



Healthy Buildings 2003

Energy-Efficient Healthy Buildings

Proceedings of ISIAQ 7th International Conference

7th – 11th December 2003
Singapore

Editors

Tham Kwok Wai

Chandra Sekhar

David Cheong

Jointly Organised by



Department of Building
National University of Singapore

and



International Society of Indoor Air Quality and
Climate (ISIAQ)

Sponsored by



U.S. Environmental
Protection Agency
(USEPA)



Your Essential Connection
American Industrial
Hygiene Association
(AIHA)

Volume 3

The papers in this book comprise the proceedings of **Healthy Buildings 2003**. They reflect the authors' opinions and are published as presented without change, in the interests of timely dissemination. Their inclusion in this publication does not necessarily constitute endorsement by the editors, the sponsors or the organisers.

ISBN: 981-04-9974-4

Copyright and Reprint Permission

All rights reserved. This book, or parts thereof, may not be reproduced in any form or by any means, electronic or mechanical, including photocopying, recording or any information storage and retrieval system now known or to be invented, without written permission from the organiser.

All rights reserved. © 2003 by Healthy Buildings 2003

Prepress and Printed by Stallion Press, e-mail: sales@stallionpress.com

Foreword

The Healthy Buildings conference is, for the first time, convened outside its traditional European-American circuit, and signifies the international recognition that healthy buildings and indoor environments are as much needed and desired in the developed and developing worlds, across all climatic regions. In the aftermath of the first emergence of Severe Acute Respiratory Syndrome (SARS), issues of environmental quality and control have become much more pertinent and important. In an unprecedented way, the linkage between health and environmental quality on the “consumer end” of the chain, and the policies, management and technologies on the “supply end” has been highlighted and articulated beyond the usual platforms of scientific publications to popular media. This presents HB2003, the 7th International Conference in tropical Singapore, as a unique opportunity for scientists, practitioners and policy makers to convene, discuss and share their latest findings and thinking on healthy buildings.

HB2003 continues the excellent work achieved by its predecessors in recognizing emergent issues and focusing on developing practical solutions based on rigorous scientific explorations and information. In recognising the importance, relevance and challenges of both IAQ and energy globally over the past four decades, the thrust of HB2003 is towards Energy-Efficient Healthy Buildings. Keynote addresses provide the state-of-the-art reviews and insights along the following five conference themes:

- Theme 1 : Science of Indoor Air Quality (IAQ) parameters
- Theme 2 : Materials, systems and technologies for healthy buildings
- Theme 3 : IAQ and human response
- Theme 4 : Practice and implementation issues in creating healthy buildings
- Theme 5 : Issues of healthy buildings and energy efficiency in the developing countries

Almost 400 papers from 45 countries documenting the research, thinking, innovative solutions and technologies for the achievement and sustenance of energy-efficient healthy buildings are published in three volumes of proceedings that are organised according to the five themes of the conference. Whilst 40% of the papers presented at HB2003 relate to the study of fundamental issues of indoor contaminants including thermal comfort aspects in THEME 1, 27% of the papers provide an insight into practical solutions across different climatic conditions in THEME 2. Environmental health related studies that impact upon occupant perception and work performance constitute 17% of the papers and are presented in THEME 3. Considerations from practitioners’ viewpoint are addressed in another 14% of the papers in THEME 4. The perspectives of the developing world are presented in a small number of papers in THEME 5.

All the technical papers published in HB2003 proceedings are presented as either ORAL or POSTER mode. To facilitate maximum interaction among authors and delegates, about half the total number of papers is presented as POSTERS, which are displayed throughout the duration of the conference. The poster papers are briefly introduced following oral presentations in a particular theme in each of the 55 parallel sessions that are spread across four days of the conference. Additionally, the technical sessions also incorporate six ISIAQ Task Force Workshops and a special SARS workshop.

A summary of the deliberations at the various Technical Sessions will be consolidated and made available to all delegates (by email) as a Post-Conference document and will also be uploaded on the conference website: www.hb2003.org

*Tham Kwok Wai
Chandra Sekhar
David Cheong*

December 2003

Organising Committee

Organising Committee

Tham KW, *President*

Sekhar SC, *Technical chair*

David Cheong KW, *Technical chair*

Wong NH, *Treasurer*

Chan P, *Secretary*

Tan ST, *Logistics*

Yap HM, *Member*

Local Advisory Committee

Bong TY

Cheong HF

Chew YT

Chou SK

Goh KT

Kam F

Lam KP

Lee SE

Ofori G

Ooi PL

Sze G

Tan TC

Wong WC

Local Scientific Committee

Chan P

Cheong KWD

Foo SC

Jayamaha L

Lai A

Lee A

Lee EL

Lee HK

Lee SE

Ng EH

Ng KC

Ng TP

Rajasekhar B

Seah D

Sekhar SC

Sun D

Tan F

Teh KJ

Tham KW

Wong NH

Wong R

Yap C

Conference Secretariat

Integrated Meetings Specialist Pte Ltd

1122A Serangoon Road, Singapore 328206

Tel: (65) 6295 5790 Fax: (65) 6295 5792

Email: ims@inmeet.com.sg

International Coordinators

Agarwal RS, India
Banhidi L, Hungary
Boschi N, USA
Chow T T, China (HKSAR)
Cochet C, France
Fanger PO, Denmark
Fernandes EO, Portugal
Girman JR, USA
Haghighat F, Canada
Jantunen M, Finland
Levin H, USA
Lindvall T, Sweden
Maroni M, Italy

Matthews EH, South Africa
Mayer E, Germany
Morawska L, Australia
Murakami S, Japan
Murthy SS, India
Nathanson T, Canada
Olesen BW, Germany
Petras D, Slovakia
Pickering A, UK
Raw GJ, UK
Roulet C-A, Switzerland
Schwela D, Switzerland
Seifert B, Germany

Seppanen O, Finland
Shaughnessy R, USA
Su J, Taiwan
Sundell J, Denmark
Tanabe S, Japan
Tiffany J, USA
Todorovic B, Serbia
Weschler CJ, USA
White JH, Canada
Zhang G Q, China
Zhao R, China

International Scientific Committee

Allard F, France
Awbi HB, UK
Axley J, USA
Barakat S, Canada
Bencko V, Czech Republic
Berglund B, Sweden
Bluyssen P, The Netherlands
Bojic M, Yugoslavia
Bornehag C-G, Sweden
Broadbent C, Australia
Brohus H, Denmark
Chan D, China (HKSAR)
Chung KS, South Korea
Clausen G, Denmark
Croome DC, UK
Da Silva MCG, Portugal
De Aquino RFN, Brazil
Dingle P, Australia
Fang L, Denmark
Fisk W, USA
Flatheim G, Norway
Godish T, USA
Gunnarsen L, Denmark
Gupta AB, India
Hagstrom K, Finland
Hayter R, USA

Ikedo K, Japan
Jaakkola J, Finland
Jensen O, Denmark
Johannesson G, Sweden
Kannan KS, Malaysia
Khalil E, Egypt
Khattar MK, USA
Kimura K, Japan
Knudsen H, Denmark
Korkin V, Russia
Kosonen R, Finland
Krishan A, India
Kulic E, Bosnia and Herzegovina
Li A, China
Li Y, China (HKSAR)
Liddament M, UK
Luxton RE, Australia
Maiya P, India
Melikov A, Denmark
Mendell MJ, USA
Mizielinski B, Poland
Moschandreas D, USA
Nazaroff W, USA
Nevalainen A, Finland
Nielsen P, Denmark
Novak P, Slovenia

Pejtersen J, Denmark
Persily A, USA
Popiolek Z, Poland
Rane MV, India
Rodriguez ES, Spain
Saarela K, Finland
Salthammer T, Germany
Sandberg M, Sweden
Scartezzini JL, Switzerland
Shao L, UK
Shaw CY, Canada
Sherman M, USA
Shyu RY, Taiwan
Smith K, USA
Sowa J, Poland
Spengler J, USA
Steimle F, Germany
Tam LM, China (MSAR)
Toftum J, Denmark
Valbjorn O, Denmark
Wargocki P, Denmark
Wibulswas P, Thailand
Wolkoff P, Denmark
Wyon D, Denmark
Yoshino H, Japan
Yoshizawa S, Japan

Acknowledgements

Sponsored by:

U.S. Environmental Protection Agency
Lifa Air Ltd
Halton Oy
American Industrial Hygiene Association
Innova AirTech Instruments A/S

Supported by:

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
Association of Consulting Engineers Singapore (ACES)
Australian Institute of Refrigerating, Air-conditioning and Heating (AIRAH)
Building and Construction Authority, Singapore (BCA)
Chartered Institution of Building Services Engineers (CIBSE)
Federation of European Heating and Air-conditioning Associations (REHVA)
Institution of Engineers Singapore (IES)
International Academy of Indoor Air Sciences (IAIAS)
International Council for Research and Innovation in Building and Construction (CIB)
Ministry of Health, Singapore (MOH)
National Environment Agency, Singapore (NEA)
Society of Heating, Air-Conditioning and Sanitary Engineers of Japan (SHASE)
The Finnish Society of HVAC Engineers (FINVAC)

Exhibitors

Dantec Dynamics A/S
GETC Asia Pte Ltd
Lee Hung Scientific Pte Ltd
MycoMeter ApS
Setsco Services Pte Ltd

Brief Contents for Volume 1

KEYNOTES

1A) CHEMICAL POLLUTANTS

1B) MICROBIALS

1C) THERMAL COMFORT (Continued to Volume 2)

Brief Contents for Volume 2

1C) THERMAL COMFORT (Continued from Volume 1)

1D) PARTICULATE MATTER

2A) CLIMATE SPECIFIC DESIGN

2B) BUILDING TYPES

2C) VENTILATION

2D) CONTROL STRATEGIES

2E) ENERGY EFFICIENCY

2F) INNOVATIVE TECHNOLOGIES & SOLUTIONS

Contents for Volume 3

	Page
Foreword	iii
Organising Committee	iv
International Coordinators	v
International Scientific Committee	vi
Acknowledgements	vii
Brief Contents for Volume 1 and Volume 2	viii
 (3A) HEALTH EFFECT & SBS SYMPTOMS	
Sick Building Syndrome Symptoms Caused by Low Humidity	1
<i>L. Fang, D. P. Wyon, P. O. Fanger</i>	
Reliability of Cross-Seasonal Memory of Environmental Conditions and Symptoms	7
<i>G. J. Raw, S. K. D. Coward</i>	
Excess Cancer Risk and its Damage Cost due to Indoor Air Pollution in Seoul	11
<i>Y. Kim, H. Park, Y. Lee, Y. Kim, D. Shin</i>	
A Framework for Performance Criteria of Healthy and Energy-efficient Buildings	17
<i>P. M. Bluyssen, M. G. L. C. Loomans</i>	
Health Performance Indicators of Housing	23
<i>E. Hasselaar</i>	
Coincidence of Microbial Findings, Complaints and Symptoms in a Building	30
<i>M. Reiman, P. Yli-Pirilä, L. Kujanpää, H. Kokotti, M. Seuri, R. Halonen, V. Asikainen, T. Raunemaa</i>	
2-Ethyl-1-Hexanol Emission From Floor Structure and Health Symptoms	36
<i>P. Metiäinen, H. Mussalo-Rauhamaa, M. Viinikka</i>	
Study of Ventilation Performance and Indoor Air Quality in Eight Sick Houses	42
<i>H. Yoshino, K. Ikeda, A. Nozaki, K. Amano, J. Wada, N. Iida, N. Suzuki, M. Matsumoto</i>	
Indoor Air Quality and Sick Building Syndrome of Office Buildings in Taiwan	48
<i>P. C. Wu, H. J. Su, Y. Y. Li, C. M. Chiang</i>	
Field Survey of Indoor Chemical Pollution and Health Hazards in Sick Houses	54
<i>K. Amano, H. Yoshino, K. Ikeda, A. Nozaki, N. Iida, M. Matsumoto, N. Suzuki, K. Kakuta, S. Hojo, S. Ishikawa</i>	
Prevalence of Respiratory Symptoms of the Upper and Lower Airways in Office Block Workers, Rio De Janeiro, Brazil	60
<i>J. L. Boechat, J. L. Rios, A. Gioda, J. R. L. e Silva, F. R. A. Neto</i>	

Health Complaints After Moving Into a New Office Building: Results of Measurements and Investigations of Employees	65
<i>H. P. Hutter, H. Moshhammer, P. Wallner, B. Damberger, P. Tappler, M. Kundi</i>	
SBS and Chemical Sensitivity in Residents of Renovated Multi-Family Apartment Buildings	70
<i>A. G. Gunnarsson, B. Berglund</i>	
European Project HOPE (Health Optimisation Protocol For Energy-Efficient Buildings) ..	76
<i>P. M. Bluyssen, C. Cox, M. Maroni, N. Boschi, G. Raw, C. A. Roulet, F. Foradini</i>	
Rhinological Reactions in Persons with Self-Reported Chemical Sensitivity (SCS)	82
<i>G. A. Wiesmüller, C. Bachert, C. van Thriel, A. Steup, M. Blaszkewicz, E. Kiesswetter, A. Seeber</i>	
A Principal Component Analysis of Perception and SBS Symptoms of Office Workers in the Tropics at Two Temperatures and Two Ventilation Rates	88
<i>K. W. Tham, H. C. Willem</i>	
The Influence of Psychological Factors on the Reporting of IEQ Complaints	95
<i>J. L. Leyten, A. C. Boerstra</i>	
Psychosocial Factors Associated with Sick Building Syndrome in a Biased and Unbiased Population of Office Employees Occupying Two Buildings in South Africa	101
<i>K. Heslop</i>	
Different HVAC Airside System Designs of the Surgical Operating Theatres—Their Impact on the Surgery Staff and Patient Health	108
<i>R. Kameel, E. E. Khalil</i>	
Proposed Modular Demountable Isolation Mini-En-Suites for Protecting Patients and Health Care Workers Against Infectious Diseases in Hospitals	114
<i>K. P. Cheung, S. H. L. Cheung, T. T. Chow, M. W. Lo, K. S. Fung</i>	
Indoor Air Related Health Disorders: Experiences of an Advisory Center for Environmental Medicine	120
<i>C. Hornberg, S. Mourheg, G. S. Siao, H. F. Neuhaus, U. Ranft, W. Dott, G. A. Wiesmüller</i>	
Gender-Specific Aspects of Exposure	126
<i>C. Hornberg, D. Krings, H. Niggemann, H. F. Neuhaus, U. Ranft, W. Dott, G. A. Wiesmüller</i>	
Meeting Workplace Healthy Building Information Needs	132
<i>B. P. Pathak, R. C. Cockerline, W. Maksylewich, H. J. Heinz</i>	
Ranking Indoor Pollutants According to their Potential Health Effect, for Action Priorities and Costs Optimization in The French Permanent Survey on Indoor Air Quality	138
<i>L. Mosqueron, V. Nedellec, S. Kirchner, S. Gauvin, F. Dor, P.-A. Cabanes, F. Golliot, O. Blanchard, M. Derbez, F. De Blay, F. Lieuter-Colas</i>	
Sick Building Transformed Into a Feel-good building	144
<i>L. P. Hulsman, A. C. Boerstra, A. K. Raue, B. Bronsema</i>	
 (3B) OTHER INDOOR AIR POLLUTANTS	
Comparison of Exposure to Allergens in Homes in Uppsala, Sweden and Tartu, Estonia	151
<i>L. Elfman, R. Jögi, A. Soon, E. Intermitte, C. Janson, U. Spetz-Nyström, D. Norbäck</i>	
Initial Studies of Oxidation Processes on Filter Surfaces and Their Impact on Perceived Air Quality	156
<i>G. Bekö, O. Halás, G. Clausen, C. J. Weschler, J. Toftum</i>	
Objective and Subjective Responses to Low Relative Humidity in an Office Intervention Study	163
<i>L. Lagercrantz, D. P. Wyon, H. W. Meyer, J. U. Prause, L. Fang, G. Clausen, J. Sundell</i>	

Sensory Emission Rates From Personal Computers and Television Sets	169
<i>P. Wargocki, Z. Bakó-Biró, S. Baginska, T. Nakagawa, P. O. Fanger, C. Weschler, S. Tanabe</i>	
Examination of Influence of CO₂ Concentration by Scientific Methods in Laboratory	176
<i>L. Kajtár, L. Herczeg, E. Láng</i>	
The SBS Symptoms and Environmental Perceptions of Office Workers in the Tropics at Two Air Temperatures and Two Ventilation Rates	182
<i>K. W. Tham, H. C. Willem, S. C. Sekhar, D. P. Wyon, P. Wargocki, P. O. Fanger</i>	
Occupational Exposure of Hairdressers to Air Pollutants in Hong Kong	188
<i>E. Li, S. C. Lee</i>	
Indoor Climate and Perceived Comfort in Offices	195
<i>J. Ribéron, P. O'Kelly, G. Orset</i>	
Odor Intensity Assessment From Solid Flooring Materials—Comparison of Continuous and Discrete Scales	201
<i>O. Ramalho, M. Jacquelin, F. Maupetit</i>	
The Effect of Perceived Indoor Air Quality on Productivity	207
<i>R. Kosonen, F. Tan</i>	
Call-Centre Operator Performance with New and Used Filters at Two Outdoor Air Supply Rates	213
<i>P. Wargocki, D. P. Wyon, P. O. Fanger</i>	
Individual Control of Air Velocity for Increasing Productivity	219
<i>N. Nishihara, S. Tanabe</i>	
A New Method for Evaluating Productivity and Fatigue With Human Voice Under 800 lx and 3 lx Lighting Conditions	225
<i>M. Nishikawa, N. Nishihara, S. Hirose, S. Tanabe</i>	
Effects of Building Characteristics on Self-reported Productivity of Office Workers: The Base Study	231
<i>A. C. Rohr, H. Brightman</i>	
Effects of Indoor Air Quality on Office Workers' Work Performance—A Preliminary Analysis	237
<i>H. J. Chao, J. Schwartz, D. K. Milton, M. L. Muilenberg, H. A. Burge</i>	
Colour and Environmental Quality: Second-Level Parameters	244
<i>F. Gugliermetti, F. Bisegna, P. Gori</i>	
Prevalence of SBS-Symptoms as an Indicator of Health and Productivity in Office Buildings	251
<i>R. Niemelä, O. Seppänen, K. Reijula</i>	
Sensory Pollution Load From a Used Ventilation Filter at Different Airflow Rates	257
<i>P. Strøm-Tejsen, G. Clausen, J. Toftum</i>	
Environmental Quality and the Productive Workplace	262
<i>D. J. Clements-Croome</i>	
The Influence of Typical Ways of Operating an Air-Handling Unit on the Sensory Pollution Load from Used Bag Filters	267
<i>M. Mysen, G. Clausen, G. Beko, O. Halas</i>	
Effects of Humidity and Indoor Air Chemical Pollutants on Human Comfort and Productivity	273
<i>H. Tsutsumi, Y. Chen, T. Akimoto, S. Tanabe, T. Suzuki</i>	
Temperature and Ventilation Effects on the Work Performance of Office Workers (Study of a Call Center in the Tropics)	280
<i>K. W. Tham, H. C. Willem, S. C. Sekhar, D. P. Wyon, P. Wargocki, P. O. Fanger</i>	

The Influence of Sick Building Syndrome on Self-Reported Productivity and Work Disruption amongst Office Employees in Two Buildings in South Africa	287
<i>K. Heslop</i>	
Subjective Experiments on the Effects of Relative Humidity and Humidity Ratio During Summer Season	293
<i>Y. Chen, H. Tsutsumi, T. Akimoto, S. Tanabe, T. Takagi</i>	
Effect of Cleaning on Symptoms and Perceived IAQ in an Office Building	299
<i>H. Kokotti, R. Halonen, L. Kujanpää, J. Tarhanen, E. Korhonen, P. Lavonen, M. Linnainmaa, J. Honkanen, M. Reiman</i>	
A Review of Occupant Responses to Localised Air Distribution Systems	305
<i>K. E. Charles</i>	
Effect of Temperature on Perceived Work Environment, Symptoms and Self-Estimated Productivity in Office Work	311
<i>P. A. Korhonen, K. Salmi, M. Tuomainen, J. Palonen, E. Nykyri, R. Niemelä, O. Seppänen, K. Reijula</i>	
Comparison of Productivity and Absenteeism Effects of Indoor Environmental Quality in Offices	318
<i>J. L. Leyten, A. C. Boerstra</i>	
Documentation of Mould Odour Remediation in Flats	324
<i>H. N. Knudsen</i>	
An Interaction Model for Odour Intensity	330
<i>O. Böttcher</i>	
The Occupant Perception and Investigation of Indoor Air Quality at Home in Seoul	336
<i>J. R. Sohn, Y. W. Kim, S. H. Byeon, D. W. Choi</i>	
Odor Assessment as a Necessary Complement to Chemical Evaluation of Building Products	342
<i>O. Ramalho, F. Maupetit</i>	
 (3C) COST EFFECTS AND BENEFITS OF GOOD IAQ	
Air and Well being—A Way To More Profitability	348
<i>D. v. Kempster</i>	
Indoor Air Quality in Residential Buildings: Costs, Effects and Benefits of Mechanical Ventilation Systems.	345
<i>S. Mazzacane, V. Raisa, S. Rossi</i>	
Economizer System Cost Effectiveness: Accounting for the Influence of Ventilation Rate on Sick Leave	361
<i>W. J. Fisk, O. Seppänen, D. Faulkner, J. Huang</i>	
A Conceptual Model to Estimate Cost Effectiveness of the Indoor Environment Improvements	368
<i>O. Seppänen, W. J. Fisk</i>	
The Effect of Structures on IAQ and Thermal Comfort	375
<i>J. Kurnitski, A. Suursoho, J. Palonen</i>	
Estimate of an Economic Benefit From Investment in Improved Indoor Air Quality in an Office Building	382
<i>P. Wargocki, R. Djukanovic</i>	
Potential Benefits of Reduced Summer Time Room Temperatures in an Office Building	388
<i>J. Smolander, J. Palonen, M. Tuomainen, P. Korhonen, O. Seppänen</i>	

Cost Benefit Analysis of the Night-Time Ventilative Cooling in Office Building	394
<i>O. Seppänen, W. J. Fisk, D. Faulkner</i>	
(4A) SPECIFICATION, DESIGN, CONSTRUCTION, COMMISSIONING, OPERATION AND MAINTENANCE	
Creating Healthy Buildings: Early Design Stage and Handing Over Are Crucial	400
<i>C. Cox</i>	
Pilot Study on Vocs during Indoor Renovation	406
<i>M. Jona, K. Kumagai, N. Shinohara, M. Fujii, A. Iio, Y. Yanagisawa</i>	
Hazardous Wastes in the Process of Managing Construction— Whose Interest is it Finally?	412
<i>J.-P. Majjala</i>	
Ageing Gracefully: How Can a Whole Life Support Services Framework Enhance the Life of the Building Services Systems?	417
<i>G. A. John, H. M. Loy, D. J. Clements-Croome, V. Fairey, K. Neale</i>	
Implementation of a Web-Based Global Optimal Management System in District Cooling	423
<i>L. Yu, G. Zhang, Y. Chen</i>	
Effective Sampling Protocol for Managing Indoor Air Quality in Air-Conditioned Buildings	428
<i>C. S. Wong, D. W. T. Chan, J. Burnett</i>	
From Healthy Buildings to Healing Buildings	434
<i>R. Bozovic-Stamenovic, B. L. Ong, I. Said</i>	
Measured Outdoor Performance of Radiant Barriers in Tropical Climate	440
<i>T. Soubdhan, J. L. Bernard, P. H. Nguyen, M. Dupont</i>	
Performance Based Building—A State-of-the-Art with respect to Healthy Buildings	446
<i>M. G. L. C. Loomans, P. M. Bluyssen</i>	
A Cleaning Concept for HVAC System	453
<i>R. Holopainen, V. Asikainen, P. Pasanen, A. Majanen, A. Seppälä, T. Jalonen, O. Seppänen</i>	
Reducing the Risk of Future Moisture Problems in Buildings	460
<i>A. Nielsen</i>	
Integrating Health and Sustainability in Life Cycle Assessment	467
<i>E. Hasselaar, G. Klunder, L. Morawska</i>	
Constructional Materialism from the Healthy-Building Viewpoint	474
<i>I. C. Chen, P. C. Chou</i>	
Linoleum Floors—Properties, Maintenance and Effects on Indoor Air Quality—Recommended Methods for Cleaning and Maintenance	478
<i>I. E. Dahl, S. K. Nilsen, P. Blom</i>	
Linoleum Floors—Properties, Maintenance and Effects on Indoor Air Quality— Maintenance With Floor Polish—Powdering Problems and VOC Emissions	484
<i>S. K. Nilsen, P. Blom, I. E. Dahl</i>	
Sustainable Management Strategies Improve Building Performance: The Case of Italian Large Building Owners	490
<i>N. Boschi</i>	
Environmental and Durability Performance of Building Elements— Assessment Through a LCA Tool Application	495
<i>E. Costanzo, L. D. Santoli</i>	

Indoor Air Quality as an Impact Category in Life Cycle Assessment of Building Materials—The Case Study of Indoor Paints	501
<i>L. D. Santoli, A. Sferra</i>	
Fault Introduction and Detection in Building HVAC Systems	508
<i>B. Yu, W. de. Jong, A. H. C. van Paassen</i>	
Implementation of a Ventilation System with Clean Installation Method	514
<i>R. Alén, S. Kolari</i>	
Exploring the Use of Non-Conventional Materials for Self-Sufficient Housing as Healthy Buildings	520
<i>D. Sanyal</i>	
 (4B) IAQ STANDARDS & GUIDELINES	
Analysis on the Grey Classification to Indoor Air Quality	527
<i>F. Zhang, G. Jing, J. Song, Z. Li</i>	
Updates on Legislation and Insurance Activity in the United States for “Mould, Asbestos, & Lead”	533
<i>W. H. Carter, D. R. Miller</i>	
Principles, Experiences and New Developments of the Emission Classification of Building Materials in Finland	539
<i>E. Kukkonen</i>	
Emissions From Construction Materials. Results From the National “Healthy Building” Programme	545
<i>K. Saarela</i>	
German Guide for the Prevention, Investigation, Evaluation and Remediation of Indoor Mould Growth (“Mould Guide”)	550
<i>R. Szewzyk, H.-J. Moriske, H.-G. Muecke, B. Seifert</i>	
Air Distribution Design Based on EN ISO 7730 With the Help of a Computer Program	556
<i>E. Venko, B. Gantar</i>	
Performance Criteria For Healthy Buildings: Target Values For Some Indoor Air Quality Parameters	562
<i>M. Maroni, P. Carrer, D. Cavallo, M. d. Torre, N. Boschi</i>	
Harmonization of Indoor Material Labelling Systems in the EU— a Critical Review of Existing Labelling Systems	567
<i>S. Kephelopoulos, R. Augustin, C. Cochet, B. Seifert, M. Maroni, K. Saarela, D. Crump, P. Wolkoff, P. Leva, D. Kotzias</i>	
Multicriteria Analysis of Health, IEQ and Energy Use for Sustainable Buildings	574
<i>C. A. Roulet, N. Johner, F. Flourentzou, G. Greuter</i>	
Striving for Excellent Indoor Air Quality—The Hong Kong Experience	580
<i>A. K. L. Lam, J. W. Y. Fong</i>	
Recommendations for Establishing Target Values and Guidance Values for Volatile Organic Compounds (VOC) in Indoor Air	586
<i>H. Schleibinger, U. Hott, P. Braun, D. Marchl, H. Rueden</i>	
Setting Indoor Air Guidelines in Austria	593
<i>H. P. Hutter, P. Tappler, H. Moshhammer</i>	
Criteria for Design of Indoor Environment in Sustainable Buildings	597
<i>P. C. Chou, C. M. Chiang, K. F. Chang, Y. Y. Li, N. T. Chen</i>	
Quality Assesment in Building Investigations	603
<i>O. E. Carlson, J. Mattsson</i>	

(4C) POLICY & LEGAL ISSUES

Indoor Climate 2002 Education and Information Campaign	609
<i>J. Säteri</i>	
Concept of Radon Protection Measures For New Buildings in Germany	615
<i>R. Lehmann, J. Kemski, R. Klingel, R. Stegemann</i>	

(4D) SURVEYS & CASE STUDIES

Indoor Air Quality in Two Different Commercial Buildings: Part 1: Ventilation, Temperature, Humidity of Air and Gas Concentrations	620
<i>B. Ribot, A. Ginestet, M. Henninot, D. Pugnet</i>	
IAQ Evaluation of Educational Buildings	626
<i>A. Baglioni, I. Oberti, S. Piardi, F. Plantamura, A. Ratti</i>	
Benchmark of Data Center Energy Performance	631
<i>H. S. Sun, S. E. Lee</i>	
IAQ at Two Vocational Institutes in Hong Kong	637
<i>K. S. Fung, S. T. A. Tang, W. C. Lee, S. K. Ng, Y. K. Szeto</i>	
Study of Air Infection Risk in Operating Theatre	643
<i>T. T. Chow, Z. Lin, X. Y. Yang</i>	
Moisture Damage in Residential Buildings as a Function of Engineer and Occupant Observations	649
<i>U. Haverinen-Shaughnessy, A. Hyvärinen, J. Pekkanen, A. Nevalainen, J. Halla-aho, J. Koivisto, D. Moschandreas</i>	
IAQ in Office Buildings Located in the North and in the South of Italy	654
<i>S. Bonetta, S. Bonetta, S. Sampò, S. Mosso, S. Romussi, F. Genova, E. Carraro</i>	
Quality of Indoor Air and Functionality of Ventilation in Day Care Centres	660
<i>J. Jalas</i>	
Long Term Monitoring of the Performances of an Innovative HVAC System for Cinemas	665
<i>A. Gastaldello, A. Gerrard-Smith, L. Schibuola, S. Venco</i>	
A Case Study on the Application of Underfloor Air Conditioning and Ventilation System in a School Assembly Hall	671
<i>A. Law, M. P. Wan, C. Chao, J. S. Hu</i>	
Magnitude of the Mould and Moisture Problem in Danish Homes	677
<i>L. Gunnarsen, L. Keiding</i>	
Measured IAQ in Two New Blocks of Flats	683
<i>M. Tuomainen, J. Pirinen</i>	
Design Strategy for Sustainable Hospital Planning—A Case Study	688
<i>P. M. Kumari</i>	
A Case Study on the Application of Nano-Confined Catalytic Oxidation (NCCO) Air Purification Technology in Ammonia Gas Removal in an Office Building	694
<i>A. Law, G. Y. W. Chan, T. H. M. Yip, T. S. C. Law</i>	
A Life-Cycle Costs Study of an Office Building in Scandinavian Conditions: A Case-Study Approach	701
<i>R. Kosonen, K. Hagström, T. Laine, V. Martiskainen</i>	
Ventilation Management for Patient Care Protection During Construction in a Bone Marrow Transplant Unit	707
<i>A. Streifel, M. Mazzarella, J. Groot, A. Guelcher, C. Hendrickson, J. Eilrich</i>	

The French National Survey on Indoor Air Quality: Sample Survey Design	712
<i>F. Golliot, I. Annesi-Maesano, M. C. Delmas, F. Dor, Y. Le Moullec, L. Mosqueron, V. Nedellec, J. Ribéron, G. Salines, S. Kirchner</i>	

(5A) STATUS-QUO ASSESSMENT

Indoor Air Quality and Health	718
<i>L. K. Nagrani</i>	
Sick Building Syndrome in Mauritius: A Need for Concern	723
<i>A. H. Subratty, R. Bholah, V. Jowaheer, M. F. L. C. Wah</i>	
Sick Building Syndrome Among Office Workers in Mauritius	728
<i>R. Bholah, H. Subratty, P. Gorroochand</i>	
Assessment of Building Environmental Impacts for Sustainable Development	734
<i>G. Zhang, L. Yu, Y. Chen</i>	

(5B) SOLUTIONS FOR HEALTHY BUILDINGS

Natural Ventilation in Dense Residential Areas: Studying Alternatives	740
<i>Z. N. Ahmed</i>	
Ventilation in a Mosque—An Additional Purpose the Minarets May Serve	746
<i>S. M. N. Imam</i>	
Investigation of Indoor Air Quality and Emission of Indoor Used Materials in Hungary	752
<i>L. Kajtár, T. Hrustinszky</i>	
Development of a Life Cycle Cost Optimization Tool for Buildings	758
<i>V. Garg, J. Mathur, N. K. Bansal</i>	
Optimisation of the Glazed Surface of a Building With Reference to its Consumption for Thermal and Lighting Purposes	764
<i>A. Idone, C. Marino, A. Nucara, M. Pietrafesa</i>	
Author Index	771
Author Index for Volume 1	I
Author Index for Volume 2	III