



## Project Summary

# Proceedings: The 1991 International Symposium on Radon and Radon Reduction Technology

Timothy M. Dyess, Compiler

The proceedings of the 1991 International Symposium on Radon and Radon Reduction Technology are contained in four volumes. Volume 1 contains three opening session papers and 31 oral papers from Sessions I through V. Volume 2 contains 31 oral papers from Sessions VI through X. Volume 3 contains 14 panel session papers and 19 poster papers from Sessions I through V. Volume 4 contains 21 poster papers from Sessions VI through X. The presentation of these papers provided an opportunity for and stimulated the exchange of information among participants on a variety of topics relating to indoor radon and its control.

The symposium was jointly sponsored by the EPA's Air and Energy Engineering Research Laboratory (AEERL), the EPA Office of Radiation Programs (ORP), and the Conference of Radiation Control Program Directors (CRCPD), Inc. The meeting was held in Philadelphia, PA, April 2-5, 1991. Participants included over 400 individuals representing federal, state, and local governments, radon measurement companies, radon mitigation companies, research organizations, academia, construction companies, real estate and relocation companies, and school facilities.

*This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to highlight key findings of the symposium. The results of recent research are fully documented in the four volumes of the proceedings by the same title. (Information for ordering the full proceedings is at the back of this Summary.)*

### Introduction

The co-chairpersons of the symposium were Timothy M. Dyess of EPA-AEERL, Susan M. Conrath of EPA-ORP, and Charles M. Hardin of CRCPD. The Opening Address was given by Charles M. Hardin, Executive Director of CRCPD, who briefed the audience on the history and objectives of that organization. The Welcome Address was given by Edwin B. Erickson, Administrator of EPA Region 3. The Lead Address, entitled "Comparative Dosimetry of Radon in Mines and Homes: and Overview of the NAS Report," was presented by Jonathan M. Samet of the New Mexico Tumor Registry at the University of New Mexico. This paper addressed the results of recent risk estimate calculations by the National Academy of Sciences. The Keynote Address, given by John R. Garrison, Managing Director of the American Lung Association, focused on ways to promote public respect for the health hazard which indoor radon presents.

In all, 65 oral papers, 14 panel session papers, and 40 poster papers were presented. The papers addressed a wide range of radon topics: government programs and policies, health studies, health risk communication, measurement methods, radon reduction methods in existing houses, radon transport and entry dynamics, survey results, geological data, radon-resistant new construction methods, and radon measurement and mitigation in schools and large buildings.

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struction and real estate industries. Attendees represented 14 countries other than the U.S.: Austria, Belgium, Canada, Finland, Greece, Hong Kong, Ireland, Israel, Italy, Korea, Sweden, Switzerland, the United Kingdom, and Yugoslavia. The international papers updated government policies, results of surveys, and technological developments in radon and radon reduction technology issues.

The session on government programs and policies gave the audience a view of how various government organizations, in both the U.S. and Europe, assess the radon problem. A paper by a representative of the Commission of European Communities summarized efforts that are being made collectively by the European countries. A representative of the International Atomic Energy Agency called for a global effort to unify the approach to understanding the issues of radon in the indoor environment. Two programs in the U.S. were described and compared, those of the Department of Energy (DOE) and the EPA. The DOE program on indoor air described its objective as one of developing information to enable an improved health risk estimate for radon exposure so that sound public policy may be developed. In somewhat of a contrast, the EPA summarized its mission as public protection, citing that sufficient studies link radon to lung cancer, and that immediate action is required in order to reduce the health threat that radon poses to the public.

In the health effects session, two papers by the New Mexico Tumor Registry suggested that ecological studies cannot currently address the gaps in the scientific understanding of indoor radon and lung cancer risk; however, further follow-up of miner data, animal experiments, and well-designed epidemiological studies should reduce the uncertainty. Results of current animal studies were presented by Pacific Northwest Laboratory, indicating that lung tumors were the principal biological effects observed in male Wistar rats and that the risk of lung tumors in the animals was similar to that predicted in humans by the BEIR IV study. The results of studies using glass as a retrospective radon measurement device were presented in two papers, one from Europe and the other from the U.S. These papers indicated continued advancement in the technology of measurement of absorbed Pb-214 and Pb-210 in the surface of glass to determine long-term radon exposure.

Risk communication was a key topic of the symposium. In the health effects session, one paper compared the health risks associated with radon to other more readily recognized risks, including exposure to poly-

chlorinated biphenyls (PCBs), asbestos, and drunk drivers. A panel session was conducted to address current risk communication activities by various organizations. A paper from Rutgers University delineated the sciences of risk communication as it relates to the indoor radon issue. The American Lung Association presented information describing their activities in communicating the radon health risk to the public and some initial results of this program. The EPA described their work with the Advertising Council to develop the first wave of a nationwide radon advertising campaign, with the goal of motivating people to test their houses for radon and to fix houses where elevated levels are detected. The State of Kentucky described their efforts in risk communication through a network enlisting community support in promoting radon testing and follow-up actions to reduce elevated levels.

The measurement methods session dealt with current and developing technologies in the measurement of radon and radon progeny. The papers in this session included the use of personal radon monitors to measure the exposure of occupants to radon, a device that measures ion concentrations in the air, and the use of a Graded Screen Array for measurement of radon decay product activity size distributions. A comparison of measured radon levels in basements in New Jersey to radon levels measured in the living areas of 983 residences suggested that the measurement of radon in basements increasingly overestimates actual exposures as radon concentrations rise, resulting in a high proportion of false positives. A Finnish paper presented methods to predict radon availability in future construction sites from the use of indoor radon measurements.

Two panel sessions regarding measurement of radon were also held at the symposium. A session on determining radon measurement tampering was of particular interest to those in the radon measurement and real estate transaction businesses. A presentation of the status of current efforts to develop guidance to assist consumers in real estate transactions was presented by the EPA. An overview was given of the Indiana Responsible Property Transfer Law, which requires disclosure of the presence of radon gas in many commercial real estate transactions in that state. The American Association of Radon Scientists and Technologists (AARST) presented their recently developed guidelines for radon and radon decay product testing in real estate transactions of residential dwellings. A report by the state of New Jersey described a method to determine the accuracy of radon

measurements through statistical analysis using a test-difference curve. A presentation was made on recently developed software that can be used to ensure quality assurance in radon measurements. A paper demonstrated how grab sampling, as a secondary measurement strategy, can be used to provide improved quality assurance. The other panel session on radon measurement concerned the use of short-term measurements to determine long-term radon concentrations in houses. A paper by Princeton University evaluated temperature correction as a method to estimate long-term average concentrations. Another paper addressed the development of a protocol for post-construction indoor radon measurement in Florida houses using short-term measurements. Results were also presented on a study to determine the relationship between 2-day, wintertime, closed-house measurements and annual living area averages in basement and nonbasement houses in the U.S.

In the radon reduction session, various methods of reducing radon levels in existing houses were presented. An EPA follow-up study of 40 houses with high premitigated radon levels found that a significant number of the systems were not achieving the EPA guideline of  $4 \text{ pCi L}^{-1}$  due to various factors such as exhaust re-entrainment and radon from water sources. Various methods to decrease levels were also presented, including natural ventilation and a method to increase pressure field extension for active soil depressurization using a pressure washer.

The session on radon entry dynamics focused on current work in modeling and measurement of radon transport through soil, radon entry into structures, and interior house dynamics. Results were presented from models developed by Lawrence Berkeley Laboratories to determine entry of radon into slab-on-grade houses typical of Florida housing stock, and by Pacific Northwest Laboratory to determine the effect of wind on the driving forces for radon entry. A study of radon entry into Swedish dwellings compared factors affecting entry into these structures with similar factors in the New Jersey Piedmont research houses. A technique to quantify the potential for pressure-driven entry of soil gas was presented; it found, in six New Mexico houses, that locations along the perimeter of slab floors had soil gas entry potentials approximately 18 times greater and radon entry potential approximately 10 times greater than locations more central to the slab. A paper presented by Rogers and Associates Engineering gave results of recent measurements of radon diffusion through a sample

of typical Florida concretes, and identified diffusion as a significant contributor to radon entry. A presentation by the U.S. Department of Energy reported that pressure-driven flow accounted for only a small fraction of the total radon entering three basement houses studied in Colorado, thus indicating that diffusion of radon through the concrete was significant.

The radon surveys session presented results from current studies of large samples of radon measurements in various localities. Results of the radon survey in U.S. federal buildings were presented, indicating that office buildings are not immune to radon problems and that radon may be transported throughout a building by the ventilation system, resulting in a larger exposure potential for workers in buildings with elevated levels of radon. A study of radon measurements in 1,600 Swiss homes estimates that the average indoor radon concentration for the Swiss population is 2 pCi L<sup>-1</sup> and that 5% of them are exposed to concentrations exceeding 5 pCi L<sup>-1</sup>. A survey of 966 housing units in Winnipeg, Manitoba, Canada, found wintertime radon concentrations approximately twice as high as those of summertime. Results from a survey of public school buildings in the state of Maine found that there was at least one room above 4 pCi L<sup>-1</sup> in 32% of the school buildings measured, and that 8.7% of all rooms tested had a radon level equal to or greater than 4 pCi L<sup>-1</sup>. A study conducted in Greek spas found that thermal spring waters used in water-physiotherapy are rich in Radium-226 and Radon-222 and that workers in the spas receive doses between 10% and 30% more than the effective dose equivalents limit. A session was also conducted regarding the geologic occurrence of radon in the environment. The U.S. Geological Survey presented a preliminary radon potential of the U.S. broken into 55 geologic provinces. A paper reported the results of measurements of ambient levels in and near coal-fired power plants and phosphate fertilizer plants in the Croatian region of Yugoslavia. Two papers found correlations between soil radon measurements and indoor radon measurements in houses in Minnesota and southern California.

The state programs and policies session provided information about current activities in U.S. state governments pertaining to programs dealing with radon. The states of Washington, Kentucky, and New Jersey presented status reports on their programs funded by the EPA Innovative Grants Program. A paper was delivered on the development of the Connecticut laws that combine requirements for successful comple-

tion of both state registration and federal proficiency programs in order for radon mitigation contractors to perform mitigation work in that state. The New Jersey paper also detailed the history of its program and current efforts to adopt a certification program for testers and mitigators.

Radon prevention in new construction provided the latest technology and experiences in constructing radon-resistant housing. A paper by the University of Colorado concluded that there was a significant difference in post-mitigation indoor radon concentrations between preconstruction and post-construction mitigated houses and that preconstruction mitigated houses exhibited the lower radon average. A double-barrier approach to prevent soil gas entry into structures was presented as an innovative strategy to construct a radon-resistant structure. A paper by the Washington State Energy Office described a research house constructed to demonstrate that energy efficiency and adequate indoor air quality could be achieved using a two-cell barrier-enhanced pressure-difference control system. Another innovative mitigation system was presented, involving the use of a mini-fan for active soil depressurization. Results of a demonstration involving mitigation of a new multi-housing unit with an inaccessible crawlspace were presented by the EPA. A report by Princeton University on the effect of subslab aggregate size on active soil depressurization pressure field extension found that the permeability of soil around the foundation walls and periphery of the residence is a more crucial parameter affecting the pressure field extension than the permeability of the gravel bed.

A session on radon in schools and other large buildings provided the latest information regarding this emerging field of study. An EPA paper described seasonal variations found for short- and long-term measurements in 21 public schools. Results of the EPA School Evaluation Team were presented, recommending a holistic approach that considers the broader issues of indoor air quality, comfort, cost, and energy issues in school buildings. A number of papers dealt with the effects that operation of heating, ventilation, and air conditioning (HVAC) systems have on radon levels in schools. These papers cited a lack of adequate maintenance and energy-reduction techniques as contributors to high radon levels and poor indoor air quality in the school buildings studied. Mitigation techniques for crawlspace-foundation schools and a large commercial office building were also presented. The EPA presented, as a final paper for this session, a report discussing features having the greatest effect on radon

levels in school buildings and a recommendation on design parameters to be applied when constructing new radon-resistant school buildings.

## **Volume 1 — Papers**

Volume 1 contains 3 papers that were delivered at the opening session and 31 papers presented orally in the five sessions listed below. The titles, principal authors, and affiliations are listed below for each session.

### ***Opening Session***

The Conference of Radiation Control Program Directors, Inc. Its Beginning, Role, and Operation

Charles M. Hardin, Executive Director, CRCPD

Comparative Dosimetry of Radon in Mines and Homes: An Overview of the NAS Report

Jonathan M. Samet, New Mexico Tumor Registry, University of New Mexico

Keynote Address

John R. Garrison, Managing Director, American Lung Association

### ***Session I: Government Programs and Policies Relating to Radon***

The Need for a Coordinated International Assessment of the Radon Problem

Friedrich Steinhäusler, International Atomic Energy Agency, Austria

European Radon Research Sponsored by the Commission of European Communities  
Martial Olast, Jaak Sinnaeve, and Augustin Janssens, CEC, Belgium

The UK Radon Programme

Michael O'Riordan, National Radiological Protection Board, UK

The U.S. DOE Radon Research Program: A Different Viewpoint

Susan L. Rose, Office of Energy Research, U. S. DOE

Policies and Progress of EPA's Radon Action Program (Abstract)

Margo Ogé, EPA - Office of Radiation Programs

### ***Session II: Radon-Related Health Studies***

Residential Radon Exposure and Lung Cancer in Women (Paper Withdrawn)

Goran Pershagen, Karolinska Institute, Sweden

An Evaluation of Ecological Studies of Indoor Radon and Lung Cancer

Christine Stidley and Jonathan M. Samet, New Mexico Tumor Registry, University of New Mexico

Review of Radon and Lung Cancer Risk (Abstract)

Jonathan M. Samet, University of New Mexico; and Richard Hornung, NIOSH

Lung Cancer in Rats Exposed to Radon/ Radon Progeny (Abstract)

F. T. Cross and G. E. Dagle, Pacific Northwest Laboratory

Startling Radon Risk Comparisons

JoAnne D. Martin, DMA-RADTECH, Inc.

Estimating Radon Levels from Polonium-210 in Glass

J. Cornelis, State University of Gent; Hans Vanmarcke, Nuclear Research Center, Belgium; and C. Landsheere and A. Poffijn, State University of Gent, Belgium

Expanded and Upgraded Tests of the Linear-No Threshold Theory for Radon-Induced Lung Cancer

Bernard L. Cohen, University of Pittsburgh

### **Session III: Measurement Methods**

Current Status of Glass as a Retrospective Radon Monitor

Richard Lively, Minnesota Geological Survey; and Daniel Steck, St. John's University

Soil Gas Measurement Technologies

Harry E. Rector, GEOMET Technologies, Inc.

Results from a Pilot Study to Compare Residential Radon Concentrations with Occupant Exposures Using Personal Monitoring

B. R. Litt, New Jersey Department of Environmental Protection; J. M. Waldman, UMDNJ; and N. H. Harley and P. Chittaporn, New York University Medical Center

Rapid Determination of the Radon Profile in a Structure by Measuring Ions in the Ambient Atmosphere

W. G. Buckman and H. B. Steen III, Western Kentucky University

Intercomparison of Activity Size Distribution Measurements with Manual and Automated Diffusion Batteries - Field Test

P. K. Hopke and P. Wasiolek, Clarkson University; E. O. Knutson, K. W. Tu, and C.

Gogolak, U.S. DOE; A. Cavallo and K. Gadsby, Princeton University; and D. Van Cleef, EPA - NAREL

Influence of Radon Concentrations on the Relationship Among Radon Measurements Within Dwellings (Abstracts)

Judith B. Klotz, Janet B. Schoenberg, and Homer B. Wilcox, NJ Department of Health

The Use of Indoor Radon Measurements and Geological Data in Assessing the Radon Risk of Soil and Rock in Construction Sites in Tampere

Anne Voutilainen and Ilona Mäkeläinen, Finnish Centre for Radiation and Nuclear Safety

### **Session IV: Radon Reduction Methods**

Causes of Elevated Post-Mitigation Radon Concentrations in Basement Houses Having Extremely High Pre-Mitigation Levels

D. Bruce Henschel, EPA - Office of Research and Development; and Arthur G. Scott, AMERICAN ATCON, Inc.

A Measurement and Visual Inspection Critique to Evaluate the Quality of Sub-Slab Ventilation Systems

Richard W. Tucker, Gemini Research, Inc.; and Keith S. Fimian, Radonics, Inc.

Pressure Field Extension Using a Pressure Washer

William P. Brodhead, WPB Enterprises

A Variable and Discontinuous Sub-Slab Ventilation System and Its Impact on Radon Mitigation

Willy V. Abeele, New Mexico Environmental Improvement Division

Natural Basement Ventilation as a Radon Mitigation Technique

A. Cavallo, K. Gadsby, and T.A. Reddy, Princeton University

### **Session V: Radon Entry Dynamics**

A Modeling Examination of Parameters Affecting Radon and Soil Gas Entry Into Florida-Style Slab-on-Grade Houses

R. G. Sextro, K. L. Revzan, and W. J. Fisk, Lawrence Berkeley Laboratory

Effect of Winds in Reducing Sub-Slab Radon Concentrations Under Houses Laid Over Gravel Beds

P. C. Owczarski, D. J. Holford, K. W. Burk, H. D. Freeman, and G. W. Gee, Pacific Northwest Laboratory

Radon Entry Into Dwellings Through Concrete Floors

K. K. Nielson and V. C. Rogers, Rogers and Associates Engineering Corporation

Radon Dynamics in Swedish Dwellings: A Status Report

Lynn M. Hubbard, Nils Hagberg, Anita Enflo, and Gun Astri Swedjemark, Swedish Radiation Protection Institute

Soil Gas and Radon Entry Potentials for Slab-on-Grade Houses

Bradley H. Turk, New Mexico; David Grumm, Yanxia Li, and Stephen D. Schery, New Mexico Institute of Mining and Technology; and D. Bruce Henschel, EPA - Office of Research and Development

Direct Measurement of the Dependence of Radon Flux Through Structure Boundaries on Differential Pressure

D. T. Kendrick and G. Harold Langner, Jr., U.S. DOE/Chem-Nuclear Geotech, Inc.

Radon Resistance Under Pressure

William F. McKelvey, Versar, Inc.; and Jay W. Davis, Versar A/E, Inc.

## **Volume 2 — Papers**

Volume 2 contains 31 oral papers that were presented. The titles, principal authors, and affiliations are listed below for each session.

### **Session VI: Radon Surveys**

Factors Associated with Home Radon Concentrations in Illinois

Thomas J. Bierma and Jennifer O'Neill, Illinois State University

Radon in Federal Buildings

Michael Boyd, EPA - Office of Radiation Programs; and Terry Inge, S. Cohen & Associates

Radon in Switzerland

H. Surbeck and H. Volkle, University Perolles; and W. Zeller, Federal Office of Public Health, Switzerland

A Cross-Sectional Survey of Indoor Radon Concentrations in 966 Housing Units at the Canadian Forces Base in Winnipeg, Manitoba

D. A. Figley and J. T. Makohon, Saskatchewan Research Council

Radon Studies in British Columbia, Canada

D. R. Morley and B. G. Phillips, Ministry of Health; M. M. Ghomshei, Orchard Geothermal, Inc.; and C. Van Netten, The University of British Columbia

**The State of Maine Schools Radon Project: Results**

Lee Grodzins, NITON Corporation; T. Bradstreet, Division of Safety and Environmental Services, Maine; and E. Moreau, Department of Human Services, Maine

**Radon in Belgium: The Current Situation and Plans for the Future**

A. Poffijn, State University of Gent; J. M. Charlet, Polytechnical Faculty; E. Cottens and S. Hallez, Ministry of Public Health; H. Vanmarcke, Nuclear Research Center; and P. Wouters, BBRI, Belgium

**A Radiological Study of the Greek Radon Spas**

P. Kritidis, Institute of Nuclear Technology - Radiation Protection, Greece

**Session VII: State Programs and Policies Relating to Radon**

**Washington State's Innovative Grant: Community Support Radon Action Team for Schools**

Patricia A. McLachlan, Department of Health, Washington

**Kentucky Innovative Grant: Radon in Schools Telecommunication Project**

M. Jeana Phelps, Kentucky Cabinet for Human Resources; and Carolyn Rude-Parkins, University of Louisville

**Regulation of Radon Professionals by States: the Connecticut Experience and Policy Issues**

Alan J. Siniscalchi, Zygmunt F. Dembek, Nicholas Macelletti, Laurie Gokey, and Paul Schur, Connecticut Department of Health Services; Susan Nichols, Connecticut Department of Consumer Protection; and Jessie Stratton, State Representative, Connecticut General Assembly

**New Jersey's Radon Program - 1991**

Jill A. Lapoti, New Jersey Department of Environmental Protection

**Session VIII: Radon Prevention in New Construction**

**A Comparison of Indoor Radon Concentrations Between Preconstruction and Post-Construction Mitigated Single Family Dwellings**

James F. Burkhart, University of Colorado at Colorado Springs; and Douglas L. Kladder, Residential Service Network, Inc.

**Radon Reduction in New Construction: Double-Barrier Approach**

C. Kunz, New York State Department of Health

**Radon Control - Towards a Systems Approach**

R. M. Nuess and R. J. Prill, Washington State Energy Office

**Mini Fan for SSD Radon Mitigation in New Construction**

David W. Saum, INFILTEC

**Building Radon Mitigation into Inaccessible Crawlspace - New Residential Construction**

D. Bruce Harris and A. B. Craig, EPA - Office of Research and Development; Jerry Haynes, Hunt Building Corporation

**The Effect of Subslab Aggregate Size on Pressure Field Extension**

K. J. Gadsby, T. Agami Reddy, D. F. Anderson, and R. Gafgen, Princeton University; and A. B. Craig, EPA - Office of Research and Development

**Session IX: Radon Occurrence in the Natural Environment**

**Combining Mitigation and Geology: Indoor Radon Reduction by Accessing the Source**

Stephen T. Hall, Radon Control Professionals, Inc.

**Preliminary Radon Potential Map of the United States**

L. C. S. Gundersen, R. R. Schumann, J. K. Otton, R. F. Dubiel, D. E. Owen and K. A. Dickenson, U. S. Geological Survey; and R. T. Peake and S. J. Wirth, EPA - Office of Radiation Programs

**Technological Enhancement of Radon Daughter Exposures Due to Non-nuclear Energy Activities**

Jadranka Kovač, D. Cesar, and A. Bauman, University of Zagreb, Yugoslavia

**A Site Study of Soil Characteristics and Soil Gas Radon**

Richard Lively, Minnesota Geological Survey; and Daniel Steck, St. John's University

**Geological Parameters in Radon Risk Assessment - A Case History of Deliberate Exploration**

Donald Carlisle and Haydar Azzouz, University of California at Los Angeles

**Session X: Radon in Schools and Large Buildings**

**Seasonal Variation in Short-Term and Long-Term Radon Measurements in Schools**

Anita L. Schmidt, EPA - Office of Radiation Programs; and John T. MacWaters and Harry Chmelynski, S. Cohen & Associates

**Diagnostic Evaluations of Twenty-six U. S. Schools - EPA's School Evaluation Program**

Gene Fisher and Bob Thompson, EPA - Office of Radiation Programs; Terry Brennan, Camroden Associates; and William Turner, H. L. Turner Group

**Extended Heating, Ventilating and Air Conditioning Diagnostics in Schools in Maine**

Terry Brennan, Camroden Associates; Gene Fisher and Robert Thompson, EPA - Office of Radiation Programs; and William Turner, H. L. Turner Group

**Mitigation Diagnostics: The Need for Understanding Both HVAC and Geologic Effects in Schools**

Stephen T. Hall, Radon Control Professionals, Inc.

**A Comparison of Radon Mitigation Options for Crawl Space School Buildings**

Bobby E. Pyle, Southern Research Institute; and Kelly W. Leovic, EPA - Office of Research and Development

**HVAC System Complications and Controls for Radon Reduction in School Buildings**

Kelly W. Leovic, D. Bruce Harris, and Timothy M. Dyess, EPA - Office of Research and Development; Bobby E. Pyle, Southern Research Institute; Tom Borak, Western Radon Regional Training Center; and David W. Saum, INFILTEC

**Radon Diagnosis in a Large Commercial Office Building**

David Saum and Marc Messing, INFILTEC

**Design of Radon-Resistant and Easy-to-Mitigate New School Buildings**

Alfred B. Craig, Kelly W. Leovic, and D. Bruce Harris, EPA - Office of Research and Development

**Volume 3 — Papers**

This volume contains 14 panel session papers and 19 poster papers that were presented. The titles, principal authors, and affiliations are listed below for each session.

**Panel Session I: Risk Communication**

**Apathy vs. Hysteria, Science vs. Drama: What Works in Radon Risk Communication (Withdrawn)**

Peter Sandman, Rutgers University

**American Lung Association's Radon Public Information Program**

Leyla Erk McCurdy, American Lung Association

Radon Media Campaign  
Dennis Wagner and Mark Dickson, EPA - Office of Radiation Programs

Developing a Community Radon Outreach Program: A Model for Statewide Implementation

M. Jeana Phelps, Kentucky Cabinet for Human Resources

### **Panel Session II: Detection of Radon Measurement Tampering**

Policy and Technical Considerations for the Development of EPA Guidance on Radon and Real Estate

Lawrence Pratt, EPA - Office of Radiation Programs

State Property Transfer Laws Now Include Radon Gas Disclosure

Michael A. Nardi, The Nardi Group

Guidelines for Radon/Radon Decay Product Testing in Real Estate Transactions of Residential Dwellings

William P. Brodhead, AARST

How to Determine if Radon Measurement Firms are Providing Accurate Readings

Herbert C. Roy and Mohammed Rahman, New Jersey Department of Environmental Protection

What Happens When You Do 477 Radon Inspections Preceded by Grab Samples? (Abstract)

Marvin Goldstein, Building Inspection Service, Inc.

Exploring Software Device Management Routines that Ensure the Overall Quality of Continuous Working Level and Continuous Radon Monitor Performance in a Field Environment

Richard Tucker, Gemini Research; and Rick Holland, Radonics, Inc.

Use of Grab Samples as a Quality Assurance Tool to Enhance Overall Radon Measurement Accuracy and Reproducibility

Brian Fimian, Radonics, Inc.; and Richard Tucker, Gemini Research

### **Panel Session III: Short-Term/Long-Term Measurement**

Predicting Long-Term Indoor Radon Concentrations from Short-Term Measurements: Evaluation of a Method Involving Temperature Correction

T. Agami Reddy, A. Cavallo, K. Gadsby, and R. Socolow, Princeton University

Correlation Between Short- and Long-Term Indoor Radon Concentrations in Florida Houses

Susan E. McDonough and Ashley Williamson, Southern Research Institute; and David C. Sanchez, EPA - Office of Research and Development

Relationship Between Two-day Screening Measurements of Radon-222 and Annual Living Area Averages in Basement and Nonbasement Houses

S. B. White, N. F. Rodman, and B. V. Alexander, Research Triangle Institute; and J. Phillips and F. Marcinowski, EPA - Office of Radiation Programs

### **Poster Session I: Government Programs and Policies Relating to Radon**

The State Indoor Radon Grants Program: Analysis of Results After the First Year of Funding (Withdrawn)

Laurie Amaro, EPA - Office of Radiation Programs

EPA Radon Policy and Its Effects on the Radon Industry

David Saum, INFILTEC

EPA's National Radon Contractor Proficiency Program

G. Lee Salmon, John MacKinney, John Hoornbeek, and Jed Harrison, EPA - Office of Radiation Programs

Draft Guidance to States on Radon Certification Programs

John Hoornbeek, EPA - Office of Radiation Programs; and Barbara Zakheim, S. Cohen & Associates

National Radon Measurement Proficiency (RMP) Program

Philip P. Jalbert, John Hoornbeek, and Jed Harrison, EPA - Office of Radiation Programs

### **Poster Session II: Radon-Related Health Studies**

Occupational Safety During Radon Mitigation: Field Experience and Survey Monitoring Results

Jean-Claude F. Dehmel, S. Cohen & Associates; Peter Nowlan, R. F. Simon Company; and Eugene Fisher, EPA - Office of Radiation Programs

Cost Benefit Analysis of Radon Mitigation Systems in 157 Iowa and Nebraska Homes

Kenneth D. Wiggers and Tom D. Bullers, American Radon Services, Ltd; and J.

Peter Mattila and Laurent Hodges, Iowa State University

The Effect of Passive Cigarette Smoke on Working Level Exposures in Homes

Raymond H. Johnson, Jr. and Randolph S. Kline, Key Technology, Inc.; and Eric Geiger and Augustine Rosario, Jr., Radon QC

### **Poster Session III: Measurement Methods**

Characterization of Structures Using Simultaneous Single Source Continuous Working Level and Continuous Radon Gas Measurements

Brian Fimian and John E. McGreevy, Radonics, Inc.

Radon and Water Vapor Co-Adsorption on Solid Adsorbents

Neguib M. Hassan, Tushar K. Ghosh, Sudarshan K. Loyalka, and Anthony L. Hines, University of Missouri-Columbia

Calibration of Modified Electret Ion Chamber for Passive Measurement of Radon-222 (Thoron) in Air

P. Kotrappa and J. C. Dempsey, Rad Elec, Inc.

Unit Ventilator Operation and Radon Concentrations in a Pennsylvania School

Norm Grant, Quoin Partnership; and William P. Brodhead, WPB Enterprises

### **Poster Session IV: Radon Reduction Methods**

Radon Mitigation Failure Modes

William M. Yeager, Research Triangle Institute; D. Bruce Harris, EPA - Office of Research and Development; and Terry Brennan and Mike Clarkin, Camroden Associates, Inc.

Mitigation by Sub-Slab Depressurization Under Structures Founded on Relatively Impermeable Sand

Donald A. Crawshaw and Geoffrey K. Crawshaw, Pelican Environmental Corporation

A Laboratory Test of the Effects of Various Rain Caps on Sub-Slab Depressurization Systems

Mike Clarkin, Terry Brennan, and David Fazikas, Camroden Associates, Inc.

Analysis of the Performance of a Radon Mitigation System Based on Charcoal Beds

P. Wasiolek, N. Montassier, and P. K. Hopke, Clarkson University; and R. Abrams, Rad Systems, Inc.

Control of Radon Releases in Indoor Commercial Water Treatment  
D. Bruce Harris and A. B. Craig, EPA - Office of Research and Development

### **Poster Session V: Radon Entry Dynamics**

Model Calculations of the Interaction of a Soil Depressurization System With the Radon Entry Process  
Ronald B. Mosley, EPA - Office of Research and Development

Effects of Humidity and Rainfall on Radon Levels in a Residential Dwelling  
Albert Montague and William E. Belanger, EPA - Region 3; and Francis J. Haughey, Rutgers University

### **Volume 4 — Papers**

This volume contains 21 poster papers that were presented. The titles, principal authors, and affiliations are listed below for each session.

### **Poster Session VI: Radon Surveys**

A Cumulative Examination of the State/EPA Radon Survey  
Jeffrey L. Phillips, EPA - Office of Radiation Programs; and Jane W. Bergsten and S. B. White, Research Triangle Institute

Seasonal Variation in Two-Day Screening Measurements of Radon-222  
Nat F. Rodman, Barbara V. Alexander, and S. B. White, Research Triangle Institute; and Jeffrey Phillips and Frank Marcinowski, EPA - Office of Radiation Programs

The State of Maine School Radon Project: Protocols and Procedures of the Testing Program  
Lee Grodzins and Ethel G. Romm, NITON Corporation; and Henry E. Warren, Bureau of Public Improvement, Maine

Results of the Nationwide Screening for Radon in DOE Buildings  
Mark D. Pearson, D. T. Kendrick, and G. H. Langner, Jr., DOE/Chem-Nuclear Geotech, Inc.

### **Poster Session VII: State Programs and Policies Relating to Radon**

Quality Assurance - The Key to Successful Radon Programs in the 1990's  
Raymond H. Johnson, Jr., Key Technology, Inc.

Radon in Illinois: A Status Report  
Richard Allen and Melanie Hamel-Casparly, Illinois Department of Nuclear Safety

### **Poster Session VIII: Radon Prevention in New Construction**

Radon Prevention in Residential New Construction: Passive Designs That Work  
C. Martin Grisham, National Radon Consulting Group

Preliminary Results of HVAC System Modifications to Control Indoor Radon Concentrations  
Terry Brennan and Michael Clarkin, Camroden Associates; Timothy M. Dyess, EPA - Office of Research and Development; and William Brodhead, Buffalo Homes

Correlation of Soil Radon Availability Number with Indoor Radon and Geology in Virginia and Maryland (Visuals only)  
Stephen T. Hall, Radon Control Professionals, Inc.

### **Poster Session IX: Radon Occurrence in the Natural Environment**

Geologic Evaluation of Radon Availability in New Mexico: A Progress Report  
Virginia T. McLemore and John W. Hawley, New Mexico Bureau of Mines and Mineral Resources; and Ralph A. Manchego, New Mexico Environmental Improvement Division

Paleozoic Granites in the Southeastern United States as Sources of Indoor Radon (Visuals only)  
Stephen T. Hall, Radon Control Professionals, Inc.

Comparison of Long-Term Radon Detectors and Their Correlations with Bedrock Sources and Fracturing  
Darioush T. Ghahremani, Radon Survey Systems, Inc

Geologic Assessment of Radon-222 in McLennan County, Texas  
Mary L. Podsednik, Law Engineering, Inc.

Radon Emanation from Fractal Surfaces  
Thomas M. Semkow, Pravin P. Parekh, and Charles O. Kunz, New York State Department of Health and State University of New York at Albany; and Charles D. Schwenker, New York State Department of Health

National Ambient Radon Study  
Richard D. Hopper, Richard A. Levy, and Rhonda C. Rankin, EPA - Office of Research and Development; and Michael Boyd, EPA - Office of Radiation Programs

### **Poster Session X: Radon in Schools and Large Buildings**

Design and Application of Active Soil Depressurization (ASD) Systems in School Buildings  
Kelly W. Leovic, A. B. Craig, and D. Bruce Harris, EPA - Office of Research and Development; Bobby E. Pyle, Southern Research Institute; and Kenneth Webb, Bowling Green, KY Public Schools

Radon in Large Buildings: Pre-Construction Soil Radon Surveys  
Ralph A. Llewellyn, University of Central Florida

Radon Measurements in North Dakota Schools  
Thomas H. Morth, Arlen L. Jacobson, James E. Killingbeck, Terry D. Lindsey, and Allen L. Johnson, North Dakota State Department of Health and Consolidated Laboratories

Major Renovation of Public Schools that Includes Radon Prevention: A Case Study of Approach, System Design and Installation, and Problems Encountered  
Thomas Meehan, TFM/SAF - Air Radon

The State of Maine School Radon Project: The Design Study  
Henry E. Warren, Maine Bureau of Public Improvement; and Ethel G. Romm, NITON Corporation

Planning and Implementing the National School Radon Survey  
Lisa Ratcliff, EPA - Office of Radiation Programs; and Jane W. Bergsten, Ronald Iachan, Harvey Zelon, and Lisa Williams, Research Triangle Institute