration in.
PROJECT DETAILS: Continuous monitoring of NO2 and CO levels in homes. Also using passive NO2 and CO detectors to record average exposure to these gasses. Residents fill in a questionnaire about their home and a daily diary of cooker and heater usage to identify indoor pollution sources. In addition, carrying out measurements and modelling of NO2 and CO in a test house to compare with levels observed in homes. Using simple mass balance models with first order term for sorption.
NO2 detectors Scintrex LMA3 chemiluminescent monitors and Palmes tubes. CO detectors. Infra-red, electrochemical sensors and Draeger tubes.
STARTDATE: 01:08:1992
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: approx 2000 so far
SELECTED BIBLIOGRAPHY:
1. Raw G J, and Coward S K D. Exposure to nitrogen dioxide in homes in the UK a pilot study. Proc. of Unhealthy Housing the public health response, Warwick University, Dec. 1991.
2. Stevenson K J. Measurements of carbon monoxide and nitrogen dioxide in British homes using unflued heating or cooking appliances. Tokea J. Esp. Clin. Med. 1985; 10 (4); 295-301.
3. Spicer C W, Coutant R W, Ward G F, Joseph D W, Gaynor A J, Billick I H. Rates and mechanisms of NO2 removal from indoor air be residential materials. Environmental International 1989; 15; 643-654.
4. Ross D and Hartless R. Continuous monitoring of nitrogen dioxide in UK homes. Proc. Indoor Air '93, 189-194.

REF UK24
TITLE OF PROJECT: Review of Buildings & Health.
PRINCIPAL RESEARCHER: Gary J Raw
ORGANISATION: Building Research Establishment.
ADDRESS: Garston, Watford, WD2 7JR, United Kingdom
TELE: +44 (0) 1923 894 040
FAX: +44 (0) 1923 664 088
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Moisture mould generation and prevalence.
BUILDING TYPE: Occupied, Dwellings, Commercial/office, Other non-industrial.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Review of buildings and health, including chapters on all major pollutant groups. Aimed primarily at informing discussion of regulation and housing standards in the UK.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. "Building Regulation an Health" D C Mant and Muir Gray BRE Report 1986. GarstonBRE.

REF UK25
TITLE OF PROJECT: Environment and health in commercial buildings.
PRINCIPAL RESEARCHER: Gary J Raw
ORGANISATION: Building Research Establishment.
ADDRESS: Garston, Watford, WD2 7JR, United Kingdom
TELE: +44 (0) 1923 894 040
FAX: +44 (0) 1923 664 088
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movements, IAQ, Airtightness/air leakage of buildings, Moisture mould generation and prevalence, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Commercial/office.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Reviews and experimental studies of the causes of sick building syndrome. Work to date has concentrated on the cleanliness of office furnishings.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. "Sick Building Syndrome a review of the evidence on causes and solution" G J Raw. HSE Contract Research Report 42/1992. LondonHMSO.
2. "Sick Building Syndrome cleanliness is next to healthiness" G J Raw, M.S.Roys & C.Whitehead. 1993. Indoor Air , 237-245.
3. "Further findings from the office environment survey productivity" G J Raw, M.S. Roys & A Leaman. 1990. Indoor Air 90, Vol 1, 287-292. Ottawa Canada Mortgage & Housing corporation.
4. "A new approach to the investigation of sick building syndrome." 1991. G J Raw, P Leinster et al. CIBSE National Conference, Canterbury, England.

5. "The importance of indoor surface pollution in sick building syndrome" 1994 G J Raw, BRE Information Paper IP 3/94. GarstonBRE.

REF UK26
TITLE OF PROJECT: Ventilation and house dust mite population in homes.
PRINCIPAL RESEARCHER: Gary J Raw
ORGANISATION: Building Research Establishment.
ADDRESS: Garston, Watford, WD2 7JR, United Kingdom
TELE: +44 (0) 1923 894 040
FAX: +44 (0) 1923 664 088
E-Mail Address:
SPECIFIC OBJECTIVES: Airtightness/air leakage of buildings, Moisture mould generation and prevalence, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Simulated occupancy, Dwellings.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Examines the feasibility of using mechanical ventilation in British homes to reduce indoor humidity sufficiently to reduce house dust mite populations.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK27
TITLE OF PROJECT: European Indoor Air Quality Audit Project.
PRINCIPAL RESEARCHER: Gary J Raw
ORGANISATION: Building Research Establishment.
ADDRESS: Garston, Watford, WD2 7JR, United Kingdom
TELE: +44 (0) 1923 894 040
FAX: +44 (0) 1923 664 088
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Energy impact of ventilation.
BUILDING TYPE: Occupied, Commercial/office.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Seeks to develop and validate a one-day building audit to identify IAQ problems, relate them to health of occupants and assess energy implications.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:

1. N.A.Oseland and G J Raw (1993) The new units for perceived air quality - a discussion paper. Building Services Engineering Research and Technology.

REF UK28
TITLE OF PROJECT: Domestic Ventilation Behaviour.
PRINCIPAL RESEARCHER: Gary J Raw
ORGANISATION: Building Research Establishment.
ADDRESS: Garston, Watford, WD2 7JR, United Kingdom
TELE: +44 (0) 1923 894 040
FAX: +44 (0) 1923 664 088
E-Mail Address:
SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Dwellings.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED:
PROJECT DETAILS: Examines the ventilation strategies adopted in modern homes, the reasons for different strategies and the level of success as measured by satisfaction with the indoor environment and avoidance of moisture problems.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK29
TITLE OF PROJECT: Indoor Air Pollution in Homes.
PRINCIPAL RESEARCHER: Gary J Raw
ORGANISATION: Building Research Establishment.
ADDRESS: Garston, Watford, WD2 7JR, United Kingdom
TELE: +44 (0) 1923 894 040
FAX: +44 (0) 1923 664 088
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Moisture mould generation and prevalence.
BUILDING TYPE: Occupied, Dwellings.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Pollutant levels are measured in homes in order t determine typical levels and the main characteristics of housing and occupant behaviour which determine pollutant levels. Covers NDx, VOCs, formaldehyde, bacteria, fungi and house dust mites.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)

ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. G J Raw and S K D Coward (1991) Exposure to nitrogen dioxide in homes in the UK. BRE Occasional Paper pp 46. Garston BRE.

REF UK30
TITLE OF PROJECT: Air flow, smoke and pollutant modelling using Computational Fluid Dynamics.
PRINCIPAL RESEARCHER: Geoff Whittle
ORGANISATION: Ove Arup and Partners
ADDRESS: 13 Fitzroy Street, London. W1P 6BQ. United Kingdom.
TELE: +44 (0) 171 465 3437
FAX: +44 (0) 171 465 3669
E-Mail Address:
SPECIFIC OBJECTIVES: To develop and apply CFD methods for air flow, fire and smoke, wind environment and pollutant prediction associated with buildings and enclosures.
BUILDING TYPE: Non Domestic
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Building geometry, Fabric, System and /or Industrial process, Weather
PROJECT DETAILS: An in-house cfd CODE (airflo) is being developed and applied to predict air movement, temperature distribution, wind velocities, smoke movement and pollutant concentration in design and analysis associated with buildings and enclosures. The code is a finite volume, Navier Stokes solver which uses a pressure coupled formulation. Applications include most types of non domestic buildings, including offices, large spaces such as atria and process environments including offshore production platforms. Areas of specific modelling interest include : Improving convergence rate for (high Raleigh number) buoyant flows, time-dependent simulations for inherently unsteady flows, and improving usability.
STARTDATE: 00:04:1988
EXPECTED TERMINATION DATE: Ongoing (reviewed Annually)
ESTIMATED NUMBER OF PERSON HOURS: 700 person-hours per year
SELECTED BIBLIOGRAPHY:
1. Holmes MJ et al (1990), Conduction, convection and radiation in the perimeter zone of an office space. Proc. of ROOMVENT 90 Conf. Oslo, June 1990.
2. Whittle GE (1990), Air flow modelling in atria. Proc. of IMechE/CIBSE conf. on Atrium Engineering, London, June 1990.
3. Lam JKW, Ruddick KG and Whittle GE (1990), Air Curtains for infiltration control - a CFD analysis. Poc. 11th AIVC Conf. Belgirate, Italy. September 1990.
4. Whittle GE (1991), Flow Field Modelling in Buildings. Building Services (CIBSE) Journal pp 51-53, May 1991.
5. MuGuirk JJ and Whittle GE (1991), Calculation of Buoyant air movement in buildings - proposals for a numerical benchmark test case. Proc. IMechE Seminar on CFD for the environmental and buildings Services Engineer. London 26 November 1991.
6. Whittle GE (1992), A fluid situation . Building Services (CIBSE) Journal, pp37-38 August 1992.
7. Whittle GE, Ong IBS and Gardiner AJ (1993), The prediction of wind driven ventilation, fire and smoke movement on offshore production platforms using CFD. Proc of Engineering Applications of CFD, Institution of Mechanical Engineers, London, 7-8 September 1993.

REF UK31
TITLE OF PROJECT: Energy Conservation, Natural Ventilation And Weathertightness Characteristics Of Buildings
PRINCIPAL RESEARCHER: Provan, T F & Younger, J D
ORGANISATION: University of Paisley,
ADDRESS: High Street, Paisley, PA1 2BE. SCOTLAND. UNITED KINGDOM.
TELE: +44 (0) 141 887 1241
FAX +44 (0) 141 887 0812
E-Mail Address: TLX 778951 PCT LIB
SPECIFIC OBJECTIVES: (SEE PROJECT DETAILS BELOW)
BUILDING TYPE: All
COMPONENT TYPE: All components (windows, doors; openings etc)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: weather (temperature; pressure; velocity); performance standards
PROJECT DETAILS Weathertightness of buildings has been an increasingly important aspect of building design with respect to air infiltration, water penetration and wind resistance. In recent years it has become apparent that the application of weathertightness criteria to building design, although achieving a better conservation of energy, has resulted in a reduction in natural ventilation and a greater risk of condensation and dampness. The purpose of these investigations is to measure the differences between weathertightness and natural ventilation criteria, in order to achieve a better balance between energy conservation needs and ventilation requirements.
STARTDATE: 01:06:1984
EXPECTED TERMINATION DATE: (As appropriate)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:

1 Provan T F and Younger J D (1985), Weathertightness of windows, Building Technical File, 10,pp57-58
2 Provan T F and Younger J D (1986), Air Infiltration Characteristics of windows Energy and Buildings, 9(4), pp281-92.
3 Provan T F and Younger J D (1986), Weathertightness and Natural Ventilation Characteristics of windows, Proc. of symposium on Air infiltration and moisture transfer BTECC, Fort Worth, Texas, pp420-432, Dec 1986
4 Provan T F and Younger J D (1988), Airtightness of windows-Energy conservation verses Natural Ventilation Building, Tech File, 22, pp65-69.
5 Downey E and Provan T F (1986), Energy conservation - side effects of reduced ventilation rates and increased ventilation, Building Tech File, 13, pp63-4.

REF UK32
TITLE OF PROJECT: Variable Area Diffuser - An Alternative VAV System.
PRINCIPAL RESEARCHER: Robert McDermott
ORGANISATION: AIRRITE LTD.,
ADDRESS: 104A High Street, Bangor, BT20 5BB Northern Ireland, United Kingdom
TELE: +44 (0) 1247 273700
FAX: +44 (0) 1247 273707
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor Air Movement, Energy Impact of ventilation, Heating and ventilation systems and strategies.
BUILDING TYPE: Occupied, Commercial/Office, Test Chamber or Test Structure.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Guidance on efficiency and distribution.
PROJECT DETAILS: Innovative design of a variable area diffuser for HVAC. Ability to stabilize system pressure , thus ensuring constant dimensional jet. To report on its energy effect and installed cost comparisons with traditional HVAC systems.
STARTDATE: 00:08:1992
EXPECTED TERMINATION DATE: 00:08:1994
ESTIMATED NUMBER OF PERSON HOURS: 1800
SELECTED BIBLIOGRAPHY:
AT -90-2-3 3711 Regional Airflow Characteristics
CH-93-2-1 6532 Characteristics of Diffuser aIR Jets.
BA - 92-2-3 5869 Turbulent behaviour of room vent flows.
6193 Attachment of Cold Plane jets and Ceiling.
Fundamentals of Industrial ventilation . VV Baturim 1972. Ventilation of Buildings Awbi 1991.

REF UK33
TITLE OF PROJECT: Ventilation and Asthma.
PRINCIPAL RESEARCHER: D A McIntyre
ORGANISATION: EA Technology
ADDRESS: Capenhurst, Chester, CH1 6ES. United Kingdom
TELE: +44 (0) 151 347 2308
FAX: +44 (0) 151 347 2570
E-Mail Address:
SPECIFIC OBJECTIVES: Control of indoor humidity by ventilation, Moisture mould generation and prevalence
BUILDING TYPE: Simulated Occupancy, Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Moisture release, Type of ventilation system, Weather
PROJECT DETAILS: A test house has been refurbished as a ventilation test facility. It is equipped with Mechanical Ventilation and heat recovery, passive stack ventilation and extract fans.
The aim is to determine whether indoor humidity may be maintained reliably below 7g/kg during the winter months, Below 7g/kg moisture, house dust mites do not flourish.
Internal air movement will be studied by multi tracer gas measurements. Dynamics of moisture movement through the house will be measured as a function of ventilation rate and type of system.
STARTDATE: 00:08:1993
EXPECTED TERMINATION DATE: 00:08:1995
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. McIntrye DA (1992),The control of house dust mites by ventilation : a pilot study. 13TH AIVC Conference, NICE 1992.

REF UK34
TITLE OF PROJECT: Modelling non-uniform zone air with a nodal network approach.
PRINCIPAL RESEARCHER: Hensen, Jan or A Roos (Eindhoven University of Technology)
ORGANISATION: University of Strathclyde
ADDRESS: Energy Simulation Research Unit, 75 Montrose Street, James Weir Bldng, Glasgow. G1 1XJ, United Kingdom
TELE: +44 (0) 141 552 4400 Ext 2042
FAX: +44 (0) 141 552 8513
E-Mail Address: jan@esru.strathclyde.ac.uk
SPECIFIC OBJECTIVES: To develop an approach for modelling non-uniform zone air temperature and velocity, based on a mass balance method., for incorporation with a multizone building energy simulation system.
BUILDING TYPE: Any
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Temporal ambient conditions (temperature, wind speed and direction),

Exposure (pressure coefficients),
Leakage distribution, and temporal indoor conditions (air and wall temperatures, convection heat transfer coefficients, and air flow impulses).
PROJECT DETAILS: This work is done in collaboration with the Eindhoven University of Technology in the Netherlands. The objective of this work is to develop a technique for simulating air flows inside buildings which is suitable for incorporating into a multizone building and plant energy simulation system. The technique will be a mass balance network approach. Validation will be carried out relative to results generated by a CFD approach. The method must be able to identify the main (or bulk) air flows and temperature gradients inside a room. This needs to be achieved with a minimal amount of computational resources. The latter is a requirement which is necessary in order to be able to approximate the flow field during each discrete time step of a longer (potentially up to one year) simulation period.
STARTDATE: 00:00:1992
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 6500 person hours
SELECTED BIBLIOGRAPHY:
1. Hensen JLM (1991), On the thermal interaction of building structure and heating and venting system. Phd. Dissertation Eindhoven University of Technology., 1991.
2. Hensen JLM and Clarke JA (1991), A simulation approach to the evaluation to coupled heat and mass transfer in buildings. Poc. 2nd IBPSA World Congress. Nice , Aug 1991.
3. Hensen JLM and A Roos (1994), An attempt to model non uniform zone air with a nodal network. In Proc 15th AIVC Conference, "The Role of Ventilation", Buxton Uk, Sept 1994. IEA Air infiltration Centre, Coventry (UK). Abstract submitted.

REF UK35
TITLE OF PROJECT: Aerosol Particles in Buildings
PRINCIPAL RESEARCHER: Professor S B Riffat
ORGANISATION: Nottingham University
ADDRESS: Building Technology Group, School of Architecture, Nottingham, NG7 2RD, United Kingdom
TELE: +44 (0) 1159 513158
FAX: +44 (0) 1159 513159
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air quality, Indoor air movement, Aerosol particles
BUILDING TYPE: Simulated Occupancy, Unoccupied, Dwellings, Commercial/ Office Test Chamber or test structure.
COMPONENT TYPE: Windows, Doors, Walls, Floors, Cracks, Carpets
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED:
(a) temperature, humidity
(b) windows, doors, walls, floors, cracks, carpets
(c) simulated occupants
(d) commercial particles, smoke particles, dusts
PROJECT DETAILS: To analyse the distribution and deposition of aerosol particles in a single zone by measurement and computational fluid dynamics modelling; To analyse the migration and deposition of aerosol particles between two zones by measurement and CFD modelling.
To analyse the migration and deposition of aerosol particles in a small HVAC system by measurement and CFD modelling.
To develop a guide for the measuring and modelling of aerosol particles in buildings and systems.
(a) Measurements in buildings.
Size : up to 135 cubic metres
type: wood/brick
Natural and Mechanical Ventilation.
Gas and electricity Heating
Pressurisation, SF6 N20 tracer gases, smoke, aerosol particles
Tracer gas detector, particle generators, particle monitors, smoke generators.
(b) Theoretical / model calculations Commercial CFD software "Fluent"
STARTDATE: 00:12:1993
EXPECTED TERMINATION DATE: 00:12:1995
ESTIMATED NUMBER OF PERSON HOURS: 8000
SELECTED BIBLIOGRAPHY:
1. Riffat SB and Cheong KW (1992), Measurement of ventilation and aerosol particles in buildings", Int J Energy Research,1992.
2. Adam NM and Riffat SB (1993), Flow of aerosol particles through large openings" 14th AIVC Conference, 1993.

REF UK36
TITLE OF PROJECT: Determination of k-factor of HVAC system components
PRINCIPAL RESEARCHER: Professor S B Riffat
ORGANISATION: Nottingham University
ADDRESS: Building Technology Group, School of Architecture, Nottingham, NG7 2RD, United Kingdom
TELE: +44 (0) 1159 513158
FAX: +44 (0) 1159 513159
E-Mail Address:
SPECIFIC OBJECTIVES: Energy impact of ventilation, Heating and ventilation systems
BUILDING TYPE: Commercial/Office, Test Chamber or test structure.
COMPONENT TYPE: HVAC system components.

PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (Not applicable)
PROJECT DETAILS: To determine velocity pressure loss-factors (k-factors) of HVAC system components using CFD and tracer gas techniques.
(a) Measurements in buildings (Not applicable)
(b) Theoretical modal calculations. Commercial CFD software "Fluent"
STARTDATE: 00:10:1993
EXPECTED TERMINATION DATE: 00:09:1996
ESTIMATED NUMBER OF PERSON HOURS: 10,000
SELECTED BIBLIOGRAPHY:
1. Riffat SB (1990), Comparison of tracer gas techniques for measuring airflow in a duct. J Institute Energy LXIII, 454, 1990.
2. Cheong KW and Riffat SB (19920, A new method for determination of velocity pressure loss factors for HVAC system components, Proc 13th AIVC Conf, pp549-561, 1992.
3. Shao L and Riffat SB, (1994), CFD for prediction of k- factors of duct fittings. Int J Energy Research, 1994 (in press).

REF UK37
TITLE OF PROJECT: Pollution in vehicles
PRINCIPAL RESEARCHER: Professor S B Riffat
ORGANISATION: Nottingham University
ADDRESS: Building Technology Group, School of Architecture, Nottingham, NG7 2RD, United Kingdom
TELE: +44 (0) 1159 513158
FAX: +44 (0) 1159 513159
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Indoor air quality
BUILDING TYPE: (Not applicable)
COMPONENT TYPE: Windows, Doors, Walls, Floors, Cracks, Carpets, Vent
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED:
(a) temperature, humidity, wind direction and speed
(b) windows, doors, walls, floors, cracks, carpets.
(c) real occupants.
(d) CO, NxO, VOC, O3, smoke particles, dusts.
PROJECT DETAILS: To determine pollutant distribution in and around vehicles and cross contamination between then using tracer gas techniques, scale models and wind tunnel and computational fluid dynamics modelling.
(a)Theoretical /Modal Calculations - Commercial CFD Software "Fluent".
STARTDATE: 00:10:1993
EXPECTED TERMINATION DATE: 00:09:1996
ESTIMATED NUMBER OF PERSON HOURS: 6000
SELECTED BIBLIOGRAPHY:
1. Riffat SB and Clarke R (1994), Tracer gas techniques for the measurement of cross contamination between vehicles". J Wind Engineering, 1994 (in press)

REF UK38
TITLE OF PROJECT: Airflow through horizontal openings
PRINCIPAL RESEARCHER: Professor S B Riffat
ORGANISATION: Nottingham University
ADDRESS: Building Technology Group, School of Architecture, Nottingham, NG7 2RD, United Kingdom
TELE: +44 (0) 1159 513158 FAX: +44 (0) 1159 513159
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Aerosol particles
BUILDING TYPE: Dwellings, Commercial / Office, Test chamber or test structure
COMPONENT TYPE: Stairwells, Lift shafts, Service shafts, trap doors, cracks
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (Not Stated)
PROJECT DETAILS: To analyse air flow between two zones through a horizontal opening, using tracer gas measurement and CFD modelling.
(a) Measurements in buildings
Size : upto 135 cubic metres
type: wood/brick
Natural and Mechanical Ventilation.
Gas and electricity heating
Pressurisation, SF6, N20 tracer gases
Tracer gas detectors, smoke generators
(b) Theoretical / model calculations. Commercial CFD Software "Fluent"
STARTDATE: (Not Stated)
EXPECTED TERMINATION DATE: (Not Stated)
ESTIMATED NUMBER OF PERSON HOURS: 2000
SELECTED BIBLIOGRAPHY:
1. Kohal JS and Riffat SB (1994), Evaluation of heat and mass transfer through a large horizontal opening., J Energy Research, 1994 (in press).

REF UK39
TITLE OF PROJECT: A study of moisture movement and its effect on condensation risk.
PRINCIPAL RESEARCHER Littler, J, Saiz, N.
ORGANISATION: University of Westminster
ADDRESS: Research in Building, 35 Marylebone Road, London NW1 5LS. United Kingdom
TELE: +44 (0) 171 911 5000 ext 3162
FAX: +44 (0) 171 911 5168
E-Mail Address:
SPECIFIC OBJECTIVES: The study of the distribution of moisture within a zone and of the

methods for moisture removal via interzonal air movement and extract fans.
BUILDING TYPE: Two-storey houses and flats.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Temperature, humidity, building geometry.
PROJECT DETAILS Water vapour and tracer gas concentrations are measured in a two zone test room and in dwellings (houses and flats).The moisture measurements are compared with the tracer gas measurements to evaluate the effect of air flow on the moisture movement within a zone and of air transport between rooms separated by doorways, corridors and stairs. The effectiveness of extractor fans used in moisture producing spaces, (kitchens and bathrooms), for removing water vapour at source to provide lower condensation risk in the rest of the dwelling is evaluated. In addition, the CFD model FLOVENT is used to compare measurements with simulation predictions with the aim of developing a simple model for predicting the risk of condensation and mould growth.
STARTDATE: 00:01:1991
EXPECTED TERMINATION DATE: 00:12:1993
ESTIMATED NUMBER OF MAN HOURS: Three years
SELECTED BIBLIOGRAPHY:
1. "Cold Bridging and Mould Growth", SERC,Final report, T.Oreczszyn and J Littler, RIB, PCL, 1989.
2. "Condensation Risk Prediction: The addition of a condensation model to BREDEM", D. Boyd, P Cooper and T. Oreszczyn, Building Serv.Eng.Res. Technol, 9(3) 117-125, 1988.
3. "Cold bridging at corners": surface temperature and condensation risk" T. Oreszczyn. Building Serv.Eng.Res. Technol. October 1988.

REF UK40
TITLE OF PROJECT: Modelling Of Air Movement Within Buildings
PRINCIPAL RESEARCHER: Linden, P F
ORGANISATION: Cambridge University
ADDRESS DAMTP, Silver Street, Cambridge, CB3 9EN. UNITED KINGDOM.
TELE: +44 (0) 1223 337845
FAX: +44 (0) 1223 337918
E-Mail Address: P.F.Linden@ damtp.cambridge.ac.uk
SPECIFIC OBJECTIVES: To model the physics of airflow, driven by natural ventilation in domestic and industrial buildings.
BUILDING TYPE: Domestic, Commercial, "Atria"
COMPONENT TYPE: (None Stated):
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: weather, performance of building components, effects of the heating systems
PROJECT DETAILS Mathematical and small-scale laboratory modelling (using water tanks) to investigate the physical processes relevant to air movement in buildings. Flow visualisation, predictions of flow patterns, measurements of flow velocities and temperature distributions. Development of an "expert-system" for use by architects and ventilation engineers.
STARTDATE: 00:00:1985
EXPECTED DATE OF TERMINATION: Ongoing
ESTIMATED NUMBER OF MAN HOURS: (Not Stated)
SELECTIVE BIBLIOGRAPHY:
1. P F Linden & J E Simpson (1985), Buoyancy driven flow through an open door AIR 6, pp4-5
2. G F Lane-Serff et. al. (1987), Transient flow through doorways produced by temperature differences Proceed.Room Vent 1987 Stockholm
3. P F Linden (1990), Emptying filling boxes: the fluid mechanics of natural ventilation, J Fluid Mech.(SUBMITTED)
4. Linden , P.F., Lane-Serff, G.F. and Penz F (1990), Simulation of natural ventilation in buildings by means of fluid flows applied to the case of Crown and County courts. Proc 2nd European Conf. on Architecture Science and Technology in the Service of Architecture. pp 138-142 Eds. Steems, TC and Plaz W, Kluwer Acadenic Publishers.
5. Baker N and Linden P F (1991), Physical modelling of airflows - a new design tool. Atrium Buildings Architecture and engineering . pp 12-22 Ed F.Mills.
6. Cooper P and Linden P F (19994), Natural ventilation of enclosures containing two sources of buoyancy. J.Fluid Mech.
7. Linden PF and Cooper P (1994), Multiple sources of buoyancy in a naturally ventilated enclosure. J Fluid Mech.
8. Lane-Serff et al (1990), Laboratory and mathematical modelling: the design of a naturally ventilated building. Proc. Conf. Indoor air quality and ventilation in warm climates., pp45-54. Eds F.Lunau and GL Reynolds. Seper.
9. Davies, GMJ and Linden PF (1992), The effects of headwind on buoyancy driven flow through a doorway. Proc. of ROOMVENT 1992, pp419-433.
10. Lane-Serff et al (1991), Laboratory modelling of naturally ventilation via chimneys. Architecture and Urban Space pp 505-510. Eds S Alvarez et al Kluwer Academic Publishers.

REF UK41
TITLE OF PROJECT: Thermal Comfort and Air Quality
PRINCIPAL RESEARCHER : Derek Croome & Guohui Gan
ORGANISATION: University of Reading
ADDRESS Department of Construction Management & Engineering, PO BOX 219, Whitenights, Reading, RG6 2AW

TELE: +44 (0) 1734 318201
FAX: +44 (0) 1734 313856
E-Mail Address:
SPECIFIC OBJECTIVES: Thermal comfort, IAQ, Heating and ventilation strategies and systems
BUILDING TYPE: Offices
COMPONENT TYPE:
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: air velocity, turbulence intensity, air temperature, air change rate, concentration of CO2
PROJECT DETAILS: Experiments carried out in naturally ventilated offices to measure the indoor environmental parameters such as air velocity, turbulence intensity, air temperature, air change rate, and the concentration of carbon dioxide (CO2). Subjective assessment are undertaken to evaluate the thermal comfort and indoor air quality in the offices. The data is used to develop models which can be used to assess the indoor environment of naturally ventilated offices. Potential energy savings for space heating under the UK climate are being assessed. Natural ventilation methods are also being assessed.
STARTDATE: 01:10:1988
EXPECTED DATE OF TERMINATION: 23:04:1995
ESTIMATED NUMBER OF MAN HOURS: (None Stated)
SELECTIVE BIBLIOGRAPHY:
1. Croome DJ et al (1992), Evaluation of thermal comfort and indoor air quality, Proc. of CIB'92 World Building Congress, Montreal: Session 3B, 1992,2,404-406.
2. Croome D J et al (1992), Evaluation of thermal comfort, Proc of World Renewable Energy Congress. University of Reading, 1992.
3. Croome et al (1993), Thermal comfort and air quality in offices, 6th international Conf. on indoor air climate, Helsinki, Finland, 4-8 July, 37-42, 1993

REF UK42
TITLE OF PROJECT: Microwave Heating
PRINCIPAL RESEARCHER: Derek Croome
ORGANISATION: University of Reading
ADDRESS Department of Construction Management & Engineering, PO BOX 219, Whitenights, Reading, RG6 2AW
TELE: +44 (0) 1734 318201
FAX: +44 (0) 1734 313856
E-Mail Address:
SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies
BUILDING TYPE: low energy buildings
COMPONENT TYPE: Building shell
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED:
PROJECT DETAILS The project is a feasibility study on using microwaves for comfort heating in a very low energy building. The advantages of using microwaves in general and for heating of buildings in particular are being studied. The proposed system comprises self-contained microwave-absorbent panels which include special cavities for microwave radiation injection. These panels are incorporated in the shell. Practical features and safety aspects of the systems are a microwave absorbing screen.
STARTDATE:00:00: 1991
EXPECTED DATE OF TERMINATION: Ongoing
ESTIMATED NUMBER OF MAN HOURS: (None Stated)
SELECTIVE BIBLIOGRAPHY:
1. Croome et al (1991), Preliminary investigation into the potential of microwave heating for low energy buildings. Habitat for the 21st Century.
2. Croome D J and Swaid H (1992), Heating of buildings by microwaves, Proc. CIB '92 World Building Congress. Montreal Sessions 3C, 1992, 2, 439-442.
3. Croome D J and Swaid H (1992), Heating of buildings by microwaves, CLIMA 2000 London, 31 October to 3 November, 1993.

REF UK43
TITLE OF PROJECT: Passive building intelligence : night cooling.
PRINCIPAL RESEARCHER : Derek Croome & Claire Bailey
ORGANISATION: University of Reading
ADDRESS Department of Construction Management & Engineering, PO BOX 219,Whitenights, Reading, RG6 2AW, United Kingdom
TELE: +44 (0) 1734 318201
FAX: +44 (0) 1734 313856
E-Mail Address:
SPECIFIC OBJECTIVES: To develop a simple calculation method for the estimation of night Cooling requirement, for a given internal architecture and heat gains.
BUILDING TYPE: (None Stated)
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Cooling
PROJECT DETAILS:
1) To develop a simple calculation method for the estimation of night Cooling requirement, for a given internal architecture and heat gains.
2) To link the above to a quantified review of night cooling options, thus ensuring that, for a given cooling requirement, the solution with the minimum CO2 overhead is selected.
3) To produce a Reading/BRE EnREI Design Guidance Report on the above. Results will be fed into CIBSE guides, Building Regulations, the proposed IEA Annex on innovative cooling and more complex computer modelling systems.
STARTDATE: 01:01:1994
EXPECTED DATE OF TERMINATION: 31:12:1997

ESTIMATED NUMBER OF MAN HOURS: (None Stated)
SELECTIVE BIBLIOGRAPHY: (None Stated)

REF UK44
TITLE OF PROJECT: Thermal Comfort
PRINCIPAL RESEARCHER: Derek Croome
ORGANISATION: University of Reading
ADDRESS Department of Construction Management & Engineering, PO BOX 219, Whitenights, Reading, RG6 2AW,United Kingdom
TELE: +44 (0) 1734 318201
FAX: +44 (0) 1734 313856
E-Mail Address:
SPECIFIC OBJECTIVES: Energy study
BUILDING TYPE: (None Stated)
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Thermal Comfort
PROJECT DETAILS: To establish a new energy strategy for building designers covering technical, social, economic and human issues.
STARTDATE: 01:01:1993
EXPECTED DATE OF TERMINATION: 01:01:1994
ESTIMATED NUMBER OF MAN HOURS: (None Stated)
SELECTIVE BIBLIOGRAPHY: (None Stated)

REF UK45
TITLE OF PROJECT: Personal Ventilation Systems
PRINCIPAL RESEARCHER : Derek Croome & Kathryn McCartney
ORGANISATION: University of Reading
ADDRESS Department of Construction Management & Engineering PO BOX 219, Whitenights, Reading. RG6 2AW. United Kingdom
TELE: +44 (0) 1734 318201
FAX: +44 (0) 1734 313856
E-Mail Address:
SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies Energy impact of ventilation
BUILDING TYPE: Office/Commercial
COMPONENT TYPE: HVAC
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED:
PROJECT DETAILS: User-controlled localised environmental systems (UCLES) can save energy and achieve healthier environments. The advantages of UCLES over conventional air conditioning systems include the provision of personal control, energy savings in use, improved comfort conditions, and a positive impact on productivity at the workplace. UCLES could save as high as 30% of the energy required by convenient systems for providing the same thermal conditions. The comfort patterns produced by UCLES do not always comply with existing comfort standards. Experiments are being conducted with BICC to evaluate their effectiveness.
STARTDATE: 01:09:1993
EXPECTED DATE OF TERMINATION: 31:08:1996
ESTIMATED NUMBER OF MAN HOURS: (None Stated)
SELECTIVE BIBLIOGRAPHY:
1. Croome DJ & Swaid H (1992), Energy and comfort characteristics of User-controlled localised environmental systems (UCLES), Proc. of CIB '92 World Congress, Montreal Session 3B, 1992, 2 400-403
2. Croome DJ & Swaid H (1992), The potential of User-controlled localised environmental systems (UCLES), CLIMA 2000, London 31 October to 3 November
3. Croome DJ & Swaid H (1993) Comparison between the performance of task and zonal environmental control systems in office buildings., 6th International Conf. on Indoor Air Quality and Climate, Helsinki, Finland, 4 to 8 Jul, 5, 461-466 1993.

REF UK46
TITLE OF PROJECT: Air Leakage Identification, Quantification, And Control On Industrial And Commercial Buildings
PRINCIPAL RESEARCHER: Douglas Lawson
ORGANISATION: Building Sciences Ltd,
ADDRESS Birchwood, PO Box 238A, Surbiton, Surrey, KT7 OUA. UNITED KINGDOM.
TELE: +44 (0) 181-398-2390
FAX: +44 (0) 181-390-5580
E-Mail Address:
SPECIFIC OBJECTIVES: Airtightness /air leakage of buildings to customers with comfort, energy or interstituler problems.
BUILDING TYPE: Mainly offices and commercial
COMPONENT TYPE: Windows, Walls, Doors, Whole building shell
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Temperature and wind energy usage, Staff Comfort Reduction infill air contaminants
PROJECT DETAILS: All types of buildings handled, with and without mechanical ventilation. Heating by oil, gas, district hot water, etc. Buildings usually occupied but advisory service available at design stage. Leakage usually visually identified with use of a smoke pencil. If necessary a part of a building (eg an exterior wall office) can be depressurised using our blower door to highlight the air leakage. Having identified all rectifiable leakage cracks, gaps and holes in the envelope an equivalent leakage area is calculated using Ashrae and Public Works Canada formulae. Based on windage only an average air leakage is calculated and using degree days a yearly

cost of leakage is calculated. A cost to rectify is provided and a simple payback period.
STARTDATE: Canada 00:06:1970; UK 00:10:1986
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: Ongoing
SELECTIVE BIBLIOGRAPHY:
1 Ashrae Handbook of Fundamentals.
2 Ashrae Systems Handbook.
3 Public Works Canada Standards and Guidelines EC 128 1980-04-30.

REF UK47
TITLE OF PROJECT: Target room air tightness levels for controlled environment enclosures such as clean rooms, air conditioned rooms, gaseous fire protected rooms etc.
PRINCIPAL RESEARCHER: Douglas Lawson
ORGANISATION: Building Sciences Ltd,
ADDRESS: Birchwood, PO Box 238A, Surbiton, Surrey, KT7 OUA. UNITED KINGDOM.
TELE: +44 (0) 181-398-2390
FAX: +44 (0) 181-390-5580
E-Mail Address:
SPECIFIC OBJECTIVES: Airtightness/air leakage of buildings
BUILDING TYPE: Effective isolation of controlled environment rooms.
COMPONENT TYPE: Windows, Doors, Walls, Complete room envelopes.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Predict and control enclosure envelope leakage to permit:
* Retention of fire fighting gases
* Control of room pressures and limit potential for cross contamination between enclosures
* Control of room environments and limit loss of conditioned air.
PROJECT DETAILS: Enclosures: Areas from 5m2 to 3000m2. All variations in envelope construction.
Ventilation: Varies from no heating/ventilation through to full air supply and extract and air conditioning systems.
Conceptual Approach. Building sciences have conducted air leakage tests on hundreds of controlled environment rooms. The majority failed such tests, sometimes several times and resulted in expensive and time consuming post build remedial sealing and delays to the completion process. This experience together with demands from some clients to avoid such problems in the future has identified a need for an improved method of addressing this matter. Based upon our wide expertise of enclosure tightness levels we have developed a database which permits us to provide the following services to the designers / Builders of such enclosures.
* Based upon required room performance criteria and geometry, provide optimum design air leakage rate.
* design review of envelope at detailed drawing stage, providing comments in related to tightness and recommendations on how details can be upgraded.
* Post build, conduit door fan air leakage testing to ensure compliance with design
Estimation techniques: Analysis of hundreds of room geometry and leakage patterns and leakage prediction equations for the retention of fire fighting gases in enclosures.
Validation: Where out target leakage and envelope design review services have been used enclosures have been built to good airtightness standards and passed subsequent tests.
STARTDATE: 00:06:1991
EXPECTED TERMINATION DATE: 00:05:1992
ESTIMATED NUMBER OF PERSON HOURS: 120
SELECTIVE BIBLIOGRAPHY:
Building sciences Ltd; Publications information on subjects of building/ enclosures air tightness.:
1. Lawson D (1989), Air vapour barriers, Building technology file.
2. Lawson D (1990), Building air leakage, Facility
3. Lawson D (1990), Problems with air leakage, CIBSE.
4. Lawson D (1993), Try to remember to seal the envelope, Energy in Buildings.

REF UK48
TITLE OF PROJECT: Applied research into transfer of odorous air from lower floor fish meat market to upper floor offices.
PRINCIPAL RESEARCHER: Douglas Lawson
ORGANISATION: Building Sciences Ltd,
ADDRESS Birchwood, PO Box 238A, Surbiton, Surrey, KT7 OUA. UNITED KINGDOM.
TELE: +44 (0) 181-398-2390
FAX: +44 (0) 181-390-5580
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Airtightness/air leakage of buildings, Identification and elimination of paths of odour, transfer to offices
BUILDING TYPE: Occupied, Commercial/Office, Offices with market and storage areas below.
COMPONENT TYPE: Walls, Floors, Cracks, Floor slab below offices and all building riser walls.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Indoor air quality impacted by movement of odorous air into offices which could not be let. Identify and control infiltration of market air into offices.
PROJECT DETAILS: Building: Approx. 8000m2, concrete column and beam construction with floors of precast slabs and walls of external brick, unfilled cavity and interior masonry. Internal plaster finish. Concrete roof slab.
Ventilation: Market area warm air heaters and mechanical ventilation via top of lightwells , offices perimeter hot water radiators.

Conceptual Approach. Prior research had eliminated possibility of transfer of odours via air handling systems. It was considered likely that market via was finding its way into the offices via leakage through the building envelope.
An envelope air leakage audit was conducted with a hand held smoke generator to indentify significant areas of leakage. The exterior envelope of the offices was checked to see if the odorous air could be being expelled from the market and be blown back into the offices via a leaky envelope . This area of the envelope was found to be generally tight. Next the plane of the envelope air barrier between the market and the offices was checked including floor slab and all building risers.
It was found that these risers and in particular the lightwells and service risers were pressurised by stack effect and this was driving the odour laden air through all the cracks, gaps and holes in the riser walls. An air leakage report was provided specifying all areas requiring to be sealed. Building Sciences Ltd sealed all riser walls and key riser slabs with specialist air barrier products to ensure lasting tightness.
Validation: Since completion of the retrofit smelling works odours in the office areas have been eliminated and the offices have been let.
STARTDATE: Leakage Audit 00:12:1992
EXPECTED TERMINATION DATE: Sealing Completed 00:12:1993
ESTIMATED NUMBER OF PERSON HOURS: Audit 70 hours; Sealing works 150 hours
SELECTIVE BIBLIOGRAPHY:
Building sciences Ltd; Publications information on subjects of building/ enclosures air tightness.:
1. Lawson D (1989), Air vapour barriers, Building technology file.
2. Lawson D (1990), Building air leakage, Facility
3. Lawson D (1990), Problems with air leakage, CIBSE.
4. Lawson D (1993), Try to remember to seal the envelope, Energy in Buildings.

REF UK49
TITLE OF PROJECT: Impacts of Climatic Change
PRINCIPAL RESEARCHER: Brenda Boardman
ORGANISATION: University of Oxford
ADDRESS: Environmental Change Unit, 1a Mansfield Road, Oxford, OX1 3TB, UNITED KINGDOM
TELE: +44 (0) 1865 281180 / 281183
FAX: +44 (0) 1865 281181
E-Mail Address: ECU @ UK.AC.OXFORD.VAX
SPECIFIC OBJECTIVES: Energy impact of ventilation, Passive cooling systems, Climatic Change
BUILDING TYPE: All
COMPONENT TYPE: HVAC
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Interactions exist between climate, building design and energy use. With global warming, there is the prospect of a positive feedback loop, with increased use of active cooling systems giving rise to further emissions of greenhouse gases that exacerbate climate change.
To limit this potential feedback, designers need to produce buildings that avoid the use of active cooling systems.
However the performance of passive and other low energy cooling systems is very sensitive to climate and therefore, to climatic change. Hence knowledge of the extent of future climatic change and its effect on the performance of different types of building and cooling system is n important component of measures to migrate global warming. The present state of climate modelling is such that it is difficult to predict that changes in he relevant climate variables with the required level of detail or certainty. A further problem in both the prediction of the effects of climate change on building energy consumption and in constraining the use of active cooling systems is that the present growth in air conditioning is often related to socio-economic factors., such as perceptions of prestige, and external conditions, for instance air quality and noise, that override climatic considerations.
By 2050, the average increase in average gobal-mean surface air temperature over the 1990 level is expected to be in the range 1.2-2.6 degrees C, with a best estimate of 1.8 degrees C. The average number of Summer days when the daytime temperature exceeds 27degrees C is estimated to increase from 3 to 8 in Copenhagen, from 13 to 47 in Paris and from 65 to 87 in Madrid. Changes in summertime solar radiation and windspeed are uncertain but are likely to be small. Relative humidity is expected to remain approximately constant. The probability of events that are now considered extreme, such as a hot summer over Europe in 1976, may increase in frequency by as much as 100 fold.
STARTDATE: Ongoing
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTIVE BIBLIOGRAPHY:
1. Mike Hulme et al (1992), Impacts of climate change. Presented to IEA Energy Conservation in Buildings and Community Systems. Future Buildings Forum, Innovative Cooling Systems Workshop. Solihull 12-14 May 1992.

REF UK50
TITLE OF PROJECT: Incorporating a CFD model in a multizone building and plant energy simulation system.

PRINCIPAL RESEARCHER: Clarke, Joe and Cezar, Negrao
ORGANISATION: University of Strathclyde
ADDRESS: Energy Systems Research Unit, 75 Montrose Street, James Weir Building, GLASGOW G1 1XJ. Scotland, United Kingdom
TELE: +44 (0) 141 552 4400 Ext 3986
FAX: +44 (0) 141 552 8513
E-Mail Address: esru@esru.strathclyde.ac.uk
SPECIFIC OBJECTIVES: To extend the ESP-r system to allow the evaluation of non-uniform zone air.
BUILDING TYPE: Any
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Temporal ambient conditions (temperature, wind speed and direction), exposure (pressure coefficients), leakage distribution, and temporal indoor conditions (temperature).
PROJECT DETAILS Since the early 1980's the ESP-r system has been equipped to perform building and plant energy and air flow simulation. In accordance with current modelling practice, the air inside a zone is considered to be perfectly mixed, ie there is no information on temperature gradients or velocities. This project seeks to alleviate this by incorporating a CFD model within ESP-r. The approach corresponds to a hybrid CFD and nodal network approach. The CFD part is able to model the flow field within a domain; the nodal network part links the various domains representing rooms and, potentially, plant components.
STARTDATE 01:01:1992
EXPECTED DATE OF TERMINATION: 01:06:1995
ESTIMATED NUMBER OF PERSON HOURS: 5000 person hours
SELECTED BIBLIOGRAPHY
1. Clarke J.A and Hensen J.L.M (1990), An approach to the simulation of coupled heat and mass flow in buildings. Proc. 11th AIVC Conf. Belgirate.
2. Hensen J.L.M. (1991), On the thermal interaction of building structure and heating and venting system. PhD dissertation Eindhoven University of Technology.
3. Aasem, E., N. Cezar, J.A. Clarke, J.L.M. Hensen, N. Kelly, and J. McQueen 1994. "Current plant and flow modelling potential of the ESP-r simulation environment," in Proc. 4th International Conference on System Simulation in Buildings, Liege, December 5-7, University of Liege. (Abstract submitted)

REF UK51
TITLE OF PROJECT: Ventilation and Asthma.
PRINCIPAL RESEARCHER: Don A McIntyre
ORGANISATION: EA Technology
ADDRESS: Capenhurst, Chester, CH1 6ES. United Kingdom
TELE: +44 (0) 151 347 2308 FAX +44 (0) 151 347 2570
E-Mail Address:
SPECIFIC OBJECTIVES Establish ventilation guidelines for control of house dust mites.
BUILDING TYPE: Occupied, Simulated Occupancy, Dwellings, Test chamber of test structure, (Both test house and field study)
COMPONENT TYPE: Mechanical ventilation
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Humidity house dust mites population and asthma, Ventilation rate, Ventilation system, Weather.
PROJECT DETAILS
1. Measurements are being undertaken in an unoccupied test house with internal humidity generation. Humidity is measured in all rooms and related to ventilation rate, ventilation system and weather.
Results will be generalised using a dynamic model. Guidelines will be produced for recommended ventilation systems in the UK to reduce indoor humidity sufficiently to control house dust mites.
2. EA Technology is cooperating in a clinical trial with Southhampton University and BRE. Temperature , humidity, and dust mite concentration are being recorded in the houses of 40 asthmatics. Balanced mechanical ventilation will be installed in 20 houses. The effect of Mechanical ventilation on dust mites of clinical progress will be monitored for at least 1 year.
STARTDATE 01:07:1993
EXPECTED DATE OF TERMINATION: 01:01:1996
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY (None Stated)

REF UK52
TITLE OF PROJECT: Air movement from sub floor voids and basements into the living space.
PRINCIPAL RESEARCHER: P T McGrath
ORGANISATION: Nottingham Trent University
ADDRESS: Department of Building and Environmental Health, Burton Street, Nottingham, NG1 4BU. United Kingdom
TELE: +44 (0) 1159 418418 FAX:
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, Energy impact of ventilation, Airtightness/air leakage of buildings
BUILDING TYPE: Occupied, Unoccupied, Dwellings, Test chamber of test structure
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated).

PROJECT DETAILS Currently investigating air flow through sub floors as a function of floor type and pressure difference between the two seperated zones.
STARTDATE 01:04:1994
EXPECTED DATE OF TERMINATION: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY (None Stated)

REF UK53
TITLE OF PROJECT: Solar Flue
PRINCIPAL RESEARCHER: Declan Kruppa
ORGANISATION: University of Westminster
ADDRESS: Research in Building, 35 Marlyebone Road, London. NW1 5LS. United Kingdom
TELE: +44 (0) 171 911 5000 ext 3219
FAX: +44 (0) 171 911 5168
E-Mail Address:
SPECIFIC OBJECTIVES: Energy impact of ventilation, Heating and ventilation systems and strategies
BUILDING TYPE: Occupied, Commercial/office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated).
PROJECT DETAILS: Thermal modelling of office block with external glass panels. Glass pannelling attached to outside of office building will form a sunspace, reducing exposure to wind and insulating the offices in winter. During summer the temperatures reached in the sunspace are potentially very high due to solar gains. The top and bottom of the sunspace will be open and so there will be a degree of natural ventilation as air is draw through the sunspace by the stack effect. In addition exhaust air from the offices will be passed into the sunspaces. This should reduce the summer temperatures. The supply air to the offices will pass through ducts which are in the sunspace. This will also be preheating of the supply air in the ducts as they pass through the sunspace which contains exhaust air from the offices.
The research in Building Group are thermally modelling the design in order to calculate the typical temperatures achieved in the building and to advise on shading and ventilation to control the environment. The extra insulation provided by the design should allow the use of a cheaper and less powerful heating system than would be otherwise required.
In addition we are using a computer fluid dynamic simulation of the air flow in the offices out to the external sunspace in order to predict the temperature profile and the typical air flow speeds. The greatest impediment to air flow in the sunspace will be a catwalk which are in the sunspace to allow workers to clean glazing.
STARTDATE: 00:00:1994
EXPECTED DATE OF TERMINATION: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: 500
SELECTED BIBLIOGRAPHY (None Stated)

REF UK54
TITLE OF PROJECT: Extension of Railway Station in Lisbon.
PRINCIPAL RESEARCHER: John Littler
ORGANISATION: University of Westminster
ADDRESS: Research in Building Group, 35 Marlyebone Road, London. NW1 5LS. United Kingdom
TELE: +44 (0) 171 911 5000
FAX: +44 (0) 171 911 5168
E-Mail Address::
SPECIFIC OBJECTIVES Energy impact of ventilation, Use of cooling resource in tunnels and thermal mass.
BUILDING TYPE: Occupied, Railway Station
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated).
PROJECT DETAILS: Design for cooling with minimum energy consumption.
Extension of a railway station involve the addition of considerable extra overhead glazing for natural light. This project was designed to minimse the cooling requirement.
STARTDATE: 00:07:1994
EXPECTED DATE OF TERMINATION: 00:09:1994
ESTIMATED NUMBER OF PERSON HOURS: d
SELECTED BIBLIOGRAPHY (None Stated)

REF UK55
TITLE OF PROJECT: Evaluation of thermal comfort and air quality in offices.
PRINCIPAL RESEARCHER: Croome D J and Gan G
ORGANISATION: University of Reading
ADDRESS: Department of Construction Management and Engineering, Whiteknights, Reading, RG6 2BU. United Kingdom
TELE: +44 (0) 1734 875 123
FAX: + 44 (0) 1734 313 856
E-Mail Address: Hqsgan@Reading.ac.uk
SPECIFIC OBJECTIVES Indoor air movement, IAQ, Energy impact of ventilation, Heating and ventilation systems and strategies
BUILDING TYPE: Occupied, Commercial/Office
COMPONENT TYPE: Windows, Doors, Walls, Floors
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED:
1. Indoor : Air temperature, velocity, turbulence intensity, mean radiant temperature, PMV, PPD, CO2, draught, humidity, air change rate,
2. Outdoor: Wind speed, and direction, air temperature.

PROJECT DETAILS:
Objectives:
1. developments for assessing indoor comfort and air quality based on field measurements.
2. Investigate the potential for saving energy by exploiting some measures to reduce the space heating use
3. Predict the indoor environment using CFD techniques.
Method: (carried out in offices):
1. Physical measurements; Indoor air velocity, turbulence intensity and air temperatures were measured using thermal anemometers. The radiant temperature and air humidity were measured using an indoor climate analyser. PMV and PPD were measured using a comfort meter. CO2 concentrations were monitored using a gas analsyer. Air change rate was determined using the tracer gas analyser (type of tracer gas - C4H10). Wind speed was measured using vane cup anemometers and wind direction using a wind anemometer.
2. Subjective assessment: Occupants' vote on thermal comfort and air movement at head and foot levels as well as for overall comfort. Occupants impressions of odour and air freshness.
3. CFD simulation: A computer program is developed for predicting the indoor environment using the cfd method. The program produces distribution air velocity , turbulence intensity, air temperature, air humidity (vapour pressure) and contaminant concentration. Thus it enables thermal comfort (PMV,PPD and draught) and air quality in spaces to be predicted.
STARTDATE: 01:04:1990
EXPECTED DATE OF TERMINATION: 30:04:1994
ESTIMATED NUMBER OF PERSON HOURS: 10,000
SELECTED BIBLIOGRAPHY:
1. Gan G and Croome D J (1994), Thermal comfort models based on field measurements. ASHRAE Trans. Vol 100 Pt1.
2. Gan (1994), Numerical method for a full assessment of indoor thermal comfort, to be published in Inter. J. of Indoor air quality and Climate.

REF UK56
TITLE OF PROJECT: Ventilation in Dwellings
PRINCIPAL RESEARCHER: Lynn Parkins
ORGANISATION: Building Research Establishment
ADDRESS: Bucknalls Lane, Garston, Watford, Herts, WD2 7JR, United Kingdom
TELE:+44 (0) 1923 664506
FAX: +44 (0) 1923 664088
E-Mail Address:
SPECIFIC OBJECTIVES IAQ, Heating and ventilation systems and strategies
BUILDING TYPE: Occupied, Unoccupied, Dwellings
COMPONENT TYPE: Passive Stack Ventilation
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather, Performance of PSV, Water vapour
PROJECT DETAILS: Monitoring performance of passive stack ventilation systems in occupied dwellings with regard to moisture control.
Monitoring psv systems in test house using different configurations, terminals and sized.
STARTDATE: 00:00:1989
EXPECTED DATE OF TERMINATION: 00:00:1995
ESTIMATED NUMBER OF PERSON HOURS: 4,000
SELECTED BIBLIOGRAPHY:
1. Parkins L M (1991), Experimental passive stack systems for controlled natural ventilation.Proc. CIBSE National Conference, Canterbury, April 1991.
2. Parkins L (1994), Case studies of passive stack ventilation systems in occupied dwellings - to be presented at 15th AIVC Conference, Buxton 1994.
3. Parkins L (1994), A study of various passive stack ventilation systems in a test house - to be presented at 15th AIVC Conference, Buxton 1994.
4. Shepard T, Parkins L and Cripps A (1994), Effectiveness of various means of extract ventilation at removing moisture from a kitchen. - to be presented at 15th AIVC Conference, Buxton 1994.
5. Stephen T, Parkins L and Wolliscroft M (1994), Passive stack ventilation systems - design and installation. BRE Report to be published July 1994.

REF UK57
TITLE OF PROJECT: Modelling of soil gas movement
PRINCIPAL RESEARCHER: Andrew Cripps
ORGANISATION: Building Research Establishment
ADDRESS: Bucknalls Lane, Garston, Watford, Herts, WD2 7JR, United Kingdom
TELE: +44 (0) 1923 664471
FAX: +44 (0) 1923 664088
E-Mail Address: CrippsA@BRE.CO.UKNET
SPECIFIC OBJECTIVES: Improve the protection of buildings against soil gas stress
BUILDING TYPE: Dwellings, Test Chamber or test structure
COMPONENT TYPE: Floors, Cracks, Soil
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Soil permeability,Radon/Methene concentrations.
PROJECT DETAILS: Analytical experimental and computational studies of gas movement in soil and into dwellings.
The next period will look at time dependent effects, particularly with respect to landfill gas sites.
STARTDATE: 00:00:1990
EXPECTED DATE OF TERMINATION: 00:00:1996

ESTIMATED NUMBER OF PERSON HOURS: 1,000
SELECTED BIBLIOGRAPHY
1. Cripps A (1993), Flow rates and pressure distribution produced by radon sumps. 1st International conference on radon remediation. Italy, July 1993.
2. Cripps (1993), Gas flow into voids below timber floors, theory and experiment. Denver USA September 1993.

REF UK58
TITLE OF PROJECT: Internal airflows in the ventilation of non domestic buildings
PRINCIPAL RESEARCHER: Earle Perera
ORGANISATION: Building Research Establishment
ADDRESS: Bucknalls Lane, Garston, Watford, Herts, WD2 7JR, United Kingdom
TELE: +44 (0) 1923 664486
FAX: +44 (0) 1923 664095
E-Mail Address: perera@uk.co.bre
SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies, Energy impact of ventilation
BUILDING TYPE: Commercial/Office, Industrial
COMPONENT TYPE: Windows, Doors
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Single sided ventilation, cross ventilation of deep plan offices
PROJECT DETAILS: The objective of this project is to develop and provide guidance on designing UK non domestic buildings for natural ventilation. This will be achieved through field work on the ventilation performance of naturally ventilated non-domestic buildings, in particular the effectiveness of single sided and cross ventilation efficiencies. Also through design study, specifically assessing current CFD design; and information dissemination through various professional and technical bodies. The output will feed directly into codes and standards at the national and international levels to guides and codes.
STARTDATE: 00:04:1991
EXPECTED DATE OF TERMINATION: 00:03:1995
ESTIMATED NUMBER OF PERSON HOURS: Four man years
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK59
TITLE OF PROJECT: Ventilation efficiency and indoor air quality strategies to minimse energy liabilities.
PRINCIPAL RESEARCHER: Richard Walker
ORGANISATION: Building Research Establishment
ADDRESS: Bucknalls Lane, Garston, Watford, Herts, WD2 7JR, United Kingdom
TELE: +44 (0) 1923 664469
FAX: +44 (0) 1923 664095
E-Mail Address: walker @uk.co.bre
SPECIFIC OBJECTIVES: Indoor air quality, Energy impact of ventilation systems and strategies
BUILDING TYPE: Commercial/Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Energy conservation, CO2 concentrations, ventilation strategies
PROJECT DETAILS: The objective of this programme is (a) to assess the energy liabilities of strategies to optimise ventilation with good indoor air quality and (b) to investigate the influence of design factors affecting the distribution of fresh outside air supply in naturally ventilated buildings. The work addresses the validity of using sensory evaluation of IAQ in buildings to guide ventilation rates and materials selection, and involves field measurements and modelling of local ventilation rates. The work will contribute to design guidance on strategies for optimum ventilation and is directly relevant to meeting the UK target for reduced CO2 emissions to CEN standards activities.
STARTDATE: 00:04:1994
EXPECTED DATE OF TERMINATION: 00:03:1997
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK60
TITLE OF PROJECT: Energy efficient ventilation of large buildings
PRINCIPAL RESEARCHER: Richard Walker
ORGANISATION: Building Research Establishment
ADDRESS: Bucknalls Lane, Garston, Watford, Herts, WD2 7JR, United Kingdom
TELE: +44 (0) 1923 664469
FAX: +44 (0) 1923 664095
E-Mail Address: walker @uk.co.bre
SPECIFIC OBJECTIVES: Indoor air quality, IAQ, Heating and ventilation systems and strategies
BUILDING TYPE: Industrial/factory
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Thermal environment, energy consumption, excessive ventilation
PROJECT DETAILS: The objectives of this project are (a) to assess and develop methods of applying measurement and prediction procedures to the problem of ventilation and contaminant transport in large enclosures and , (b) to develop design guidance by carrying out measurements and applying prediction procedures to case studies. Monitoring of the new Engineering Building at De Montfort University represents an ideal opportunity to achieve these goals. Design guidance on atria and energy use performance modelling of a factory will also be addressed.
STARTDATE: 00:04:1993
EXPECTED DATE OF TERMINATION: 00:03:1996

ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK61
TITLE OF PROJECT: Natural ventilation of Non domestic buildings in urban areas and city centres
PRINCIPAL RESEARCHER: Earl Perera and Vina Kukadia
ORGANISATION: Building Research Establishment
ADDRESS: Bucknalls Lane, Garston, Watford, Herts, WD2 7JR. United Kingdom
TELE: +44 (0) 1923 664486/4878
FAX: +44 (0) 1923 664095
E-Mail Address: perera@UK.CO.BRE
SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies, External contamination, Airtightness/Air leakage of buildings
BUILDING TYPE: Commercial/Office
COMPONENT TYPE: Windows, doors, ducts
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: External air pollution, noise, energy consumption, air tightness
PROJECT DETAILS: The project is aimed at obtaining and disseminating information on strategies and methodologies for the design of naturally ventilated non domestic buildings, like offices in urban areas and city centres where, at present, the external environment constrains such design. The work will consist of field measurements with a string input from industry , design and prediction studies using state of the art procedures and wind tunnel facilities, and on going dialogue and interactions with building professional thereby ensuring the needs of the industry are being met.
STARTDATE: 00:04:1994
EXPECTED DATE OF TERMINATION: 00:03:1997
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK62
TITLE OF PROJECT: The validation and application of a model to assess infiltration energy loss in factory buildings.
PRINCIPAL RESEARCHER: Phil Jones and G Powell
ORGANISATION: University of Wales College of Cardiff
ADDRESS: Welsh School of Architecture, Bute Building, King Edward VII Avenue, Cardiff, Wales, CF1 3AP. United Kingdom
TELE: +44 (0) 1222 874078
FAX +44 (0) 1222 874192
E-Mail Address:
SPECIFIC OBJECTIVES: Energy Impact of Ventilation, Airtightness / air leakage of buildings, Validation and application of a model that uses air, leakage data to predict air infiltration rates of factories under varying climatic conditions.
BUILDING TYPE: Unoccupied, Industrial/factory
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Wind speed, wind direction, internal and external air temperatures.
PROJECT DETAILS: The aim of this project is to use previously collected data to validate a model (BREAIR) that uses the results from fan pressurisation testing to predict the air infiltration rate performance of a factory without the need for tracer gas testing. One of the objectives is to establish a consistent procedure for assigning the leakage distribution without too much in-depth knowledge of the building being studied.
After validation it is proposed to use the model to predict the air infiltration rate performance of several classes of building found in the UK factory stock to estimate the energy impact of ventilation reduction measures in the UK factory stock.
Validation data:The Welsh School of Architecture has approximately 10-12 case studies of factories for which constant concentration, tracer decay and air leakage test results are available. The majority of the case studies were performed under a previous BRE contract "Infiltration Rates of Large Single Celled Buildings". Other case studies have come from previous WDA/ETSU and WDA/BRITISH GAS/ROCKWOOL work. The buildings are in the volume range 300m3 to 1500m3 and are of mostly cladding construction. For each case study, there is 2-3 weeks of constant concentration data (N2O), together with r=tracer decay tests on selected ventilation options , ie extract fans on door open etc. Pressurisation tests have also been performed in each case study.
Equipment: Most tracer gas studies have been performed with BRITISH GAS "autovent" system. Most recent work has been performed with an automated tracer gas system developed at the Welsh School of Architecture. Pressurisation tests have been performed using a 4 fan system developed at the Welsh School of Architecture.
STARTDATE: 01:02:1994
EXPECTED TERMINATION DATE: 01:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 560
SELECTED BIBLIOGRAPHY:
1. BRE Digest 210 "Principles of natural ventilation" 1978
2. BRE Digest 346 " Assessment of wind loads" 1992.
3. CIBSE Guides Vols A and B

REF UK63
TITLE OF PROJECT: Development of ventilation guidelines for industrial buildings.
PRINCIPAL RESEARCHER: Phil Jones and G Powell

ORGANISATION: University of Wales College of Cardiff
ADDRESS: Welsh School of Architecture, Bute Building, King Edward VII Avenue, Cardiff, Wales, CF1 3AP. United Kingdom
TELE: +44 (0) 1222 874078
FAX +44 (0) 1222 874192
E-Mail Address:
SPECIFIC OBJECTIVES: To develop advice / guidelines for architects concerning naturally ventilated factories.
BUILDING TYPE: Unoccupied, Industrial/factory
COMPONENT TYPE: Doors (Main loading Door), Roof Vents, Extract fans
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: General climate conditions,
PROJECT DETAILS: The project is a continuation of work performed in collaboration with the WDA concerning modern factories. The aims of the project are:
* to review ventilation requirements for modern factories.
* to review results of measurements performed in factories.
* to carry out predictions of ventilation performance in winter and summer conditions.
* to provide guidelines on industrial ventilation.
Constant concentration (N2O tracer), tracer decay and air leakage tests have been performed in a number of factories of different sizes and construction. Tracer gas tests have been performed in a number of factories with British Gas autovent system (12 channels), and also a 10 channel automated tracer gas system built by the Welsh School of Architecture. Air leakage tests have been performed using a 4 fan pressurisation test rig built at the Welsh Sc. of Arch. The model used for the predicative work is HTB2 which now incorporates a ventilation module.
STARTDATE: 01:06:1993.
EXPECTED TERMINATION DATE: 31:05:1994
ESTIMATED NUMBER OF PERSON HOURS: 480 (60 man days x 8 hours)
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK64
TITLE OF PROJECT: Fluctuating air flows through building cracks
PRINCIPAL RESEARCHER: Steve Sharples
ORGANISATION: University of Sheffield
ADDRESS: Building Science Research Unit, School of Architectural Studies, PO BOX 595, The Arts Tower, Sheffield, S10 2UJ, United Kingdom
TELE: +44 (0) 1142 824713
FAX +44 (0) 1142 798276
E-Mail Address:
SPECIFIC OBJECTIVES: Airtightness/air leakage of buildings
BUILDING TYPE: Test chamber or test structure
COMPONENT TYPE: cracks
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED:
(a) Weather (wind fluctuations)
(b) Performance of building components (cracks)
PROJECT DETAILS: The projects major aim is to determine experimentally flow equations for fabricated building - type cracks subjected to fluctuating pressure differentials. In parallel, attempts will be made to model the crack-fluctuating flow regime using the CFD code FLOWVENT. Measurements are being made on cracks mounted on the side of a 1m3 box. Fluctuating pressures are being generated by rotating a damper within a duct connected to a constant speed fan. Flows are measured with either orifice plates of furnace controls laminar flow devices. The damper is driven , via a stepper motor by 1 0-10V sinusoidal signal generator. The instantaneous pressure drop across the crack and the corresponding flow will be recorded. It is hoped to develop relationships between the steady-state flow equation of a crack and its fluctuating flow equation for a range of frequencies corresponding to those observed in the natural wind.
STARTDATE: 01:01:1994
EXPECTED TERMINATION DATE: 31:07:1995
ESTIMATED NUMBER OF PERSON HOURS: 3040
SELECTED BIBLIOGRAPHY:
1. Baker P H et al (1987), Air flow through cracks, Bldg and Environ. 22.
2. Sahin B et al (1988), ventilation generated by fluctuating pressure differential. Proc 9th AIVC Conf.
3. Haghight, F et al (1992) Modelling fluctuating airflow through large openings. 13th AIVC Conf.
4. Sharples S and Palmer R G (1994), Fluctuating air flows through building cracks. Proc AIVC 15th Conf. 1994 .

REF UK65
TITLE OF PROJECT: The effect of the Indoor Environment on Productivity.
PRINCIPAL RESEARCHER: Tim Whitley
ORGANISATION: EA Technology and The School of Management, UMIST
ADDRESS: Capenhurst, Chester, CH1 6ES, United Kingdom
TELE: +44 (0) 151 347 3489
FAX +44 (0) 151 347 2570
E-Mail Address: tdw@EATL.CO.UK
SPECIFIC OBJECTIVES: IAQ, Effect of IAQ on performance and behaviour of office workers.
BUILDING TYPE: Occupied, Commercial/Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS:

IAQ to be related to the behaviour and hence performance and productivity of office workers.
IAQ to include indoor temperature, humidity, dust, and possibly VOC's.
Self report of IAQ and productivity to be circulated.
behavioural checklist or performance related behaviour to be developed to specific work being monitored.
The effect of mediating/moderating personality variables as well as organised climate and culture.
STARTDATE: 00:10:1993
EXPECTED TERMINATION DATE: 00:10:1996
ESTIMATED NUMBER OF PERSON HOURS: 5400
SELECTED BIBLIOGRAPHY:
1. Kroner et al (1992), Rensselaers West Bend Mutual Study: Using Advanced office technology to increase productivity. New York: The centre for Architectural Research.

REF UK66
TITLE OF PROJECT: Modelling water vapour conditions in a furnished unoccupied dwelling.
PRINCIPAL RESEARCHER: L Serive Mattei; M Kolokotroni and J Littler
ORGANISATION: University of Westminster
ADDRESS: Research in Buildings Group, 35 Marylebone Road, London NW1 5LS, United Kingdom
TELE: +44 (0) 171 911 5000 ext. 3162
FAX +44 (0) 171 911 5168
E-Mail Address: SERIVL@WESTMINSTER.AC.UK
SPECIFIC OBJECTIVES: Indoor air movement, Moisture mould generation and prevalence
BUILDING TYPE: Unoccupied, Dwellings
COMPONENT TYPE: Doors, Walls
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Moisture content - adsorption/desorption process
PROJECT DETAILS:
The project is based on the empirical equation developed by the BRE to predict water vapour conditions in buildings. This equations uses 2 coefficients alpha and Beta, to take account of absorption and desorption of moisture by walls and furniture.
The aim of the project is to measure the coefficients alpha and beta in an unoccupied furnished dwelling, and to show whether an experimental procedure called "Dynamic Equilibrium Conditions". can be used to establish these coefficients for a range of situations.
The project encompasses:
* Measurements in unoccupied dwellings (heavyweight masonry)
* use of equilibrium conditions to determine alpha +and beta
* Calculation of the best couple alpha and beta for each case
* Comparison of measurements and predictions using the selected alpha and beta and statistical tests.
* Guidelines for insitu experiments
* Comments on the validity of the admittance model compared to previous ones.
* Ventilation tests done with SF6 and B&K 1302.
STARTDATE: 00:09:1992
EXPECTED TERMINATION DATE: 00:03:1993
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Serive Mattei et al (1993), Moisture Admittance model: measurements in a furnished dwelling. 14TH AIVC Conference. Denmark.
2. Serive Matteri et al (1994), Modelling water vapour conditioned in a furnished unoccupied dwelling Final report to BRE. UK

REF UK67
TITLE OF PROJECT: Modelling water vapour conditions in Dwellings (2)
PRINCIPAL RESEARCHER: L Serive Mattei, J Littler
ORGANISATION: University of Westminster
ADDRESS: Research in Buildings Group, 35 Marylebone Road, London. NW1 5LS United Kingdom
TELE: +44 (0) 171 911 5000 ext. 3162
FAX +44 (0) 171 911 5168
E-Mail Address: SERIVL@WESTMINSTER.AC.UK
SPECIFIC OBJECTIVES: Indoor air movement, Moisture mould generation and prevalence
BUILDING TYPE: Unoccupied, Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Moisture content - adsorption/desorption process.
PROJECT DETAILS: Aims : Following a previous project conducted in the same field , the study aims at :
* determining alpha and beta for 2 types of building construction under winter and summer conditions.
* Develop mathematical program to deduce alpha and beta from optimised curve-fitting.
Field Measurements: Brick students hall of residence plus 1980's masonary house. In summer and Winter. Both natural ventilation, heating provided by fan heater,
temperature and RH recorded.
ACH measured with SF6 and B&K 1302
Analysis. Fortran program: written to compute data and optimize curve fitting based on least square method. Comparison of measurement/prediction . Determination of root mean square error and mean deviation.
STARTDATE: 00:09:1993
EXPECTED TERMINATION DATE: 00:04:1994
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)

SELECTED BIBLIOGRAPHY: (None Stated)

REF UK68
TITLE OF PROJECT: Improved fresh air control.
PRINCIPAL RESEARCHER: Kevin Pennycook
ORGANISATION: BSRIA
ADDRESS: Old Bracknell Lane West, Bracknell, Berkshire, RG12 7AH United Kingdom
TELE: +44 (0) 1344 426511
FAX +44 (0) 1344 487575
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Heating and Ventilation Systems and Strategies
BUILDING TYPE: Commercial Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Objective: to use BEMS (Building Energy Management Systems) to improve the level of fresh air control in an air handling unit.
Testing: Following a literature search and analysis of published data, laboratory tests were performed on an air handling unit that incorporated three flow rate control dampers (fresh air inlet, exhaust and recirculation). A range of damper sizes and types were included in the test programme.
To determine the effects of understanding, oversizing and flow rate control charcterisates on performance. Alternative control strategies were examined and recommendations made based on results.
STARTDATE: 00:05:1992
EXPECTED TERMINATION DATE: 00:03:1994
ESTIMATED NUMBER OF PERSON HOURS: 1700
SELECTED BIBLIOGRAPHY:
1. CO2 Controlled Ventilation Systems. TN12/94
2. Building Air tightness and ventilation : an overview of international practice. TN5/86 .
3. Ventilation heat loss in factories and warehouse. TN 7/92
4. Displacement Ventilation Performance - office space application. TN3/93
5. Design Guidelines for exhaust hoods. TN 3/85
6. Buildings and Health Database. EM.
7. Opportunities in indoor air quality. SR 102641/1
8. Specification of indoor environmental performance of buildings.
9. Design Guidelines for exhaust hoods. TN 3/85.
10. A laboratory study of the downward displacement systems of ventilation in operating theatres. LR 19.
11. A study of the natural ventilation of tall office buildings. LR 53.

REF UK69
TITLE OF PROJECT: Indoor air quality sensors.
PRINCIPAL RESEARCHER: Kevin Pennycook
ORGANISATION: BSRIA
ADDRESS: Old Bracknell Lane West, Bracknell, Berkshire, RG12 7AH. United Kingdom
TELE: +44 (0) 1344 426511 FAX +44 (0) 1344 487575
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ
Objective: To determine the effectiveness and practical implications of adopting IAQ sensors for the control of fresh air supplies in buildings.
BUILDING TYPE: (None Stated)
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Laboratory trials with 5 sensors to determine their sensitivity and recovery characteristic when exposed top different pollutants. These are being followed by tests to determine the impact of IAQ sensors on indoor air quality and energy consumption.
STARTDATE: 00:05:1992
EXPECTED TERMINATION DATE: 00:11:1994
ESTIMATED NUMBER OF PERSON HOURS: 1675
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK70
TITLE OF PROJECT: Refurbishment of air conditioned Buildings.
PRINCIPAL RESEARCHER: Jill Brown
ORGANISATION: BSRIA
ADDRESS: Old Bracknell Lane West, Bracknell, Berkshire, RG12 7AH United Kingdom
TELE: +44 (0) 1344 426511
FAX +44 (0) 1344 487575
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy Impact of ventilation
BUILDING TYPE: Commercial/Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Objectives: Phase I : To provide examples by case studies of the implementation of natural ventilation in buildings originally designed with natural mechanical cooling.
Phase II: To provide guidance on the design and implementation of natural ventilation for refurbishment projects.
Phase I work programme include:
* Literature Search
* Assessment of refurbishment policies/procedures used.
* Site monitoring / Assessment.
* Production and publication of case study material
STARTDATE: 00:04:1993
EXPECTED TERMINATION DATE: 00:03:1997
ESTIMATED NUMBER OF PERSON HOURS: 3000

SELECTED BIBLIOGRAPHY: (None Stated)

REF UK71
TITLE OF PROJECT: Control of Natural Ventilation
PRINCIPAL RESEARCHER: A J Martin
ORGANISATION: BSRIA
ADDRESS: Old Bracknell Lane West, Bracknell, Berkshire, RG12 7AH. United Kingdom
TELE: +44 (0) 1344 426511
FAX +44 (0) 1344 487575
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor Air Movement, IAQ, Energy Impact of Ventilation
BUILDING TYPE: Commercial/Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS:
Objective: To provide guidance on the control of natural ventilation.
Scope: Manual / passive and automatic means of control. Following an extensive literature search, consultations were made with design engineers equipment suppliers, (ventilation hardware and control systems) contractors and major building owners/operators.
Comprehensive industry guidance will be published concerning:
* Ventilation hardware
* Sensors / Actuators
* Control strategies
* Mixed mode buildings
* Case studies (3)
STARTDATE: 00:04:1993
EXPECTED TERMINATION DATE: 00:03:1995
ESTIMATED NUMBER OF PERSON HOURS: 1800
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK72
TITLE OF PROJECT: Air filters Application Guide
PRINCIPAL RESEARCHER: P G Pike
ORGANISATION: BSRIA
ADDRESS: Old Bracknell Lane West, Bracknell, Berkshire, RG12 7AH United Kingdom
TELE: + 44 (0) 1344 426511
FAX + 44 (0) 1344 487575
E-Mail Address:
SPECIFIC OBJECTIVES: IAQ, Energy Impact of Ventilation
BUILDING TYPE: Commercial/Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Objective: To produce authoritative practical guidance on the application of air filters in the HVAC industry.
The selection and specification procedure will be in the form of a cost/benefit analysis, weighing the cost of implementing the filtration against the benefits which be expected to accrue.
STARTDATE: 00:04:1994
EXPECTED TERMINATION DATE: 00:03:1996
ESTIMATED NUMBER OF PERSON HOURS: 1700
SELECTED BIBLIOGRAPHY: (None Stated)

REF UK73
TITLE OF PROJECT: Ventilation and Asthma (1)
PRINCIPAL RESEARCHER: Don A McIntyre
ORGANISATION: E A Technology
ADDRESS: Energy and Buildings Division, Capenhurst, Chester, CH1 6ES. UNITED KINGDOM.
TELE:+44 (0) 151 347 2308
FAX: +44 (0) 151 347 2570
E-Mail Address:
SPECIFIC OBJECTIVES: The effect of mechanical ventilation on humidity and dust mites.
BUILDING TYPE: Occupied, Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Internal and external humidity, Use of mechanical ventilation, Abundance of house dust mites.
PROJECT DETAILS: This is a joint Dept of Child Health, Southampton (Dr Jill Warner) and Buildings Research Establishment (Dr Gary Raw) collaboration.
EA Technology contribution: Install mechanical ventilation in 20 homes occupied by asthmatics. Monitor bedroom temperature and humidity in 20 homes plus 20 controls.
BRE: Take the dust samples from mattress and carpets and count house dust mites.
Southampton: Recruit subjects and monitor lung function and other indicators.
Hypothosis: Continuous ventilation throughout winter reduces indoor humidity and so reduces house dust mite numbers. This results in lower levels of allergen and improved health of asthmatics.
Other IAQ and health issues are addressed in this study, but not by EA technology.
STARTDATE: 00:07:1993
EXPECTED TERMINATION DATE: 00:01:1996
ESTIMATED NUMBER OF PERSON HOURS: 3000 (by EA technology)
SELECTED BIBLIOGRAPHY:
1. Colloff M J et al (1992), Control of allergies of dust mites and domestic pets. a position paper. Clinical and experimental Allergy. 22 Sept 2 p1-28 1992.
2. McIntrye D (1992), Ventilation and house dust mites - a pilot study. EA Tech. R 2733 July 1992

3. International Workshop Report. Dust mites Allergies and Asthma - A world wide problem. J. Allergy Clin Immunol 83, 416-427, 1989.

REF UK74
TITLE OF PROJECT: Ventilation and Asthma
PRINCIPAL RESEARCHER: Don A McIntyre
ORGANISATION: EA Technology Ltd.,
ADDRESS: Energy and Buildings Division, Capenhurst, Chester, CH1 6ES. UNITED KINGDOM
TELE: +44 (0) 151 347 2308 FAX: +44 (0) 151 347 2570
E-Mail Address:
SPECIFIC OBJECTIVES: Control of humidity by ventilation, Heating and ventilation systems and strategies
BUILDING TYPE: Simulated Occupancy
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Internal and external humidity, Internal moisture generation, ventilation strategy
PROJECT DETAILS: Study based on ET Technology ventilation test house.
Aim: To produce ventilation guidelines for the control of humidity to reduce house dust mites, as a function of moisture generation and local climate.
Moisture transport and room by room humidities in the test house are measured., Independent variables: Moisture generation, Rate and type of ventilation , weather.
Ventilation types: (mechanical ventilation with heat recovery) MVHR, (passive stack ventilation) PSV, Extract fans.
Measured results will be compared with available models to extend and generalise findings to other parts of the UK.
STARTDATE: 00:04:1993
EXPECTED TERMINATION DATE: 00:03:1995
ESTIMATED NUMBER OF PERSON HOURS: 5000
SELECTED BIBLIOGRAPHY:
1. The Capenhurst ventilation test house. D A McIntrye, SL Palin, RE Edwards. 15th AIVC Conf. Buxton, September 1994.

2.13 UNITED STATES OF AMERICA

REF USA01
TITLE OF PROJECT: Attic Performance Project.
PRINCIPAL RESEARCHER: William B Rose.
ORGANISATION: Building Research Council, University of Illinois,
ADDRESS: 1 E St. Mary's Road, Champaign IL, 61820 USA.
TELE: +1 217 333 1801 FAX: +1 217 244 2204
E-Mail Address:
SPECIFIC OBJECTIVES: Determine heat and moisture performance at attics. Energy impact of ventilation. Airtightness/air leakage of buildings. Moisture mould generation and prevalence.
BUILDING TYPE: Unoccupied. Dwellings. Test chamber or test structure.
COMPONENT TYPE: Cracks.
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Weather, construction components and assemblies.Results focus on component temperature and moisture content.
PROJECT DETAILS: The aim of the Attic performance Project is to monitor the performance of typical residential attic and cathedral ceiling assemblies under natural conditions. A laboratory of 160m2 with eight study bays was constructed in 1989. The laboratory is instrumented to measure weather, air temperature, surface temperatures, air humidity, moisture content of wood materials, air speed at openings, pressure differences, heat flux and energy consumption. Hourly values of these conditions have been gathered since 1991. The results are used to determine the impact of several construction variables on the temperature and moisture performance of the assemblies. The principal construction variables include ventilation of the attic cavity, airtightness of the ceiling plane, framing configuration and insulation placement.
The results are used to provide accurate and precise field data for model validation and to help develop construction guidelines.
Additional work under this project involves development of a method and apparatus for testing equivalent net free area of vent devices and development of a moisture flux sensor.
The project receives major funding from Certain Teed Corporation.
STARTDATE: Construction 1989, verification 1990, data collection began in 1991
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: 3000
SELECTED BIBLIOGRAPHY:
1. "Conditions for Mold Growth in Vaulted Ceilings" Buildings and the Environment, CIB Task Group 8 Environmental Assessment of Buildings, Garston, Watford, UK May 1994.
2. "A Review of Field Thermal Performance of Loose-Fill Insulation in Residential Attics and Cathedral Ceilings." William B Rose and David McCaa PhD. 22nd International Thermal Conductivity Conference, Tempe AZ, November 7, 1993. Proceedings Publication.
3. "Energy Effects of Attic Construction" 14th Air Infiltration and Ventilation Centre Conference, Copenhagen, September 1993. Proceedings publication.
4. "Measured Values of Temperature and Sheathing Moisture Content in Residential Attic Assemblies",

PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: Development of multizone air flow model COMIS, evaluation of model based on experimental data, development of user friendly interface.
Task shared annex, Participants are Belgium, Canada, France, Italy, Japan, Greece, Switzerland, The Netherlands, People's Republic of China, USA.
STARTDATE: 00:10:1990
EXPECTED TERMINATION DATE: 00:03:1996
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. COMIS Fundamentals, AIVC TN 29, 1990.
2. COMIS User guide, AIVC, Special Public last Update Ocober 1993.
3. Proceedings "International Symposium Air Flow in Multizone Structures"University of Budapest, Hungary, September 1992.

REF USA12
TITLE OF PROJECT: Computer Modelling Of Air Movement In Slot-Ventilated Enclosures.
PRINCIPAL RESEARCHER: Albright, Louis D
ORGANISATION: Cornell University,
ADDRESS 206 Riley-Robb Hall, Ithaca, NY 14853, USA.
TELE: 607-255-2483
FAX 607-255-4080
E-Mail Address: ldal@cornell.edu (bitnet)
SPECIFIC OBJECTIVES Develop analysis method to use as a tool for designing ventilation systems in slot-ventilated agricultural buildings.
BUILDING TYPE: Slot-ventilated animal housing barns and greenhouses
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: k-epsilon
PROJECT DETAILS: The k-epsilon model of turbulence transport is being used. Effects of obstructions within a ventilated space, nonisothermal ventilation jets, and boundary conditions are being investigated to develop a workable computer model that predicts airflows that compare well with experimental data.
STARTDATE: 00:00:1983
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: (Not Stated)
SELECTED BIBLIOGRAPHY:
1.Choi H L et al (1988), An application of the k-epsilon turbulence model to predict air distribution in a slot- ventilated enclosure. Trans. of the ASE. 31(6):1804-1814.
2.Choi H L & Albright L D (1989), Modelling the effects of obstructions in slot ventilated enclosures. Proceedings of the symposium Building Systems: Room Air and Air Contaminant distribution. Am. Soc. Htg. Refrig. and Air Cond. Engrs. (ASHRAE). Atlanta, GA pp127-130
3.Saunders D and Albright L D (1989), A quantitative air mixing visualisation techniques for two dimensional flow using aerosol tracers and digital imaging analysis. Proceedings of the symposium Building Systems: Room Air and Air Contaminant distribution. Am. Soc. Htg. Refrig.and Air Cond. Engrs. (ASHRAE). Atlanta, GA pp 84- 87
4.Choi H L et al (1990), An application of the k-epsilon turbulence method to predict how a rectangular obstacle in a slot ventilated enclosure affects air flow. Trans. ASAE 33(1):174-281.

REF USA13
TITLE OF PROJECT: Indoor Air Pollution Exposure Assessments.
PRINCIPAL RESEARCHER: Traynor, Greg
ORGANISATION: Lawrence Berkeley Laboratory,
ADDRESS: 1 Cyclotron Rd, MS:B44B, Berkeley, CA 94720, USA.
TELE: +1 (415) 486 5729
FAX + 1 (415) 486 6658
E-Mail Address: GWTraynor@LBL.GOV
SPECIFIC OBJECTIVES To assess, via measurements and modelling, indoor air pollution concentrations and the factors that affect these concentrations.
BUILDING TYPE: Residences
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Volume, specific leakage area, appliance usage rates, appliance emission rates, outside temperature and wind speed, misc. energy parameters.
PROJECT DETAILS The factors that affect indoor air pollution concentrations, based on experimental research, can be mathematically combined to predict indoor air pollution levels. Initial research has concentrated on indoor concentrations of combustion-generated pollutants because of the existence of source usage information and models. Future work will address the sensitivity of the model to various input factors and will expand the model to include other important indoor pollutants.
STARTDATE: 00:00:1986
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: (Not Stated)
SELECTED BIBLIOGRAPHY
1 Traynor G W et. al. (1988), The effects of infiltration and insulation on the source strengths and indoor air pollution from combustion space heating appliances, JAPCA 38: 1011-1015, 1988.
2 Traynor G W et. al. (1989), Macromodel for assessing residential concentrations of combustion-generated pollutants: Model Development and Preliminary Predictions for CO,

NO2 and Respirable Suspended Particles,. LBL-25211, Lawrence Berkeley Laboratory, Berkeley, CA

REF USA14
TITLE OF PROJECT Measurements Of Moisture Permeability And Equilibrum Moisture Content Of Common Building Materials In The United States
PRINCIPAL RESEARCHER: Kuehn, Thomas H & Ramsey, James W
ORGANISATION: University of Minnesota,
ADDRESS: Dept of Mechanical Engineering, 111 Church Street SE, Minneapolis, MN 55455-0111, USA.
TELE: +1 612-625-4520
FAX: +1 612-625-6069
EMail Address: kuehnool@maroon.TC.umn.edu
SPECIFIC OBJECTIVES To measure moisture permeability and equilibrium moisture content of common building materials in the US.
BUILDING TYPE: Interior construction materials
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Moisture adsorption-desorption, transient moisture storage in building materials.
PROJECT DETAILS A new moisture permeability chamber has been designed and constructed to obtain moisture permeability measurements under both isothermal and non isothermal conditions. Each side of the test specimen maintained at a set humidity level. Initial tests are being performed for isothermal conditions with gypsum board. Later tests have been conducted under temperature and moisture concentration gradients. An equilibrium moisture apparatus has also been constructed to measure the equilibrium moisture content of typical building materials and to serve as a pre-conditioning chamber for the permeability tests.
STARTDATE: 00:01:1987
EXPECTED DATE OF TERMINATION: 00:12:1995
ESTIMATED NUMBER OF PERSON HOURS: 3000 person-hours
SELECTED BIBLIOGRAPHY:
1. Douglas J (1991), Determination of moisture properties for common building materials: Methods and measurements.MS Thesis, University of Minnesota.
2. Douglas et al (1992), A new moisture permeability measurement method and representative teat data. ASHRAE Trans vol 98, pt2 .
3. Douglas et al (1993), An improved Moisture permeability measurement method. Journal of testing and evaluation . JTEVA, Vol21 No. 4 pp302 - 308 (1993).
4. Dahl SD (1993), Determination of the moisture storage and transport properties of common building materials. MS Thesis, University of Minnesota. typical residential akp0LNevx,.?AWDFFW'b X4iN/'bb"]

REF USA15
TITLE OF PROJECT Control of Bioaerosols in buildings.
PRINCIPAL RESEARCHER: Kuehn, Thomas H
ORGANISATION: University of Minnesota,
ADDRESS: Dept of Mechanical Engineering, 111 Church Street SE, Minneapolis, MN 55455-0111, USA.
TELE: +1 612-625-4520
FAX: +1 612-625-6069
E-Mail Address: kuehnool@maroon.TC.umn.edu
SPECIFIC OBJECTIVES: Control viable bioaerosol concentrations in buildings, IAQ
BUILDING TYPE: Occupied, Dwellings, Commercial/Office, Test Chamber of test structure
COMPONENT TYPE: Filters
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Filtering, temperatures and humidity levels.
PROJECT DETAILS: Several projects have been conducted on the control of bioaerosols in buildings. One project measured the filtration efficiency of an electronic air cleaner and two types of bag filters. Efficiencies on viable fungal spores and bacteria were measured with 100% outdoor air for one year, air reciruculated in an environmental chamber at 21 degrees C and 90% Relative Humidity, for one year, a bag filter in a commercial building for one year and an electronic air cleaner in a residence for one year. Conditions necessary for fungal and bacterial growth on filters was also investigated by periodic challenges of fungal spores and bacteria onto clean filters. In another study, the control of virus aerosol in indoor air was investigated. Sampling techniques, identification methods and control options were reviewed, other studies include the impact of construction and rennovation activities on indoor air quality and the effectiveness of various duct cleaning techniques on the control of moulds and fungi.
STARTDATE: 00:09:1990
EXPECTED DATE OF TERMINATION: 00:09:1995
ESTIMATED NUMBER OF PERSON HOURS: 3000 person-hours
SELECTED BIBLIOGRAPHY:
1. Berg C (1991), Matching Filtration to health requirements. MS Thesis, University of Minnesota, 1991.
2. Kuehn TH et al (1991), Matching Filtration to health requirements, ASHRAE Trans. Vol97, Pt 2 (1991).

3. Kemp et al (1993), Filter collection efficiency and growth of microorganisms on filters loaded with outdoor air . Submitted to ASHRAE Trans, November 1993.
4. Kemp et al (1993), Growth of Microoganisms on HVAC filters under controlled temperature and humidity conditions. Submitted to ASHRAE Trans, November 1993
5. Brosseau et al (1993), Identification and control of viral aerosols in indoor environments. Submitted to ASHRAE Trans, October 1993

REF USA16
TITLE OF PROJECT Liabilities of Domestic Ventilation.
PRINCIPAL RESEARCHER: Max Sherman
ORGANISATION: Lawrence Berkeley Laboratory
ADDRESS: Building 90, Room 3074, Berkeley, CA 94720, USA
TELE: +1 510 486 4022
FAX: + 1 510 486 6658
E-Mail Address: MHSherman@lbl.gov
SPECIFIC OBJECTIVES: IAQ/Energy in Dwellings
BUILDING TYPE: (Whole Buildings) Dwellings
COMPONENT TYPE:
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Related ACH to building properties and climate
PROJECT DETAILS: Use weather, leakage, and population and building data with simplified models to calculate the ventilation rates for the stock of US housing and then to project improved methods of ventilation as a function of region, house type etc Intermediate tasks include data gathering and analysis, model development and standarisation.
STARTDATE: 00:10:1992
EXPECTED DATE OF TERMINATION: 00:09:1995
ESTIMATED NUMBER OF PERSON HOURS: 1.5 Man Years.
SELECTED BIBLIOGRAPHY:
1. Sherman M, Matson N (1993), Ventilation-energy liabilities in US dwellings. UK, Air Infiltration and Ventilation Centre, 14th AIVC Conference, "Energy Impact of Ventilation and Air Infiltration",held Copenhagen, Denmark, 21-23 September 1993, proceedings, pp 23-40. #DATE 21:09:1993 in English

REF USA17
TITLE OF PROJECT: Residential Ventilation Systems
PRINCIPAL RESEARCHER: Helmut Feustel, Nance Matson
ORGANISATION: Lawrence Berkeley Laboratory
ADDRESS Energy Performance of Building Group, Indoor Environment Program, 1 Cyclotron Road, Berkeley CA 94720, USA
TELE: +1 510-486-4021 (Feustel)
Fax: +1 510-486-6658
TELE: +1 510-486-7328 (Matson)
E-Mail Address: envhef@lbl.gov (Feustel)
nematson@lbl.gov (Matson)
SPECIFIC OBJECTIVES: Indoor Air Movement, Airtightness/air leakage of buildings, IAQ, Moisture mould generation and prevalence, Energy impact of ventilation, Heating and ventilation systems and strategies
BUILDIMG TYPE: Occupied, Simulated occupancy, (leakage data from occupied houses used in analysis), Dwellings
COMPONENT TYPE: (None Stated)
PARAMETERS WITH WHICH INFILTRATION AND IAQ WILL BE RELATED: air change rates, performance of ventilation strategies in relationship to moisture removal, inter-zonal air flow rates
PROJECT DEATILS: This project will determine the effect of building tightness and installed passive and mechanical ventilation systems on ventilation rates and indoor air quality, and provide guidance to the building community regarding providing sufficient ventilation rates and indoor air quality in residences. Hourly and annual ventilation rates, based on infiltration and installed passive and mechanical ventilation systems, are determined using the LBL infiltration model, for a minimum of 100 New York and 60 California post-1980 single family detached houses. The houses modeled include those built under existing building energy codes and those built under utility-sponsored energy-efficient construction programs (such as New York's NY-STAR program). To determine the effectiveness of various passive and mechanical ventilation in providing adequate ventilation and moisture removal, prototypical houses and ventilation systems are modelled using the COMIS multi-zone infiltration model. Houses and systems are modelled on peak and low infiltration days using four New York and four California weather files.
Two surveys are conducted, one of residential builders and HVAC contractors, and the other of equipment distributors. Builders and HVAC contractors are surveyed as to their use and understanding of various passive and mechanical ventilation strategies. Distributors are surveyed to determine residential ventilation equipment availability.
A ventilation guidebook will be written for New York state residential builders and HVAC contractors. The ventilation guide will include sections on why to build tight, indoor air quality, how to select, size and install residential ventilation systems, and an appendix including listings of ventilation equipment.
STARTDAT: 15:08:1993
EXPECTED TERMINATION DATE: 15:11:1994
ESTIMATED NUMBER OF PERSON HOURS: 1.5 person-years SELECTED BIBLIOGRAPGHY:

1. Matson, N.E., Feustel, H.E., Warner, J, Talbott, J., "Residential Ventilation Systems," AIVC 15th Annual Conference, Buxton, Great Britian, 27-30 September, 1994. LBL Project Report, "Residential Ventilation Systems," (November, 1994)
2. "Residential Ventilation Guide for New York Contractors," (November, 1994)

REF USA18
TITLE OF PROJECT: A Computational investigation of indoor air quality
PRINCIPAL RESEARCHER: Brian A Rock
ORGANISATION: The University of Kansas
ADDRESS: Agricultural Engineering Dept, Marvin Hall, Lawrence, KS 66045 - 2222, USA
TELE: +1 913 864 3434
FAX: +1 913 864 5099
E-Mail Address:
SPECIFIC OBJECTIVES: Indoor air movement, IAQ
BUILDING TYPE: Unoccupied, Test Chamber or test structure
COMPONENT TYPE: Floors, Walls, Diffusers
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Through ventilation and air change effectiveness measures.
PROJECT DETAILS: A 2-D cfd study of room air distribution and air change effectiveness measures.
STARTDATE: 01:07:1993
EXPECTED TERMINATION DATE: 01:08:1994
ESTIMATED NUMBER OF PERSON HOURS: 300
SELECTED BIBLIOGRAPHY:
1. Yu Fu (1994) Room air distribution and indoor pollutant modelling by computational fluid dynamics, Masters Thesis, The University of Kansas, Lawrence.

REF USA19
TITLE OF PROJECT: Development of Multi zone Indoor Air Quality Models - CONTAM
PRINCIPAL RESEARCHER: George Walton
ORGANISATION: NIST
ADDRESS: Building 226, Room A313, Gaithersburg, MD 20899, USA
TELE: +1 301 975 6421
FAX: +1 301 990 4192
E-Mail Address: gwalton@enh.nist.gov
SPECIFIC OBJECTIVES: To develop an advanced airflow and contaminant dispersal model in the CONTAM series, specially CONTAM94, and to investigate multizone airflow and contaminant analysis with building thermal models.
BUILDING TYPE: None
COMPONENT TYPE: None
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)
PROJECT DETAILS This project will encompass two parts: the improvement of CONTAM93 through the development of CONTAM94 and the preliminary implementation of approaches to linking airflow and contaminant dispersal analysis with thermal building analysis.
In the first part of the project, CONTAM93 will be evaluated in terms of its existing component models, the user interface and its potential for integration with other types of analysis. Based on this evaluation on the highest priority areas for further development will be identified and pursued in the development of CONTAM94. It is anticipated that this subsequent development will include improvements in the ventilation system and the source and sink models.
The second part of the project will address the integration of airflow and contaminant dispersal analysis with building thermal analysis. The various possibilities for such integration will be investigated including: the further development of CONTAM94 to include thermal analysis and other types of anaylsis; the implementation of CONTAM94 by linking its input and output with other programs within another program such as TRNSYS; and, the use of simulation environments to develop a fully integrated indoor air quality anaylsis tool. Preliminary attempts to develop integrated tools will be pursued to evaluate the appropriateness of these approaches.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: 00:01:1995
ESTIMATED NUMBER OF PERSON HOURS: (NOT STATED)
SELECTED BIBLIOGRAPHY:
1. Walton GN ; CONTAM93 User Manual, NISTIR 5385, National Institute of Standards and Technology, Gaithersburg, MD,1994.
2. Fang JB and Persily AK CONTAM88 Building Input Files for Multi Zone Airflow and Contaminant Dispersal Modelling, NISTIR 5440,National Institute of Standards and Technology, Gaithersburg, MD, 1994.

REF USA20
TITLE OF PROJECT: Development of Protocols for Ventilation System Performance Evaluation.
PRINCIPAL RESEARCHER: Andrew Persily
ORGANISATION: NIST
ADDRESS: Building 226, Room A313, Gaithersburg, MD 20899, USA
TELE: +1 301 975 6418
FAX: +1 301 990 4192
E-Mail Address:
SPECIFIC OBJECTIVES: To identify needs for standardised protocols to evaluate ventilation system performance for use in building air quality studies and to develop evaluation protocols to meet these needs.
BUILDING TYPE: None
COMPONENT TYPE: None
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)

PROJECT DETAILS This project will begin by conducting an assessment of the needs of the practitioners identified above for ventilation evaluation protocols. This assessment will invoke obtaining and analysing the response to our Building and HVAC Characterisation Checklists and the] Ventilation Assessment Manual developed previously by NIST. Based on this effort , a list of needs for ventilation evaluation protocols will be developed in the areas of diagnostics, preventive maintenance and research. In addition, manufacturer's of instrumentation to evaluate ventilation system performance will be contacted to discuss their products, existing protocols, user needs and future products to meet these needs. A workshop will be held at NIST to bring together these manufacturers , the users of ventilation assessment protocols, representative of relevant industry associations, and researchers. At this workshop , the participants will discuss the need for different ventilation evaluation protocols and the instrumentation needed to implement these protocols. Based on the results of the workshop, NIST will identify and define ventilation evaluation protocols that need to be developed. Draft protocols will be prepared and submitted to ASTM or ASHRAE committees as appropriate for development into standards.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: 00:01:1995
ESTIMATED NUMBER OF PERSON HOURS: (NOT STATED)
SELECTED BIBLIOGRAPHY:
1. Persily AK , Manual for ventilation assessment in mechanically ventilated Commercial Buildings, NISTIR 5329. National Institute of Standards and Technology, Gaithersburg, MD, 1994.
2. Persily AK , Building and HVAC charaterisation for commercial building indoor air quality investigations. NISTIR 4979. National Institute of Standards and Technology, Gaithersburg, MD, 1993.

REF USA21
TITLE OF PROJECT: Radon Entry and Mitigation in Large Buildings.
PRINCIPAL RESEARCHER: Andrew Persily
ORGANISATION: NIST
ADDRESS: Building 226, Room A313, Gaithersburg, MD 20899, USA
TELE: +1 301 975 6418
FAX: +1 301 990 4192
E-Mail Address:
SPECIFIC OBJECTIVES: To evaluate radon entry and air movement in large, non-industrial building by studying the complex relationship between radon, ventilation and building features and by studying the impact of radon mitigation strategies in this same building.
BUILDING TYPE: large, non industrial
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)
PROJECT DETAILS: This project involves detailed monitoring of ventilation parameters in a large, non industrial building to evaluate radon entry and transport. NIST will employ existing instrumentation systems and in house expertise to study ventilation and air movement in conjunction with radon monitoring conducted by an EPA contractor. These simultaneous measurements will be used to develop an understanding of radon entry and transport within the building and to develop recommendations for reductions of radon levels through modifications of the ventilation system operation and other mitigation strategies.
The NIST monitoring effort will include the installation of an automated tracer gas monitoring system in order to measure building air change rates and an automated carbon dioxide measurement system to obtain some information on general indoor air quality within the building. In addition, one week of intensive, on-site measurements will be conducted to obtain more detailed information on ventilation system performance. During this week of on-site evaluation, the mechanisms of radon entry and transport will be diagnosed and recommendations will be developed for mitigation approaches. After a mitigation approach is selected and implemented in the building, the automated systems will be employed to determine the effect on building ventilation rates and carbon dioxide levels.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: 00:09:1994
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF USA22
TITLE OF PROJECT: Modelling Airflow and Radon Transport in Large Buildings
PRINCIPAL RESEARCHER: Andrew Persily
ORGANISATION: NIST
ADDRESS: Building 226, Room A313, Gaithersburg, MD 20899, USA
TELE: +1 301 975 6418
FAX: +1 301 990 4192
E-Mail Address:
SPECIFIC OBJECTIVES: Employ advanced , multi zone computer simulation programs to study airflow and radon transport in large buildings. These modelling studies will be used to examine the effects of HVAC system design and operation , building envelope tightness and interiour layout and configuration as they impact radon transport in large buildings and the resultant radon concentrations.
BUILDING TYPE: None
COMPONENT TYPE: HVAC systems

PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)
PROJECT DETAILS: This study will employ the multi zone airflow and contaminant dispersal model CONTAM88. As part of a current, NIST funded project, standardised building input files are being developed for CONTAM88. These building files will describe a multi family residential building, two office buildings and a school. In the EPA funded study, the building files created in the NIST project will be used to study airflow and radon transport in these four buildings. Because the building models will be created as part of the NIST project, all of the EPA resources will be devoted to the modelling studies themselves rather than developing the complex building files for CONTAM88. In the radon modelling effort, NIST will study the impact of HVAC system operation , building envelope airtightness, interior zone configuration and radon source terms. Numerous cases will be modelled with different outdoor air intakes rates, different levels of building pressurisation and depressurisation, and different paths for the interiour radon movement. This modelling will focus on the identification of those factors that have significant impacts on radon transport and radon levels in large buildings.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: 00:09:1994
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF USA23
TITLE OF PROJECT: Residential IAQ Improvement using HVAC and other Building Systems.
PRINCIPAL RESEARCHER: Steven Emmerich
ORGANISATION: NIST
ADDRESS: Building 226, Room A313, Gaithersburg, MD 20899, USA
TELE: +1 301 975 6459
FAX: +1 301 990 4192
E-Mail Address:
SPECIFIC OBJECTIVES: To develop technologies, practices and strategies fro HVAC and other building systems that will improve residential indoor air quality.
BUILDING TYPE: None
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)
PROJECT DETAILS: The Phase I consisted of two tasks: conduct a literature review and develop a plan for computer analysis. In the first task, NIST reviewed and assessed the published literature on residential indoor air quality and HVAC systems for relevant information on pollutant source strengths in single family residential buildings , the impact of HVAC systems and components on residential indoor air quality, options for the use of these systems to improve indoor air quality , and computer simulation models applicable to the project objectives. The objective of the literature review was to obtain information for planning the computer simulations that would take place in Phase II of this project.
In the second task of the Phase I effort, NIST developed a detailed plan for the computer simulations to be conducted in the second phase of the project. The objectives of these simulations are to analyse the impact of residential HVAC systems on indoor air quality for selected pollutant sources and to analyse the beneficial impact of selected HVAC components. The development of this plan included the following items: selection of appropriate computer simulation techniques; the definition of the base case buildings to be analysed in the simulations, including the building and HVAC system designs, climates, pollutant source profiles within the building and ambient pollutant levels; the selection of HVAC technologies to investigate their impact on indoor air quality; and the development of a plan and schedule to complete the simulations during phase II.
In Phase II of the project, NIST will perform the computer simulations evaluating the effectiveness of the IAQ control retrofits. Three different retrofits will be simulated in the four baseline houses, and the predicted contaminant concentrations will be compared with and without the retrofits as a means of evaluating their effectiveness.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: 00:01:1995
ESTIMATED NUMBER OF PERSON HOURS: (NOT STATED)
SELECTED BIBLIOGRAPHY:
1. Emmerich SJ and Persily AK Indoor air quality impacts of residential HVAC systems Phase I. Report: Computer Simulation Plan. NISTIR 5346. National Institute of Standards and Technology, Gaithersburg, MD, 1994.

REF USA24
TITLE OF PROJECT: Energy Impacts of Infiltration and Ventilation System Airflows in Commercial Buildings.
PRINCIPAL RESEARCHER: Steven Emmerich
ORGANISATION: NIST
ADDRESS: Building 226, Room A313, Gaithersburg, MD 20899, USA
TELE: +1 301 975 6459
FAX: +1 301 990 4192
E-Mail Address:
SPECIFIC OBJECTIVES: To analyse energy impacts of large building infiltration and ventilation system airflows employing integrated building thermal analysis and network airflow analysis.
BUILDING TYPE: None

COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)
PROJECT DETAILS: This project consists of two main tasks, a study of the energy impacts of infiltration and ventilation system airflows and participating in the development of industry standards and guidelines. In the first task , NIST will build on existing abilities and expertise in the field of large building airflow to carry out a comprehensive analysis of the energy impacts of infiltration and ventilation system airflows and to assess the national impacts of energy conservation strategies in this area. This analysis will employ the building energy simulation program TRNSYS. TRNSYS is modular in nature, and there is currently a library of modules available for performing building energy simulations. These existing TRNSYS modules will be used with a new TRNSYS module based on the multi zone airflow program AIRNET to provide the needed simulation capacity. The model will be exercised on the DOE defined prototype buildings. Two subtasks will be completed in this effort, the first being the development of TRNSYS modules of AIRNET and CONTAM for use in analysing the energy impacts of infiltration and ventilation in large, multizone buildings. The second subtasks will be to develop an anylsis strategy to study these energy impacts based on the TRNSYS computer simulation program and begin the anaylsis needed to quantify these impacts.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: 00:01:1995 and ongoing
ESTIMATED NUMBER OF PERSON HOURS: (NOT STATED)
SELECTED BIBLIOGRAPHY: (None Stated)

REF USA25
TITLE OF PROJECT: Indoor Air Quality Commissioning Program in a New Office Building.
PRINCIPAL RESEARCHER: W Stuart Dols
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ADDRESS: Building 226, Room A313, Gaithersburg, MD 20899, USA
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FAX: +1 301 990 4192
E-Mail Address:
SPECIFIC OBJECTIVES: To develop and apply an indoor air quality commissioning program to a new office building to ensure an acceptable workplace to the building occupants.
BUILDING TYPE: None
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (NONE STATED)
PROJECT DETAILS: In order to reduce the likihood of indoor air quality problems in a new building, NIST is developing and implementing a series of indoor air quality commissioning procedures. This project will consist of several stages including an evaluation of the ventilation system design, initial indoor air quality monitoring during construction, the development of criteria for the acceptability of the space prior to and immediately after occupancy, and acceptance of spaces within the building for occupancy based on these criteria. The basic objective of this effort is to minimise the potential for indoor air quality problems given the fact that our understanding of the causes of and solutions to indoor air quality problems is limited. During the initial monitoring effort, NIST will evaluate the ventilation system design, and the design will be compared with current practice and relevant standards for its adequacy to address indoor air quality concerns.
In the next phase of the project, NIST will develop criteria for the acceptability of a portion of the building occupancy. These criteria will be based on the results of on-site inspections, tests of the ventilation system performance and indoor pollutant concentration measurements. Criteria will be developed for spaces both before they are acceptable for occupancy and then for re-evaluation approximately one month into occupancy. The individual criteria will include outdoor air delivery rates, pressure relationships between spaces, and indoor concentrations of particulates, formaldehyde, radon and VOC's. The post occupancy criteria will also include indoor carbon dioxide levels. Once the criteria have been developed, they will be applied in the building to spaces as they become ready for occupancy. When a portion of the building is ready for occupancy, NIST will inspect the space and the HVAC system and conduct indoor contaminant measurements.The results of the inspection and measurement efforts will be compared to the criteria to determine the acceptability of the space. Roughly one month after the space is occupied, NIST will return to the building to respect the space and the HVAC system and to conduct follow up measurements. The results will then be compared to the post occupancy environmental criteria to determine if the space is still acceptable.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: 00:01:1995
ESTIMATED NUMBER OF PERSON HOURS: (NOT STATED)
SELECTED BIBLIOGRAPHY: (None Stated)

REF USA26
TITLE OF PROJECT: Infiltration, Ventilation and Indoor Air Quality
PRINCIPAL RESEARCHER: Joan Daisey, Willam Fisk, Max Sherman, Al Hodgson, Rich Sextro & Ashok Gadgil
ORGANISATION: Lawrence Berkeley Laboratory

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SPECIFIC OBJECTIVES: Indoor air movement, IAQ, Energy Impact of Ventilation, Airtightness/air leakage of buildings, Heating and ventilation systems and strategies, Health Effects
BUILDING TYPE: Occupied, Simulated Occupancy, Unoccupied Dwellings, Commercial/Office
COMPONENT TYPE: (Not applicable)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Building characteristics, climate, energy use, health effects
PROJECT DETAILS: The US DOE infiltration, ventilation and IAQ research program emphasizes:
1. Fundamental research on the causes of IAQ problems, which provides the basic information needed to develop solutions
2. The inter-relationships between IAQ, the characteristics of buildings, and building energy use
3. Ventilation, including energy liabilities associated with ventilation and improved ventilation technologies.
4. The development of new energy efficient and cost effective methods of improving IAQ
5. The development of measurement methods and computer models used by the building industry
6. Experimental evaluations of methods of reducing sick building symptoms among office workers; and in, the future,
7. Evaluations of methods to increase worker and institutional productivity and reduce health care costs by improving the indoor environment.
An important strength of the DOE-IVIAQ program is its strong linkage to building science, a consequence of DOE's leadership of in building science. Many of the opportunities to improve indoor environments, involve changes in building and ventilation technologies.
STARTDATE: 00:00:1978
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: 3 full time Scientists, 3 full time research associates, and several students per year.
SELECTED BIBLIOGRAPHY: To many to include

REF USA27
TITLE OF PROJECT: Experimental and Theoretical Investigations of Radon Availability, transport and Entry
PRINCIPAL RESEARCHER: Richard Sextro, William Fisk , T N Marasimhan
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FAX: +1 510 486 6658
E-Mail Address: {firstInitial_lastname}@diana.lbl.gov
SPECIFIC OBJECTIVES: IAQ, Radon Entry Research
BUILDING TYPE: Unoccupied, Dwellings, Test Chamber or test structure
COMPONENT TYPE: Not applicable
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: This project aims to advance our fundamental understanding of the mechanisms of radon entry into basements and the dependence of entry rates on characteristics of soil structure, and climate. Experiments at highly instrumented research structures and numerical modelling are used in this research project.
STARTDATE: 00:00:1988
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: approx 2 to 3 person years per year
SELECTED BIBLIOGRAPHY:
1. Fisk W J et al (1992), Radon entry into basements: Approach, experimental structures and instrumentation of small structures research project. Lawrence Berkeley Laboratory, LBL 31864, 1992.
2. Flexser s et al (1993), Distribution of radon sources and effects on radon emanation in granitic soil at Ben Lomond, California. Environmental Geology, 22, 162-177, 1993.
3. Garbesi K (1993) Toward Resolving the Model Measurement Discrepancy of Radon Entry into Houses. PhD Dissertation. Lawrence Berkeley Laboratory, LBL 34244, 1993.

REF USA28
TITLE OF PROJECT: Characterisation of Indoor Radon Concentration.
PRINCIPAL RESEARCHER: Ashok Gadgil, Richard Sextro, William Fisk
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SPECIFIC OBJECTIVES: IAQ
BUILDING TYPE: Dwellings
COMPONENT TYPE: Not applicable
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Indoor Radon
PROJECT DETAILS: The major elements of this project are:
1. Investigations of radon concentration in the US housing stock
2. Modelling of radon entry into buildings
3. Behaviour of radon decay products and particles in indoor environments (eg transport and deposition)
4. General technical assistance to the US DOS within respect to indoor radon.

STARTDATE: 00:00:1980
EXPECTED TERMINATION DATE: Ongoing
ESTIMATED NUMBER OF PERSON HOURS: 2 person years per year
SELECTED BIBLIOGRAPHY:
1. Abu-Jarad F and Sextron R G "Reduction of Radon Progeny Concentration in Ordinary Room Due to a Mixing Fan" Radiation Protection Dosimetry, 24, 507-511, 1988.
2. Bonnefous et al (1992), Impact of subslab ventilation techniques on residential ventilation rate and energy costs. 13th AIVC conference: ventilation for energy efficiency and optimum indoor air quality.Sept 15-18 1992.
3. Bonnefous et al (1992), Field study and numerical simulation of subslab ventilation systems. Environmental Science and Technology, 26, 1752-1759, LBL 31942
4. Gadgil (1992), Models of Radon Entry, Radiation Protection Dosimetry45, 373-380, 1992.

REF USA29
TITLE OF PROJECT: Applications of pollution prevention techniques to reduce indoor air emissions from aerosol consumer products.
PRINCIPAL RESEARCHER: Michael Cui
ORGANISATION: University of Illinois
ADDRESS: 1304 West Pennsylvania Ave., Urbana, Illinois 61801, USA
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E-Mail Address:
SPECIFIC OBJECTIVES: Develop pollution prevention techniques. Indoor air Movement, IAQ, Energy Impact of ventilation, Heating and ventilation systems and Strategies.
BUILDING TYPE: Simulated Occupancy, Unoccupied, Commercial /Office
COMPONENT TYPE: Walls, Floors
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Air flow pattern, velocity, temperature, particle size, concentration, velocity.
PROJECT DETAILS:
1. Characterisation of aerosol consumer products as a source of indoor air pollutants as a function of time.
2. Development of methods and technologies to measure and predict emissions and personal exposures.
3. Development of pollution prevention technologies and guidelines for the manufacture and use of products.
STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF USA30
TITLE OF PROJECT: 2-D Computational Fluid Dynamics Vorticity IAQ model validation
PRINCIPAL RESEARCHER: John Brain Priest/ Les Christianson
ORGANISATION: University of Illinois, BERL Laboratory
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FAX: +1 (217) 244 0323
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SPECIFIC OBJECTIVES: Validation of 2-D cfd model for bulk flow
Indoor air movement, Heating and Ventilation systems and strategies
BUILDING TYPE: Unoccupied, Test chamber or test structure
COMPONENT TYPE: Commercial diffusers
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Parameters will really involve thermal comfort variables (T,V,Tu)
PROJECT DETAILS: Validation of the bulk flow predictions from 2-d vorticity model using 2-d flow field in a full size room (4.88mx4.88m). The model's validity is in question since it utilises many simplifications in order to be solved using 486 PC. processors within a minute. Validation will involve low speed and temp. air flow measurement and the project will last 6 months.
STARTDATE: 00:02:1994
EXPECTED TERMINATION DATE: 00:08:1994
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF USA31
TITLE OF PROJECT: Influence of space air movement on exhaust hoods.
PRINCIPAL RESEARCHER: Les Christianson
ORGANISATION: University of Illinois, BERL Laboratory
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FAX: +1 (217) 244 0323
E-Mail Address: AMZ8917@AGE2.AGE.UIUC.EDU
SPECIFIC OBJECTIVES: Heating and ventilation systems and strategies.
BUILDING TYPE: Simulated Occupancy, Industrial / factory
COMPONENT TYPE: local ventilation
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Influence of air movement on hood performance
PROJECT DETAILS: Hood design proceeding development with respect to the ambient air movement due to general ventilation , infiltration etc.

STARTDATE: (None Stated)
EXPECTED TERMINATION DATE: (None Stated)
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF USA32
TITLE OF PROJECT: VAV Control strategies for supplying adequate outdoor air
PRINCIPAL RESEARCHER: John McLaughlin / Les Christianson
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SPECIFIC OBJECTIVES: IAQ, Heating and ventilation systems and strategies
BUILDING TYPE: Occupied, Commercial / Office
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Indoor air quality will be related to the amount of fresh outside air delivered to the occupied spaces.
PROJECT DETAILS: The basic concept is to devise a control strategy which ensures adequate amounts of fresh outside air are delivered to the occupied region as the air delivery rates are adjusted through the seasonal range. Air flow supply rates will be measured and appropriate equipment adjustments made based on the control scheme. Various cases will be compared for operation of an occupied commercial office building using a variable air volume system.
STARTDATE: 00:06:1994
EXPECTED TERMINATION DATE: 00:04:1995
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY: (None Stated)

REF USA33
TITLE OF PROJECT: Air and air contaminate movement studies for improving HVAC design.
PRINCIPAL RESEARCHER: Zhenhai Li
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SPECIFIC OBJECTIVES: Indoor air movement, IAQ
BUILDING TYPE: Simulated Occupancy, Commercial / Office, Test Chamber or test structure
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Contaminate movement, partitions, thermal plumes
PROJECT DETAILS: Study the influence of partitions, heat loads , diffuser types, return locations, ventilation rates etc., on the movement of indoor air and contaminate , ventilation effectiveness.
Measure the air velocity, temperature, contaminate distribution, in various ventilation conditions.
Provide design guidance for air distribution in partitioned offices.
STARTDATE: 00:01:1993
EXPECTED TERMINATION DATE: 00:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 2500 person hours
SELECTED BIBLIOGRAPHY:
1. Li Z , L Christianson (1994) Air and air contaminant movement . Roomvent 94, in Krakow, Poland.
2. Li Z et al (1994), Outdoor air delivery rates to occupants and age of air. 1994 ASHRAE IAQ'94 St Louis.
3. Li Z et al (1994), Air contaminant movement in partitioned offices. Indoor Air Quality in Asia, 1994, Beijing, China.

2.14 NON-PARTICIPATING COUNTRIES

REF Australia01
TITLE OF PROJECT: Carbon dioxide levels as a surrogate parameter in the assessment of indoor air quality and sick building syndrome and its consequences on human health
PRINCIPAL RESEARCHER: Ramakrishnan, K
ORGANISATION: AWS PTY LTD
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SPECIFIC OBJECTIVES: IAQ
BUILDING TYPE: Hospital, Schools (Teaching room in a college), Office/Commercial - high rise, Library - Murdoch University library
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: CO2, Ozone, SO2, VOC
PROJECT DETAILS: This study aims to establish levels of indoor environment of representative buildings in Perth, Australia, and investigate its use as a basis of assessing indoor air quality. Despite the availability of large overseas literature, virtually no information exists for Australian indoor spaces. Frequently indoor pollutant concentrations are found to be higher than indoor levels of the same pollutant.

There remains a significant potential for adverse effects on human health, many of which remain clearly to be identified.
The current standards recommend limiting indoor CO2 levels to 1000 ppm. There are no requirements of legislation to enforce this requirement. In many instances maintaining lower CO2 levels incurs higher energy use. No information exists on the actual CO2 levels in indoor environments. Along with investigating CO2 levels other common pollutants (e.g. CO, Ozone, SO2, VOC's will be measured as spot checks. A survey instrument will also be used to assess the perception of the occupants indoor air quality. and health effects . An olfactory panel will also assess the perceived air quality.
Some preliminary investigations will also be attempted on the possible health effects of living in environments of 1000ppm and higher CO2 levels considering that ambient levels are in the order of 300-500ppm. A higher level cognitive tests will be administered to students. A double blind tests will be used.
STARTDATE: 00:00:1993
EXPECTED TERMINATION DATE: 00:00:1996
ESTIMATED NUMBER OF PERSON HOURS: (None Stated)
SELECTED BIBLIOGRAPHY:
1. Indoor air quality and its impact on man. European Concerted action. ReportNo. 11. Guidelines for the ventilation requirements in Buildings. 1992.

REF Austria01
TITLE OF PROJECT: Critical Climatological Data In Design Of Building Envelope And Heating System.
PRINCIPAL RESEARCHER: Stoecher, H
ORGANISATION: Technische Universitaet Wien,
ADDRESS: Karlsplatz 13, A-1040 Wien, AUSTRIA.
TELE: +43 1 58801-3455
FAX + 43 1 5054006
E-Mail Address:
SPECIFIC OBJECTIVES Which combination of outdoor temperature and wind velocity has to be applied in the design of the building envelope and the heating system, with data from Austrian meteorological stations.
BUILDING TYPE: Various.
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: Outdoor temperature, wind velocity, air humidity, indoor temperature, humidity, Building environmental parameters.
PROJECT DETAILS: Preparatory theoretical work for new Austrian Standards.
STARTDATE: 00:00:1988
EXPECTED TERMINATION DATE: 00:00:1993
ESTIMATED NUMBER OF PERSON HOURS: 500 person-hours
SELECTED BIBLIOGRAPHY (None Stated)

REF Poland01
TITLE OF PROJECT: Problems of identification of air flows and change in multizone buildings with natural ventilation.
PRINCIPAL RESEARCHER: Marian Nantka
ORGANISATION: Silesian Technical University
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SPECIFIC OBJECTIVES: Indoor Air Movement, IAQ, Energy Impact of ventilation, Airtightness / air leakage of buildings
BUILDING TYPE: Occupied, Simulated Occupancy, Unoccupied, Dwellings
COMPONENT TYPE: Windows, Doors, Walls, Cracks, Natural ventilation ducts
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED:
(a) temperature, velocity and wind direction, barometric pressure, outdoor pollution;
(b) all building components (as above) ; real and simulated behaviour of occupants; gases pollution (CO)
PROJECT DETAILS (a) 70 multi-family buildings (5th and 11th floor levels) built from brick (30%) and concrete panels (70%) with natural ventilation (90%) or mechanical ventilation (exhaust). Heating systems in 80% of buildings are heat exchangers (converted with district heating systems), in 20% are internal toilets.
Measurements include (a) preliminary tests such as thermovisions and visualisation methods and (b) detailed tests such as small (for building components) or large (for rooms or flats) pressurisation tests (c) blower door technique (for rooms, flats and staircases). All equipment was calibrated in laboratory of STU (accuracy of these tests are between 5% and 10%). Besides pressurisation tests the tracer gas methods were used (with co2, n2o and sf6 as tracers - accuracy of these tests are 2%). Besides the measurement works, the additional methods have been used. These methods based on the mathematical models of buildings and air flows or air exchange (from building as a point, through individual floor levels and flats as points , to detailed model named SYMVENT). This model SYMVENT based on the main ideas. There are : two types of zones (real and formal or conventional), detailed description of building components (windows, cracks,doors, ventilation ducts, staircases, additional air openings etc.), internal conditions and air flow conditions (temperature in separate zones, resistance of building components and all elements of structure of buildings) and the alternative description of driving forces such as stack effect and especially wind action. Results of

air flow simulation (with SYMVENT) are optimistic. Recently, the way of validation tests will be elaborated.
STARTDATE: 00:01:1989
EXPECTED TERMINATION DATE: 00:12:1994
ESTIMATED NUMBER OF PERSON HOURS: 10 persons and 1200 hours year
SELECTED BIBLIOGRAPHY:
1. Nantka M B, Examination of an infiltration in ventilation of multizone building, Proc of Scientific Conference on HVAC (in Polish) 1990
2. Nantka M B, Investigation of air flows and change in buildings with a complex inner structure. COW (in Polish), 1991, (No. 10 and 11).
3. Nantka M B New concepts aimed to improve the multizone model for predicting the air flows in the building, Proc. Indoor Air 93. Helsinki (p563, Vol5), 1993.
4. Nantka M B, Development of multizone air flow model for indoor quality studies. Proc. Inter. Confer IAQ, Warsar, 1993.

REF Taiwan01
TITLE OF PROJECT: Detailed measurement of air velocity characteristics in a clean room.
PRINCIPAL RESEARCHER: Shih Cheng Hu
ORGANISATION: Industrial Technology Research Institute
ADDRESS: Energy and Resources Labs, B - 64,Sec 4 #195, Chung Hsin Rd. Chutung, Hsinchu, Taiwan, R.O.C.
TELE: +886 35 916281 FAX: +886 35 820850
E-Mail Address: x790475@erl560.erl.itri.org.tw
SPECIFIC OBJECTIVES: Indoor air movement
BUILDING TYPE: Industrial/factory
COMPONENT TYPE: (None Stated)
PARAMETERS TO WHICH INFILTRATION AND IAQ WILL BE RELATED: (None Stated)
PROJECT DETAILS: The objectives of this study reported in this paper were to 1. identify the turbulence characteristics of air flow in a class 1 an exist,operating microelectronic clean room and 2. provide detailed experimental data for validation and improving the current numerical models.
Anaylsis of air flow characteristics in a clean room is considered very significant from the viewpoint of cleaniness level maintain and gaseous contaminants control. To date, hot wire anemometer of similar equipment has been used for most measurements of airflow in clean rooms. As another mode, the visual observation of a thread hanging on the ceiling has also been employed for the streamline observation. However, it is very difficult to obtain the air flow direction and change of turbulence caused by equipments in the clean room. By the way, the visual observation method is difficult to satisfy some conditions in a running clean room. The three-dimensional ultrasonic anemometer determines velocity by sensing the time of flight of ultrasonic sound pulses which are related to both the magnitude and direction of a velocity vector. Theoretically the ultrasonic anemometer is feasible for 0 m/s measurement. In this study, detailed air turbulence characteristics in a full scale, actually operation, fan-filter units (FFU) type clean room are presented. The measurements of the three components of air velocity were conducted by using a three dimensional ultrasonic anemometer. Velocity histogram, mean velocity, flow pattern, turbulence kinetic energy, turbulence intensity, normalised auto correlation function and normalised energy spectra distribution of air are discussed in detail. A slight redefinition of the conventional turbulence intensity is proposed to compare the degree of turbulence in the clean room which with similar mean velocity distribution.
STARTDATE: 00:06:1994
EXPECTED TERMINATION DATE: 00:06:1995
ESTIMATED NUMBER OF PERSON HOURS:
SELECTED BIBLIOGRAPHY:
1. Design of the flow path for a display cabinet using numerical models. Proc. IIR meeting, Commission B1,B2,D1 and D2/3. Nov 15-18th 1993. Palmerston North. New Zealand.
2. Turbulent forced convective heat transfer in the entrance region of a confined jet. Numerical Heat Transfer. Pt A, Vol 21, 1992
3. Detailed measurements of air velocity characteristics in a clean room. Submitted to Buildings and Environment, June 1994.

APPENDIX A

PRINCIPAL RESEARCHERS' ADDRESSES REFERENCED BY COUNTRY AND PROJECT REFERENCE NUMBER.

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APPENDIX B

PROJECTS REFERENCED BY PRINCIPAL RESEARCHER

APPENDIX C

SURVEY FORM

Air Infiltration and Ventilation Centre

1994 Survey of Current Research into Air Infiltration, Ventilation and Indoor Air Quality

Title of Project			
Principal Researcher			
Organisation			
Address			
Telephone		Fax	
Electronic Mail No			
Date Survey Form Completed			
Description of Project			
Specific Objectives			
Indoor air movement	☐	Airtightness/air leakage of buildings	☐
IAQ	☐	Moisture mould generation and prevalence	☐
Energy impact of ventilation	☐	Heating and ventilation systems and strategies	☐
Other (please specify)			
Building Type (Occupied ☐ Simulated occupancy ☐ Unoccupied ☐)			
Dwellings	☐	Industrial/factory	☐
Commercial/office	☐	Test chamber or test structure	☐
Other (please specify)			
Component Type			
Windows	☐	Floors	☐
Doors	☐	Cracks	☐
Walls	☐	Other (please specify)	
Parameters with which infiltration and indoor air quality will be related			
Project Details			
(Continued overleaf...)			

Project Duration

Start Date Expected Termination Date

Estimated number of person-hours

Important reports and publications, both past and future (titles, authors, publishers, date of publication)

Please return completed forms or ASCII text format to:

Mark Limb, Air Infiltration and Ventilation Centre, Warwick University Science Park
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THE AIR INFILTRATION AND VENTILATION CENTRE was inaugurated through the International Energy Agency and is funded by the following thirteen countries:

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

The Air Infiltration and Ventilation Centre provides technical support to those engaged in the study and prediction of air leakage and the consequential losses of energy in buildings. The aim is to promote the understanding of the complex air infiltration processes and to advance the effective application of energy saving measures in both the design of new buildings and the improvement of existing building stock.

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