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REVIEW OF RECENT RESEARCH IN INDOOR AIR QUALITY

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Prepared by

Industrial Environmental Research
Laboratory
Research Triangle Park NC 27711

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REVIEW OF RECENT RESEARCH IN INDOOR AIR QUALITY

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ABSTRACT

This report presents a review of indoor air quality research in an effort to define the state-of-the-art.

Several approaches were taken. Approximately 150 recent journal articles, symposium presentations, and bibliographic reports were reviewed and these are presented in an annotated bibliography arranged by subject. In addition, roughly 30 prominent researchers in the field of indoor air quality were contacted, and summaries of these contacts are provided. Significant articles (prior to 1980) were also reviewed, and these are listed in a separate bibliography which is not annotated. Two tables summarize the information in the annotated bibliography and contact summaries.

The report also provides a short discussion of the quality and apparent deficiencies of the reviewed data base of articles, reports, and books.

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CONTENTS

LIST OF TABLES

LIST OF ABBREVIATIONS

AEC	Atomic Energy Commission
AGA	American Gas Association
APCA	Air Pollution Control Association
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
BPA	Bonneville Power Authority
CDC	Center for Disease Control
CPSC	Consumer Product Safety Commission
DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
FDA	Federal Drug Administration
GRI	Gas Research Institute
HERL	Health Effects Research Laboratory (EPA)
IAQ	Indoor Air Quality
IITRI	Illinois Institute of Technology, Research Institute
JAPCA	Journal of the Air Pollution Control Association
LBERI	Lovelace Biological and Environmental Research Institute
LBL	Lawrence Berkeley Laboratory
NAS	National Academy of Science
NBS	National Bureau of Standards (DOC)
NCI	National Cancer Institute
NHLBI	National Heart, Lung, and Blood Institute
NIEHS	National Institute of Environmental Health Sciences
NIH	National Institute of Health
NIOSH	National Institute of Occupational Safety and Health
NYERDA	New York Energy Research and Development Administration
ORNL	Oak Ridge National Laboratories
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated biphenyls
PHS	U.S. Public Health Service

LIST OF ABBREVIATIONS (continued)

RTI	Research Triangle Institute
SCBR	Swedish Council for Building Research
SERI	Solar Energy Research Institute
WHO	World Health Organization

1.0 INTRODUCTION

Indoor air quality is recognized as a significant factor affecting the well-being of the average American. In recent years, energy conservation practices such as weatherizing buildings and the greater use of unvented combustion (heating) devices have apparently increased indoor concentrations of hazardous air pollutants. Thus the identification and evaluation of sources of indoor air pollution and their control has increasingly received attention from numerous Federal and State agencies concerned with health and environmental protection.

The objective of this report is to establish the state-of-the-art in indoor air quality research. This was done by contacting prominent researchers in the field, summarizing their efforts and capabilities, and by reviewing published articles and reports. The report is intended to assist the indoor air quality research community in assessing the content and quality of its recent research efforts, to highlight milestone indoor air quality studies or symposia and to identify research facilities available to the user community. This information should serve to enhance coordination of government and private research efforts.

Section 2.0, Conclusions and Recommendations, provides a short discussion of the quality and apparent deficiencies of the reviewed data base of articles, reports, and books. Section 3.0, Results and Discussion, contains an overview of indoor air quality research efforts and special capabilities. Section 4.0 presents an annotated bibliography uniquely arranged by subject and Section 5.0 presents a list of unannotated citations similarly arranged. Section 6.0 documents our telephone contacts with researchers engaged in studies of indoor air quality.

2.0 CONCLUSIONS AND RECOMMENDATIONS

Our review of current literature covering the period through December 1983 (Section 4.0) and the telephone survey of prominent investigators (Section 6.0) indicates that more indoor air quality research has been directed toward the characterization and measurement of a limited number indoor pollutants. Within this area, many studies have sought to establish an average concentration level of a pollutant or the relationship of indoor concentrations to outdoor pollutant levels.

A small but significant body of research provides preliminary information on source types and emissions. Emphasis has been directed toward the characterization of sources of formaldehyde and home combustion sources. Control and mitigation of indoor air quality problems has generally emphasized the use of ventilation techniques.

Mathematical modeling of indoor air concentrations has been attempted and the results indicate some success based on comparisons with pollutant monitoring results.

Further study is needed to characterize emission rates from exclusively indoor sources such as kerosene heaters. Further study of control options other than ventilation--for example, source modification to reduce emission rates or air purifying methods to reduce pollutant levels--should also be pursued. The development of mathematical models should continue as they may be a cost-effective mechanism for assessing the total health significance of indoor air quality. These models should be expanded to consider a wider range of pollutants as well as integrated with laboratory and field measurements of input parameters. This development will only occur when expanded monitoring data becomes available. This would provide a more complete characterization of the indoor environment.

3.0 RESULTS AND DISCUSSION

Our attempt to define the state-of-the-art in indoor air pollution research used two approaches: (1) a review of recent literature and, (2) telephone contacts to prominent investigators. The literature review covers several sources including searches of computer files, and the citation lists in the NAS *Indoor Pollutants* document, in *Indoor Air Pollution* by Wadden and Scheff, and in review articles such as "Indoor Air Pollution: A Public Health Perspective" by Spengler and Sexton, (1983). Manual searches of several journals that frequently publish indoor air quality research provided articles current through December, 1983. Primary emphasis was placed on peer-reviewed journal articles rather than government reports or symposia presentations. Roughly 30 prominent investigating laboratories were contacted to assess the extent of on-going research in indoor air quality. Specific inquiries as to the nature of the work, the measurements performed, funding levels, sponsor, and special facilities provided an up-to-date inventory.

In the Overview (Section 3.1), two tables summarize the information gained from telephone contacts and our review of the most recent (post 1980) literature. The Annotated Bibliography (Section 4.0) reviews the same recent literature and provides capsule summaries of the literature. Under Additional Citations (Section 5.0), significant early literature (prior to 1980) and a few recent articles for which there was insufficient time to annotate, are listed. Both these bibliographies are arranged by subject.

3.1 Overview: Summary Tables

Table 3-1 is a summary of activities in indoor air quality research providing the sponsor, investigating organization, description of the subject area, broad classification of the work, and the pollutants measured. Recent articles (1980-83) and telephone contact summaries formed the basis of this table. The format of the table follows C.B. Meyer et al.'s *Inventory of Current Indoor Air Quality-Related Research* (EPA-600/7-81-119). In general, this report is supplementary and updates the Meyer et al. report.

Table 3-2 summarizes the special capabilities of various organizations for conducting indoor air quality research. This table is also based on recent articles and telephone contact summaries. Tables 3-1 and 3-2 are cross-referenced by using the "Inventory number" for each Table 3-1 entry. In addition, each Table 3-2 entry is cross-referenced to a "hard" reference, within either the Annotated Bibliography or the Contact Summaries.

TABLE 3-1 SUMMARY OF ACTIVITIES IN INDOOR AIR QUALITY RESEARCH

				Study Area						Pollutant											
Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
1	DOE	Craig Hollowell, Robert Miksch, LBL (B46)	Sources of indoor organic compounds	X					X				X			X					
2	DOE	Robert Miksch, Craig Hollowell, and H. Schmidt, LBL (B52)	Trace organics in offices	X				X	X							X					
3	DOE	K. Geisling, M. Tashima, V. Girman, and R. Miksch, LBL; S. Rappafort, U. of California (Berkeley) (B44)	Passive formaldehyde sampler, Na HSO_3 soaked glass filters		X								X								
4	DOE	G. Traynor, D. Anthon, and C. Hollowell, LBL (B81)	Technique for determining gas range pollutants	X					X		X	X	X		X						
5	DOE	J. Girman, M. Apte, G. Traynor, J. Allen, and C. Hollowell, LBL (B74)	Pollutant rates from combustion and smoking	X					X								X				
6	DOE	G. Traynor, M. Apte, J. Dillworth, C. Hollowell, and E. Sterling, LBL (B82)	Effects of residential ventilation on gas-range emissions	X				X	X		X	X			X						
7	DOE	W. Nazaroff, M. Boegel, C. Hollowell, and G. Roseme, LBL (B89)	Ventilation for radon	X					X	X											
8	DOE	I. Turiel, C. Hollowell, R. Miksch, J. Rudy, and R. Young, LBL; M. Coye, S. F. F. General Hospital (B109)	Reduced ventilation effects in offices	X					X		X	X	X		X	X		X		X	
9	DOE	C. Hollowell, J. Berk, M. Boegel, R. Miksch, W. Nazaroff, and G. Traynor, LBL (B97)	Ventilation and indoor air quality						X	X	X	X	X		X	X					
10	DOE	J. Offerman, C. Hollowell, W. Nazaroff, G. Roseme, LBL; J. Rizzuto, NY State ERDA in Rochester, NY (B105)	Low ventilation and air quality	X					X	X	X	X	X								
11	DOE	D. Grimsrud, LBL (C1)	Passive instrumentation for formaldehyde, H_2O, CO, and NO_2						X		X	X	X								

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

				Study Area						Pollutant											
Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
12	DOE	D. Grimsrud, LBL (C2)	Building materials emissions	X	X				X							X				X	
13	DOE, EPRI and GRI	D. Grimsrud, LBL (C3)	Numerical data base for IAQ																		
14	DOE/OHER and BPA	D. Grimsrud, LBL (C4)	Radon and progeny: national distribution		X				X	X											X
15	DOE/HEAD	Gregory Traynor, J. Allen, Michael Apte, J. Dillworth, J. Girman, C. Hollowell, and J. Koonce, LBL (B83)	Indoor air pollution from kerosene heaters, wood stoves, and wood furnaces	X					X		X	X	X		X						
16	DOE	W. Cain and B. Leaderer, Yale University (B94)	Ventilation requirements during smoking and nonsmoking	X					X								X				
17	DOE	W. Cain, B. Leaderer, R. Isseroff, L. Berglund, R. Huey, E. Lipsitt, and D. Perlman, Yale University (B93)	Control of odors--ventilation requirements	X					X		X						X	X			
18	DOE	A. Persily, Princeton (B106)	Heat exchanger evaluation						X												X
19	DOE	Thomas Hernandez, Princeton; James Ring, Hamilton College (B59)	Two-chamber radon model	X					X	X											
20	DOE	Brian Mokler, Brian Wong, and Michael Snow, LBERI (B68)	Respirable particulate from pressurized consumer products						X						X						
21	DOE	Brian Mokler, Brian Wong, and Michael Snow, LBERI (B69)	Experimental conditions effects on resp. particles *from consumer products*						X						X						
22	DOE and CPSC	T. Matthews, A. Hawthorne, T. C. Howell, C. Metcalfe and R. Gammage, ORNL (B50)	Formaldehyde monitoring methods evaluation		X								X								
23	DOE	T. Matthews, ORNL (C9)	IAQ of unoccupied homes	X	X			X	X	X			X								
24	DOE	A. Hawthorne, ORNL (C10)	Radon and formaldehyde in energy conserving homes	X				X	X	X			X								X
25	DOE	Russell Dietz, and Edgar Cote, Brookhaven Nat. Lab (B96)	Air infiltration measurement technique	X					X												X

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

				Study Area						Pollutant											
Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
26	DOE	E. Knutson, Dept. of Energy (C15)	Assessment of radon and other contaminants	X	X				X	X											
27	DOE	J. Rundo, Argonne (C16)	Single home radon	X					X	X											
28	DOE	D. Davidson, Carnegie Mellon U. (C17)	Energy monitoring of houses	X					X												
29	EPA	Kathryn MacLeod, EPA/HERL (B49)	PCBs in indoor air	X	X				X												X
30	EPA	M. Jackson and R. Lewis, EPA/HERL (B67)	Pest control strips	X					X												X
31	EPA	R. Stacy, and J. Green EPA/HERL (B130)	Pollutant effects on pulmonary function			X					X								X		X
32	EPA	Ronald Bruno, EPA/ORP (B57)	Radon sources in houses	X				X	X	X											
33	EPA	F. Black, EPA/ESRL (C19)	Auto emissions testing	X							X	X	X		X	X					X
34	EPA	L. Wallace, EPA	CO in an underground office	X		X		X	X			X									
35	EPA	L. Wallace, EPA; R. Zweidinger, M. Erikson, S. Cooper, D. Whitaker, and E. Pellizzari, RTI (B30)	Volatile organics in air and water	X	X				X							X					
36	EPA	Edo Pellizzari, Research Triangle Institute (RTI) (C20)	Personal exposure to 21 volatile organics	X	X				X				X			X					X
37	EPA	Edo Pellizzari, RTI (C21)	Personal exposure to halogenated organics	X		X			X												X
38	EPA	Edo Pellizzari, RTI (C22)	Total exposure and assessment methodology	X					X			X	X	X			X	X			X
39	EPA	Ty Hartwell, RTI (C23)	Study of personal CO exposure	X	X				X			X									
40	EPA	Linda Sheldon, RTI (C24)	Monitoring of organics and inorganics around buildings	X					X	X	X	X	X	X	X	X					X
41	EPA	K. Dally, L. Hanrahan, and M. Woodbury, Wisc. Div. of Health; M. Kanarek, U. of Wisconsin (B41)	Nonoccupational formaldehyde exposure	X		X							X								

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

				Study Area						Pollutant											
Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
42	EPA	A. Eckmann, State Lab. of Hygiene; K. Dally, L. Hanrahan, and H. Anderson, Wisc. Div. of Health (B42)	Comparison of formaldehyde determination methods	X	X								X								
43	EPA	W. Hinds, S. Rudnick, E. Maher, and M. First, Harvard School of Public Health (B88)	Control of radon by air treatment devices	X				X	X	X											
44	EPA	T. Tosteson, J. Spengler, and R. Weker, Harvard School of Public Health (B29)	Metal content of particulates from personal monitoring	X					X												X
45	EPA	P. Ryan, J. Spengler, and R. Letz, Harvard School of Public Health (B79)	Kerosene heater pollution; monitoring and modeling	X					X		X										
46	EPA	W. Ott, EPA and D. Flachsbart, University of Hawaii (B26)	Personal monitors for CO	X					X			X									
47	EPA	R. Ziskind, and K. Fite, Science Applications; D. Mage, U.S. EPA (B31)	CO monitoring in the general population	X					X			X									
48	EPA and NIH	M. Lebowitz, University of Arizona (C26)	Pollutants, allergens, and resp. disease	X		X			X			X			X		X		X	X	
49	EPA	H. Prichard, T. Gesell, C. Hess, C. Weiffenbach, and D. Nyberg, U. of Texas, S. of P.H. (B66)	Sampling comparison for radon	X						X											
50	EPA	N. Esmen, M. Corn, Y. Hammad, D. Whittier, and N. Kotsko, U. of Pittsburgh (B10)	Exposure to dust and fiber in man-made fiber facilities	X					X					X	X						
51	EPA	Roy Neulicht, Del Green Assoc.; John Core, NEA, Inc. (B77)	Wood burning applicances and indoor air quality	X					X						X	X					X
52	AEC and EPA	M. Culot, Centro Nuclear de Mexico; R. Schiager, U. of Pittsburgh; H. Olson, Colorado State U. (B111)	Increased gamma fields from radon barrier on concrete	X					X	X											

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

				Study Area						Pollutant											
Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
53	NIOSH	M. Selway, R. Allan, R. Wadden, U. of Illinois, Chicago (B37)	Ozone from photocopying machines	X				X											X		
54	NIOSH	W. Hedley, Monsanto (C27)	Exposure assessment of formaldehyde production	X				X	X				X								
55	NIOSH	R. Mitchell, Battelle Columbus (C28)	Worker exposure in electronics components industry	X				X	X	X	X	X	X		X				X		X
56	NIOSH and OSHA	R. Young, R. Rinsky, and P. Infante, NIOSH; J. Wagoner, OSHA (B71)	Benzene in consumer products	X		X			X							X					
57	NIEHS	H. Ozkaynak, Harvard University; P. Ryan, G. Allen, and W. Turner, Harvard S. of Public Health (B134)	Indoor air modeling: compartmental approach	X					X		X										
58	NIEHS	C. Ju, NY State Health Dept.; J. Spengler, Harvard School of P.H. (B1)	Respirable particles by room	X					X						X						
59	NIEHS	J. Spengler, D. Dockery, W. Turner, J. Wolfson, and B. Ferris, Harvard School of P.H. (B3)	Long-term measurement of respirable particles and sulfates	X					X						X		X				
60	NIEHS	S. Colome, J. Spengler, and S. McCarthy, Harvard School of P.H. (B16)	Inorganics comparison indoor-outdoor	X					X		X				X						X
61	NIEHS	D. Dockery and J. Spengler, Harvard School of P.H. (B24)	Exposure to particulates and sulfates	X					X												X
62	NIEHS and EPRI	J. Spengler, Harvard S. of Public Health (C29)	SO_2 & particulate health effects			X			X		X	X			X						X
63	NIEHS and EPRI	J. Spengler, Harvard S. of Public Health (C30)	SO_2 & particulate health effects (continuation of above)	X	X	X			X	X	X	X	X		X		X				
64	NIEHS	K. Helsing, G. Comstock, M. Meyer, and M. Tockman, Johns Hopkins U. (B121)	Tobacco smoke and gas appliance respiratory effects on nonsmokers			X	X														

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

				Study Area						Pollutant											
Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
65	NIEHS and NHLBI	M. Schenker, Harvard Medical School; S. Weiss, Beth Israel Hospital; B. Murawski, Brigham and Women's Hospital (B128)	Urea formaldehyde insulation health effects in homes			X	X						X								
66	NIEHS	B. Leaderer, J. B. Pierce Foundation Lab (Yale) (C32)	Side stream tobacco smoke smoke						X								X				
67	NIEHS	A. Stolwijk, J. B. Pierce Lab (C33)	Human responses to thermal stress pollutants	X		X	X		X												X
68	NIEHS	W. Cain and B. Leaderer, J. B. Pierce Lab (C34)	Ventilation filtration for tobacco smoke					X	X								X				
69	NIEHS	B. Leaderer; J. B. Pierce Lab, Yale U. (C35)	Decay of SO_2 and NO_2 on surfaces					X			X										X
70	NIEHS	B. Leaderer, J. B. Pierce Lab, Yale U. (C36)	Comparison of portable with stationary particulate monitors		X				X												
71	NIEHS	W. Cain, J. B. Pierce Lab (C37)	Irritation effects of formaldehyde								X										X
72	NIEHS	W. Nicholson, E. Swoszowski, A. Rohl, J. Todaro, and A. Adams, Mt. Sinai School of Medicine (B8)	Asbestos in schools	X					X					X							
73	NIEHS	R. Jaeger, NYU Med. Center (B33)	CO in homes/cars			X			X			X									
74	CPSC	A. Hawthorne, ORNL (C11)	Volatile organics in homes	X	X				X							X					X
75	CPSC, BPA, and DOE/OHER	D. Grimsrud, LBL (C5)	Appliance emissions	X					X		X	X	X		X						X
76	CPSC	K. Gupta, A. Ulsamer, and P. Preiss, CPSC (B120)	Formaldehyde: sources and toxicity										X								
77	CPSC and DOE	A. Hawhorne, ORNL (C12)	IAQ of E. Tennessee homes	X				X	X	X			X								X
78	CPSC	T. Matthews, ORNL (C13)	Characterization of formaldehyde sources	X	X				X				X								
79	CPSC and DOE	J. Pickrell, B. Mokler, L. Griffis, C. Hobbs, and A. Bathija, LBERI (B70)	Formaldehyde from consumer products						X				X								

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Study Area						Pollutant											
				Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
80	U.S. Air Force	J. Livington and C. Jones, Aer. Med. Res. Lab (B48)	Chlordane from termite treatment	X					X												X
81	U.S. Air Force	J. Lodge, RTI (C25)	Analysis of termiticide air samples	X																	X
82	NCI	E. Sansome and M. Slein, Frdrk. Cancer Research Center (B114)	Redispersion of surface contaminants						X												X
83	NHLBI	R. Binder, C. Mitchell, H. Hosein, and A. Bouhuys, Yale University (B117)	Importance of indoor air pollution exposure	X					X		X				X						X
84	NHLBI	M. Lebowitz, D. Armet, and R. Knudson, NHLBI (B125)	Passive smoking effects on pulmonary function in children			X	X														
85	CDC, Colorado Dept. of Health, and Tri-County District Health Dept.	K. Kreiss, CDC, M. Gonzalez, Col. Dept. of Health; K. Conright and A. Scheere, Tri-County District Health Dept. (B124)	Carpet shampoo respiratory irritation			X															X
86	NAS/NRC	T. Sterling, H. Dimich, S. Fraser U.; D. Kobayashi, Columbia U. (B6)	Tobacco smoke byproduct levels	X					X								X				
87	NSF	C. Davidson, Carnegie Mellon U. (C18)	Building design and other IAQ factors	X				X	X	X	X	X	X		X	X					X
88	SERI	M. Rogozen, Sciences Applications (Los Angelos) (B137)	Radon from rockbed heat storage						X	X											
89	NBS	T. Kusuda, S. Silberstein, and P. McNall, NBS (B64)	Modeling of radon in ventilated spaces					X		X											
90	NBS	P. McNall, NBS (B103)	Building ventilation measurements, predictions and standards	X					X								X				X
91	TVA	R. Maxwell, TVA (C40)	Radioactivity in non-slag homes	X					X	X											
92	TVA and EPA	R. Imhoff, TVA (C41)	Woodstoves & IAQ	X					X						X						X
93	TVA and BPA	J. Harper, TVA (C42)	Woodburning evaluation	X				X	X		X	X			X						
94	TVA and EPRI	A. Hawthorne, ORNL (C14)	IAQ related to energy conservation	X				X	X	X			X								X

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

				Study Area						Pollutant											
Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
95	ASHRAE	F. Jarke, A. Dravnieks, and S. Gordon, IITRI (B47)	Organics, indoor-outdoor relationship	X					X							X					
96	ASHRAE	Tsen Wang, Harbor Branch Foundation Lab (Florida) (B55)	Bioeffluents in college classroom	X					X							X					X
97	ASHRAE	Garry Caffey, Texas Power and Light Co. (B92)	Residential air infiltration		X				X												
98	ASHRAE	J. Janssen, A. Pearman, and T. Hill, Honeywell, Inc. (B99)	Examination of Infiltration models						X												
99	GRI	James Cole, Thomas Zawacki, Robert Elkins, Jon Zimmer, and Robert Macriss, Inst. of Gas Technology (B95)	Application of an air infiltration model to homes						X												
100	GRI	J. Spengler, Harvard S. of Public Health (C31)	Personal and total exposure assessment	X								X									
101	GRI	D. Moschandreas, IITRI (C43)	Emissions from gas appl., kerosene, cigarettes	X				X	X		X	X	X		X	X					
102	AGA	R. Coutant, E. Merryman, and A. Levy, Battelle Columbus (B73)	NO_2 from ranges	X					X		X										
103	EPRI	N. Nagda, Geomet (C48)	CO exposure	X					X			X									
104	EPRI	N. Nagda, Geomet (C49)	Energy, infiltration, and indoor air quality	X				X	X	X	X	X	X		X						X
105	EPRI	J. Yocum, TRC (C56)	Risk assessment evaluation																		
106	EPRI	K. McGill and D. Miller, Washburn U. (Kansas) (B76)	Exposure to organic particulates from wood heating	X	X				X						X	X					
107	NY Lung Association	Marc Halpern, City U. of NY (B17)	Lead indoor/outdoor exposure relationships	X					X												X
108	Chicago Lung Association	Robert Allen and Richard Wadden, U. of Illinois School of Public Health (B12)	Indoor concentration of CO and O_3 in a hospital	X					X			X							X		
109	Industrial Health Foundation	P. Gross, U. of Pittsburgh; J. Tuma and R. de Treville, Industrial Health Foundation (B119)	Lungs of workers exposed to fiber glass			X	X														X

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Study Area: Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Pollutant: Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
110	Prince George's Envir. Coalition	J. Repace and A. Lowry, Naval Research Laboratory (B5)	Indoor air pollution, tobacco, Pub. Health	X			X		X						X		X				
111	Minnesota State Planning Agency	M. Garry, L. Oatman, R. Pleus, and D. Gray, Minnesota Dept. of Health (B43)	Formaldehyde levels	X		X			X				X								
112	Andrew Mellon Foundation	F. Shair, Cal. Inst. of Tech. (B90)	Filtration of ozone and SO_2 from make up air	X				X	X										X		X
113	Northeast States for Coordinated Air Use Management	Barbara Beck and Joseph Brain, Harvard School of Public Health (B116)	Pulmonary toxicity due to wood and coal stove combustion products			X	X								X	X					
114	Ball State U.	T. Godish, Ball State U. (B45)	Formaldehyde sickness	X		X	X						X								
115	Cal. Inst. of Tech.	F. Shair, and K. Heitner, Cal. Inst. of Technology (B135)	Model of indoor/outdoor levels	X					X									X			
116	U. of Cincinnatti	D. Sterling, S. Clark, and S. Bjomsan, U. of Cinc. Medical Center (B11)	Air control effects on Viable particle distribution	X					X						X						
117	Drexel University	L. Levin and P. Purdom, Drexel University (B126)	Health effects of energy conserving materials			X	X						X	X							X
118	U. of Illinois	R. Wadden, U. of I. School of Pub. Health (B51)	Indoor air research	X					X	X		X	X	X	X		X	X			
119	Indiana U. and Minnesota Dept. of Health	Ingrid Ritchie, U. of Indiana; Laura Oatman, Minnesota Dept. of Health (B78)	Kerosene heater pollution	X					X		X	X			X						X
120	Harvard S. of P.H.	P. Bellin and J. Spengler, Harvard S. of P.H. (B14)	Indoor/outdoor CO at airport	X					X			X									
121	Johns Hopkins	C. Billings, J. Hopkins, and S. Vanderslice, Exxon Co. (B113)	Methods for control of indoor air quality					X	X												X
122	U. of Maine	C. Hess, C. Weiffenbach, and S. Norton, U. of Maine (B60)	Water and airborne radon in houses	X					X	X											

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

				Study Area						Pollutant											
Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
123	U. of Pittsburgh	J. Alzona, B. Cohen, H. Rudolph, H. Jow, and J. Frohliger, U. of Pittsburgh (B13)	Indoor-outdoor relationships for dust of outdoor origin	X				X	X						X						
124	U. of Michigan	J. Jones, F. Higgins, M. Higgins, and J. Keller, U. of Michigan (B123)																			
125	LBL	J. Janssen and T. Hill, Honeywell; J. Woods, and E. Maldonado, Iowa State U. (B98)	Case study of ventilation for control	X					X			X									
126	LBL	Miksch, Hollowell, Fanning, Newton, Schmidt, LBL (B51)	Trace organics indoors	X	X				X							X					
127	LBL	D. Grimsrud, LBL (C6)	Particulate-Radon interaction					X	X	X											X
128	LBL	D. Grimsrud, LBL (C7)	IAQ control techniques					X	X		X		X								X
129	Yale University	Sawyer, R., and E. Swoszowski, Yale U. (B115)	Asbestos abatement in schools						X					X							
130	TSI, Inc.	R. Quant, P. Nelson, and G. Sem, TSI (B2)	Measurement of aerosols in offices	X	X										X	X	X				
131	IITRI	D. Moschandraes, IITRI; J. Zabransky, Geomet (B35)	Spatial variation of CO and NO_2 in houses	X					X		X	X			X						
132	IITRI	D. Moschandreas, IITRI (C47)	Tracer development		X																X
133	Honeywell, Inc.	D. Sutton, K. Nodolf, and K. K. Makino, Honeywell (B141)	Ozone in residences	X					X										X		
134	Honeywell, Inc.	D. Sutton, K. Nodolf, and K. Makino, Honeywell, Inc.	Predicting ozone concentrations in homes						X										X		
135	GTE	Oblas, D., Dugger, D., and S. Lieberman, GTE (B54)	Organics in telephone central offices													X					
136	GE (Louisville)	F. Mueller, L. Loeb, and W. Mapes, GE (B140)	Ozone decomposition rates	X					X										X		
137	GE R&D Center (Schenectady)	R. Fleisher, W. Giard, A. Mogro-Campero, and L. Turner, GE; H. Alter and J. Gingrich, Terradex Corp. (B58)	Low dose radon dosimetry: methods and theory	X	X					X											

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

				Study Area						Pollutant											
Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
138	GE R&D Center	Robert Fleischer, GE (B118)	Lung cancer and phosphates			X	X														
139	J. B. Pierce Foundation	Stolwijk and Leaderer, J. B. Pierce Lab (C38)	Epidemiological study of residential exposure to combustion and tobacco smoke	X		X			X		X		X			X					X
140	J. B. Pierce Foundation	N. Schackter, J. B. Pierce Lab (C39)	Irritation effects of formaldehyde																		
141	BPA	D. Grimsrud, LBL (C8)	Residential and commercial survey for retrofit effects on IAQ	X					X	X	X	X	X		X						X
142	Pac. Power & Light	D. Zerba, Battelle Northwest (C52)	Residential ventilation	X					X												X
143	Wisc. Power & Light	J. Spengler, R. Letz, Harvard School of P.H.; J. Quackenboss, M. Kanarek, U. of Wisconsin (B36)	Personal monitoring for NO_2	X					X		X										
144	Wisconsin Power and Light	J. Quackenboss, U. of Wisconsin (Harvard support) (C53)	Weatherization & IAQ	X		X	X		X	X	X		X		X	X					X
145	Nat. Kerosene Heaters Ass., Kerosun	K. Jones, R. F. Weston (C54)	IAQ from kerosene heaters	X	X				X	X		X	X			X					X
146	Niagara Mohawk and NYERDA	G. Adams, Niagara Mohawk, (W. S. Flemming, contractor) (C55)	Residential & commercial IAQ	X						X	X	X	X	X		X					
147	Philip Morris, Inc.	D. Good, C. Vilcins, W. Harvey, D. Clabo, and A. Lewis, Philip Morris (B32)	Smoking effects on residential NO_2	X					X		X										
148	Systems, Science and Software	P. Lagus, Systems, Science and Software (B101)	Tracer-dilution method for infiltration						X												
149	Rand Corporation	Naihua Duan, Rand Corporation (B131)	Human exposure models to air pollution							X											
150	Bell Laboratories	C. Weschler, Bell Telephone (B4) (B110)	Characterization of organics in aerosols	X					X							X					
151	Bell Labs	C. Weschler, S. Kelty, and J. Lingousky, Bell (B110)	Effect of tans on dust levels																		
152	Geomet	D. Moschandreas, IITRI; H. Rector, Geomet (B65)	Indoor radon	X					X	X											

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Study Area						Pollutant											
				Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
153	Geomet	N. Nagda, Geomet (C50)	Respirable particle exposure	X	X									X							
154	TRC	J. Yocum, TRC Environmental Consultants (C57)	Indoor air quality research at TRC	X			X		X		X	X	X	X	X	X	X	X	X		X
155	TRC	John Yocum, TRC (B23)	Indoor/outdoor air quality relationships	X					X	X	X	X	X		X	X			X		X
156	Various	D. Moschandreas, IITRI (C44)	Odor						X										X		X
157	Private (confidential)	D. Moschandreas, IITRI (C45)	Particulate control device					X							X					X	X
158	Private (confidential)	D. Moschandreas, IITRI (C46)	Woodstove--PAH emissions	X					X		X	X									X
159	Various manufacturers	Enno Toomsalu, Underwriters Lab Inc. (C58)	Kerosene heater certification						X			X									
160	Various manufacturers	Kathy Blair, PFS Corporation (C60)	Kerosene heater certifcation						X			X									
161	CPSC	Warren Porter, CPSC (C59)	Evaluation of kerosene heater emissions						X		X	X	X			X					X
162	French laboratories	P. Sebastien, Laboratoire d'Etude des Particules Inhalées; J. Bignon, Inst. Nat. de la Santé et de le Recherche Medicale; M. Martin, Ecole Centrale des Arts et Manufactures de Paris (B9)	Ceiling & floor asbestos contamination	X					X					X							
163	SPPS (France)	F. Lorenz, Laboratoire de Physique du Batiment (B133)	Ventilation requirements in parking garages	X					X		X										
164	Tokyo foundation	H. Nitta and K. Maeda, U. of Tokyo (B25)	NO_2 monitoring	X					X		X										
165	EPA of Japan	S. Yamanaka, H. Hirose, and S. Takada, Kyoto City Inst. of Public Health (B85)	NO_x from kerosene and gas-fired appliances	X					X		X										
166	U. of Tokyo	Y. Yanagisawa and H. Nishimura, Chem. Engineering Dept., U. of Tokyo (B39)	Filter badge sampler for NO_2 and NO	X					X		X	X									X
167	Japan Tobacco and Salt Public Corporation	Y. Ishizu, Jap. Tok. & Salt Pub. Corp. (B132)	Equation for estimating pollution	X					X								X				

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

				Study Area						Pollutant											
Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
168	Chuba Inst. of Tech., Osaka City U.	M. Narasaki, S. Ishido, Chuba Inst.; Y. Nakane, Osaka City U. (B104)	Indoor air pollution and ventilation in dining rooms and kitchens																		
169	Canadian Testing and Research	T. Sterling, Simon Fraser U.; D. Kobayashi, Columbia U. (B80)	Gas range pollutants	X					X			X									
170	WHO	Silverman, P. Corey, S. Mintz, P. Olver, and R. Hosein, Gage Research Inst. (B28)	Personal samplers for ambient air pollution	X					X						X						X
171	WHO	K. Sega and M. Fugas, Inst. for Med. Res. and Occupational Health, Yugoslavia (B27)	Personal vs. general monitoring for respirable particles	X					X						X						
172	Arya-Mehr U. of Technology (Iran)	Rashidi, Massoudi, and Shadman, U. of Tech. (B112)	Kerosene heating CO reduction	X					X			X									
173	U. of Petroleum and Minerals (Saudi Arabia)	Abu-Jarad, U. of Petroleum and Minerals (Saudi Arabia); J. Fremlin, U. of Birmingham, England (B56)	Radon in high-rise buildings	X					X	X											
174	Pilkington Brothers Limited (England)	J. Hill, W. Whitehead, J. Cameron, and G. Hedgecock, Pilkington Bros. Lim. (B122)	Absence of pulmonary hazard due to glass fibers			X	X														X
175	Swedish Council Building Research (SCBR)	T. Malmstrom and A. Ahlgren, Royal Inst. of Tech. (B102)	Office room ventilation	X					X												
176	SCBR	B. Berglund, Univ. of Stockholm; T. Lindvall, Karolinska Institute (B40)	New preschool air contaminants	X				X	X							X					
177	SCBR	B. Berglund, Univ. of Stockholm; T. Lindvall, Karolinska Institute (B91)	Influence of ventilation in office indoor/outdoor contaminants	X					X		X	X				X					
178	SCBR	B. Berglund, H. Nicander-Biedberg, Univ. of Stockholm; J. Berglund and T. Lindvall, Nat. Inst. of Envir. Medicine (B87)	Psychophysical model of air quality						X								X				
179	Peterson AB--Sweden	D. Sodergren, Peterson AB--Sweden (B108)	CO_2 ventilation	X					X	X		X									

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

Inv. No.	Sponsor	Investigator & organization (cross reference)[a]	Subject	Study Area						Pollutant											
				Monitoring	Instrumentation	Health Effects	Risk Assessment	Control Technology	Characterization	Radon	NO_x	CO	HCOH	Asbestos	TSP	Organics	Tobacco Smoke	Odor	Ozone	Biological	Multi-pollutant
180	Swedish Nat. Testing	O. Hildingson, Swedish Nat. Testing (B61)	Radon in Swedish homes	X		X			X	X											
181	Lund Inst. of Tech. (Sweden)	H. Lannefors and H. Hansson, Lund Inst. (B19)	Nursery school elemental indoor/outdoor concentrations	X					X												X
182	Danish National Health Foundation	L. Molhave, U. of Aarhus (Denmark) (B139)	Building material organic pollutants	X		X			X							X					X
183	U. of Aarhus	F. Andersen, G. Lundgvist, and L. Molhave, U. of Aarhus (B138)	Chipboard indoor pollution	X					X				X								
184	U. of Aarhus	G. Lundgvist, M. Iversen, and J. Korsgaard, U. of Aarhus (B34)	Day care climate with low ventilation	X					X			X									X
185	U. of Copenhagen	J. Olsen and M. Dossing, U. of Copenhagen (B127)	Formaldehyde symptoms in day care centers	X		X			X				X								
186	Techn. U. of Denmark	N. Jonassen, Techn. U. of Denmark; J. McLaughlin, U. College, Dublin (B63)	Air filtration and radon daughter levels					X	X	X											
187	Technical U. of Denmark	N. Jonassen, Technical U. of Denmark (B62)	Radon and building materials control of Radon	X		X			X	X											
188	U. of Denmark	B. Berg-Munch and F. Fanger, U. of Denmark (B86)	Air temperature influence on body odor perception	X					X									X			
189	Norwegian Inst. of Tech	E. Skaret and H. Mathisen Norwegian Inst. of Tech. (B107)	Ventilation efficiency	X					X												
190	U. of Kuopio (Finland)	P. Kalliokoski, U. of Kuopio; R. Niemela, Inst. of - Occupational Health; J. Salmivaara, Technical Research Center of Finland (B100)	Tracer gas technique for industrial hygiene	X					X		X	X									X
191	Bundesministerium (W. Germany)	J. Postendorfer, A. Wicke, and A. Schraub, Inst. fur Biophysik (B136)	Effects on radon concentrations						X	X											
192	Federal Inst. of Technology, Zurich	A. Weber-Tschopp, A. Fischer, and E. Grandjean, Fed. Inst. of Tech. (B7)	Physiologic and irritating effects of cigarette smoke	X		X			X		X	X	X								
193	U. de Santiago, U. Catolica, (Chile)	T. Caceres, H. Soto, E. Lissi, U. de Santiago; R. Cisternas, U. Catoljca, (Chile) (B72)	Appliance emissions and indoor concentrations	X					X		X	X	X								X

[a] Numbers preceded by "B" denote references in the Annotated Bibliography (Section 4.0). Numbers preceded by "C" refer to the contact summaries (Section 6.0).

TABLE 3-2. SUMMARY OF SPECIAL CAPABILITIES FOR INDOOR AIR QUALITY RESEARCH

Organization	Special facilities	Inv. number (see Table 1)
DOE New York, NY E. Knutson, 212-620-3652	Research chamber--20 m^3, temperature and humidity controlled	26
EPA/HERL Research Triangle Park, NC Kathryn MacLeod, 919-541-2281	Research chamber--30 m^3, instrument testing, polyurethane foam emissions testing	29-31
EPA/ESRL Research Triangle Park, NC Frank Black, 919-629-3037	Research chamber--vehicle emissions, refrigeration for cold weather simulation	33
Brookhaven National Laboratory Upton, NY 11973 Russel Dietz, 516-282-2123	Perfluorocarbon tracer developed for infiltration studies (BNL/AIMS)	25
Argonne National Laboratory Argonne, Illinois J. Rundo, 312-972-4156	Research chamber--6 m^3, radiation research	27
ORNL Oak Ridge, TN 37830 T, Matthews, 615-574-6248	3 research chambers--0.2 m^3, teflon lined 4 research houses--1 has 110 m^3 0.3 - 0.5 ach^{-1}	22-24, 74, 77, 78
Naval Research Laboratory Washington, DC 20375 Alfred Lowry, 202-545-6700	Research chambers--ventilation controlled	110

(continued)

TABLE 3-2 (continued)

Organization	Special facilities	Inv. number (see Table 1)
Consumer Products Safety Commission Washington, DC Warren Porter, 301-245-1445	Research chamber--25 m^3	161
LBL Berkeley, CA D. Grimsrud, 415-486-4023	3 research chambers--27 m^3-ventilation controlled; --30 m^3 (stainless steel construction) temperature, humidity and ventilation controlled --30 m^3 (gypsumboard construction) Residence prototype--Radon research facility with remote data acquisition --testing for heat exchangers and HCOH with temperature, humidity, and ventilation control --260 m^3 Mobile Atmospheric Research Laboratory (MARL) Research facility for passive monitor testing with temperature, humidity, and ventilation control	1-15, 75, 126-128, 141
J. B. Pierce Foundation Laboratory New Haven, CT B. P. Leaderer, 203-562-9901	3 thermal chambers for physiological research 1 test chamber--34 m^3, ventilation, temperature, and humidity controlled (aluminum construction) Mobile monitors--CO, CO_2, O_2, NO_x, SO_2 Pollutant generation capability Odor testing--psychophysical research	16, 17, 66, 71, 130, 140
Princeton U. Center for Energy and Environmental Studies Princeton, NJ 08544 Dave Harrie, 609-452-5445	Research chamber--16 m^3 ventilation controlled, extensive instrumentation	18, 19

(continued)

TABLE 3-2 (continued)

Organization	Special facilities	Inv. number (see Table 1)
Harvard School of Public Health Boston, MA 02115 John Spengler, 617-732-1255	Research chamber--78 m^3, ventilation controlled	43-45, 57-63, 100, 113, 120, 143, 144
RTI Research Triangle Park, NC 27709 Edo Pellizzari, 919-541-6579	4 research chambers--18 m^3, 3.6 m^3, 0.7 m^3, 0.04 m^3 Mobile monitoring laboratory Personal monitors--pesticides, PCB's Spirometer developed to breath analysis	35-40, 81
IITRI Chicago, IL 60616 D. Moschandreas, 312-567-4310	2 research chambers--32 m^3 for human exposure studies, temperature, humidity, and ventilation controlled --28 m^3 for control device evaluation Mobile monitoring laboratory--air quality, infiltration odor, and meteorological testing Sensory lab--odor panel	95, 101, 131, 132, 152, 156-158
U. of Illinois Chicago, IL 60680 Richard Wadden, 312-996-0810	Electrical aerosol analyses, condensation nuclei counter, nebulizers Standard measurement systems	53, 108, 118
Lovelace Biomedical and Environmental Research Institute Albuquerque, NM 87115 Brian Mokler, 505-844-2203	3 research chambers--1.0 m^3 ventilation controlled --2.0 m^3 ventilation controlled --8.0 m^3 ventilation controlled	20, 21, 79
Carnegie Mellon U. Pittsburgh, PA C. Davidson, 412-578-2951	Research house--ventilation controlled, remote computer-assisted data acquisition system	87

(continued)

TABLE 3-2 (continued)

Organization	Special facilities	Inv. number (see Table 1)
Geomet, Inc. Gaithersburg, MD N. L. Nagda, 301-424-9133	2 research houses--325 m^3 each Mobile monitoring laboratory--radiation, criteria pollutants, tracer studies (SF_6)	103, 104, 131, 152, 153
Battelle Columbus Columbus, OH Ralph Mitchell, 614-424-7441	2 research chambers--17 m^3 Mobile monitoring laboratory--criteria pollutants, tracer studies, (SF_6), radiation	55
TRC East Hartford, CT John Yocum, 203-289-8631	Trace atmospheric gas analyzer (mass spectrometer) Odor testing Standards laboratory	105, 154, 155
Pacific Power and Light Portland, OR D. Zerba, 503-243-4876	3 test houses--100-140 m^2 --1 energy conserving 1 conventional construction test facility	142
R. F. Weston, Inc. West Chester, PA K. Jones, 215-692-3030	Mobile monitoring lab--GC-MS analysis	145
General Electric Louisville, KY Leopold Loeb, 502-452-4603	3 research chambers--7.1 m^3, testing for odors and pollutants, ventilation controlled (aluminum construction) --39.0 m^3 ventilation controlled (aluminum construction) --48.7 m^3 ventilation controlled (stainless steel construction)	136

(continued)

TABLE 3-2 (continued)

Organization	Special facilities	Inv. number (see Table 1)
U. of Aarhus, Inst. of Hygiene Denmark	3 research chambers Climate chamber--1.0 m^3 (stainless steel construction)	183-184
Technical U. of Denmark	Research chamber--324 m^3, for ventilation experiments	186
Norwegian Institute of Technology Norway	Research chamber--81 m^3, ventilation controlled	189
Federal Inst. of Technology Zurich, Switzerland	Research chamber--30 m^3, climate and ventilation controlled, organics and inorganics monitoring	192
U. of Tokyo, Chemical Eng. Dept. Japan	NO and NO_2 filter badge sampler developed	166
Arya-Mehr University of Technology Tehran, Iran	Research chamber--7.5 m^3, silver-paint lined, temperature and ventilation controlled	172

4.0 ANNOTATED BIBLIOGRAPHY

This Section provides an annotated bibliography of selected, recent literature on indoor air quality. The bibliography is arranged by subject. The bulk of the citations in the bibliography are from peer-reviewed journal articles, dated from 1980. Presentations from a few, very recent symposia are also included to provide the most current work. Government reports have not been included, except where they are annotated bibliographies, literature reviews, or general treatises. Some articles prior to 1980 were included because the subject matter seemed unique or the article represented a major work that was frequently cited thereafter.

As shown in the Outline (p.27), the bibliography is organized under five major headings: I. Characterization and Measurement; II. Control; III. Health Studies; IV. Modeling; and V. General Reviews. The first, second, and fourth of these subject areas were of prime concern for this project and, consequently, have been further divided into specific topics as shown in the outline. Many articles, of course, span several subject areas; where this occurs, the work was classified according to the primary objective of the research.

The summary information for each citation is organized as follows: citations are listed alphabetically by principal author within each category or subcategory; underneath the citation is a capsule summary providing the names of the investigating organization and sponsor, pollutants measured, pollutant sources, premises, geographical location, season, ventilation rates, and major findings. Most articles do not address all of these considerations, hence "NA" is used to denote "not applicable." In some cases "NA" may mean "not available," as in those cases where the sponsoring agency is not provided, but the distinction should be clear from the context. Following each citation, one or more of the letters "A" through "F" appear in brackets. These represent a shorthand classification scheme as follows:

A - Monitoring
B - Instrumentation
C - Health Effects
D - Risk Assessment
E - Control Technology
F - Characterization

This scheme provides both a cross-referencing to Table 3-1 (under the heading "Study Area") and a succinct characterization of the work.

The Annotated Bibliography is by no means complete. Nevertheless, several observations may be made about these studies and perhaps generalized to indoor air quality research. The area we have labeled "Characterization and Measurement" has certainly received the most attention. Researchers have expended much effort to sample various premises for levels of certain pollutants. Sometimes an identified pollutant source such as a gas-fired range is present; in other cases, a large number of premises are sampled to determine an average level, or an attempt is made to relate indoor pollutant levels to outdoor levels. These studies seem to reflect an older perception that indoor air quality is determined largely by outdoor air quality. Two significant changes in the habits of building occupants tend to challenge this perception. First, the reduction of air infiltration rates to conserve energy has further insulated the indoor environment from outdoor air, and second, the popularity of unvented combustion sources for space heating suggests that indoor pollutant sources may be far greater than outdoor sources. However, very few studies have attempted to determine emission rates from these unvented combustion sources.

In the area of "Control Methods", the majority of studies have measured the effect of ventilation rates on indoor air quality. This trend may also reflect the early emphasis on ventilation as the principal control option. Very few studies deal with other control options such as air purification and only one study considered source modification to reduce emission rates. In the area of "Modeling," several studies attempted to predict indoor pollutant levels using mass-balance approaches These models typically consider only one or perhaps a few pollutants and are therefore incomplete in characterizing the indoor environment. The accuracy of these models is also limited by the input parameters such as source emission rates and mixing factors.

In summary, based on our review of the articles contained in the annotated bibliography, several study areas appear to deserve further investigation. These include: the determination of source emission rates, especially with regard to the use of these rates in mathematical models; further study of control options for pollutant sources, such as air-purifying devices and source modification; and more sophisticated modeling efforts that consider more than one or two pollutants.

4.1 Outline of Annotated Bibliography

I. CHARACTERIZATION AND MEASUREMENT

- A. Aerosols
  - 1. Indoor aerosols
  - 2. Tobacco smoke
  - 3. Asbestos
  - 4. Fibrous glass and mineral wool
  - 5. Viable aerosols
- B. Indoor-Outdoor Relationships
  - 1. Fixed site
  - 2. Exposure monitoring
- C. Gaseous Pollutants
  - 1. Inorganics (also CO, CO_2)
  - 2. Organics (not CO, CO_2)
- D. Radon
- E. Consumer Products
- F. Combustion Sources
- G. Odor

II. CONTROL METHODS

- A. Air-Purifying Methods
- B. Ventilation
- C. Source Modification
- D. Miscellaneous

III. HEALTH STUDIES

IV. MODELING

- A. General Models
- B. Radon
- C. Formaldehyde
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V. GENERAL REVIEWS: INDOOR AIR QUALITY

- A. Treatises
- B. Bibliographies

4.2 Annotated Bibliography

I. CHARACTERIZATION AND MEASUREMENT

A1. Aerosols: Indoor aerosols

1. Ju, C., and J. D. Spengler. 1981. Room-to-room variations in concentration of respirable particles in residences. Environmental Science & Technology 15(5):592-596. [A, F]
   Investigator: Harvard School of Public Health
   Sponsor: NIEHS; EPRI
   Pollutants Measured: respirable particles
   Pollutant Sources: NA
   Premises: homes
   Geographical Location: Boston, MA
   Season: Nov-Feb
   Ventilation Rates: NA

   Major Findings: Respirable particle concentrations were measured in four homes located in the metropolitan Boston area. Based on an analysis of variance, two homes showed significant differences between rooms, but the other two homes showed no significant differences ($P < 0.05$). Whereas outdoor concentrations were found to be comparable, indoor concentrations varied greatly.

2. Quant, F. R., P. A. Nelson, and G. J. Sem. 1982. Experimental measurements of aerosol concentrations in offices. Environment International 8:223-227. [A, B]
   Investigator: TSI, Inc.
   Sponsor: TSI, Inc.
   Pollutants Measured: aerosols less than 10 μm
   Pollutant Sources: NA
   Premises: offices
   Geographical Location: St. Paul, MN
   Season: NA
   Ventilation Rates: NA

   Major Findings: A new automated version of the piezoelectric microbalance was used to sample particles (less than 10 μm) in several offices. The effect of a single smoker was evident in the time-series data.

3. Spengler, J. D., D. W. Dockery, W. A. Turner, J. M. Wolfson, and B. G. Ferris, Jr. 1981. Long-term measurements of respirable sulfates and particles inside and outside homes. Atmospheric Environment 15:23-30. [A, F]

Investigator: Harvard School of Public Health
Sponsor: NIEHS; EPRI
Pollutants Measured: respirable particles
Pollutant Sources: NA
Premises: homes
Geographical Location: six cities
Season: year-round
Ventilation Rates: NA

Major Findings: Indoor and outdoor monitoring for respirable particles and the sulfate fraction of these particles are reported. Homes were monitored in six U.S. cities. The major source of indoor particulate matter is cigarette smoke which contributes about 20 $\mu g/m^3$ to indoor concentrations for each smoker. Even in homes without smokers, indoor particle concentrations equal or exceed outdoor levels.

4. Weschler, C. J. 1980. Characterization of selected organics in size-fractionated indoor aerosols. Environmental Science & Technology 14(4): 428-431. [A, F]

Investigator: Bell Telephone Labs
Sponsor: Bell Telephone Labs
Pollutants Measured: size-fractioned aerosols, organics
Pollutant Sources: NA
Premises: Bell labs
Geographical Location: Holmdel, NJ
Season: Jan-Aug
Ventilation Rates: 10% make-up outside

Major Findings: A variety of organic compounds were extracted from size-fractioned indoor aerosol samples. Among these were aliphatic alcohols, phosphate esters, and phthalate ester plasticizers.

I. CHARACTERIZATION AND MEASUREMENT

A2. Aerosols: Tobacco smoke

5. Repace, J. L. and A. H. Lowrey. 1980. Indoor air pollution, tobacco smoke, and public health. Science 208:464-472. [A, D, F]

Investigator: Private capacity
Sponsor: Prince George's Environmental Coalition
Pollutants Measured: respirable particles
Pollutant Sources: tobacco smoke
Premises: various public places
Geographical Location: Washington, DC
Season: Mar-Jun
Ventilation Rates: 0.7-9.4 ach

Major Findings: An experimental and theoretical investigation is made into the range and nature of exposure by the nonsmoking public to respirable suspended particles from cigarette smoke. A modified Turk model incorporating both physical and sociological parameter is shown to be useful in understanding particulate levels from cigarette smoke in indoor environments. It is shown that nonsmokers are exposed to significant air pollution burdens from indoor smoking.

6. Sterling, T. D., H. Dimich, and D. Kobayashi. 1982. Indoor byproduct levels of tobacco smoke: A critical review of the literature. JAPCA 32(3):250-259. [A, F]

Investigator: Simon Fraser & Columbia Universities
Sponsor: NAS/NRC
Pollutants Measured: cigarette combustion products
Pollutant Sources: cigarette smoking
Premises: varied
Geographical Location: varied
Season: NA
Ventilation Rates: varied

Major Findings: Levels reported in diverse pubications of cigarette combustion byproducts (gases and particles) are summarized in tabular form. Summaries also include information on test conditions such as ventilation, size and types of premises, monitoring conditions, number of smokers, and rate of smoking.

7. Weber-Tschopp, A., A. Fischer, and E. Grandjean. 1976. Physiological and irritating effects of indoor air pollution due to cigarette smoke. In, Proceedings of the 6th Congress of the International Ergonomics Association and 20th annual meeting of The Human Factor Society (11-16 July), pp. 286-289. University of Maryland at College Park. [A, C, F]

Investigator: Federal Institute of Technology, Zurich
Sponsor: NA
Pollutants Measured: CO, NO, NO_2, formaldehyde, acrolein
Pollutant Sources: cigarette smoking
Premises: climate chamber
Geographical Location: NA
Season: NA
Ventilation Rates: 3 m^3/h

Major Findings: Subjects were exposed to 28 minutes of cigarette smoke in a climate chamber. CO, NO, NO_2, formaldehyde and acrolein levels were recorded. Eye and nose irritation, annoyance and blinking rate increased in relation to the number of smoked cigarettes. Annoyance about air quality and the wish to open the windows proved to be a very good criterion of air quality.

8. Nicholson, W. J., E. J. Swoszowski, Jr., A. N. Rohl, J. D. Todaro, and A. Adams. 1979. Asbestos contamination in United States schools from use of asbestos surfacing materials. Annals New York Academy of Sciences 330:587-596. [A, F]

Investigator: Mt. Sinai School of Medicine
Sponsor: NIEHS
Pollutants Measured: asbestos
Pollutant Sources: sprayed surfaces
Premises: schools
Geographical Location: NY; NJ
Season: NA
Ventilation Rates: NA

Major Findings: Ten schools in which asbestos materials were used as surface coatings were sampled. When significant asbestos levels were found, physical deterioration of the surface material was evident.

9. Sebastian, P., J. Bignon, and M. Martin. 1982. Indoor airborne asbestos pollution: from the ceiling and the floor. Science 216: 1410-1413. [A, F]

Investigator: French Laboratories
Sponsor: NA
Pollutants Measured: asbestos
Pollutant Sources: flooring tiles
Premises: office building
Geographical Location: 20 km south of Paris, France
Season: winter
Ventilation Rates: NA

Major Findings: Electron microscopic measurements of the concentrations of airborne asbestos were carried out in and outside an office building having ceilings sprayed with a crocidolite-containing material and floors covered with vinyl-chrysotile tiles. Under normal conditions in this building, the two asbestos-containing materials released fibers into the air. This is the first measurement of elevated concentrations of indoor airborne asbestos associated with the weathering of asbestos floor tiles during their service life.

10. Esmen, N., M. Corn, Y. Hammad, D. Whittier, and N. Kotsko. 1979. Summary of measurements of employee exposure to airborne dust and fiber in sixteen facilities producing man-made mineral fibers. American Industrial Hygiene Association Journal 40:108-117. [A, F]

Investigator: Univ. of Pittsburgh
Sponsor: EPA
Pollutants Measured: suspended particles (total); fibers
Pollutant Sources: fibrous glass and mineral wool production
Premises: sixteen production facilities
Geographical Location: varied
Season: NA
Ventilation Rates: NA

Major Findings: Measurements of worker exposure to airborne particles and fibers were made at sixteen production facilities. The nominal fiber size of the manufactured fibers and the average airborne fiber concentrations were highly correlated.

11. Sterling, D. A., C. Clark, and S. Bjornson. 1982. The effect of air control systems on the indoor distributions of viable particles. Environment International 8:409-414. [A, F]

Investigator: Univ. of Cincinnati Medical Center
Sponsor: Univ. of Cincinnati
Pollutants Measured: viable particles
Pollutant Sources: NA
Premises: wastewater treatment and sludge composting facilities
Geographical Location: Washington, DC
Season: autumn
Ventilation Rates: NA

Major Findings: Thermophilic organisms found at the facilities served as monitors for viable particles. The indoor concentration of viable particles were found to be affected by building design and use of conventional mechanical air systems. There was evidence of growth of viable particles within these mechanical air systems.

B1. Indoor-Outdoor Relationships: Fixed site

12. Allen, R. J. and R. A. Wadden. 1982. Analysis of indoor concentrations of carbon monoxide and ozone in an urban hospital. Environmental Research 27:136-149. [A, F]

Investigator: Univ. of Illinois, School of Public Health
Sponsor: Chicago Lung Assoc.
Pollutants Measured: CO, O_3
Pollutant Sources: NA
Premises: hospital
Geographical Location: Chicago, IL
Season: year-round
Ventilation Rates: 18% of air filtered and recirculated

Major Findings: Carbon monoxide levels averaged 0.2 to 1.3 ppm higher inside a hospital compared with outside levels. Ozone levels were higher outdoors on average. Predicted and observed annual averages were within 0.3 ppm for CO and 0.03 ppm for O_3.

13. Alzona, J., B. L. Cohen, H. Rudolph, H. N. Jow, and J. O. Frohliger. 1979. Indoor-outdoor relationships for airborne particulate matter of outdoor origin. Atmospheric Environment 13:55-60. [A, F]

Investigator: Univ. of Pittsburgh
Sponsor: NA
Pollutants Measured: Fe, Zn, Pb, Br, Ca
Pollutant Sources: NA
Premises: various closed rooms
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Elements from transportation and industrial sources were measured indoors and out in various rooms. An experimental room was designed to measure filtration through walls, deposition on walls, and resuspension from room surfaces. The model found indoor exposure to these pollutants was no more than 1/3 of expected outdoor exposure over the same time period.

14. Bellin, P. and J. D. Spengler. 1980. Indoor and outdoor carbon monoxide measurements at an airport. JAPCA 30(4):309-394. [A, F]

Investigator: Harvard School of Public Health
Sponsor: NA
Pollutants Measured: CO
Pollutant Sources: NA
Premises: airport
Geographical Location: Boston, MA
Season: winter, 1978
Ventilation Rates: NA

Major Findings: Indoor/outdoor carbon monoxide measurements were taken at Logan International Airport. Indoor concentrations were found to be lower than outdoor concentrations. The carbon monoxide levels do not constitute a health threat to the general public or the working population.

15. Biersteker, K. 1982. Indoor-outdoor air quality relationships: Discussion. JAPCA 32(9):908-913. [A, C, F]

Investigator: K. Biersteker
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: NA
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Biersteker reviews indoor air quality problems in the Netherlands with regard to health effects and indoor/outdoor relationships of SO_2, CO, and NO_2. Both historical and recent data are summarized.

16. Colome, S. D., J. D. Spengler, and S. McCarthy. 1982. Comparisons of element and inorganic compounds inside and outside of residences. Environment International 8:197-212. [A, F]
Investigator: Harvard School of Public Health
Sponsor: NIEHS; EPRI; EPA
Pollutants Measured: SO_2; NO_2; respirable particles
Pollutant Sources: NA
Premises: 10 houses
Geographical Location: Steubenville, OH; Portage; WI
Season: year-round
Ventilation Rates: NA

Major Findings: Results of more than one year of air monitoring inside and outside of five homes in each of two communities are presented for SO_2, NO_2, respirable particles, SO_4, Al, Br, Cl, Mn, Na, and V. Outdoor levels across the home site in each city are consistent with proximity to outdoor sources. Indoor levels of SO_2, SO_4, Mn, and V are lower than those measured outdoors.

17. Halpern, M. 1978. Indoor/outdoor air pollution exposure continuity relationships. JAPCA 28(7):689-691. [A, F]
Investigator: City University of New York, School of Health Sciences
Sponsor: New York Lung Association
Pollutants Measured: respirable particulate lead
Pollutant Sources: NA
Premises: 2 apartments and a museum
Geographical Location: New York City
Season: Aug, Oct (1974)
Ventilation Rates: NA

Major Findings: Indoor/outdoor respirable particulate lead measurements were made using a stacked filter sampler. Indoor respirable lead values tended to be lower than outdoor levels. Significant differences were observed for indoor lead levels between air conditioned and non-air conditioned sites.

18. Howlett, Jr., C. T. 1982. Indoor-outdoor air quality relationships: Discussion. JAPCA 32(9):913-916. [D]

Investigator: NA
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: NA
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Reviewing J. E. Yocum's article (entry 23), Howlett uses formaldehyde as a model for comparing what is known about indoor air quality and the potential adverse health effects. The problem of regulating indoor exposures must consider what is known about indoor air levels, what can be done to reduce exposure levels, and the role of building codes in limiting exposure.

19. Lannefors, H. and H. C. Hansson. 1981. Indoor/outdoor elemental concentration relationships at a nursery school. Nuclear Instruments and Methods 181:441-444. [A, F]

Investigator: Lund Institute of Technology
Sponsor: NA
Pollutants Measured: particulate lead and bromine
Pollutant Sources: NA
Premises: nursery school
Geographical Location: Lund, Sweden
Season: August 1978
Ventilation Rates: 0.5-1.0 ach

Major Findings: Indoor and outdoor concentrations of lead and bromine at a nursey school were measured using streaker samplers. Observed variation in concentration correlated well with traffic intensity variations. The indoor concentrations of the elements studied were about one-fifth of outdoor levels.

20. Moschandreas, D. J. 1982. Indoor-outdoor air quality relationships: Discussion. JAPCA 32(9):904-907. [F]

Investigator: Moschandreas, D.
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: NA
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Moschandreas reviews J. E. Yocum's paper on indoor-outdoor air quality relationships (entry 23) and specifically addresses the limitations and contributions of his I/O ratio. Mr. Moschandreas feels that adequate work has been done on characterization of U.S. housing and that efforts should be directed towards IAQ model formulation, validation and proper use.

21. Spengler, J. D. 1982. Indoor-outdoor air quality relationships: Discussion. JAPCA 32(9):907-909. [D]

Investigator: J. D. Spengler
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: NA
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Spengler reviews J. E. Yocum's paper on indoor-outdoor air quality relationships (entry 23) and notes that Yocum has not critically reviewed published data. Spengler discusses the contribution of indoor pollutants to health effects, the areas where more research is needed, and some possible governmental initiatives.

22. Spengler, J. D., C. P. Duffy, R. Letz, T. W. Tibbitts, and B. G. Ferris, Jr. 1983. Nitrogen dioxide inside and outside 137 homes and implications for ambient air quality standards and health effects research. Environmental Science and Technology 17(3):164-168.

Investigator: Harvard School of Public Health; Univ. of Wisconsin
Sponsor: Wisconsin Power Companies; EPRI; NIEHS
Pollutants Measured: NO_2
Pollutant Sources: gas stoves
Premises: 137 homes
Geographical Location: Portage, WI
Season: year-round
Ventilation Rates: NA

Major Findings: Annual mean ambient concentration of NO_2 was 10-15 $\mu g/m^3$, while homes with gas ranges averaged 50 $\mu g/m^3$ higher in the kitchen and 30 $\mu g/m^3$ higher in bedroom. Electric stoves did not contribute to indoor NO_2 and levels were 1/2 to 2/3 of ambient levels. No predictive models were developed due to large variations of NO_2 concentrations in homes--most likely due to differences in stove use, emission rates, and air exchange rates.

23. Yocum, J. E. 1982. Indoor-outdoor air quality relationships: A critical review. JAPCA 32(5):500-520. [A, F]

Investigator: TRC Environmental Consultants, Inc.
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: NA
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: This is a critical review article in which the implications and shortcomings of key research efforts are discussed. A useful grouping of air pollutants by source (predominantly outdoor, both indoor and outdoor, and predominantly outdoor) provides the basis for reviewing indoor-outdoor air quality relationships.

B2. Indoor-Outdoor Relationships: Exposure monitoring

24. Dockery, D. and J. D. Spengler. 1981. Personal exposure to respirable particulates and sulfates. JAPCA 31(2):153-159. [A, F]

Investigator: Harvard School of Public Health
Sponsor: NIEHS; EPRI
Pollutants Measured: respirable particles and sulfates
Pollutant Sources: NA
Premises: indoor (homes); outdoor; personal
Geographical Location: Watertown; MA; Steubenville, OH
Season: summer and winter
Ventilation Rates: NA

Major Findings: Personal exposure to respirable particles and sulfates were measured in Watertown, MA and Steubenville, OH. Mean personal exposure for each city was related to mean outdoor levels for the city. A time-weighted indoor/outdoor activity model only modestly improved estimates of personal exposure over those predicted from measured indoor concentrations alone.

25. Nitta, H. and K. Maeda. 1982. Personal exposure monitoring to nitrogen dioxide. Environment International 8:243-248. [A, F]

Investigator: University of Tokyo
Sponsor: Tokyo Foundation and Ministry of Education, Science, and Culture
Pollutants Measured: NO_2
Pollutant Sources: NA
Premises: houses, offices
Geographical Location: Tokyo, Japan
Season: summer and winter
Ventilation Rates: NA

Major Findings: Indoor, outdoor, and personal exposure measurements of NO_2 were made in a number of houses and offices in different seasons. Unvented space heaters were found to increase personal exposure. A time-weighted indoor/outdoor activity model gives modestly improved estimates of personal exposure over those predicted from indoor concentrations alone.

26. Ott, W. and P. Flachsbart. 1982. Measurement of carbon monoxide concentrations in indoor and outdoor locations using personal exposure monitors. Environment International 8:295-304. [A, F]

Investigator: Univ. of Hawaii
Sponsor: EPA
Pollutants Measured: CO
Pollutant Sources: NA
Premises: commercial settings
Geographical Location: California cities
Season: Nov 1979-June 1980
Ventilation Rates: NA

Major Findings: Personal exposure monitoring measurements for CO were made in four California cities (San Francisco, Palo Alto, Mountain View, and Los Angeles). Most commercial settings had CO concentrations above zero, because CO tends to seep into buildings from outside vehicular emissions. Indoor garages and buildings with attached parking garages can experience relatively high CO levels.

27. Sega, K. and M. Fugas. 1982. Personal exposure versus monitoring station data for respirable particles. Environment International 8:259-263. [A, F]

Investigator: Inst. for Medical Research and Occupational Health, Zagreb, Yugoslavia
Sponsor: WHO; Research Council of Croatia
Pollutants Measured: respirable and total suspended particles
Pollutant Sources: NA
Premises: NA
Geographical Location: Zagreb, Yugoslavia
Season: Dec 1980-Mar 1981
Ventilation Rates: NA

Major Findings: Twelve subjects working at the same location, but living in various parts of Zagreb, were monitored for 7 consecutive days for personal exposure to respirable particles. These data were compared with simultaneously obtained data from the outdoor network station nearest to subject's home. The ratio between average personal exposure and respirable particle levels in the outdoor air decreases with the increased outdoor concentration; thus, this relationship might serve as the basis for rough estimations of personal exposure.

28. Silverman, F., P. Corey, S. Mintz, P. Olver, and R. Hosein. 1982. A study of effects of ambient urban air pollution using personal samplers: A preliminary report. Environment International 8:311-316. [A, F]

Investigator: Gage Research Institute, Univ. of Toronto
Sponsor: WHO; York-Toronto Lung Association
Pollutants Measured: Suspended particles; SO_2; NO_2
Pollutant Sources: NA
Premises: homes
Geographical Location: Toronto, Canada
Season: heating/nonheating seasons
Ventilation Rates: NA

Major Findings: This study was conducted using a control and an asthmatic group in which effects of air pollution were assessed by symptom, medication diary, and pulmonary function tests. Air pollution exposure was measured using small portable samplers for particles, SO_2, and NO_2. These samplers were carried by subjects and situated inside and outside homes. Results suggest the need for using personal samplers when investigating health effects.

29. Tosteson, T. D., J. D. Spengler, and R. A. Weker. 1982. Aluminum, iron, and lead content of respirable particulate samples from a personal monitoring study. Environment International 8:265-268. [A, F]

Investigator: Harvard School of Public Health
Sponsor: EPA; EPRI; NIEHS
Pollutants Measured: respirable particles
Pollutant Sources: NA
Premises: indoor (24 homes); outdoor; personal
Geographical Location: Topeka, KS
Season: Spring, 1979
Ventilation Rates: NA

Major Findings: Samples of respirable particulate matter collected during a personal monitoring study in Topeka, KS, were analyzed for iron, aluminum, and lead. Indoor, outdoor, and personal levels of iron and aluminum were not significantly different. Indoor lead concentrations were found to be less than both personal and outdoor levels.

30. Wallace, L., R. Zweidinger, M. Erickson, S. Cooper, D. Whitaker, and E. Pellizzari. 1982. Monitoring individual exposure: Measurements of volatile organic compounds in breathing-zone air, drinking water, and exhaled breath. Environment International 8:269-282. [A, B, F]

Investigator: RTI
Sponsor: EPA
Pollutants Measured: volatile organics
Pollutant Sources: NA
Premises: varied
Geographical Location: TX, NC
Season: summer 1980
Ventilation Rates: NA

Major Findings: Personal exposure of students to volatile organics in Chapel Hill, NC and Beaumount, TX were assessed using exposure monitors, water samples, and breath analysis. Air exposure to volatile organics varied widely even among students on the same campus. Air was the main route of exposure for all target compounds except two trihalomethanes which were transmitted through water.

31. Ziskind, R. A., K. Fite, and D. T. Mage. 1982. Pilot field study: Carbon monoxide exposure monitoring in the general population. Environment International 8:283-293. [A, F]

Investigator: Science Applications, Inc., Los Angeles, CA.
Sponsor: EPA
Pollutants Measured: CO
Pollutant Sources: NA
Premises: varied
Geographical Location: Los Angeles, CA
Season: NA
Ventilation Rates: NA

Major Findings: A pilot field study enlisted nine people to measure carbon monoxide by using personal monitors. The 9 ppm ambient air quality standard was exceeded on 22 person days. Elevated carbon monoxide concentrations during commuting activity were frequently associated with the exceedances.

C1. Gaseous Pollutants: Inorganics

32. Good, D. W., G. Vilcins, W. R. Harvey, D. A. Clabo, Jr., and A. L. Lewis. 1982. Effect of cigarette smoking on residential NO_2 levels. Environment International 8:167-175. [A, F]

Investigator: Philip Morris, Inc.
Sponsor: Philip Morris, Inc.
Pollutants Measured: NO_2
Pollutant Sources: gas appliances, smoking
Premises: homes
Geographical Location: Richmond, VA
Season: summer 1980 and winter 1981
Ventilation Rates: NA

Major Findings: Gas-fired kitchen appliances were found to account for the largest increases in indoor NO_2 levels. Nonsmokers were classified as those smoking less than 20 cigarettes per week.

33. Jaeger, R. J. 1981. Carbon monoxide in houses and vehicles. Bulletin New York Academy Medicine 57(10):860-872. [C, F]

Investigator: N.Y.U. Medical Center
Sponsor: NIEHS
Pollutants Measured: CO
Pollutant Sources: natural gas combustion, tobacco smoke
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: This is a survey and literature review presented at a Symposium on the Health Aspects of Indoor Air Pollution, NY Academy of Medicine, May 1981. Health issues and potential sources of carbon monoxide are discussed.

34. Lundqvist, G. R., M. Iversen, and J. Korsgaard. 1982. Indoor climate in low-ventilated day-care institutions. Environment International 8:139-142. [A, F]

Investigator: Univ. of Aarhus, Inst. of Hygiene, Denmark
Sponsor: NA
Pollutants Measured: CO_2, water vapor
Pollutant Sources: humans
Premises: day-care nursery, kindergarten
Geographical Location: Denmark
Season: NA
Ventilation Rates: 1-2 m^3 fresh air/person/h

Major Findings: Exposure conditions in the field were duplicated under controlled conditions. The results showed that CO_2 concentrations reached 3,500 to 4,000 ppm, whereas background is 350 ppm. Water vapor reached 8-10 g/kg of dry air. The CO_2 levels were unacceptable by WHO standards. Building codes should be designed to control CO_2 buildup where ventiliation is low.

35. Moschandreas, D. J. and J. Zabransky, Jr. 1982. Spatial variation of carbon monoxide and oxides of nitrogen concentrations inside residences. Environment International 8:177-183. [A, F]

Investigator: IITRI; Geomet Technologies, Inc.
Sponsor: NA
Pollutants Measured: NO, NO_2, CO
Pollutant Sources: NA
Premises: 12 residences, 2 office buildings
Geographical Location: Boston, MA
Season: NA
Ventilation Rates: 0.5-1.2 ach

Major Findings: Concentrations of combustion gases vary from room to room in buildings using gas-cooking appliances, but not in residences with electric appliances. The magnitude of the difference is not large. More than single-zone sampling is recommended, although one indoor zone adequately characterizes the environment if sampling is done continuously.

36. Quackenboss, J. J., M. S. Kanarek, J. D. Spengler, and R. Letz. 1982. Personal monitoring for nitrogen dioxide exposure: Methodological considerations for a community study. Environment International 8:249-258. [A, F]

Investigator: Harvard School of Public Health
Sponsor: Wisconsin Power and Light Co.; EPA
Pollutants Measured: NO_2
Pollutant Sources: NA
Premises: 19 homes
Geographical Location: Portage, WI
Season: March 1981
Ventilation Rates: NA

Major Findings: Passive diffusion NO_2 monitors were placed outdoors, in the kitchen, in one bedroom on each floor of homes, and worn by family members. Individuals from gas-cooking homes had significantly higher average NO_2 exposures than those from homes using electricity for cooking. Personal exposures were more closely related to bedroom levels than to kitchen or outdoor concentrations for both cooking fuel groups. Several preliminary models are presented which relate average personal NO_2 exposure to indoor and ambient levels, and also to the proportion of time spent in different locations.

37. Selway, M. D., R. J. Allen, and R. A. Wadden. 1980. Ozone production from photocopying machines. American Industrial Hygiene Association Journal 41:455-459. [A,F]

Investigator: Univ. of Illinois, School of Public Health
Sponsor: NIOSH
Pollutants Measured: ozone
Pollutant Sources: photocopying machines
Premises: sealed rooms
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Ten photocopying machines operating in sealed rooms were sampled for ozone emissions. All but one model produced detectable amounts. Emission rates of <1 to 54 µg/copy were found. Servicing the machines reduced emissions to <1-4 µg/copy, but preservicing levels returned after several weeks of operation.

38. Wallace, L. A. 1983. Carbon monoxide in air and breath of employees in an underground office. JAPCA 33(7):678-682. [A, C, E, F]

Investigator: EPA
Sponsor: EPA
Pollutants Measured: CO
Pollutant Sources: parking garage
Premises: office building
Geographical Location: NA
Season: February
Ventilation Rates: NA

Major Findings: Elevated carbon monoxide levels were found in the air and lungs of workers in an underground office that was connected to a parking garage. Closing fire doors and activating parking garage fans rectified the situation. The methods and equipment employed in this study are recommended for identifying similar carbon monoxide problems.

39. Yanagisawa, Y., and H. Nishimura. 1982. A badge-type personal sampler for measurement of personal exposure to NO_2 and NO in ambient air. Environment International 8:235-242. [B]

Investigator: Univ. of Tokyo, Dept. of Chemical Engineering
Sponsor: NA
Pollutants Measured: NO, NO_2
Pollutant Sources: NA
Premises: laboratory
Geographical Location: Tokyo, Japan
Season: NA
Ventilation Rates: velocity: 0.15-4.0 m/s

Major Findings: A badge-type sampler was developed for monitoring personal exposure to NO_2. The sampler measured NO_2 concentration within an accuracy of ±20%. The lower limit for reliable measurement is 66 ppbh. NO is measured by providing an oxidation layer in the filter.

C2. Gaseous Pollutants: Organics

40. Berglund, B., I. Johansson, and T. Lindvall. 1982. A longitudinal study of air contaminants in a newly built preschool. Environment International 8:111-115. [A, E, F]

Investigator: Univ. of Stockholm
Sponsor: Swedish Council for Building Research
Pollutants Measured: volatile organics
Pollutant Sources: NA
Premises: preschool
Geographical Location: Stockholm, Sweden
Season: NA
Ventilation Rates: 81-91% recirculation

Major Findings: Typical air contaminants emanating from building materials were determined, their variation over time was measured, and the influence of the ventilation system on contaminant concentrations was studied. The concentrations of 22 organic compounds were far below occupational threshold limit values. All organic compounds declined over time, mainly within six months. The authors suggest a six-month "gassing-off" period with no recirculation.

41. Dally, K. A., L. P. Hanrahan, M. A. Woodbury, and M. S. Kanarek. 1981. Formaldehyde exposure in nonoccupational environments. Archives of Environmental Health 36:277-284. [A, C]

Investigator: Wisconsin Division of Health
Sponsor: EPA
Pollutants Measured: formaldehyde
Pollutant Sources: building materials
Premises: homes
Geographical Location: Madison, Wisconsin
Season: year-round
Ventilation Rates: NA

Major Findings: Air samples were collected in 100 structures, primarily mobile homes. An association was found between formaldehyde level and age of building materials. Health effects were eye irritation, runny nose, dry or sore throats, headache and cough. The authors suggest that nonoccupational indoor environmental exposure to formaldehyde is significant and may exceed the standard set for occupational exposure.

42. Eckmann, A. D., K. A. Dally, L. P. Hanrahan, and H. A. Anderson. 1982. Comparison of the chromotropic acid and modified pararosaniline methods for the determination of formaldehyde in air. Environment International 8:159-166. [A, B]

Investigator: Wisconsin Div. of Health
Sponsor: EPA; State of Wisconsin
Pollutants Measured: formaldehyde
Pollutant Sources: homes, building materials
Premises: 25 homes; 14 mobile homes
Geographical Location: Wisconsin
Season: spring
Ventilation Rates: NA

Major Findings: Ambient formaldehyde concentrations were measured using four sampling trains and two analytical methods. Analysis of variance indicated little difference among the sampling trains. Good agreement was found between chromotropic acid and pararosaniline analytical methods although the modified pararosaniline method produced lower values for field samples than the chromotropic acid method; a source of interference was postulated.

43. Garry, V. F., L. Oatman, R. Pleus, and D. Gray. 1980. Formaldehyde in the home. Minnesota Medicine 63(2):107-111. [A, C, F]

Investigator: Minnesota Dept of Health, Univ. of Minnesota
Sponsor: Minnesota State Planning Agency
Pollutants Measured: formaldehyde
Pollutant Sources: NA
Premises: homes
Geographical Location: Minnesota
Season: winter-spring-summer
Ventilation Rates: NA

Major Findings: Formaldehyde levels were found to be significantly higher in homes of persons with symptoms than those without symptoms. Asthmatics are more sensitive and smokers less sensitive to formaldehyde exposure. Newer mobile homes showed higher levels of formaldehyde.

44. Geisling, K. L., M. K. Tashima, J. R. Girman, R. R. Miksch, and S. M. Rappaport. 1982. A passive sampling device for determining formaldehyde in indoor air. Environment International 8:153-158. [B]

Investigator: LBL; Univ. of California, Berkeley
Sponsor: DOE; California Energy Commission
Pollutants Measured: formaldehyde
Pollutant Sources: NA
Premises: laboratory
Geographical Location: Berkeley, CA
Season: NA
Ventilation Rates: NA

Major Findings: A passive sampler was developed with $NaHSO_3$ (sodium sulfate) soaked glass-fiber filters. In the field, the device collects a sample by being uncapped for a specified time. Recapped, it is returned to the laboratory and the filter analyzed by the chromotropic acid method. It is a simple, sensitive device that shows excellent storage characteristics.

45. Godish, T. 1981. Formaldehyde and building-related illness. Journal of Environmental Health 44(3):116-121. [A, C]

Investigator: Ball State Univ.
Sponsor: NA
Pollutants Measured: formaldehyde
Pollutant Sources: NA
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: This is a review article covering monitoring, health effects, formaldehyde sources, and cause-effect relationships. There is an apparent causal relationship between building-related formaldehyde exposure and symptoms, although definitive epidemiological studies are needed.

46. Hollowell, C. D., and R. R. Miksch. 1981. Sources and concentrations of organic compounds in indoor environments. Bulletin New York Academy Medicine 57(10):962-977. [A, F]

Investigator: LBL
Sponsor: DOE
Pollutants Measured: organics
Pollutant Sources: NA
Premises: Office buildings, mobile homes
Geographical Location: varied
Season: NA
Ventilation Rates: NA

Major Findings: Summaries of formaldehyde and other organic compound concentrations measured in office buildings and a few mobile homes are presented. The authors emphasize the variety of organic compounds found in typical office spaces.

47. Jarke, F. H., A. Dravnieks, and S. M. Gordon. 1981. Organic contaminants in indoor air and their relation to outdoor contaminants. ASHRAE Transactions 87(1):153-166. [A, F]

Investigator: IITRI, Chicago, IL
Sponsor: ASHRAE
Pollutants Measured: organics
Pollutant Sources: NA
Premises: homes
Geographical Location: Washington, DC, Chicago IL
Season: winter/summer
Ventilation Rates: NA

Major Findings: Concentration of organics are on average, at or below 100 ppb. Indoor activities such as painting, varnishing, cleaning and cooling can produce higher levels. The number of compounds found indoors was higher than outdoors, both winter and summer. Nearby industrial operations have a slight effect on contaminants found in the homes.

48. Livingston, J. M. and C. R. Jones. 1981. Living area contamination by chlordane used for termite treatment. Bulletin Environmental Contamination Toxicology 27:406-411. [A, F]

Investigator: Air Force Medical Research Lab.
Sponsor: U.S. Air Force
Pollutants Measured: Chlordane
Pollutant Sources: pest control
Premises: apartments, homes
Geographical Location: NA
Season: all
Ventilation Rates: NA

Major Findings: An investigation of chlorodane-treated residences showed that weather parameters had no apparent effect on chlordane concentration and no degradation was found over time. Higher concentrations were found for apartments treated in two specific years, implying faculty application of the pesticide. Ducting found in residence slabs will continue to generate chlordane when termite treatment is performed.

49. MacLeod, K. E. 1981. Polychlorinated biphenyls in indoor air. Environmental Science & Technology 15(8):926-928. [A, B, F]

Investigator: HERL (EPA)
Sponsor: EPA
Pollutants Measured: PCBs
Pollutant Sources: NA
Premises: laboratories; offices; homes
Geographical Location: NA
Season: Various
Ventilation Rates: NA

Major Findings: This paper describes a method for sampling and analyzing PCB's using low-volume air sampling through polyurethane foam collectors. "Normal" levels of PCBs found in indoor air are at least 10 times higher than outdoor levels. Kitchens showed highest levels of PCB in homes.

50. Matthews, T. G., A. R. Hawthorne, T. C. Howell, C. E. Metcalfe, and R. B. Gammage. 1982. Evaluation of selected monitoring methods for formaldehyde in domestic environments. Environment International 8:143-151. [B]

Investigator: ORNL, Health and Safety Research Division
Sponsor: DOE; CPSC
Pollutants Measured: formaldehyde
Pollutant Sources: NA
Premises: homes
Geographical Location: NA
Season: Winter
Ventilation Rates: NA

Major Findings: Four methods for monitoring formaldehyde were evaluated in controlled tests: (1) The CEA Instruments, Inc. (model 555) wet chemical analyzer for indoor air monitoring; (2) a molecular sieve suitable for rapid sampling applications; (3) a passive semipermeable membrane sampler providing integrated exposure measurement; and (4) a visual colorimetric analysis, used in conjunction with passive samplers.

51. Miksch, R. R., C. D. Hollowell, L. Z. Fanning, A. Newton, and H. Schmidt. 1980. Trace organic contaminants in indoor air environments. American Chemical Society, Division of Environmental Chemistry Preprints 20(2): 57-60. [A, B, F]

Investigator: LBL
Sponsor: NA
Pollutants Measured: organics
Pollutant Sources: NA
Premises: trailers, offices
Geographical Location: Berkeley and San Francisco, CA
Season: NA
Ventilation Rates: NA

Major Findings: Internal standards were dissolved in tetradecane for a fast, simple reproducible standardization method. Organics were found to be higher indoors than outside and many of the compounds have been identified by OSHA, EPA, and NIOSH as potentially hazardous (not at the levels measured here.)

52. Miksch, R. R., C. D. Hollowell, and H. E. Schmidt. 1982. Trace organic chemical contaminants in office spaces. Environment International 8:129-137. [A, E, F]

Investigator: LBL
Sponsor: DOE
Pollutants Measured: organics
Pollutant Sources: varied
Premises: offices
Geographical Location: Berkeley, CA
Season: NA
Ventilation Rates: NA

Major Findings: Levels of indoor pollutants are higher than outdoor ambient levels but 10^2 to 10^4 times lower than occupational standards. The impacts of building materials are not well defined or understood, but "drying out" periods for new construction may be a good idea. Controlling office pollutants at the source is more efficient than increasing ventilation rates.

53. Mølhave, L. 1982. Indoor air pollution due to organic gases and vapours of solvents in building materials. Environment International 8:117-127. [A, C, F]

Investigator: Univ. of Aarhus, Denmark
Sponsor: Danish National Health Foundation
Pollutants Measured: organics compounds from solvents
Pollutant Sources: 42 commonly used building material
Premises: laboratory
Geographical Location: Aarhus, Denmark
Season: NA
Ventilation Rates: NA

Major Findings: Testing facilities are suitable for classification of emissions from building materials. Mathematical models correlated well with actual measured concentrations found in model rooms. Potential health risks exist, especially for sensitive individuals.

54. Oblas, D. W., D. L. Dugger, and S. I. Lieberman. 1980. The determination of organic species in the telephone central office ambient. IEEE: Transactions on Components, Hybrids, and Manufacturing Technology 3(1):17-20. [A, F]

Investigator: GTE Laboratories, Inc.
Sponsor: GTE Labs
Pollutants Measured: organics
Pollutant Sources: NA
Premises: offices
Geographical Location: 5 cities
Season: winter, summer
Ventilation Rates: NA

Major Findings: Organics known to interfere or effect electrical components were sampled at five telephone offices across the United States. Values ranged from 1 to 100 ppb. Halohydrocarbons originate in contact cleaners, lubricants and spray cans, however outside sources are significant for certain organics.

55. Wang, T. C. 1975. A study of bioeffluents in a college classroom. ASHRAE Transactions 81(1):32-44. [A, F]

Investigator: Harbor Branch Foundation Lab, Florida
Sponsor: ASHRAE
Pollutants Measured: organics, NH_3, H_2S, CO_2, CO
Pollutant Sources: human
Premises: college auditorium
Geographical Location: Iowa City, Iowa
Season: NA
Ventilation Rates: NA

Major Findings: Using a mass balance model, CO_2 was found to be the most abundant inorganic compond generated in the classroom. Methanol, ethanol, and acetone were found to be highest among organics. Variation was found for different times of the day, and slightly from day to day, except during exams when CO_2 was found to be 45% higher.

I. CHARACTERIZATION AND MEASUREMENT

D. Radon

56. Abu-Jarad, F. and J. H. Fremlin. 1982. The activity of radon daughters in high-rise buildings and the influence of soil emanation. Environment International 8:37-43. [A, F]

Investigator: Univ. of Petroleum and Minerals, Saudi Arabia
Sponsor: NA
Pollutants Measured: radon
Pollutant Sources: NA
Premises: high rise buildings
Geographical Location: Birmingham, England
Season: Summer, fall, winter
Ventilation Rates: 0.1-1.4 ach

Major Findings: Radon levels are most strongly correlated with floor construction and subfloor ventilation. Ventilation strongly influences radon exposure. However, ground floor residences show higher activity whether in single homes or high-rise buildings.

57. Bruno, R. C. 1983. Sources of indoor radon in houses: A review. JAPCA 33(2):105-109. [A, E, F]

Investigator: EPA, Office of Radiation Programs
Sponsor: NA
Pollutants Measured: radon
Pollutant Sources: varied
Premises: homes
Geographical Location: varied
Season: NA
Ventilation Rates: 1 ach (input)

Major Findings: Based on a mass balance model, governmental guidelines will be exceeded in regions with high radon soil levels. The best controls are sealing of cracks, rather than impermeable coatings on slabs and foundation walls. New construction techniques can reduce radon exposure without significant cost increases. Air tight homes (0.1 to 0.2 ach) present particular problems.

58. Fleischer, R. L., W. R. Giard, A. Mogro-Campero, L. G. Turner, H.W. Alter, and J. E. Gingrich. 1980. Dosimetry of environmental radon: Methods and theory for low-dose, integrated measurements. Health Physics 39:957-962. [A, B]

Investigator: General Electric Research and Development Center
Sponsor: GE
Pollutants Measured: radon
Pollutant Sources: NA
Premises: homes
Geographical Location: Schnectady, NY
Season: NA
Ventilation Rates: NA

Major Findings: A theoretical discussion of radon detection is followed by laboratory and field testing of Track-Etch® dosimeter cups. A high degree of linearity was shown between machine readings (track density) and integrated concentrations from controlled exposure chambers. Field testing in basements and first floors gave representative results.

59. Hernandez, T., and J. W. Ring. 1982. Indoor radon source fluxes: Experimental tests of a two-chamber model. Environment International 8:45-57. [A, F]

Investigator: Princeton University
Sponsor: DOE
Pollutants Measured: radon
Pollutant Sources: NA
Premises: homes
Geographical Location: Princeton, NJ
Season: spring, summer
Ventilation Rates: 0.26-1.96 ach

Major Findings: A two-chamber model, involving both living area and basement radon levels, was far superior to a single chamber (basement) model in predicting total indoor radon exposure. A one chamber model underestimates the radon source flux (pCi/min).

60. Hess, C. T., C. V. Weiffenbach, and S. A. Norton. 1982. Variations of airborne and waterborne Rn-222 in houses in Maine. Environment International 8:59-66. [A, F]

Investigator: Univ. of Maine
Sponsor: NA
Pollutants Measured: radon
Pollutant Sources: well water
Premises: homes
Geographical Location: Maine
Season: Fall, winter, spring
Ventilation Rates: 0.3-2.0 ach

Major Findings: Radon levels found in the homes were at the level at which action is recommended (3 pCi/L). Air levels correlated well with water levels, showing 1.07 pCi Rn/L in air per 10,000 pCi Rn/L of water. Increased water use in the home (shower, clothes and dishwashing) raised air levels. Health risks are suggested by the correlation of water radon levels with lung cancer in 16 Maine counties.

61. Hildingson, O. 1982. Radon measurements in 12,000 Swedish homes. Environment International 8:67-70. [A, C, F]

Investigator: Swedish National Testing Institute
Sponsor: Swedish National Testing Institute
Pollutants Measured: radon
Pollutant Sources: NA
Premises: homes, apartments
Geographical Location: Sweden
Season: annual
Ventilation Rates: NA

Major Findings: Homes having greatest contact with soils showed higher rates of radon levels (above 10 pCi/L). Many of homes in Sweden had such high radon levels and 10,000 homes (with >27 pCi/L) must be rebuilt according to government limits

62. Jonassen, N. 1981. Indoor radon concentrations and building materials control of airborne radioactivity. In *Building Energy Management*, edited by Fernandes Olivia, 695-701. London: Oxford Press. [A, C, F]

Investigator: Technical University of Denmark
Sponsor: Technical University of Denmark
Pollutants Measured: radon
Pollutant Sources: NA
Premises: basement room
Geographical Location: Denmark
Season: NA
Ventilation Rates: varied

Major Findings: Exhalation rates for various buildings materials are presented. Control measures are discussed. Limited experiments with circulation and filtration indicate that at a rate of 1-2 h^{-1} through an ordinary filter, radon daughter levels may be reduced by a factor of 5-10.

63. Jonassen, N., and J. P. McLaughlin. 1982. Air filtration and radon daughter levels. *Environment International* 8:71-75. [E, F]

Investigator: Technical Univ. of Denmark
Sponsor: NA
Pollutants Measured: radon and daughters
Pollutant Sources: walls, soils
Premises: experimental room
Geographical Location: Lyngby, Denmark
Season: NA
Ventilation Rates: 0.5-2.0 ach

Major Findings: This paper investigates the effect of filtration and aerosol concentration on the level of short-lived airborne radon daughter products. Using an experimental chamber (324 m^3), it was found that at high aerosol concentrations, the decrease in daughter products could be explained simply as the effect of the filter removing the products. But as aerosol concentrations were lowered, daughter products increasingly plated out on the walls.

64. Kusuda, T., S. Silberstein, and P. E. McNall, Jr. 1980. Modeling of radon and its daughter concentrations in ventilated spaces. JAPCA 30(11): 1201-1207. [E]

Investigator: National Bureau of Standards
Sponsor: NBS
Pollutants Measured: radon
Pollutant Sources: NA
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: A computer program (time-dependent model) based on ventilation, emanation rates, and sources, was developed to predict radon, daughters, and alpha levels. Air-tight homes (0.2 to 0.5 ach) contribute to levels that have been of concern.

65. Moschandreas, D. J., and H. E. Rector. 1982. Indoor radon concentrations Environment International 8:77-82. [A, F]

Investigator: Geomet Technologies, Inc.
Sponsor: NA
Pollutants Measured: radon
Pollutant Sources: NA
Premises: homes
Geographical Location: Washington, DC suburb
Season: NA
Ventilation Rates: 0.06-1.57 ach

Major Findings: Fifty-five percent of all surveyed basements and 30% of all main floors showed levels in excess of 4.0 nCi/m^3, a level that may be above EPA guidelines for homes built on land reclaimed from phosphate mines. Suburban levels were lower than town levels, but higher than rural. This is due either to differences in soil or construction practices.

66. Prichard, H. M., T. F. Gesell, C. T. Hess, C. V. Weiffenbach, and P. Nyberg. 1982. Associations between grab sample and integrated radon measurements in dwellings in Maine and Texas. Environment International 8:83-87. [A]

Investigator: Univ. of Texas School of Public Health
Sponsor: EPA; NIEHS; NIH
Pollutants Measured: radon
Pollutant Sources: NA
Premises: homes
Geographical Location: Texas and Maine
Season: summer, winter
Ventilation Rates: NA

Major Findings: Log normal distributions were found for all locations, though geometric means varied. Grab samples are adequate for characterization of radon level in a geographical area, but integrated samples more adequately assess individual structures. Water sampling might also be useful in identifying geographic areas of concern.

I. CHARACTERIZATION AND MEASUREMENT

E. Consumer Products

67. Jackson, M. D., and R. G. Lewis. 1981. Insecticide concentrations in air after application of pest control strips. Bulletin of Environmental Contaminants Toxicology 27:122-125. [A]

Investigator: EPA, Health Effects Research Lab
Sponsor: EPA
Pollutants Measured: 3 insecticides
Pollutant Sources: pest control strips
Premises: laboratory
Geographical Location: North Carolina
Season: NA
Ventilation Rates: 8-10 ach

Major Findings: There was a low level vaporization of insecticide from pest control strips, though no odor was detected. Highest air concentrations in a 30 m^3 room were 0.8, 1.4, and 0.25 $\mu g/m^3$ for propoxur, diazinen, and chlorpyrifos, respectively.

68. Mokler, B. V., B. A. Wong, and M. J. Snow. 1979. Respirable particulates generated by pressurized consumer products. I. Experimental method and general characteristics. American Industrial Hygiene Association Journal 40:330-338. [F]

Investigator: Lovelace Biomedical and Environmental Research Institute
Sponsor: DOE; CPSC; FDA
Pollutants Measured: respirable particles
Pollutant Sources: pressurized consumer products
Premises: laboratory test chamber
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Respirable particles are generated by pressurized consumer products. A simulated breathing zone model is developed and used to characterize these particles. There appears to be a nonlognormal size distribution with enrichment in the fine particulates that are deposited in the human respiratory tract.

69. Mokler, B. V., B. A. Wong, and M. J. Snow. 1979. Respirable particulates generated by pressurized consumer products. II. Influence of experimental conditions. American Industrial Hygiene Association Journal 40:339-348. [F]

Investigator: Lovelace Biomedical & Environmental Research Institute
Sponsor: DOE; CSPC; FDA
Pollutants Measured: respirable particles
Pollutant Sources: pressurized consumer products
Premises: laboratory test chamber
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Variation in experimental test chamber conditions had little effect on particle size characteristics. Data generated in the lab is the worst-case situation, in that actual exposure would be less than estimates based on this data.

70. Pickrell, J. A., B. V. Mokler, L. C. Griffis, C. H. Hobbs, and A. Bathija. 1983. Formaldehyde release rate coefficients from selected consumer products. Environmental Science and Technology 17(12):753-757. [F]

Investigator: Lovelace Biomedical & Environmental Research Institute
Sponsor: CPSC; DOE
Pollutants Measured: formaldehyde
Pollutant Sources: consumer/building products
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: A modified Japanese Industrial Standard dessicator procedure provided measurements of formaldehyde release from various consumer products (clothes, paper, fabric, carpet) and building materials (pressed wood, glass-fiber insulation). Release rate coefficients were calculated per unit mass and surface area for each product. Comparisons were made between the release rates and the total extractable formaldehyde measured by the perforator procedure.

71. Young, R. J., R. A. Rinksy, and P. F. Infante. 1978. Benzene in consumer products. Science 199:248. [A, C, F]
Investigator: NIOSH, OSHA
Sponsor: NIOSH; OSHA
Pollutants Measured: benzene
Pollutant Sources: paint stripper
Premises: two-car garage
Geographical Location: NA
Season: summer
Ventilation Rates: approximate wind speed 10 mph

Major Findings: Simulated paint stripping in a garage produced benzene levels ranging from 73 to 225 ppm, well above OSHA proposed standard (1978) for benzene (1 ppm). Other commercial products that contain benzene, and sources of nonoccupational exposure are mentioned.

F. Combustion Sources

72. Cáceres, T., H. Soto, E. Lissi, and R. Cisternas. 1983. Indoor house pollution: Appliance emissions and indoor ambient concentrations. Atmospheric Environment 17(5):1009-1013. [A, F]

Investigator: Univ. of Santiago, Chile
Sponsor: NA
Pollutants Measured: CO, NO, NO_2, CH_2O, SO_2
Pollutant Sources: unvented gas and kerosene heaters
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Emission rates for CO, NO_2, CH_2O and SO_2 from several unvented gas and kerosene heaters frequently employed in domestic heating have been measured. A mass balance model is presented. Predicted steady state concentration and measured values exceed many short-term air quality standards.

73. Coutant, R. W., E. L. Merryman, and A. Levy. 1982. Formation of NO_2 in range-top burners. Environment International 8:185-192. [A, E, F]

Investigator: Battelle Columbus Laboratories
Sponsor: AGA
Pollutants Measured: NO_x
Pollutant Sources: gas stoves
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Formation of NO and NO_2 on range-top burners and in diffusion flames were characterized by composition and temperature profiles. A limited series of experiments with modified burners indicated emissions could be reduced by (1) improved primary aeration and (2) designs to minimize flame surface. A simplified reaction mechanism was postulated to explain the high NO_2/NO ratios observed.

74. Girman, J. R., M. G. Apte, G. W. Traynor, J. R. Allen, and C. D. Hollowell 1982. Pollutant emission rates from indoor combustion appliances and sidestream cigarette smoke. Environment International 8:213-221. [A, F]
Investigator: LBL
Sponsor: DOE; CPSC
Pollutants Measured: CO, CO_2, NO_x, CH_2O, suspended particles
Pollutant Sources: gas stove, kerosene heater, gas space heater, tobacco smoke
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: controlled

Major Findings: Indoor pollutant emission rates from several combustion appliances and concentrations of sidestream tobacco smoke, were measured in a 27 m^3 environmental chamber. Nitrogen dioxide from combustion appliances and particles from sidestream cigarette smoke are the most serious indoor air contaminants based on existing standards.

75. Leaderer, B. P. 1982. Air pollutant emissions from kerosene space heaters. Science 218:1113-1115. [A, F]
Investigator: Yale University, John B. Pierce Foundation Laboratory
Sponsor: PHS
Pollutants Measured: NO_2, SO_2, CO, CO_2
Pollutant Sources: kerosene heaters
Premises: environmental test chamber
Geographical Location: NA
Season: NA
Ventilation Rates: varied

Major Findings: Air pollutant emissions from portable convective and radiant kerosene space heaters were measured in an environmental chamber. Emission factors for nitrogen oxides, sulfur dioxide, carbon monoxide, carbon dioxide, and oxygen depletion are presented. The data suggest that the use of such heaters in residences can result in exposures to air pollutants in excess of ambient air quality standards and in some cases in excess of occupational health standards.

76\. McGill, K. C., and D. P. Miller. 1982, Indoor exposure to carbon containing particulates and vapors in homes which use wood for heating. In: Proceedings, Residential Wood and Coal Combustion Conference (March 1982), ed. The Air Pollution Control Association, p. 281-283. [A, B, F]

Investigator: Washburn Univ., Topeka, KS
Sponsor: EPRI
Pollutants Measured: organic particulates and vapors
Pollutant Sources: wood burning appliances
Premises: 8 homes
Geographical Location: NA
Season: heating season
Ventilation Rates: NA

Major Findings: Metal wood stoves show high ratios of semi-volatiles to volatiles; glass-enclosed fireplaces show higher semi-volatiles than open fireplaces. The sampling and analysis method, using catalyst-coated glass filters followed by flame ionization is fast and yields considerable information, although it does not identify particular compounds.

77\. Neulicht, R. M., and J. Core. 1982. Impact of residential wood combustion appliances on indoor air quality. In Proceedings, Residential Wood and Coal Combustion Conference (March 1982) ed. The Air Pollution Control Association. p. 240. [A, F]

Investigator: Del Green Associates, Inc., Portland OR
Sponsor: EPA
Pollutants Measured: particulate mass and polynuclear aromatic hydrocarbon (PNA)
Pollutant Sources: wood burning stoves
Premises: 5 houses
Geographical Location: Portland, OR
Season: May, 1980
Ventilation Rates: NA

Major Findings: Four of 5 homes showed no significant increase in particulate mass or PNA when wood burning was going on. One home did have significant increases especially in PNA concentration. The potential for exposure exists and is likely due to improper appliance design, installation or operation.

78. Ritchie, I. M., and L. A. Oatman. 1983. Residential air pollution from kerosene heaters. JAPCA 33(9):879-881. [A, F]

Investigator: Indiana Univ. and Minnesota Dept. of Health
Sponsor: NA
Pollutants Measured: SO_2, NO, NO_2, CO, CO_2
Pollutant Sources: kerosene heaters
Premises: NA
Geographical Location: NA
Season: winter
Ventilation Rates: 0.49-0.81 ach

Major Findings: Kerosene heaters that are oversized for the size of the room generate contaminants in high amounts and possibly unsafe conditions can occur. Although ventilation reduces the pollutant levels, buildup of contaminants may occur at slower rates.

79. Ryan, P. B., J. D. Spengler, and R. Letz. 1983. The effects of kerosene heaters on indoor pollutant concentrations: A monitoring and modeling study. Atmospheric Environment 17(7):1339-1345. [A, F]

Investigator: Harvard School of Public Health
Sponsor: EPA; NIEHS
Pollutants Measured: NO_2, SO_2
Pollutant Sources: kerosene heater
Premises: 1 school; 2 houses
Geographical location: Vermont
Season: winter
Ventilation rates: 1-1.5 ach

Major Findings: Measurements of NO_2 levels were made in a school and two residences which used kerosene heaters. A simple, mass balance model was used to relate some of the measurement findings. In one residence in which a discrepancy between tracer gas and blower-door estimates of air exchange rates was found, the modeling suggested that the latter estimate was more likely. Modeling of both NO_2 and SO_2 concentrations suggest the possibility of very high pollutant exposures in poorly-ventilated rooms.

80. Sterling, T. D., and D. Kobayashi. 1981. Use of gas ranges for cooking and heating in urban dwellings. JAPCA 31(2):162-165. [A, F]

Investigator: Simon Fraser and Columbia Universities
Sponsor: CTR
Pollutants Measured: CO
Pollutant Sources: gas stoves
Premises: apartments
Geographical Location: New York, NY
Season: NA
Ventilation Rates: NA

Major Findings: A survey of gas consumption patterns in parts of New York (Manhattan, Bronx, Queens) is presented. Findings show that gas ranges may be used extensively as supplemental heating. Limited CO measurements in selected kitchens show that CO levels build to much higher levels in the well-maintained, subsidized housing than in the nonsubsidized units.

81. Traynor, G. W., D. W. Anthon, and C. D. Hollowell. 1982. Technique for determining pollutant emissions from a gas-fired range. Atmospheric Environment 16(12):2979-2987. [A, F]

Investigator: LBL
Sponsor: DOE
Pollutants Measured: CO, NO_x, SO_2, CH_2O, respirable particles
Pollutant Sources: gas stove
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: controlled

Major Findings: Chamber measurements of pollutant emissions from a gas-fired range have shown that carbon monoxide, nitric oxide, nitrogen dioxide, sulfur dioxide formaldehyde and respirable particles were all emitted during the combustion process. Carbon was found to be the dominant element of the respirable particles emitted. A mathematical indoor air quality model was applied to the laboratory studies to calculate pollutant emission rates per caloric value of fuel consumed.

82. Traynor, G. W., M. G. Apte, J. F. Dillworth, C. D. Hollowell, and E. M. Sterling. 1982. The effects of ventilation on residential air pollution due to emissions from a gas-fired range. Environment International 8:447-452. [A, E,F]

Investigator: LBL
Sponsor: DOE
Pollutants Measured: CO, NO_x
Pollutant Sources: gas stove
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: controlled

Major Findings: A mass balance model is used to estimate indoor concentrations of pollutants from a gas stove. In conjunction with an experimental research house, the effects of infiltration, whole house ventilation, and local exhaust are studied. The results show that a range hood is the most effective means of removing pollutants emitted from a gas-fired range.

83. Traynor, G. W. et al. 1982. Indoor air pollution from portable kerosene-fired space heaters, wood-burning stoves, and wood-burning furnaces. In Proceedings, Residential Wood and Coal Combustion Conference (March 1982), ed. The Air Pollution Control Assocciation, p. 253-263. [A, E, F]

Investigator: LBL
Sponsor: APCA
Pollutants Measured: CO, CO_2, NO_x, formaldehyde
Pollutant Sources: kerosene heaters
Premises: experimental test chamber
Geographical Location: Berkeley, CA
Season: NA
Ventilation Rates: 0.08 to 0.4 ach

Major Findings: In both the environmental chamber and in houses where the kerosene heater is operated for more than one hour, the OSHA CO_2 standard and California NO_2 standards were exceeded. Wood-burning stoves and furnaces vary greatly in contribution to indoor air quality. They need to be studied to develop ways of reducing their contribution to indoor air pollutant levels.

84. Traynor, G. W., M. G. Apte, J. F. Dillworth, C. D. Hollowell, and E. M. Sterling. 1982. The effects of ventilation on residential air pollution due to emissions from a gas-fired range. Environment International 8:447-452. [A, E, F]

Investigator: LBL
Sponsor: DOE, Office of Health & Environmental Research
Pollutants Measured: CO, CO_2, NO_x
Pollutant Sources: gas-fired range
Premises: house
Geographical Location: Berkeley, CA
Season: NA
Ventilation Rates: 0.7-1.6 ach

Major Findings: A single-equation model is shown to adequately predict average whole-house pollutant concentrations. Spot ventilation and range hoods were more effective in removing gas stove pollutants than was general room ventilation.

85. Yamanaka, S., H. Hirose, and S. Takada. 1979. Nitrogen oxide emissions from domestic kerosene-fired and gas-fired appliances. Atmospheric Environment 13:407-412. [A, F]

Investigator: Kyoto City Institute of Public Health
Sponsor: Environmental Agency of Japan
Pollutants Measured: NO_x
Pollutant Sources: Gas appliances
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Emission rates for NO_x from several gas appliances were measured. Among the appliances tested were a kerosene heater, gas stove, gas furnace, and gas water heater. A specially designed model hood collected emissions from the various appliances; samples of this combustion gas were used to estimate emission rates.

I. CHARACTERIZATION AND MEASUREMENT

G. Odor

86. Berg-Munch, B., and P. O. Fanger. 1982. The influence of air temperature on the perception of body odor. Environment International 8:333-335. [A, F]

Investigator: Univ. of Denmark
Sponsor: NA
Pollutants Measured: odor
Pollutant Sources: humans
Premises: auditorium
Geographical Location: Denmark
Season: NA
Ventilation Rates: 1.3 ach

Major Findings: The intensity of human odor in an auditorium was judged by an odor panel in an adjacent space. One half of the sampled air flow was heated, and the other half was unheated. At air temperatures 23-32° C, no significant influence of temperature on perceived intensity of body odor was found.

87. Berglund, B., U. Berglund, T. Lindvall, and H. Nicander-Bredberg. 1982. Olfactory and chemical characterization of indoor air: Towards a psychophysical model for air quality. Environment International 8:327-332. [A, F]

Investigator: Univ. of Stockholm, Sweden
Sponsor: Swedish Council for Building Research
Pollutants Measured: Odor
Pollutant Sources: NA
Premises: office buildings, school
Geographical Location: Sweden
Season: NA
Ventilation Rates: NA

Major Findings: The relationship between odor strength of total air samples and the odor strengths of the constituents was investigated in three field experiments in an office building and a new preschool. A psychological model was found that predicts overall odor strength of an air sample from the number of FID-detected components most frequently reported to have a strong odor.

II. CONTROL METHODS

A. Air-Purifying Methods

88. Hinds, W. C., S. N. Rudnick, E. F. Maher, and M. W. First. 1983. Control of indoor radon decay products by air treatment devices. JAPCA. 33(2): 134-136. [A, F]

Investigator: Harvard School of Public Health
Sponsor: EPA
Pollutants Measured: radon gas
Pollutant Sources: bubbler
Premises: laboratory test chamber
Geographical Location: NA
Season: NA
Ventilation Rates: 0.2-0.8 ach

Major Findings: The efficiency of household air cleaning devices as a means to control radon decay products in existing buildings was determined. Reductions observed at air filtration rates of 0.52 air changes per hour ranged from 50 to 89 percent. Although the electrostatic precipitator produced the greatest reductions, the low cost and simplicity of air ciculating fans appear to make them most suitable for residences.

89. Nazaroff, W. W., M. L. Boegel, C. D. Hollowell, and G. D. Roseme. 1981. The use of mechanical ventilation with heat recovery for controlling radon and radon-daughter concentrations in houses. Atmospheric Environment 15:263-270. [A,F]

Investigator: LBL
Sponsor: DOE
Pollutants Measured: radon and radon daugthers
Pollutant Sources: NA
Premises: residence
Geographical Location: Carroll County, MD
Season: September 1979
Ventilation Rates: 0.07-0.8 ach

Major Findings: The installation of a mechanical ventilation system with heat recovery was shown to be effective in reducing indoor concentrations of radon and radon daughthers. At ventilation rates of 0.6 air changes per hour and higher, radon and radon daughter levels dropped below the guidelines for indoor concentrations. Comparison with other studies indicates that indoor radon buildup may be a problem in many houses with low infiltration rates.

90. Shair, F. H. 1981. Relating indoor pollutant concentrations of ozone and sulfur dioxide to those outside: Economic reduction of indoor ozone through selective filtration of the make-up air ASHRAE Transactions 87(Pt.1):116-139. [A, E, F]

Investigator: Cal. Inst. of Technology
Sponsor: Andrew W. Mellon Foundation
Pollutants Measured: O_3 and SO_2
Pollutant Sources: NA
Premises: 13 separate buildings
Geographical Location: Los Angeles
Season: NA
Ventilation Rates: NA

Major Findings: Twenty-four separate ventilation systems were tested to determine losses of ozone and sulfur dioxide from laboratory-office buildings. The K values (rate constant heterogeneous loss) were found to be 0.04 ft^3/ft^2-min and 0.014 ft^3/ft^2 min for ozone and sulfur dioxide, respectively. It was found that air filtration with activated carbon, when properly operated and used only when ambient ozone rose above 0.08 ppm, maintained indoor levels at less than one-fifth of outside levels.

B. Ventilation

91. Berglund, B., I. Johansson, and T. Lindvall. 1982. The influence of ventilation on indoor/outdoor air contaminants in an office building. Environment International 8:395-399. [A, F]

Investigator: Univ. of Stockholm, Sweden
Sponsor: Swedish Council for Building Research
Pollutants Measured: CO, CO_2, NO_x, organics
Pollutant Sources: NA
Premises: office building
Geographical Location: Sweden
Season: Autumn, spring
Ventilation Rates: 16,000 m^3/hr

Major Findings: An energy-economized office building provides sufficient protection against outdoor pollution provided the location of the air intake system allows for adequate air makeup and mixing. The number and concentration of most air pollutants increased from the air intake along the pathway of the ventilation system. Changes in recirculation of return air affect the concentration of indoor pollutants differently for different compounds. Saving energy by using a ventilation-by-demand system cannot be generally recommended.

92. Caffey, G. E. 1979. Residential air infiltration. ASHRAE Tranactions 85(1):41-57. [F]

Investigator: Texas Power & Light
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: NA
Premises: 50 homes
Geographical Location: Dallas, TX
Season: June
Ventilation Rates: NA

Major Findings: The "super sucker" was used to effectively isolate and identify areas of infiltration. Twelve major areas of the home that are sources of air leaks are discussed. The impact of inexpensive methods for cutting down infiltration is also discussed.

93. Cain, W. S., B. P. Leaderer, R. Isseroff, L. G. Berglund, R. J. Huey, E. D. Lipsitt, and D. Perlman. 1983. Ventilation requirements in buildings-I. Control of occupancy odor and tobacco smoke odor. Atmospheric Environment 17(6):1183-1197. [A, F]

Investigator: Yale University
Sponsor: DOE; NIEHS
Pollutants Measured: CO, butanol, suspended particles
Pollutant Sources: tobacco smoke
Premises: laboratory test chamber
Geographical Location: NA
Season: NA
Ventilation Rates: controlled

Major Findings: In an array of 38 conditions of smoking occupancy, the ventilation deemed necessary so that 75 percent of the persons tested did not perceive the odor of tobacco smoke was 17.5 liter of air per second per person. For both smoking and nonsmoking conditions, a combination of high temperature and humidity exacerbated the odor problem. During smoking, carbon monoxide rarely reached dangerous levels, but suspended particulates often reached levels considered unacceptable outdoors.

94. Cain, W. S., and B. P. Leaderer. 1982. Ventilation requirements in occupied spaces during smoking and nonsmoking occupancy. Environment International 8:505-514. [A, F]

Investigator: Yale University
Sponsor: DOE; NIEHS
Pollutants Measured: CO, suspended particles
Pollutant Sources: tobacco smoke
Premises: laboratory test chamber
Geographical Location: NA
Season: NA
Ventilation Rates: Varied

Major Findings: More than 200 people made judgments of odor intensity and acceptability under various conditions of occupancy (up to 12 nonsmoking occupants; a temperature up to 25.5° C, and up to 16 cigarettes smoked per hour). The results indicate that under nonsmoking conditions and moderate humidity, 7.8 cfm of fresh air per occupant is required to satisfy the occupants while under smoking conditions, at least 5 times as much fresh air is necessary.

95. Cole, J. T., T. S. Zawacki, R. H. Elkins, J. W. Zimmer, and R. A. Macriss. 1980. Application of a generalized model of air infiltration to existing homes. ASHRAE Transactions 86(2):765-773. [A, F]

Investigator: Inst. of Gas Technology, Chicago, IL
Sponsor: Gas Research Inst.
Pollutants Measured: NA
Pollutant Sources: NA
Premises: homes
Geographical Location: metropolitan Chicago ; Ottowa, Canada
Season: NA
Ventilation Rates: 0.06-0.68 ach

Major Findings: A generalized model of air infiltration was used to estimate air infiltration characteristics of two test homes. Methodologies are presented for estimating "total crackage", wind shielding by adjacent structures, and structure permeability. Models and actual measurements are compared.

96. Dietz, R. N. and E. A. Cote. 1982. Air infiltration measurements in a home using a convenient perfluorocarbon tracer technique. Environment International 8:419-433. [A, F]

Investigator: Brookhaven National Laboratory
Sponsor: DOE
Pollutants Measured: NA
Pollutant Sources: NA
Premises: home
Geographical Location: Upton, NY
Season: December
Ventilation Rates: 0.2-5.0 ach

Major Findings: The perfluorocarbon technique (PFT) is a precise and reliable methodology for the determination of infiltration rates in homes. Comparison of the PFT tracer method with that of the SF_6 tracer decay approach showed the results of the two methods to be identical within the limits of experimental precision. With the PFT tracer technique, infiltration rates in the range of 0.2 to 5 air changes per hour can be measured over time-averaged periods of 1 day up to several years.

97. Hollowell, C. D., J. V. Berk, M. L. Boegel, R. R. Miksch, W. W. Nazaroff, and G. W. Traynor. 1980. Building ventilation and indoor air quality. Studies in Environmental Science 8:387-396. [F]

Investigator: LBL
Sponsor: DOE
Pollutants Measured: CO, NO_2, CH_2O, radon
Pollutant Sources: NA
Premises: homes
Geographical Location: Varied
Season: NA
Ventilation Rates: varied

Major Findings: Various indoor air contaminants were measured at energy-efficient research houses and buildings throughout the United States. Findings suggest that further studies are needed to develop criteria for maintaining indoor air quality without compromising energy efficiency.

98. Janssen, J. E., T. J. Hill, J. E. Woods, and E. A. B. Maldonado. 1982. Ventilation for control of indoor air quality: A case study. Environment International 8:487-496. [A, F]

Investigator: Honeywell, Inc. Minneapolis, MN
Sponsor: LBL
Pollutants Measured: CO_2
Pollutant Sources: NA
Premises: School
Geographical Location: Fridley, MN
Season: Jan-Feb
Ventilation Rates: 5 L of air/sec per occupant

Major Findings: Energy reduction of approximately 20 percent can be achieved by means of a CO_2-feedback-control ventilation system which is responsive to room occupancy load. The design of the energy-efficient ventilation system must consider the location of both the supply and return terminal units.

99. Janssen, J. E., A. N. Pearman, and T. J. Hill. 1980. Calculating infiltration: An examination of handbook models. ASHRAE Transactions 86(2): 751-764. [A, F]
Investigator: Honeywell, Inc., Minneapolis, MN
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: NA
Premises: test houses
Geographical Location: California, Minnesota
Season: NA
Ventilation Rates: 0.10-0.12 ach

Major Findings: The ASHRAE air exchange method estimates infiltration with sufficient accuracy for sizing of heating and cooling equipment for normal construction. In comparing estimated infiltration due to wind with actual measurements, they found reasonable agreement--though larger homes were underestimated. Temperature differential through fireplace stacks are inconsequential in determining air infiltration.

100. Kalliokoski, P., R. Niemela, J. Salmivaara. 1980. The tracer gas technique--a useful tool for industrial hygiene. Scandavian Journal of Work & Environmental Health 6:123-130. [A, F]
Investigator: Univ. Kupio, Kuopio, Finland
Sponsor: Univ. of Kuopio
Pollutants Measured: NA
Pollutant Sources: NA
Premises: rotogravure press
Geographical Location: Finland
Season: NA
Ventilation Rates: 16,000 to 47,000 m^3/h exhaust rate

Major Findings: Carbon dioxide, nitrous oxide, and sulfur hexfluoride were used to elicit ventilation rates and determine spreading routes of dilution air in the work environment. The local flow rates of dilution air and the percentages of makeup air present were the most important information gained in the ventilation studies.

101. Lagus, P. L. 1977. Characterization of building infiltration by the tracer-dilution method. Energy 2:461-464. [F]

Investigator: Systems, Science & Software, LaJolla, CA
Sponsor: Systems, Science, & Software
Pollutants Measured: NA
Pollutant Sources: NA
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Air infiltration cannot be reliably calculated but must be measured in a structure. The tracer-dilution method is a useful technique to determine infiltration rates. The technique entails measurement of logarithmic dilution rate of a tracer gas concentration with respect to time.

102. Malmström, T., and A. Ahlgren. 1982. Efficient ventilation in office rooms. Environment International 8:401-408. [A, F]

Investigator: Royal Institute of Technology, Sweden
Sponsor: The Swedish Council for Building Research
Pollutants Measured: NA
Pollutant Sources: NA
Premises: laboratory test chamber
Geographical Location: Stockholm, Sweden
Season: year-round
Ventilation Rates: 2 ach

Major Findings: A two-box model for calculation of tracer gas concentrations in rooms was developed and tested with dilution and tracer gas experiments. The results indicate a tendency toward lower tracer gas concentrations in the "breathing zone" when supply air is brought into a room at a low (near floor) compared to high (near ceiling) room level.

103\. McNall, P. E., Jr. 1981. Building ventilation measurements, predictions, and standards. Bulletin of the New York Academy of Medicine 57(10):1027-1043. [F]

Investigator: NBS
Sponsor: NBS
Pollutants Measured: NA
Pollutant Sources: NA
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: A predictive model (mass balance) for indoor air contaminant concentrations in residences was developed. The model was verified for the case where tobacco smoke is produced indoors. The model can be applied to a wide variety of expected indoor contaminants, production rates, and ventilation rates.

104\. Narasaki, M., S. Ishido, and Y. Nakane. 1981. Indoor air pollution and ventilation in sound insulating dining-kitchens. Osaka Diagako. Kogakubu Technology Reports. 31(16):145-152. [A, E, F]

Investigator: Chuba Inst. of Tech., Kasugai, Japan
Sponsor: NA
Pollutants Measured: CO, CO_2
Pollutant Sources: gas appliances
Premises: homes (dining-kitchen)
Geographical Location: Japan, new airfields
Season: Fall
Ventilation Rates: 0.3-1.0 ach

Major Findings: Ventilation systems have varied effects on the removal of CO and CO_2 due in part to air temperature differences and physical location of walls, fans, hoods, etc. They found that natural ventilation differed for each season with higher air exchange rates during the winter (windows closed).

105. Offerman, F. J., C. D. Hollowell, W. W. Nazaroff, G. D. Roseme, and J. R. Rizzuto. 1982. Low-infiltration housing in Rochester, New York: A study of air-exchange rates and indoor air quality. Environment International 8:435-445. [A, F]

Investigator: LBL
Sponsor: DOE
Pollutants Measured: Rn, CH_2O, NO_2, CO, respirable particles
Pollutant Sources: NA
Premises: home
Geographical Location: Rochester, NY
Season: 80-81 heating season
Ventilation Rates: 0.2-1.7 ach

Major Findings: Air exchange rates were relatively low without mechanical ventilation, yet indoor concentrations of radon, formaldehyde, carbon monoxide, and nitrogen dioxide were below existing guidelines in a sample of 58 occupied residences. Although particulate air fractions were higher indoors than outdoors, mechanical ventilation systems were effective in further reducing indoor contaminant concentrations. When contaminant source strengths are low, acceptable air quality can be compatible with low air-exchange rates.

106. Persily, A. 1982. Evaluation of an air-to-air heat exchanger. Environment International 8:453-459. [F]

Investigator: Princeton University
Sponsor: DOE
Pollutants Measured: NA
Pollutant Sources: NA
Premises: test building
Geographical Location: Princeton, NJ
Season: NA
Ventilation Rates: 0.1-4.57 ach

Major Findings: The Lossnay air-to-air heat exchanger recovered approximately 50 percent of the heat contained in the outgoing air flow from the test chamber. The manufacturers' claimed efficiency and the efficiency as measured by doing a heat balance on the device are close to 70 percent.

107. Skåret, E., and H. M. Mathisen. 1982. Ventilation efficiency. Environment International 8:473-481. [A, F]
Investigator: Norwegian Inst. of Technology, Norway
Sponsor: Norwegian Institute of Technology
Pollutants Measured: NA
Pollutant Sources: NA
Premises: laboratory test chamber
Geographical Location: NA
Season: NA
Ventilation Rates: 3.0-6.0 ach

Major Findings: Ventilation systems can be designed for higher ventilation efficiency in the zone of occupation compared to system designs based on complete mixing. Expressions for ventilation efficiency are derived using a two-box model and tracer gas experiments. The mathematical model predicts high efficiencies using diffuse air supply directly to the zone of occupation, if the air is not used for heating.

108. Södergren, David. 1982. A CO_2-controlled ventilation system. Environment International 8:483-486. [A, F]
Investigator: Paul Peterson AB, Stockholm, Sweden
Sponsor: Paul Peterson AB, Stockholm, Sweden
Pollutants Measured: CO_2, radon
Pollutant Sources: NA
Premises: office building
Geographical Location: Helsinki, Sweden
Season: winter
Ventilation Rates: 2.5 ach

Major Findings: This study showed that a ventilation system designed to maintain a constant carbon dioxide concentration in the indoor air of a building can operate successfully. Carbon dioxide indicators in the exhaust air controlled the ventilation rate. Aerosol concentrations could also be used as a reference when outside air is required for a building's ventilation system. The system can be used in new, as well as existing buildings.

109. Turiel, I., C. D. Hollowell, R. R. Miksch, J. V. Rudy, and R. A. Young. 1983. The effects of reduced ventilation on indoor air quality in an office building. Atmospheric Environment 17(1):51-64. [A, F]

Investigator: LBL
Sponsor: DOE
Pollutants Measured: CH_2O, organics, CO_2, CO, NO_2
Pollutant Sources: NA
Premises: office building
Geographical Location: San Francisco, CA
Season: September 1979
Ventilation Rates: 20 to 33 cfm/person

Major Findings: Indoor air quality was monitored at an office building. The parameters measured were outside air flow rates, temperature, relative humidity, odor perception, microbial burden, particulate mass, formaldehyde and other organics, carbon dioxide, carbon monoxide, and nitrogen dioxide. Carbon dioxide concentrations increased as the ventilation rate decreased; odor perceptibility increased slightly at the lowest ventilation rate, and other pollutants generally showed very low concentrations.

110. Weschler, C. J., S. P. Kelty, and J. E. Lingousky. 1983. The effect of building fan operation on indoor-outdoor dust relationships. JAPCA 33(6):624-629. [A, E, F]

Investigator: Bell Laboratories, New Jersey
Sponsor: Bell Labs.
Pollutants Measured: dust
Pollutant Sources: NA
Premises: telephone equipment buildings
Geographical Location: Wichita, KS and Lubbock, TX
Season: fall, winter, spring
Ventilation Rates: 0.21 ach (Wichita) and 0.24 ach (Lubbock)

Major Findings: Indoor dust concentrations increased when building fans are turned off due to loss of constant filtration. Lack of pressurization is not an important factor. An expression, applicable to similar buildings, is derived for the relative dust increase when the building fans are off.

II. CONTROL METHODS

C. Source Modification

111. Culot, M. V. J., K. J. Schiager, and H. G. Olson. 1976. Prediction of increased gamma fields after application of a radon barrier on concrete surfaces. Health Physics 30:471-478. [A, F]

Investigator: Centro Nuclear de Mexico; Univ. of Pittsburgh
Sponsor: AEC; EPA
Pollutants Measured: Rn
Pollutant Sources: concrete
Premises: varied
Geographical Location: varied
Season: NA
Ventilation Rates: NA

Major Findings: A sizable reduction in the indoor radon progeny exposure level is anticipated from the application of a radon barrier to indoor surfaces of concrete foundations. A comparison of the gamma exposures associated with concentration profiles prior to and after application of a radon barrier resulted in the prediction of sufficiently low fractional increases to justify field testing of the barrier.

112. Rashidi, M., M. S. Nassoudi, and F. Shadman. 1977. Reduction of carbon monoxide from domestic kerosene heaters. Journal Environmental Science and Health A12(3):115-126. [A, F]

Investigator: Univ. of Technology, Tehran, Iran
Sponsor: Univ. of Technology, Tehran, Iran
Pollutants Measured: CO
Pollutant Sources: kerosene heater
Premises: laboratory test chamber
Geographical Location: Tehran, Iran
Season: NA
Ventilation Rates: NA

Major Findings: A device applying the concepts of both of a thermal reactor and catalysis was developed, which upon testing proved very effective in reducing carbon monoxide emissions. In moderate burning capacities of the heater, the carbon monoxide level was reduced by a factor of two due to the use of the device. In a heater equipped with the device and operating at higher burning capacities, the concentration level of carbon monoxide was reduced by a factor of six.

II. CONTROL METHODS

D. Miscellaneous

113. Billings, C. E. and S. F. Vanderslice. 1982. Methods for control of indoor air quality. Environment International 8:497-504. [F]

Investigator: John Hopkins University, Exxon Co.
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: NA
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: This paper reviews the available methods for the control of environmental hazards due to indoor air pollutants. Alternative methods of control, the performance characteristics of ventilation systems and air cleaning devices, and models for predicting indoor air pollutant concentrations are discussed.

114. Sansome, E. B., and M. W. Slein. 1978. Redispersion of indoor surface contamination: A review. Journal of Hazardous Materials 2:347-361. [F]

Investigator: Frederick Cancer Research Center, Frederick, MD
Sponsor: NCI
Pollutants Measured: NA
Pollutant Sources: surface contamination
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: The importance of surface contamination as a potential source of exposure to hazardous materials is discussed. Data from the literature concerning the resuspension of indoor surface contamination are presented. Reported procedures for quantitating surface contamination are compared. It is suggested that surface contamination monitoring may be useful in estimating potential risks from hazardous materials.

115. Sawyer, R. N., and E. J. Swoszowski, Jr. 1979. Asbestos abatement in schools: Observations and experiences. Annals of the New York Academy of Sciences 330:765-775. [F]

Investigator: Yale University
Sponsor: Yale University
Pollutants Measured: NA
Pollutant Sources: Asbestos construction material
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: This article summarizes the considerations, failures, and recommendations and methods of the asbestos abatement program for schools. Specific information is provided for school administrators, school boards, governmental agencies, and contractors involved with asbestos abatement projects.

III. HEALTH STUDIES

116. Beck, B. D., and J. D. Brain. 1982. Prediction of the pulmonary toxicity of respirable combustion products from residential wood and coal stoves. In, Proceedings, Residential Wood and Coal Combustion Conference (March, 1982), ed. The Air Pollution Control Association, p. 264-280. [C]

Investigator: Harvard School of Public Health
Sponsor: Northeast States for Coordinated Air Use Management
Pollutants Measured: NA
Pollutant Sources: wood and coal stove
Premises: laboratory
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Respirable particles from combustion of anthracite coal, bituminous coal, and wood were tested for their potential to cause pulmonary toxicity in hamsters. The intensity of response was comparable to highly toxic alpha-quartz dust and in some cases was even greater. Coal dust showed the greatest response due only in part to its acidity, while wood combustion products showed a response between that of coal and nontoxic dusts.

117. Binder, R. E., C. A. Mitchell, H. R. Hosein, and A. Bouhuys. 1976. Importance of the indoor environment in air pollution exposure. Archives of Environmental Health 31:277-279. [A, C, D, F]

Investigator: Yale Univ. Lung Research Center
Sponsor: National Heart & Lung Institute
Pollutants Measured: respirable particulate, SO_2, NO_2
Pollutant Sources: cigarette smoke
Premises: home, school, playground
Geographical Location: Ansonia, CT
Season: April-June
Ventilation Rates: NA

Major Findings: Personal samplers were affixed to children for 24-hour periods. Particulate exposures were significantly higher for children exposed to cigarette smoke. Individual exposure appears to be determined by indoor rather than outdoor pollutants.

118. Fleischer, R. L. 1982. Lung cancer and phosphates. Environment International 8:381-385. [C, D]

Investigator: General Electric Research & Development Center, NY
Sponsor: NA
Pollutants Measured: radon
Pollutant Sources: phosphate mines, deposits or processing plants
Premises: NA
Geographical Location: various
Season: NA
Ventilation Rates: NA

Major Findings: A significant correlation was found between counties with high lung cancer rates and counties with phosphate desposits, mines, or processing. Unworked phosphate deposits are apparently not hazardous, but phosphate processing plants are of concern. Problems appear to be more widespread than occupational exposure.

119. Gross, P., J. Tuma, and R. T. P. de Treville. 1971. Lungs of workers exposed to fiber glass: A study of their pathologic changes and their dust content. Archives of Environmental Health 23:67-76. [C]

Investigator: Univ. of Pittsburgh; Industrial Health Foundation, Inc.
Sponsor: NA
Pollutants Measured: fiber glass dust
Pollutant Sources: occupational exposure
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: This study examined the lungs of 20 deceased fiberglass workers, known to have had long-term exposure to fiberglass dust. Lungs of workers were compared to a control group (urban dwellers, presumably without occupational exposure) and no significant differences were found between the two groups--in terms of lung damage, amount of dust, and total number of fibers per lung.

120. Gupta, K. C., A. G. Ulsamer, and P. W. Preuss. 1982. Formaldehyde in indoor air: Sources and toxicity. Environment International 8:349-358. [C, F]

Investigator: CPSC
Sponsor: NA
Pollutants Measured: formaldehyde
Pollutant Sources: various
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: This article reviews the research on the health effects of formaldehyde exposure. Included are studies on humans, animals and bacteria. Animal studies have shown that formaldehyde is a carcinogen although human epidemiological studies have not yet confirmed this.

121. Helsing, K. J., G. W. Comstock, M. B. Meyer, and M. L. Tockman. 1982. Respiratory effects of household exposures to tobacco smoke and gas cooking on nonsmokers. Environment International 8:365-370. [C, D]

Investigator: Johns Hopkins University
Sponsor: NIEHS; National Heart, Lung and Blood Institute
Pollutants Measured: NA
Pollutant Sources: tobacco smoking, gas stoves
Premises: homes
Geographical Location: Washington County, MD
Season: NA
Ventilation Rates: NA

Major Findings: This epidemiological study looked at the records of a nonsmoking white adult population for health effects. Tobacco smoke showed only a slight association with chronic phlegm and impaired ventilatory function. Gas cooking was more strongly associated with chronic cough and impaired respiratory function.

122. Hill, J. W., W. S. Whitehead, J. D. Cameron, and G. A. Hedgecock. 1973. Glass fibers: Absence of pulmonary hazard in production workers. British Journal of Industrial Medicine 30:174-179. [C]

Investigator: Pilkington Brothers Limited
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: industrial fiber glass exposure
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Radiographic and pulmonary function tests, as well as respiratory symptom questionnaires were administered to a group of workers exposed to glass fibers. Compared to a control group, there is no evidence of respiratory hazard.

123. Jones, J. R., I. T. Higgins, M. W. Higgins, and J. B. Keller. 1983. Effects of cooking fuels on lung function in nonsmoking women. Archives of Environmental Health 38(4):219-222. [C]

Investigator: Univ. of Michigan, School of Public Health
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: gas ranges
Premises: homes
Geographical Location: Tecumseh, Michigan
Season: NA
Ventilation Rates: NA

Major Findings: The authors looked for a relationship between gas cooking and lung function, and they found no statistically significant connection. Kitchen exhaust fan use was strongly associated with low lung function suggesting that people who use fans are more sensitive to combustion products or pollutant levels indoors.

124. Kreiss, K., M. G. Gonzalez, K. L. Conright, and A. R. Scheere. 1982. Respiratory irritation due to carpet shampoo: Two outbreaks. Environment International 8:337-341. [C, D]

Investigator: CDC, Atlanta; Colorado Dept. of Health
Sponsor: NA
Pollutants Measured: sodium dodecyl sulfate
Pollutant Sources: carpet shampoo
Premises: office building
Geographical Location: Colorado
Season: NA
Ventilation Rates: NA

Major Findings: Two outbreaks of respiratory irritation due to the use of carpet shampoo are described. A crude dose-response relationship was found for one office building and improper shampooing (underdilution of clearer) was suspected. Sodium dodecyl sulfate was common to the cleaners that caused irritation.

125. Lebowitz, M. D., D. B. Armet, and R. Knudson. 1982. The effect of passive smoking on pulmonary function in children. Environment International 8:371-373. [C, F]

Investigator: Arizona Health Sciences Center, Tucson
Sponsor: National Heart, Lung and Blood Institute
Pollutants Measured: NA
Pollutant Sources: cigarette smoking
Premises: homes
Geographical Location: Tucson, AZ
Season: NA
Ventilation Rates: NA

Major Findings: Pulmonary function was tested in children among 344 nuclear families. No association was found between children's pulmonary function and parental smoking.

126. Levin, L., and P. W. Purdom. 1983. A review of the health effects of energy conserving materials. American Journal of Public Health 73(6): 683-690. [C, D]

Investigator: Environmental Studies Institute, Drexel Univ., Philadelphia
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: insulating materials
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: This article reviews health and safety standards, exposure standards, and regulatory actions associated with insulating materials. Asbestos and formaldehyde are the primary concerns due to known health effects and potential levels of exposure.

127. Olsen, J. H. and M. Døssing. 1982. Formaldehyde induced symptoms in day care centers. American Industrial Hygiene Association Journal 43:366-370. [C, F]

Investigator: Univ. of Copenhagen, Denmark
Sponsor: NA
Pollutants Measured: formaldehyde
Pollutant Sources: new building materials
Premises: day-care centers
Geographical Location: Copenhagen
Season: NA
Ventilation Rates: NA

Major Findings: A health survey of employees in 7 new day-care centers were compared to matched employees in older buildings. The difference in formaldehyde exposure ranged from 0.43 mg/m^3 in the day care workers to 0.08 mg/m^3 in the control institutions. The day care workers showed higher frequencies of mucous membrane irritation, headache, fatigue, menstrual irregularities and use of analgesics.

128. Schenker, M. B., S. T. Weiss, and B. J. Murawski. 1982. Health effects of residence in homes with urea-formaldehyde insulation: A pilot study. Environment International 8:359-363. [C]

Investigator: Harvard Medical School; Beth Israel Hospital, Boston
Sponsor: NIEHS
Pollutants Measured: formaldehyde
Pollutant Sources: urea-formaldehyde foam insulation
Premises: NA
Geographical Location: Boston, MA
Season: NA
Ventilation Rates: NA

Major Findings: Residents of homes with urea formaldehyde foam insulation showed no skin sensitivity or respiratory function changes, though memory deficiency and depression were found at higher than expected rates. Chronic low-level formaldehyde exposure may cause mental changes, but further testing is necessary.

129. Spengler, J. D., and K. Sexton. 1983. Indoor air pollution: A public health perspective. Science 221(4605):9-17. [C, F]

Investigator: Harvard School of Public Health
Sponsor: NIEHS; EPRI; EPA
Pollutants Measured: NA
Pollutant Sources: known indoor air pollutants
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: This review article considers known indoor air pollutants and their sources in nonoccupational settings. Risk assessment efforts are hampered by insufficient information concerning number of people exposed, pattern and severity of exposure, and the resulting health consequences. Numerous references are made to recent studies. The authors suggest the need for a comprehensive strategy to investigate indoor pollutants.

130. Stacy, R. W., and J. Green et al. 1983. A survey of effects of gaseous and aerosol pollutants on pulmonary function of normal males. Archives of Environmental Health 38(2):104-115. [C]

Investigator: EPA, Health Effects Research Laboratory
Sponsor: EPA
Pollutants Measured: O_3, NO_2, SO_2, H_2SO_3, $Al(SO_4)_2$, $(NH_4)_2SO_4$, NH_4, NO_3
Pollutant Sources: NA
Premises: laboratory
Geographical Location: Chapel Hill, NC
Season: NA
Ventilation Rates: NA

Major Findings: Controlled testing revealed significant differences in several pulmonary function tests for ozone and ozone plus aerosols. None of the other pollutants singly or in combination showed significant correlation with reduced pulmonary function.

IV. MODELING

A. General Models

131. Duan, N. 1982. Models for human exposure to air pollution. Environment International 8:305-309. [F]

Investigator: The Rand Corporation, Santa Monica, CA
Sponsor: The Rand Corporation
Pollutants Measured: NA
Pollutant Sources: NA
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: Four models for human exposure to air pollution are compared, and the advantages and disadvantages of each model are discussed. The four model are: (1) a simple microenvironment monitoring model, (2) a replicated microenvironment monitoring model, (3) a integrated personal monitoring model, and (4) a continuous personal monitoring model.

132. Ishizu, Y. 1980. General equation for the estimation of indoor pollution. Environmental Science & Technology 14:1254-1257. [A, F]

Investigator: Japan Tobacco and Salt Public Corporation
Sponsor: NA
Pollutants Measured: NA
Pollutant Sources: tobacco smoke
Premises: experimental room
Geographical Location: NA
Season: NA
Ventilation Rates: 32 m^3/min outdoor air; 8 m^3/min recirculated

Major Findings: An experimental test was performed for a general equation that estimates indoor air quality. New mixing factors were developed and confirmed by experimentation. It was found that the equations developed could be extended to more general cases where pollutant generation rates are time dependent.

133. Lorenz, F. 1982. Calculation of ventilation requirements in the case of intermittent pollution: Application to enclosed parking garages. Environment International 8:515-524. [A, F]

Investigator: Laboratoire de Physique du Batiment, Belgium
Sponsor: NA
Pollutants Measured: NO_2
Pollutant Sources: 30 buses
Premises: enclosed parking garage
Geographical Location: NA
Season: NA
Ventilation Rates: 5,805 to 40,950 m^3/h

Major Findings: A mathematical model that calculates the ventilation requirements for an enclosed parking garage was developed and tested. A dynamic evaluation (a garage where all the cars enter and leave at nearly the same time) using three modes of operation was the basis for model development. Using the model, ventilation rates ranging from 5,805 to 40,950 m^3/h were calculated, compared with the classical solution (using static steady-state assumptions) of 49,050 m^3/h.

134. Ozkaynak, H., P. B. Ryan, G. A. Allen, and W. A. Turner. 1982. Indoor air quality modeling: Compartmental approach with reactive chemistry. Environment International 8:461-471. [A, F]

Investigator: Harvard University, Energy and Environmental Policy Center
Sponsor: NIEHS; EPRI; EPA; DOE
Pollutants Measured: NO, NO_2, NO_x, CO
Pollutant Sources: gas-fired appliances
Premises: homes
Geographical Location: Newton, MA
Season: April, May, October 1981
Ventilation Rates: NA

Major Findings: One- and multicompartmental models to infer and estimate concentration, emission, removal, ventilation, and transfer (mixing) variables in indoor air were developed and tested. A simple reactive chemistry model accounts for most of the essential features of the nitrogen oxide chemistry in the indoor environment. Short-term (less than 15 minutes) air flow and mixing patterns may be important in controlling pollutant concentrations and thus potential exposure in homes with gas stoves.

135. Shair, F. H. and K. L. Heitner. 1974. Theoretical model for relating indoor pollutant concentrations to those outside. Environmental Science & Technology 8(5):444-451. [A, F]

Investigator: California Institute of Technology, Pasadena, CA
Sponsor: California Institute of Technology
Pollutants Measured: ozone
Pollutant Sources: ambient air
Premises: office and conference room
Geographical Location: California Inst of Technology, campus
Season: Summer 1973
Ventilation Rates: 1,450 to 1,587 cfm

Major Findings: A dynamic model for relating indoor pollutant concentrations to those outside was developed and tested. When the time interval associated with changes in the outdoor concentration is long, compared to that required either to change the air within the building or to remove the pollutant by internal means, the indoor concentration of pollutant can be related to the outdoor concentration by means of a simple expression.

IV. MODELING

B. Radon

136. Porstendörfer, J., A. Wicke, and A. Schraub. 1978. The influence of exhalation, ventilation and deposition processes upon the concentration of radon, thoron and their decay products in room air. Health Physics 34:465-473. [F]

Investigator: Institut fur Biophysik, West Germany
Sponsor: Federal Republic of Germany
Pollutants Measured: radon and radon daughters
Pollutant Sources: Wall exhalation; air infiltration
Premises: NA
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: This report models (1) the influence of radon and thoron exhalation from building walls and (2) the air-exchange of radon and thoron between the outside and indoor air. Based on a literature review and model calculations, it was shown that compared with outdoor concentrations, the indoor concentrations of radon and thoron daughters are smaller; and the indoor radon concentration depends on building surface exhalation and room ventilation.

137. Rogozen, M. B. 1982. Dynamic simulation of radon daughter concentrations in apartments using solar rockbed heat storage. Environment International 8:89-96. [F]

Investigator: Science Applications, Inc., Los Angeles, CA
Sponsor: SERI
Pollutants Measured: radon and radon daughters
Pollutant Sources: rockbed heat storage system
Premises: home
Geographical Location: NA
Season: NA
Ventilation Rates: NA

Major Findings: A microcomputer model was developed to simulate ^{222}Rn and daughter concentrations emitted in the living space of a residential structure equipped with solar rockbed heat storage. During the day, when the living space is isolated from the radon source, interior ^{222}Rn concentrations approach those of the outdoor. At night, a steady-state concentration (0.001 to 0.018 of the working level) is approached about 6 hours after heat discharge begins. Combinations of source strength, infiltration rate, and exterior radon concentration that would lead to excessive exposure were calculated.

IV. MODELING

C. Formaldehyde

138. Andersen, I., G. R. Lundqvist, and L. Mølhave. 1975. Indoor air pollution due to chipboard used as a construction material. Atmospheric Environment 9:1121-1127. [A, F]

Investigator: University of Aarhus, Denmark
Sponsor: NA
Pollutants Measured: formaldehyde
Pollutant Sources: chipboard used in walls, floors, ceilings
Premises: homes
Geographical Location: Jutland, Denmark
Season: Feb-Sept 1973
Ventilation Rates: 0 to 2.5 ach

Major Findings: Measurements in 25 rooms in 23 Danish dwellings where chipboard was used in walls, floors, and ceilings showed an average formaldehyde air concentration of 0.62 mg/m^3. In climate chamber experiments, the equilibrium concentration of formaldehyde from chipboard was found to be directly proportional with temperature and water vapor concentration in the air. A mathematical model for room air concentrations of formaldehyde was developed and tested.

139. Mølhave, L., P. Bisgaard, and S. Dueholm. 1983. A mathematical model of indoor air pollution due to formaldehyde from urea-formaldehyde glued particle boards. Atmospheric Environment 17(10): 2105-2108. [A, F]

Investigator: Aarhus University and the Technology Institute, Denmark
Sponsor: Danish Technical Research Foundation
Pollutants Measured: formaldehyde
Pollutant Sources: glued particle boards
Premises: new home
Geographical Location: Aarhus, Denmark
Season: NA
Ventilation Rates: 0.6-2.3 ach

Major Findings: A mathematical model is presented for emissions of formaldehyde from particle board. The authors found agreement of ±15 percent between actual measurements and calculations based on the model. Confounding factors, such as painting and carpeting are not taken into account. The model may be suitable for classifying particle boards according to their emission of formaldehyde.

IV. MODELING

D. Ozone

140. Mueller, F., L. Loeb, and W. H. Mapes. 1973. Decomposition rates of ozone in living areas. Environmental Science & Technology 7:342-346. [A, F]

Investigator: General Electric, Louisville, KY
Sponsor: General Electric
Pollutants Measured: ozone
Pollutant Sources: controlled ozone generators
Premises: various
Geographical Location: Louisville, KY
Season: NA
Ventilation Rates: NA

Major Findings: The decomposition rate of ozone was monitored in several metal test facilities, an office, and a residential structure. The decomposition of ozone in the living areas followed first-order kinetics. The rate of ozone decay is dependent on variation in temperature, relative humidity, prior exposure to metal surfaces, and the number of potentially active catalytic surfaces in the room.

141. Sutton, D. J., K. M. Nodolf, and K. K. Makino. 1976. Predicting ozone concentrations in residential structures. ASHRAE Journal 18(9):21-26. [A, F]

Investigator: Honeywell, Inc. Minneapolis, MN
Sponsor: Honeywell, Inc.
Pollutants Measured: ozone
Pollutant Sources: electronic air cleaners
Premises: homes
Geographical Location: various
Season: NA
Ventilation Rates: NA

Major Findings: A model was developed for predicting ozone concentrations in closed residential structures, both with and without electronic air cleaners. Predicted ozone concentrations are compared to actual field measurements in several geographical areas. Over the normal range of outdoor ozone concentrations, the indoor ozone concentrations of the closed residences were significantly lower than the outdoor ozone concentration.

V. GENERAL REVIEWS: INDOOR AIR QUALITY

A. Treatises

142. Benson, F. B., J. B. Henderson, and D. E. Caldwell. 1972. Indoor-Outdoor Air Pollution Relationships: A Literature Review. Research Triangle Park, NC: U.S. Environmental Protection Agency, National Environmental Research Center.

Summary: This was the first major attempt to summarize what was known about indoor-outdoor relationships. SO_2, CO, CO_2 particulates, and biological pollutants are reviewed. Factors that affect indoor concentrations are discussed. Among the important conclusions is the idea that for nonbiological pollutants, outdoor concentration is the major factor determining indoor concentration.

143. Meyer, B. 1982. Indoor Air Quality. Reading, MA: Addison-Wesley.

Summary: This book provides an interdisciplinary introduction to the subject. Topics covered include a historical perspective on indoor air quality, a discussion of specific indoor air pollutants, methods of monitoring and analysis, health effects, control techniques and regulations. References and a bibliography are included.

144. National Academy of Science. 1981. Indoor Pollutants. Washington, D.C.: National Academy Press.

Summary: This report was prepared at the request of the Environmental Protection Agency, by the Committee on Indoor Pollutants, appointed by the National Research Council. The report represents an enormous undertaking: to review, compile, and appraise knowledge of indoor air pollution. By its scope and sheer volume, the work must be considered as defining the state-of-the-art at the time of its publication.

145. Wadden, R. A., and P. A. Scheff. 1983. Indoor Air Pollution. New York: John Wiley & Sons.

Summary: This book is organized into four parts: characterization, prediction, control, and application. It presents a brief overview of indoor pollutant sources, measurement techniques, and health effects criteria. The use of mathematical models to predict indoor concentration levels receives the most extensive treatment. References are arranged by chapter and are current through 1981.

A. Treatises
(continued)

146. Walsh, P. J., C. S. Dudney, and E. D. Copenhaver, eds. 1983. Indoor Air Quality. Boca Raton, FL: CRC Press.

Summary: This volume is an edited work with ten chapters by different authors writing in their area of expertise. The subject areas covered by the book are limited, but each topic is treated fully. The book is divided into four sections: (1) introduction, (2) generic aspects (measurement techniques and health risk asessment), (3) phenomenological aspects (indoor air quality in residences, indoor air quality in energy efficient residences, and building-associated epidemics), and (4) pollutant-specific aspects (formaldehyde, radon, ambient tobacco smoke, and allergens/pathogens).

V. GENERAL REVIEWS: INDOOR AIR QUALITY

B. Bibliographies

147. Geomet, Incorporated. 1979. Indoor-Outdoor Pollution Levels: A Bibliography. Palo Alto, CA. Electric Power Research Institute.

Summary: This report presents an extensive annotated bibliography of publications and research pertaining to indoor air pollution. Citations are arranged alphabetically by principal author and are current through 1978. Each listed paper was reviewed to provide an abstract. Indices by subject and by author are provided.

148. Henderson, J. J., F. B. Benson, and D. E. Caldwell. 1973. Indoor-Outdoor Air Pollution Relationships: Volume II, An Annotated Bibliography. Springfield, VA: National Technical Information Service, U.S. Dept. of Commerce.

Summary: This report presents a bibliography of publications related to indoor-outdoor air pollution. One hundred and seven early (prior to 1973) works are included, arranged alphabetically. Indexing by author, subject, and title is provided.

149. Lepman, S. R., M. L. Boegel, and C. D. Hollowell. 1981. Radon: A Bibliography. Springfield, VA: National Technical Information Service, U.S Department of Commerce.

Summary: This report presents a bibliography of radon-related research. Citations are arranged alphabetically by principal author; author abstracts are included where available. Entries are current through 1980. No indexing of citations is provided. The bibliography represents citations contained in computerized database (VIAQ).

5.0 ADDITIONAL CITATIONS

Section 5.0 contains a list of citations to significant earlier studies (dated before 1980) and a few recent studies. These have been arranged by subject following the same organization as the Annotated Bibliography. No annotation is provided, but the articles were reviewed and classified according to the primary objective of the research.

ADDITIONAL CITATIONS

I. Characterization and Measurement

A1. Aerosols: Indoor aerosols

Bridge, D. P., and Corn, M. October 29, 1971. Contribution to the Assessment of Exposure of Nonsmokers to Air Pollution from Cigarette and Cigar Smoke in Occupied Spaces. Environmental Research Vol. 5:192-209.

Davies, J. E., Edmundson, W. F., and Raffonelli, A. 1975. The Role of House Dust in Human DDT Pollution. American Journal of Public Health Vol. 65(1):53-57.

Hinds, W. C., and First, M. W. April 17, 1975. Concentrations of Nicotine and Tobacco Smoke in Public Places. The New England Journal of Medicine Vol. 292:844-845.

Lum, R. M. and Graedel, T. E. 1973. Measurements and Models of Indoor Aerosol Size Spectra. Atmospheric Environment Vol. 7:827-842.

A2. Aerosols: Tobacco smoke

Corn, M. 1974. Characteristics of Tobacco Sidestream Smoke and Factors Influencing its Concentration and Distribution in Occupied Spaces. Scandanavian Journal of Respiratory Disease Supl. Vol. 91:20-36.

Hoegg, U. R. October 1972. Cigarette Smoke in Closed Spaces. Environmental Health Perspectives Vol. 2:117-128.

Johnson, W. R., Hale, R. W., Nedlock, J. W., Grubbs, H. J., and Powell, D. H. 1973. The Distribution of Products Between Mainstream and Sidestream Smoke. Tobacco Science Vol. XVII: 141-144.

Murphy, R. L., Levine, B. W., Bazzaz, F. J. A., Lynch, J. J., and Burgess, W. A. 1971. Floor Tile Installation as a Source of Asbestos Exposure. American Review of Respiratory Disease Vol. 104:576-580.

A3. Aerosols: Asbestos

Langer, A. M. December 1974. Approaches and Constraints to Identification and Quantitation of Asbestos Fibers. Environmental Health Perspectives Vol. 9:133-136.

I. Characterization and Measurement

A3. Aerosols: Asbestos

Pooley, F. D. 1975. The Identification of Asbestos Dust with an Electron Microscope Microprobe Analyser. Ann. Occupational Hygiene Vol. 18:181-186.

Rohl, A. N., Langer, A. M., Selikoff, I. J., and Nicholson, W. J. August 15, 1975. Exposure to Asbestos in the Use of Consumer Spackling, Patching, and Taping Compounds. Science Vol. 189:551-553.

Sawyer, R. N. 1977. Asbestos Exosure in a Yale Building. Environmental Research Vol. 13:146-169.

A4. Fibrous glass and mineral wool

Esmen, N. A., Hammad, Y. Y., Corn, M., Whittier, D., Kotsko, N., Haller, M., and Kahn, R. 1978. Exposure of Employees to Man-Made Mineral Fibers: Mineral Wool Production. Environmental Research Vol. 15:262-277.

Fowler, D. P., Balzer, J. L., and Cooper, W. C. 1971. Exposure of Insulation Workers to Airborne Fibrous Glass. American Industrial Hygiene Association Journal Vol. 32:86-91.

A5. Aerosols: Fibrous glass and mineral wool

Couch, R. B. December 1981. Viruses and Indoor Air Pollution. Bulletin of New York Academy of Medicine. Vol. 57(10):907-921.

B1. Indoor-Outdoor Relationships: Fixed site

Andersen, I. 1972. Relationships Between Outdoor and Indoor Air Pollution. Atmospheric Environment Vol. 6:275-278.

Biersteker, K., De Graaf, H., and Nass, C. A. G. 1965. Indoor Air Pollution in Rotterdam Homes. International Journal of Air and Water Pollution Vol. 9:343-350.

Derham, R. L., Peterson, G., Sabersky, R. H., and Shair, F. H. February 2, 1974. On the Relation Between the Indoor and Outdoor Concentrations of Nitrogen Oxides. Journal of the Air Pollution Control Association Vol. 24(2):158-161.

Moschandreas, D. J., Winchester, J. W., Nelson, J. W., and Burton, R. M. 1979. Fine Particle Residential Indoor Air Pollution. Atmospheric Environment Vol. 13:1413-1418.

I. Characterization and Measurement

B1. Indoor-Outdoor Relationships: Fixed site

Sabersky, R. H., Sinema, D. A., and Shair, F. H. April 1973. Concentrations, Decay Rates, and Removal of Ozone and Their Relation to Establishing Clean Indoor Air. *Environmental Science and Technology* Vol. 7(4):347-353.

Spedding, D. J. 1973. Relationships Between Outdoor and Indoor Air Pollution. *Atmospheric Environment* Vol. 7:275-278.

Spengler, J. D., Ferris, B. G., Jr., Dockery, D. W., and Speizer, F. E. 1979. Sulfur Dioxide and Nitrogen Dioxide Levels Inside and Outside Homes and the Implications on Health Effects Research. *Environmental Science and Technology* Vol. 13:1276-1280.

Thompson, C. R., Hensel, E. G., and Kats, G. October 1973. Outdoor-Indoor Levels of Six Air Pollutants. *Journal of the Air Pollution Control Association* Vol. 23(10):881-886.

C1. Gaseous Pollutants: Inorganics (also CO, CO_2)

Allen, R. J., Wadden, R. A., and Ross, E. D. June 1978. Characterization of Potential Indoor Sources of Ozone. *American Industrial Hygiene Association Journal* Vol. 39: 466-471.

Foote, R. S. August 11, 1972. Mercury Vapor Concentrations Inside Buildings. *Science* Vol. 177:513-514.

Mazur, J. F., Bamberger, R. L., Podolak, G. E., and Esposito, G. G. September 1978. Development and Evaluation of an Ammonia Dosimeter. *American Industrial Hygiene Association Journal* Vol. 39:749-753.

Palmes, E. D., and Gunnison, A. F. February 1973. Personal Monitoring Device for Gaseous Contaminants. *American Industrial Hygiene Association Journal* Vol. 34:78-81.

Palmes, E. D., Gunnison, A. F., DiMattio, J., and Tomczyk, C. October 1976. Personal Sampler for Nitrogen Dioxide. *American Industrial Hygiene Association Journal* Vol. 37: 570-591.

Palmes, E. D., Tomczyk, C., and DiMattio, J. 1977. Average NO_2 Concentrations in Dwellings with Gas or Electric Stoves. *Atmospheric Environment* Vol. 11:869-872.

I. Characterization and Measurement

C1. Gaseous Pollutants: Inorganics (also CO, CO_2)

Rench, J. D., and Savage, E. P. September/October 1976. Carbon Monoxide in the Home Environment. Journal of Environmental Health Vol. 39:104-106.

Wade, W. A., Cote, W., and Yocom, J. E. September 1975. A Study of Indoor Air Quality. JAPCA Vol. 25(9):933-939.

Walsh, M., Black, A., Morgan, A., and Crawshaw, G. H. 1977. Sorption of SO_2 by Typical Indoor Surfaces Including Wool Carpets, Wallpaper and Paint. Atmospheric Environment Vol. 11:1107-1111.

Wright, G. R., Jewczyk, S., Onrot, J., Tomlinson, P., and Shephard, R. J. March 1975. Carbon Monoxide in the Urban Atmosphere. Arch. Environmental Health Vol. 30:123-129.

C2. Gaseous Pollutants: Organics (not CO, CO_2)

Bamberger, R. L., Esposito, G. G., Jacobs, B. W., Podolak, G. E., and Mazur, J. F. September 1978. A New Personal Sampler for Organic Vapors. American Industrial Hygiene Association Journal Vol. 39:701-708.

Nelms, L. H., Reiszner, K. D., and West, P. W. June 1977. Personal Vinyl Chloride Monitoring Device with Permeation Technique for Sampling. Analytical Chemistry Vol. 49(7): 994-998.

D. Radon

Cliff, K. D. 1978. Assessment of Airborne Radon Daughter Concentrations in Dwellings in Great Britain. Phys. Medical Biolgy Vol. 23(4):696-711.

Holub, R. F., and Droullard, R. F. April 1979. The Reduction of Airborne Radon Daughter Concentration by Plateout on an Air Mixing Fan. Health Physics Vol. 36:497-504.

Kotrappa, P., Bhanti, D. P., and Jha, G. June 1979. Measurement of Specific Alpha Radioactivity with Respect to Size for Uranium Ore Dust Using Aerosol Centrifuge. Health Physics Vol. 36:738-740.

Lloyd, R. D. 1976. Gamma-Ray Emitters in Concrete. Health Physics Vol. 31:71-73.

I. Characterization and Measurement

D. Radon

Raabe, O. G. 1969. Concerning the Interactions that Occur Between Radon Decay Products and Aerosols. Health Physics Vol. 17:177-185.

Raghunath, B. and Kotrappa, P. 1979. Diffusion Coefficients of Decay Products of Radon and Thoron. Aerosol Science Vol. 10:133-138.

Roessler, C. E., Smith, Z. A., Bolch, W. E., and Prince, R. J September 1979. Uranium and Radium-226 in Florida Phosphate Materials. Health Physics Vol. 37:269-277.

Rundo, J., Markun, F., and Plondke, N. J. 1979. Observation of High Concentrations of Radon in Certain Houses. Health Physics Vol. 36:729-730.

Thomas, J. W., and Countess, R. J. June 1979. Continuous Radon Monitor. Health Physics Vol. 36:734-737.

E. Consumer Products

Leary, J. S., Keane, W. T., Fontenot, C., Feichtmeir, E. F., Schultz, D., Koos, B. A., Hirsch, L., Lavor, E. M., Roan, C. C., and Hine, C. H. December 1974. Safety Evaluation in the Home of Polyvinyl Chloride Resin Strip Containing Dichlorvos (DDVP). Arch. Environmental Health Vol. 29: 308-314.

Taylor, C. G. May 1965. The Loss of Mercury from Fungicidal Paints. Journal of Applied Chemistry Vol. 15:232-236.

II. Control

A. Air-Purifying Methods

Golovoy, A., and Braslaw, J, August 1981. Adsorption of Automotive Paint Solvents on Activated Carbon: I. Equilibrium Adsorption of Single Vapors. JAPCA Vol. 31(8):861-865.

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II. Control

B. Ventilation

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Nevins, R. G., and Miller, P. L. 1972. Analysis, Evaluation and Comparison of Room Air Distribution Performance - A Summary. ASHRAE Trans. Vol. 78:235-243.

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Woods, J. E. 1979. Ventilation, Health and Energy Consumption: A Status Report. ASHRAE Journal Vol. 21(7): 23-27.

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D. Miscellaneous

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II. Control

D. Miscellaneous

Tamura, G. T. 1975. Measurement of Air Leakage Characteristics of House Enclosures. ASHRAE Trans. Vol. 81(1):202-211.

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Yates, M. W. March-April 1967. A Preliminary Study of Carbon Monoxide Gas in the Home. Journal of Environmental Health Vol. 29(5):413-420.

IV. Modeling

A. General Models

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6.0 CONTACT SUMMARIES

Telephone contacts were made with 23 organizations considered active in indoor air quality research. The following section documents these contacts and summarizes the information that was obtained. The information includes the name of the investigator, the project sponsor, project title, and a general description and categorization of the research. Separate contact summaries are provided for each project, thus, a particular organization may have several summaries. Much of this information is included in Table 3-1. Cross-referencing from Table 3-1 to Section 6.0 is provided under the column headed "Investigator and Organization;" the reference "C21", for example, indicates contact summary number 21.

C1

SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL
PHONE: (415) 486-4023
PROJECT TITLE: Passive Instrumentation
SPONSOR: DOE
FUNDING LEVEL:
EFFECTIVE DATES: 1981-1985
DESCRIPTION: Commercially available monitoring devices for NO_2 have been evaluated; passive devices for HCHO, H_2O, and CO have been developed; future plans include development of a monitoring device for CO_2 and simple means for measurement of airborne particulates.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field ___

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ___
   - Monitoring ___
   - Instrument Development ___
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ___
   - Research House ___
   - Other (Specify) ___

   Facility with controlled T, RH, flow rate for passive monitor testing.

5. Pollutants
   - CO ✓
   - CO_2 ✓
   - NO_x ✓
   - SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ✓
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ___
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C2

SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL

PHONE: (415) 489-4023

PROJECT TITLE: Building Materials Emissions

SPONSOR: DOE

FUNDING LEVEL:

EFFECTIVE DATES: 1978-1981, 1983-Ongoing

DESCRIPTION: This is a phased effort designed to examine interior finishes, adhesives, and solvent emissions. Phase I determines the identity of the heavier organics by GC/MS on samples from small chambers. Phase II (planned for FY'84) will use larger chambers to characterize the emission rates as they are influenced by selected environmental variables; Phase III will involve whole building sampling and attempts to relate the results of Phase II with actual building measurements.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ✓

Field ✓

2. Major Sources

3. Area

Characterization ✓

Modeling ✓

Monitoring ✓

Instrument Development ✓

Health Effects ___

Risk Assessment ___

Control Technology ___

4. Special Facilities

Chamber ✓*

Research House ___

Other (Specify) ___

*$30\ m^3$ (stainless) controlled T, RH, ventilation

5. Pollutants

CO ___ CO_2 ___

NO_x ___ SO_2 ___

Radioactivity ___

Formaldehyde ___

Other organics ✓

Asbestos or other fibers ___

Tobacco smoke ___

Respirable particulates/TSP ___

Odor ___

Ozone ___

Airborne Biological ___

Multi-pollutant ___

Ventilation rate (tracer) ✓

Metals ___

Pesticides ___

PCB's ___

Other (Specify) ___

C3

SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL
PHONE: (415) 486-4023
PROJECT TITLE: Numerical Data Base
SPONSOR: DOE/EPRI/GRI
FUNDING LEVEL:
EFFECTIVE DATES: 1984-Ongoing
DESCRIPTION: The objective will be to establish, maintain, archive, and evaluate a data base of field studies that examines indoor air quality in the residential setting. Two important goals are providing public access to this data base and evaluating the quality of the data considered.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ___
2. Major Sources
3. Area
   - Characterization ___
   - Modeling ___
   - Monitoring ___
   - Instrument Development ___
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___
4. Special Facilities
   - Chamber ___
   - Research House ___
   - Other (Specify) ___
5. Pollutants
   - CO ___
   - CO_2 ___
   - NO_x ___
   - SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ___
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C4

SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL
PHONE: (415) 486-4023
PROJECT TITLE: Study of Radon and Progeny
SPONSOR: DOE/OHER/Conservation/BPA
FUNDING LEVEL:
EFFECTIVE DATES: 1978-Ongoing
DESCRIPTION: Instrument development has focused on Rn progeny; new effects will attempt to characterize the national distribution of Rn sources using existing data; the various modes of Rn entry into structures will be examined; and air movement within a single room will be studied in an attempt to understand Rn and progeny removal rates.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory
   - Field

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling
   - Monitoring
   - Instrument Development ✓
   - Health Effects
   - Risk Assessment
   - Control Technology

4. Special Facilities
   - Chamber
   - Research House ✓*
   - Other (Specify)

   *3-room testhouse with remote experimental control

5. Pollutants
   - CO
   - CO_2
   - NO_x
   - SO_2
   - Radioactivity ✓
   - Formaldehyde
   - Other organics
   - Asbestos or other fibers
   - Tobacco smoke
   - Respirable particulates/TSP
   - Odor
   - Ozone
   - Airborne Biological
   - Multi-pollutant
   - Ventilation rate (tracer) ✓
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify)

C5

SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL
PHONE: (415) 486-4023
PROJECT TITLE: Pollutants Emitted by Combustion Appliances
SPONSOR: CPSC/BPA/DOE/OHER
FUNDING LEVEL:
EFFECTIVE DATES: 1976-1985
DESCRIPTION: Previously, gas ranges, ovens, kerosene heaters, unvented gas space heaters and wood stove emissions have been studied. This year two studies are planned: a laboratory study of unvented gas space heaters with O_2 depletion sensors; and a field study of wood stove emissions in two unoccupied homes in Oregon.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ✓
Field ✓

2. Major Sources

3. Area

Characterization ✓
Modeling ✓
Monitoring ✓
Instrument Development
Health Effects
Risk Assessment
Control Technology

4. Special Facilities

Chamber 30 m^3 (gypsum board) ✓
Research House ✓
Other (Specify) ✓
Mobile lab

5. Pollutants

CO ✓
CO_2 ✓
NO_x ✓
SO_2 ✓
Radioactivity
Formaldehyde ✓
Other organics
Asbestos or other fibers
Tobacco smoke
Respirable particulates/TSP ✓
Odor
Ozone
Airborne Biological
Multi-pollutant
Ventilation rate (tracer) ✓
Metals
Pesticides
PCB's
Other (Specify)

C6

SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL
PHONE: (415) 486-4023
PROJECT TITLE: Particulate Behavior and Its Interaction with Rn Progeny
SPONSOR:
FUNDING LEVEL:
EFFECTIVE DATES: 1982-1984
DESCRIPTION: The goal is to examine the interaction of particulate (generated by cigarette smoke) and Rn progeny and their removal techniques. Several commercially available control devices (i.e. filters, precipitators) were evaluated for removal of Rn and progeny.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ✓
   - Monitoring
   - Instrument Development
   - Health Effects
   - Risk Assessment
   - Control Technology ✓

4. Special Facilities
   - Chamber
   - Research House ✓
   - Other (Specify) ✓
   - Particle characterization equipment

5. Pollutants
   - CO
   - CO_2
   - NO_x
   - SO_2
   - Radioactivity ✓
   - Formaldehyde
   - Other organics
   - Asbestos or other fibers
   - Tobacco smoke
   - Respirable particulates/TSP
   - Odor
   - Ozone
   - Airborne Biological
   - Multi-pollutant
   - Ventilation rate (tracer) ✓
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify)

C7

SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL

PHONE: (415) 486-4023

PROJECT TITLE: Indoor Air Quality Control Techniques

SPONSOR:

FUNDING LEVEL:

EFFECTIVE DATES: 1979-1984

DESCRIPTION: The major focus has been air-to-air heat exhangers. The following research areas will be explored this year: exhaust with heat pump recovery, air washing for HCHO removal, contaminant transfer across heat exhanger cores, examination of methods to monitor the efficiency of ventilation systems, and if time permits NO_2 - surface interactions.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling
   - Monitoring
   - Instrument Development
   - Health Effects
   - Risk Assessment
   - Control Technology ✓

4. Special Facilities
   - Chamber
   - Research House ✓*
   - Other (Specify)

*Test facility to evaluate heat exchangers controlled T, RH, ventilation, and HCHO injection

5. Pollutants
   - CO
   - CO_2
   - NO_x ✓
   - SO_2
   - Radioactivity
   - Formaldehyde ✓
   - Other organics
   - Asbestos or other fibers
   - Tobacco smoke
   - Respirable particulates/TSP
   - Odor
   - Ozone
   - Airborne Biological
   - Multi-pollutant
   - Ventilation rate (tracer) ✓
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify)

C8

SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL

PHONE: (415) 486-4023

PROJECT TITLE: Field Survey of Residential Buildings in the Pacific Northwest

SPONSOR: BPA

FUNDING LEVEL:

EFFECTIVE DATES: 1984-1986

DESCRIPTION: 300 existing houses will be examined; 50 will be chosen for a 3-phase study of the implications of various degrees of retrofit (weatherization) on indoor air quality; air quality will be monitored in 40 commercial buildings (schools and office buildings) as well as 100 residences (50 conventionally built and 50 built to BPA specifications).

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ✓

2. Major Sources

3. Area
   - Characterization ___
   - Modeling ___
   - Monitoring ___
   - Instrument Development ___
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ___
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ✓
   - CO_2 ___
   - NO_x ✓
   - SO_2 ___
   - Radioactivity ✓
   - Formaldehyde ✓
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ✓
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ✓
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C9

SUMMARY OF RESEARCH

INVESTIGATOR: T.G. Mathews, ORNL

PHONE: (615) 574-6248

PROJECT TITLE: Indoor Air Quality Study of Experimental Unoccupied Homes

SPONSOR: DOE

FUNDING LEVEL:

EFFECTIVE DATES: 1/84-Ongoing

DESCRIPTION: The goal of this study is to examine the influence of energy conservation measures on indoor air quality. Three unoccupied research homes of standard construction will be studied.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field ___

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ✓
   - Monitoring ✓
   - Instrument Development ___
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ✓

4. Special Facilities
   - Chamber ___
   - Research House ✓
   - Other (Specify) ___

5. Pollutants
   - CO ___
   - CO_2 ___
   - NO_x ___
   - SO_2 ___
   - Radioactivity ✓
   - Formaldehyde ✓
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ___
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ✓
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C10

SUMMARY OF RESEARCH

INVESTIGATOR: A. Hawthorne, ORNL

PHONE: (615) 574-6246

PROJECT TITLE: Measure Radon and Formaldehyde

SPONSOR: DOE

FUNDING LEVEL: $90,000

EFFECTIVE DATES: 12/83-12/84

DESCRIPTION: Radon and HCHO will be monitored in three high instrumented energy conservation homes. Alternative measures will be examined for reducing pollutant levels.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ___

Field ✓

2. Major Sources

3. Area

Characterization ✓

Modeling ___

Monitoring ✓

Instrument Development ___

Health Effects ___

Risk Assessment ___

Control Technology ✓

4. Special Facilities

Chamber ___

Research House ___

Other (Specify) ___

5. Pollutants

CO ___

CO_2 ___

NO_x ___

SO_2 ___

Radioactivity ✓

Formaldehyde ✓

Other organics ___

Asbestos or other fibers ___

Tobacco smoke ___

Respirable particulates/TSP ___

Odor ___

Ozone ___

Airborne Biological ___

Multi-pollutant ___

Ventilation rate (tracer) ✓

Metals ___

Pesticides ___

PCB's ___

Other (Specify) ___

C11

SUMMARY OF RESEARCH

INVESTIGATOR: A. Hawthorne, ORNL
PHONE: (615) 574-6246
PROJECT TITLE: Volatile Organics in Homes
SPONSOR: CPSC
FUNDING LEVEL: $100,000
EFFECTIVE DATES: 10/82-6/84
DESCRIPTION: The goal is to identify sources of volatile organics from consumer products. Detailed measurements will be performed in approximately eight (8) homes.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ___
Field ✓

2. Major Sources

3. Area

Characterization ✓
Modeling ___
Monitoring ✓
Instrument Development ✓
Health Effects ___
Risk Assessment ___
Control Technology ___

4. Special Facilities

Chamber ___
Research House ___
Other (Specify) ___

5. Pollutants

CO ___ CO_2 ___
NO_x ___ SO_2 ___
Radioactivity ___
Formaldehyde ___
Other organics ✓
Asbestos or other fibers ___
Tobacco smoke ___
Respirable particulates/TSP ___
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ✓
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ___

C12

SUMMARY OF RESEARCH

INVESTIGATOR: A. Hawthorne, ORNL
PHONE: (615) 574-6246
PROJECT TITLE: Indoor Air Quality Study of 40 East Tennessee Homes
SPONSOR: CPSC/DOE
FUNDING LEVEL: $500,000
EFFECTIVE DATES: 1981-1983
DESCRIPTION: Indoor air quality was monitored in 40 East Tennessee homes. When unvented combustion devices were used, elevated CO and NO_2 were observed. Elevated particulate levels were associated with certin phases of operation (e.g. stoking, startup). Levels of HCHO and Rn were measured at concentrations above recommended guidelines.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory	
Field	✓

2. Major Sources

3. Area

Characterization	✓
Modeling	
Monitoring	✓
Instrument Development	
Health Effects	
Risk Assessment	
Control Technology	

4. Special Facilities

Chamber	
Research House	
Other (Specify)	

5. Pollutants

CO	✓	CO_2	✓
NO_x	✓	SO_2	
Radioactivity			✓
Formaldehyde			✓
Other organics			✓
Asbestos or other fibers			
Tobacco smoke			
Respirable particulates/TSP			✓
Odor			
Ozone			
Airborne Biological			
Multi-pollutant			
Ventilation rate (tracer)			✓
Metals			
Pesticides			
PCB's			
Other (Specify)			

C13

SUMMARY OF RESEARCH

INVESTIGATOR: T.G. Mathews, ORNL
PHONE: (615) 574-6248
PROJECT TITLE: Characterization of HCHO Emission Sources
SPONSOR: CPSC
FUNDING LEVEL:
EFFECTIVE DATES: 1980-Ongoing
DESCRIPTION: This broad study has focused on four areas: vapor monitoring, chamber methods, flux monitor development, and product characterization. The emission characterists of pressed wood products (particle board, plywood paneling, and fiber board), ceiling tiles, urea-formaldehyde foam, and fiberglass have been studied. A field component of this study is planned for this year to relate source strengths and observed concentrations in a field setting.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field ✓

2. Major Sources
   - Pressedwood products

3. Area
   - Characterization ✓
   - Modeling ___
   - Monitoring ✓
   - Instrument Development ✓
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ✓*
   - Research House ✓**
   - Other (Specify) ___

   *3-200L (Teflon-linked)
   **3 houses

5. Pollutants
   - CO ___ CO_2 ___
   - NO_x ___ SO_2 ___
   - Radioactivity ___
   - Formaldehyde ✓
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ___
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C14

SUMMARY OF RESEARCH

INVESTIGATOR: A. Hawthorne, ORNL

PHONE: (615) 574-6246

PROJECT TITLE: Data Analysis of 40 Home Indoor Air Quality Study

SPONSOR: TVA/EPRI

FUNDING LEVEL: $70,000

EFFECTIVE DATES: 1/84-1/85

DESCRIPTION: Evaluate the existing data from the 40 Home study. The study will focus on issues of relevance to TVA's energy conservation program. Additional data will be collected on Rn concentrations; energy use regarding conservation measures employed at the study homes will be evaluated.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ___

Field ✓

2. Major Sources

3. Area

Characterization ___

Modeling ___

Monitoring ✓

Instrument Development ___

Health Effects ___

Risk Assessment ___

Control Technology ___

4. Special Facilities

Chamber ___

Research House ___

Other (Specify) ___

5. Pollutants

CO ___

CO_2 ___

NO_x ___

SO_2 ___

Radioactivity ✓

Formaldehyde ___

Other organics ___

Asbestos or other fibers ___

Tobacco smoke ___

Respirable particulates/TSP ___

Odor ___

Ozone ___

Airborne Biological ___

Multi-pollutant ___

Ventilation rate (tracer) ___

Metals ___

Pesticides ___

PCB's ___

Other (Specify) ___

C15

SUMMARY OF RESEARCH

INVESTIGATOR: E. Knutson, DOE
PHONE: (212) 620-3652
PROJECT TITLE: Assessment of Radioactive and Chemically Active Air Contaminants
SPONSOR: DOE
FUNDING LEVEL: $1.5 million/year
EFFECTIVE DATES:
DESCRIPTION: This work focuses on Rn and progeny. Samplers and analyses are provided to state agencies in the Northeast to support characterization studies. Approximately 150-200 homes are involved. A calibration facility for measurement of Rn and Rn progeny is maintained. Efforts are also underway to upgrade, develope, and evaluate measurement methods for these materials.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory	✓
Field	✓

2. Major Sources

3. Area

Characterization	✓
Modeling	___
Monitoring	✓
Instrument Development	✓
Health Effects	___
Risk Assessment	___
Control Technology	___

4. Special Facilities

Chamber	✓*
Research House	___
Other (Specify)	✓

Special equipment for Rn
*$20m^3$ T & RH control

5. Pollutants

CO	___	CO_2	___
NO_x	___	SO_2	___
Radioactivity			✓
Formaldehyde			___
Other organics			___
Asbestos or other fibers			___
Tobacco smoke			___
Respirable particulates/TSP			___
Odor			___
Ozone			___
Airborne Biological			___
Multi-pollutant			___
Ventilation rate (tracer)			___
Metals			___
Pesticides			___
PCB's			___
Other (Specify)			___

C16

SUMMARY OF RESEARCH

INVESTIGATOR: J. Rundo, Argonne

PHONE: (312) 972-4156

PROJECT TITLE: Assessment of Natural Rn and Progeny in Single Family Houses

SPONSOR: DOE

FUNDING LEVEL: $1 million per year

EFFECTIVE DATES: 1978-Ongoing

DESCRIPTION: Argonne has examined a few houses to quantify equilibrium between Rn and progeny. They currently have data on approximately 100 houses and are working to expand the base to 1000.

Integrating samplers are being placed with a nonsmoking religious sect in Aberdeen, SD. Argonne has 25 years of experience in measuring Rn.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field ✓

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling
   - Monitoring ✓
   - Instrument Development
   - Health Effects
   - Risk Assessment
   - Control Technology

4. Special Facilities
   - Chamber ✓*
   - Research House
   - Other (Specify)

*6 m^3

5. Pollutants
   - CO
   - CO_2
   - NO_x
   - SO_2
   - Radioactivity ✓
   - Formaldehyde
   - Other organics
   - Asbestos or other fibers
   - Tobacco smoke
   - Respirable particulates/TSP
   - Odor
   - Ozone
   - Airborne Biological
   - Multi-pollutant
   - Ventilation rate (tracer)
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify)

C17

SUMMARY OF RESEARCH

INVESTIGATOR: C. Davidson, Carnegie Mellon University
PHONE: (412) 578-2951
PROJECT TITLE: Energy Performance Monitoring of Inner City Case Study
SPONSOR: DOE
FUNDING LEVEL: $100,000
EFFECTIVE DATES: 1/83-6/84
DESCRIPTION: This study will focus on energy use and air exchange. It will not focus on pollutants, but rather on relating infiltration and meteorological variables. Three (and possibly four) houses will be studied: a research house, a conventional energy efficient house, and an older nonefficient house.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory
   - Field ✓

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ✓
   - Monitoring ✓
   - Instrument Development
   - Health Effects
   - Risk Assessment
   - Control Technology

4. Special Facilities
   - Chamber
   - Research House ✓*
   - Other (Specify)

   Remote computer assisted data acquisition system

   *Controlled vent. rate

5. Pollutants
   - CO
   - CO_2
   - NO_x
   - SO_2
   - Radioactivity
   - Formaldehyde
   - Other organics
   - Asbestos or other fibers
   - Tobacco smoke
   - Respirable particulates/TSP
   - Odor
   - Ozone
   - Airborne Biological
   - Multi-pollutant
   - Ventilation rate (tracer) ✓
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify) ✓

   Meterological variances

C18

SUMMARY OF RESEARCH

INVESTIGATOR: C. Davidson, Carnegie Mellon University
PHONE: (412) 578-2951
PROJECT TITLE: Influence of Building Design and Other Factors on IAQ
SPONSOR: NSF
FUNDING LEVEL: $200,000
EFFECTIVE DATES: 1/83-6/84
DESCRIPTION: Examine the influence of energy conservation measures on indoor air quality and develop predictive models to enhance understanding of source-sink relationships. The study involves onsite measurement of emissions from gas-fired stoves, furnaces, and water heaters.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ✓

2. Major Sources
   - Stoves
   - Furnaces
   - Water heaters

3. Area
   - Characterization ✓
   - Modeling ✓
   - Monitoring ✓
   - Instrument Development ___
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ✓

4. Special Facilities
   - Chamber ___
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ✓
   - CO_2 ___
   - NO_x ✓
   - SO_2 ✓
   - Radioactivity ✓
   - Formaldehyde ✓
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ✓
   - Odor ___
   - Ozone ✓
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ✓
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ✓
     Sulfate
     Pb

C19

SUMMARY OF RESEARCH

INVESTIGATOR: Frank Black, EPA/ESRL
PHONE: (919) 541-3037
PROJECT TITLE: Automotive Emission Test Facility
SPONSOR:
FUNDING LEVEL:
EFFECTIVE DATES: Ongoing
DESCRIPTION: Refrigerated chamber for atmospheric conditioning of vehicles.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ___

2. Major Sources

3. Area
   - Characterization ___
   - Modeling ___
   - Monitoring ___
   - Instrument Development ___
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ✓
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ✓
   - CO_2 ✓
   - NO_x ✓
   - SO_2 ___
   - Radioactivity ___
   - Formaldehyde ✓
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ✓
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ✓
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ✓

   Air leakage

C20

SUMMARY OF RESEARCH

INVESTIGATOR: Edo Pellizzari, Research Triangle Institute
PHONE: (919) 541-6579
PROJECT TITLE: Total Exposure and Assessment Methodology
SPONSOR: EPA
FUNDING LEVEL: $4,697,000
EFFECTIVE DATES: 9/79-9/84
DESCRIPTION: The goal is to assess the personal exposure of people to 21 volatile organic compounds. Home measurements will be made in NJ (560), NC (30), ND (20), LA (175), and PA (75). For the overnight sampling period it has been shown that the indoor/outdoor concentration ratios are consistently above unity. A breath sampler, as well as personal monitors for pesticides and PCB's were developed in this study.

CATEGORIZATION OF RESEARCH

1. Study Type
- Laboratory ___
- Field ___

2. Major Sources

3. Area
- Characterization ✓
- Modeling ___
- Monitoring ✓
- Instrument Development ✓
- Health Effects ___
- Risk Assessment ___
- Control Technology ___

4. Special Facilities
- Chamber ✓
- Research House ___
- Other (Specify) ___

5. Pollutants
- CO ___
- CO_2 ___
- NO_x ___
- SO_2 ___
- Radioactivity ___
- Formaldehyde ✓
- Other organics ✓
- Asbestos or other fibers ___
- Tobacco smoke ___
- Respirable particulates/TSP ___
- Odor ___
- Ozone ___
- Airborne Biological ___
- Multi-pollutant ___
- Ventilation rate (tracer) ___
- Metals ✓
- Pesticides ✓
- PCB's ✓
- Other (Specify) ___

C21

SUMMARY OF RESEARCH

INVESTIGATOR: Edo Pellizzari, Research Triangle Institute
PHONE: (919) 541-6579
PROJECT TITLE: Assess Halogenated Organic Compounds in Man and Environment
SPONSOR: EPA
FUNDING LEVEL: $1,520,000
EFFECTIVE DATES: 11/77-4/83
DESCRIPTION: The goal was to assess the personal exposure of people to halogenated organics. Indoor and outdoor concentrations were monitored in approximately 150 homes in Greensboro, N.C., Baton Rouge, LA, and Houston, TX.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ✓

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ___
   - Monitoring ✓
   - Instrument Development ___
   - Health Effects ✓
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ✓
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ___
   - CO_2 ___
   - NO_x ___
   - SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ___
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ✓
     Halogenated organics

C22

SUMMARY OF RESEARCH

INVESTIGATOR: Edo Pellazzari, Research Triangle Institute

PHONE: (919) 541-6579

PROJECT TITLE: Total Exposure and Assessment Methodology--Indoor Air Study

SPONSOR: EPA

FUNDING LEVEL: $350,000

EFFECTIVE DATES: 3/82-9/84

DESCRIPTION: Three building types were studied: A home for the elderly, a secondary school, and a new office building. The first building was old and had gas heat and stoves in the 199 apartments. Measurements were made outdoors and at 4 to 6 locations indoors. The second building had electric heat and was subjected to the same sampling program. The third building was subjected to a longitudinal study--before and after occupancy. The buildings were characterized and building materials and sources were identified for subsequent chamber studies.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ___
Field ✓

2. Major Sources

3. Area

Characterization ✓
Modeling ✓
Monitoring ✓
Instrument Development ___
Health Effects ___
Risk Assessment ___
Control Technology ___

4. Special Facilities

Chamber ✓
Research House ___
Other (Specify) ___

5. Pollutants

CO ✓
CO_2 ___
NO_x ✓
SO_2 ___
Radioactivity ___
Formaldehyde ✓
Other organics ___
Asbestos or other fibers ___
Tobacco smoke ✓
Respirable particulates/TSP ✓
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ✓
Ventilation rate (tracer) ✓
Metals ✓
Pesticides ✓
PCB's ✓
Other (Specify) ___

C23

SUMMARY OF RESEARCH

INVESTIGATOR: Ty Hartwell, Research Triangle Institute
PHONE: (919) 541-6453
PROJECT TITLE: Study of Personal CO Exposure
SPONSOR: EPA
FUNDING LEVEL: $605,000
EFFECTIVE DATES: 6/82-11/83
DESCRIPTION: The CO exposure of residents of Washington, DC and Denver was studied. The project goals were to develop the study methodology for application to other pollutants and to examine 750 person-days of exposure in each location.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ✓

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ✓
   - Monitoring ✓
   - Instrument Development ✓
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ✓
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ✓
   - CO_2 ___
   - NO_x ___
   - SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ___
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C24

SUMMARY OF RESEARCH

INVESTIGATOR: Linda Shelton, Research Triangle Institute
PHONE: (919) 541-6603
PROJECT TITLE: Monitor In and Around Public Access Buildings
SPONSOR: EPA
FUNDING LEVEL:
EFFECTIVE DATES: 9/83-3/85
DESCRIPTION: Monitoring of the chemical composition of air is being performed in and around eight buildings. A broad range of vapor and particulate organic and inorganic compounds will be monitored. Emission rates will be determined using chamber studies. Models will be selected and applied to relate collected data.

CATEGORIZATION OF RESEARCH

1. Study Type
- Laboratory ✓
- Field ✓

2. Major Sources
- adhesive
- spray insulation
- wall covering
- carpet
- carpet pad
- paints
- disinfectants
- pesticides
- sealants
- plastic lenses
- lamp ballasts

3. Area
- Characterization ✓
- Modeling ✓
- Monitoring ✓
- Instrument Development
- Health Effects
- Risk Assessment
- Control Technology

4. Special Facilities
- Chamber ✓*
- Research House
- Other (Specify) ✓
- Mobile monitoring laboratory

*18 m^3, 3.6 m^3, 700L, 40L

5. Pollutants
- CO ✓
- CO_2
- NO_x ✓
- SO_2
- Radioactivity ✓
- Formaldehyde ✓
- Other organics ✓
- Asbestos or other fibers ✓
- Tobacco smoke
- Respirable particulates/TSP ✓
- Odor
- Ozone
- Airborne Biological
- Multi-pollutant ✓
- Ventilation rate (tracer) ✓
- Metals
- Pesticides
- PCB's
- Other (Specify)

C25

SUMMARY OF RESEARCH

INVESTIGATOR: J. Lodge, Research Triangle Institute
PHONE: (919) 541-6905
PROJECT TITLE: Analysis of Termiticide Air Samples
SPONSOR: USAF
FUNDING LEVEL: $375,000
EFFECTIVE DATES: 2/80-Ongoing
DESCRIPTION: 11,500 samples collected in military housing were analyzed for chlordane, dieldrin, aldrin, and heptachlor. One report entitled "chlordane in Air Force Family Housing: A study of Slad-on-Grade Houses" (USAF OEHL Report 83-129 EH111 DPB) is available. Airborne chlordane levels are unlikely to exceed 5 mg/cubic meter in houses treated prior to construction; post-construction treatment is more likely to result in detectable chlordane in the living space.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ___

2. Major Sources

3. Area
   - Characterization ___
   - Modeling ___
   - Monitoring ✓
   - Instrument Development ___
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ✓
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ___ CO_2 ___
   - NO_x ___ SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ___
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ✓
   - PCB's ___
   - Other (Specify) ___

C26

SUMMARY OF RESEARCH

INVESTIGATOR: M.D. Lebowitz, University of Arizona

PHONE: (602) 626-6379

PROJECT TITLE: Pollutants, Aeroallergens, and Respiratory Diseases

SPONSOR: EPA/NIH

FUNDING LEVEL: Approximately $600,000

EFFECTIVE DATES: 1978-1981

DESCRIPTION: A health effects study was conducted focusing on exposure to CO, O_3, TSP, RSP, pollen, bacilli, fungi, algae, and tobacco smoke. Indoor and outdoor monitoring was conducted for 40 homes; 200 homes were considered in 4 geographic clusters. Acute and chronic respiratory symptoms were considered.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ✓

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ___
   - Monitoring ✓
   - Instrument Development ___
   - Health Effects ✓
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ___
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ✓
   - CO_2 ___
   - NO_x ___
   - SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ✓
   - Respirable particulates/TSP ✓
   - Odor ___
   - Ozone ✓
   - Airborne Biological ✓
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C27

SUMMARY OF RESEARCH

INVESTIGATOR: W.M. Hedley, Monsanto Research

PHONE: (513) 268-3411

PROJECT TITLE: Industrial Hygiene/Control Technology Assessment of Formaldehyde Production Facilities

SPONSOR: NIOSH

FUNDING LEVEL: $630,000

EFFECTIVE DATES: 9/80-9/83

DESCRIPTION: Initially the study was to be a combination workplace - residence worker-exposure study. The final study did not deal with nonoccupational exposure but instead focused on occupational exposure of workers in the formaldehyde industry. Ten preliminary surveys were performed and four detailed surveys were conducted.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory	
Field	✓

2. Major Sources

Formaldehyde manufacturing

3. Area

Characterization	✓
Modeling	
Monitoring	✓
Instrument Development	
Health Effects	
Risk Assessment	
Control Technology	✓

4. Special Facilities

Chamber	
Research House	
Other (Specify)	

5. Pollutants

CO		CO_2	
NO_x		SO_2	
Radioactivity			
Formaldehyde	✓		
Other organics			
Asbestos or other fibers			
Tobacco smoke			
Respirable particulates/TSP			
Odor			
Ozone			
Airborne Biological			
Multi-pollutant			
Ventilation rate (tracer)			
Metals			
Pesticides			
PCB's			
Other (Specify)			

C28

SUMMARY OF RESEARCH

INVESTIGATOR: Ralph Mitchell, Battelle Columbus

PHONE: (614) 424-7441

PROJECT TITLE: Exposure Study for Workers in Electronic Components Manufacturing Industry

SPONSOR: NIOSH

FUNDING LEVEL: $1,150,000 (?)

EFFECTIVE DATES: 1981-1983

DESCRIPTION: A pilot study was conducted in one home monitoring IAQ in the living room and kitchen. Nine workers in Portland, Maine were followed to assess total exposure during the summer of 1982 and the winter of 1982-1983. The following were monitored: SF$_6$ (tracer), NO, NO$_2$, O$_3$, SO$_2$, THC, HCHO, RSP, BaP, Ra, CO, and approximately 10 additional compounds.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ___
Field ✓

2. Major Sources

3. Area

Characterization ✓
Modeling ___
Monitoring ✓
Instrument Development ___
Health Effects ___
Risk Assessment ___
Control Technology ✓

4. Special Facilities

Chamber ✓
Research House ___
Other (Specify) ___

5. Pollutants

CO ✓
CO$_2$ ___
NO$_x$ ✓
SO$_2$ ✓
Radioactivity ✓
Formaldehyde ✓
Other organics ✓
Asbestos or other fibers ___
Tobacco smoke ___
Respirable particulates/TSP ✓
Odor ___
Ozone ✓
Airborne Biological ___
Multi-pollutant ✓
Ventilation rate (tracer) ___
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ___

C29

SUMMARY OF RESEARCH

INVESTIGATOR: J. Spengler, Harvard
PHONE: (617) 732-1255
PROJECT TITLE: Health Effects of Sulfur Oxides and Particulates
SPONSOR: NIEHS/EPRI
FUNDING LEVEL: $500K/yr for first five yrs; $1000K/yr for final four years
EFFECTIVE DATES: 7/74-8/83
DESCRIPTION: The goal is to evaluate the effects of low levels of SO_2 and RSP on the health of humans and to determine the degree of interaction of these pollutants. Six communities have been chosen with high, medium, and low levels of SO_2 and RSP. Random samples of the adult population have been selected for study. A cohort of children has been selected from each community and is being followed prospectively. Monitoring for SO_2, RSP, and NO_2 is conducted indoors and outdoors.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ✓

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ___
   - Monitoring ✓
   - Instrument Development ___
   - Health Effects ✓
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ___
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ___ CO_2 ___
   - NO_x ✓ SO_2 ✓
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ✓
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ✓
   - Metals ✓
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ✓
     Sulfate

C30

SUMMARY OF RESEARCH

INVESTIGATOR: J. Spengler, Harvard
PHONE: (617) 732-1255
PROJECT TITLE: Effects of SO_2 and Respirable Particulates on Health
SPONSOR: NIEHS/EPRI
FUNDING LEVEL: Approximately $1,000,000/yr
EFFECTIVE DATES: 1983-1988
DESCRIPTION: This project is a continuation of the first (six communities) study A new cohort of 1000 children will be identified in each of the cities and followed prospectively. The original cohort of young people will also be followed. Results will be analyzed to determine the differences in health effects associated with the different exposure of the two groups.

CATEGORIZATION OF RESEARCH

1. Study Type
Laboratory ___
Field ✓

2. Major Sources

3. Area
Characterization ✓
Modeling ✓
Monitoring ✓
Instrument Development ✓
Health Effects ✓
Risk Assessment ___
Control Technology ___

4. Special Facilities
Chamber ___
Research House ___
Other (Specify) ___

5. Pollutants
CO ✓ CO_2 ✓
NO_x ✓ SO_2 ___
Radioactivity ✓
Formaldehyde ✓
Other organics ___
Asbestos or other fibers ___
Tobacco smoke ✓
Respirable particulates/TSP ✓
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ✓
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ✓
Humidity

C31

SUMMARY OF RESEARCH

INVESTIGATOR: J. Spengler Harvard
PHONE: (617) 732-1255
PROJECT TITLE: Personal Exposure and Monitoring in the Home.
SPONSOR: GRI
FUNDING LEVEL: $1,300,000
EFFECTIVE DATES: 7/83-12/86
DESCRIPTION: Protocol development and equipment specification currently underway. Current thinking--broad based study maybe 1000 homes. Identify homes for personal exposures, and identify homes for passive and continuous monitoring. Hope to be in the field by end of 1984.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ___
Field ✓

2. Major Sources

3. Area

Characterization ___
Modeling ✓
Monitoring ✓
Instrument Development ___
Health Effects ___
Risk Assessment ___
Control Technology ___

4. Special Facilities

Chamber ___
Research House ___
Other (Specify) ___

5. Pollutants

CO ✓
CO_2 ___
NO_x ✓
SO_2 ___
Radioactivity ___
Formaldehyde ___
Other organics ___
Asbestos or other fibers ___
Tobacco smoke ___
Respirable particulates/TSP ___
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ___
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ___

C32

SUMMARY OF RESEARCH

INVESTIGATOR: B. P. Leaderer, J.B. Pierce Foundation
PHONE: (203) 562-9901
PROJECT TITLE: Emission Factors for Side Steam Tobacco Smoke
SPONSOR: NIEHS
FUNDING LEVEL:
EFFECTIVE DATES: 7/82-7/85
DESCRIPTION: Organic and Inorganic Portion of Gaseous and Particulate Tobacco smoke will be studied.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field ___

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ___
   - Monitoring ___
   - Instrument Development ___
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ✓ *
   - Research House ✓ **
   - Other (Specify) ✓

   Mobile monitors for residence
   (CO, CO_2, O_2, NO, NO_2, SO_2)

   ~~Pollutant generation~~ capabilities for laboratory

   *1-34m^3 Al recirculation 0-100ACH Temp. 1-50° C ± 0.1° C; fresh air 0-20 ACH dew pt. 4-45° C ± 0.2° C

   **3-thermal chambers for physiological research

5. Pollutants
   - CO ___ CO_2 ___
   - NO_x ___ SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ✓
   - Respirable particulates/TSP ___
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C33

SUMMARY OF RESEARCH

INVESTIGATOR: A.J. Stolwijk, J.B. Pierce Foundation

PHONE: (203) 562-9901

PROJECT TITLE: Human Responses to the Indoor Environment (Program Project Grant)

SPONSOR: NIEHS

FUNDING LEVEL:

EFFECTIVE DATES:

DESCRIPTION: Four programs and directors given below:

Characterization of the Thermal Indoor Environment - L. Bergland
Human Responses to the Indoor Thermal Environment - R. Gonzales
Characterization and Modeling of Indoor Contaminants - B. Leaderer
Human Responses to Indoor Air Pollutants - W. Cain

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ___

2. Major Sources

3. Area
   - Characterization ___
   - Modeling ___
   - Monitoring ___
   - Instrument Development ___
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ___
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ___ CO_2 ___
   - NO_x ___ SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ___
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C34

SUMMARY OF RESEARCH

INVESTIGATOR: W. Cain and B. P. Leaderer, J.P Pierce Foundation
PHONE: (203) 562-9901
PROJECT TITLE: Odor Experiments
SPONSOR: NIEHS
FUNDING LEVEL:
EFFECTIVE DATES: 7/82-7/85
DESCRIPTION: Assess the required ventilation rates for smoking versus nonsmoking occupancy Investigate efficacy of fabric filters, precipitators, and sorption beds.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field ___

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ___
   - Monitoring ___
   - Instrument Development ___
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ✓

4. Special Facilities
   - Chamber ✓
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ___
   - CO_2 ___
   - NO_x ___
   - SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ✓
   - Respirable particulates/TSP ___
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C35

SUMMARY OF RESEARCH

INVESTIGATOR: B.P. Leaderer, J.P. Pierce Foundation
PHONE: (203) 562-9901
PROJECT TITLE: Decay of SO_2 and NO_2 on Surfaces
SPONSOR: NIEHS
FUNDING LEVEL:
EFFECTIVE DATES: 7/82-7/85
DESCRIPTION:

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling
   - Monitoring
   - Instrument Development
   - Health Effects
   - Risk Assessment
   - Control Technology

4. Special Facilities
   - Chamber ✓
   - Research House
   - Other (Specify)

5. Pollutants
   - CO
   - CO_2
   - NO_x ✓
   - SO_2 ✓
   - Radioactivity
   - Formaldehyde
   - Other organics
   - Asbestos or other fibers
   - Tobacco smoke
   - Respirable particulates/TSP
   - Odor
   - Ozone
   - Airborne Biological
   - Multi-pollutant
   - Ventilation rate (tracer)
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify)

C36

SUMMARY OF RESEARCH

INVESTIGATOR: B.P. Leaderer, J.B. Pierce Foundation
PHONE: (203) 562-9901
PROJECT TITLE: Comparison of Aerosol Monitors
SPONSOR: NIEHS
FUNDING LEVEL:
EFFECTIVE DATES: 7/82-7/85
DESCRIPTION: The calibration of aerosol monitors compares several portable particulate monitors to filters measurements; the lab will examine particulate loss due to volatilization.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field ___

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ___
   - Monitoring ___
   - Instrument Development ✓
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ✓
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ___
   - CO_2 ___
   - NO_x ___
   - SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ✓
   - Respirable particulates/TSP ✓
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C37

SUMMARY OF RESEARCH

INVESTIGATOR: W. Cain, J.B. Pierce Foundation

PHONE: (203) 562-9901

PROJECT TITLE: Formaldehyde Irritation to Humans

SPONSOR: NIEHS

FUNDING LEVEL:

EFFECTIVE DATES: 7/82-7/85

DESCRIPTION: Investigate the irritation resulting from human exposure to formaldehyde (in chambers).

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ✓

Field

2. Major Sources

3. Area

Characterization ✓

Modeling

Monitoring

Instrument Development

Health Effects ✓

Risk Assessment

Control Technology

4. Special Facilities

Chamber ✓

Research House

Other (Specify)

5. Pollutants

CO

CO_2

NO_x

SO_2

Radioactivity

Formaldehyde ✓

Other organics

Asbestos or other fibers

Tobacco smoke

Respirable particulates/TSP

Odor

Ozone

Airborne Biological

Multi-pollutant

Ventilation rate (tracer)

Metals

Pesticides

PCB's

Other (Specify)

C38

SUMMARY OF RESEARCH

INVESTIGATOR: J.A.J. Stolwijk and B.P Leaderer, J.B. Pierce Foundation

PHONE: (203) 562-9901

PROJECT TITLE: Residential Exposures to NO_2, SO_2 and Formaldehyde

SPONSOR:

FUNDING LEVEL:

EFFECTIVE DATES: 10/82-6/84

DESCRIPTION: Unvented keorsene space heaters, gas appliances and side stream emissions from tobacco smoke were the subjects of an epidemiological study in 350 homes.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ___
Field ✓

2. Major Sources

3. Area

Characterization ✓
Modeling ___
Monitoring ✓
Instrument Development ___
Health Effects ✓
Risk Assessment ___
Control Technology ___

4. Special Facilities

Chamber ___
Research House ___
Other (Specify) ___

5. Pollutants

CO ___ CO_2 ___
NO_x ✓ SO_2 ✓
Radioactivity ___
Formaldehyde ✓
Other organics ✓
Asbestos or other fibers ___
Tobacco smoke ___
Respirable particulates/TSP ___
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ___
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ___

C39

SUMMARY OF RESEARCH

INVESTIGATOR: N. Schackter, J.B. Pierce Foundation
PHONE: (203) 562-9901
PROJECT TITLE: Human Response to SO_2, NO_2 and Formaldehyde
SPONSOR:
FUNDING LEVEL:
EFFECTIVE DATES:
DESCRIPTION: Investigate the effects mainfested by human subjects exposed to SO_2, NO_2, and HCHO

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ✓
Field ___

2. Major Sources

3. Area

Characterization ✓
Modeling ___
Monitoring ___
Instrument Development ___
Health Effects ✓
Risk Assessment ___
Control Technology ___

4. Special Facilities

Chamber ✓
Research House ___
Other (Specify) ___

5. Pollutants

CO ___ CO_2 ___
NO_x ✓ SO_2 ✓
Radioactivity ___
Formaldehyde ✓
Other organics ___
Asbestos or other fibers ___
Tobacco smoke ___
Respirable particulates/TSP ___
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ___
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ___

C40

SUMMARY OF RESEARCH

INVESTIGATOR: R. Maxwell, TVA
PHONE: (205) 386-2767
PROJECT TITLE: Background Study of Radioactivity in 60 Nonslag Homes
SPONSOR:
FUNDING LEVEL:
EFFECTIVE DATES: 1/84-1/85
DESCRIPTION: Phosphate slag, a byproduct from fertilizer, has naturally occuring radioactivity. This material has been used as a filler in some building materials. As a result, TVA conducted a 30 home survey of radioactivity levels in slag and nonslag homes in 1979. Results of this study have prompted the upcoming investigation into the variability of radioactivity in 60 nonslag homes.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory
   - Field ✓

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling
   - Monitoring ✓
   - Instrument Development
   - Health Effects
   - Risk Assessment
   - Control Technology

4. Special Facilities
   - Chamber
   - Research House
   - Other (Specify)

5. Pollutants
   - CO
   - CO_2
   - NO_x
   - SO_2
   - Radioactivity ✓
   - Formaldehyde
   - Other organics
   - Asbestos or other fibers
   - Tobacco smoke
   - Respirable particulates/TSP
   - Odor
   - Ozone
   - Airborne Biological
   - Multi-pollutant
   - Ventilation rate (tracer) ✓
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify)

C41

SUMMARY OF RESEARCH

INVESTIGATOR: R. Imhoff, TVA
PHONE: (205) 386-2788
PROJECT TITLE: Ambient Woodstove Emissions and Indoor Air Quality
SPONSOR: TVA/EPA (Biomass Integrated Environmental Assessment)
FUNDING LEVEL: $20,000
EFFECTIVE DATES: 12/83-6/84
DESCRIPTION: The goal of this project will be to study the impact of a woodstove plume on the indoor air quality of an affected house. Two houses will be involved in this study. The study duration is expected to be two months.

CATEGORIZATION OF RESEARCH

1. Study Type
Laboratory ___
Field ✓

2. Major Sources

3. Area
Characterization ✓
Modeling ✓
Monitoring ✓
Instrument Development ___
Health Effects ___
Risk Assessment ___
Control Technology ___

4. Special Facilities
Chamber ___
Research House ___
Other (Specify) ___

5. Pollutants
CO ___ CO_2 ___
NO_x ___ SO_2 ___
Radioactivity ___
Formaldehyde ___
Other organics ___
Asbestos or other fibers ___
Tobacco smoke ___
Respirable particulates/TSP ✓
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ✓
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ✓
Nephelometer
Trace Elements

C42

SUMMARY OF RESEARCH

INVESTIGATOR: J. Harper, TVA
PHONE: (615) 751-6887
PROJECT TITLE: Effects of Residential Woodburning Stoves on Indoor Air Quality
SPONSOR: TVA-BPA
FUNDING LEVEL: $110,000
EFFECTIVE DATES: 1/83-3/83
DESCRIPTION: Four woodburning stoves were tested in a test house--2 catalytic and 2 noncatalytic stoves. The house has 1200 ft^2 and has 0.3 to 0.5 ach. The following were monitoired: NO$_x$, CO, CO$_2$, TSP & RSP (both indoor and outdoors), and PAH as well as other organics.

CATEGORIZATION OF RESEARCH

1. Study Type
Laboratory ___
Field ___

2. Major Sources
2 noncatalytic stoves
2 catalytic stoves

3. Area
Characterization ✓
Modeling ✓
Monitoring ✓
Instrument Development ___
Health Effects ___
Risk Assessment ___
Control Technology ✓

4. Special Facilities
Chamber ___
Research House ✓*
Other (Specify) ___
*4 test houses

5. Pollutants
CO ✓ CO$_2$ ✓
NO$_x$ ✓ SO$_2$ ___
Radioactivity ___
Formaldehyde ___
Other organics ✓
Asbestos or other fibers ___
Tobacco smoke ___
Respirable particulates/TSP ✓
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ___
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ___

C43

SUMMARY OF RESEARCH

INVESTIGATOR: D. Moschandreas, IITRI

PHONE: (312) 567-4310

PROJECT TITLE: Emissions Rate from Unvented Gas Appliances, Kerosene Heaters, and Cigarette Smoking

SPONSOR: GRI

FUNDING LEVEL:

EFFECTIVE DATES: 1982-1984

DESCRIPTION: Emission rates of various pollutants will be examined from unvented gas appliances, kerosene heaters, and cigarette smoking. In addition chemical reaction, absorption, and adsorption will be studied.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ✓
Field ___

2. Major Sources

3. Area

Characterization ✓
Modeling ✓
Monitoring ✓
Instrument Development ___
Health Effects ___
Risk Assessment ___
Control Technology ✓

4. Special Facilities

Chamber ✓*
Research House ✓**
Other (Specify) ✓
Mobile laboratory - Air Qual, Infil, Odor, Met

*$32m^3$ Al, Temp, RH, Recir, Vent, Human Exposure

**$28m^3$ plywood - control device evaluation chamber

5. Pollutants

CO ✓
CO_2 ___
NO_x ✓
SO_2 ___
Radioactivity ___
Formaldehyde ✓
Other organics ✓
Asbestos or other fibers ___
Tobacco smoke ___
Respirable particulates/TSP ✓
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ___
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ✓
VOC

C44

SUMMARY OF RESEARCH

INVESTIGATOR: D. Moschandreas, IITRI
PHONE: (312) 567-4310
PROJECT TITLE: Odor Studies
SPONSOR: Varied
FUNDING LEVEL:
EFFECTIVE DATES:
DESCRIPTION: Studies of indoor air quality have been performed in response to compliants. The goal is usually to identify the source as well as the chemicals responsible.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ___

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ___
   - Monitoring ___
   - Instrument Development ___
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ___
   - Research House ___
   - Other (Specify) ✓
   - Sensory Laboratory (Odor panel)

5. Pollutants
   - CO ___ CO_2 ___
   - NO_x ___ SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ___
   - Odor ✓
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ___
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ✓
   - VOC

C45

SUMMARY OF RESEARCH

INVESTIGATOR: D. Moschandreas, IITRI
PHONE: (312) 567-4310
PROJECT TITLE: Evaluation of Indoor Particulate Control Devices
SPONSOR: Industry Confidential
FUNDING LEVEL:
EFFECTIVE DATES: 1983-1984
DESCRIPTION:

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ✓
Field

2. Major Sources

3. Area

Characterization
Modeling
Monitoring
Instrument Development
Health Effects
Risk Assessment
Control Technology ✓

4. Special Facilities

Chamber ✓
Research House
Other (Specify)

5. Pollutants

CO
CO_2
NO_x
SO_2
Radioactivity
Formaldehyde
Other organics
Asbestos or other fibers
Tobacco smoke
Respirable particulates/TSP ✓
Odor
Ozone
Airborne Biological ✓
Multi-pollutant
Ventilation rate (tracer)
Metals
Pesticides
PCB's
Other (Specify) ✓
Smoke, Dust, Pollen

C46

SUMMARY OF RESEARCH

INVESTIGATOR: D. Moschandreas, IITRI
PHONE: (312) 567-4310
PROJECT TITLE: Woodstove Emissions of PAH
SPONSOR: Industry Confidential
FUNDING LEVEL:
EFFECTIVE DATES: 1983-1984
DESCRIPTION: Measurements will be conducted in 10 to 15 residences.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ✓

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ___
   - Monitoring ✓
   - Instrument Development ✓
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ___
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ✓ CO_2
   - NO_x ✓ SO_2
   - Radioactivity
   - Formaldehyde
   - Other organics
   - Asbestos or other fibers
   - Tobacco smoke
   - Respirable particulates/TSP
   - Odor
   - Ozone
   - Airborne Biological
   - Multi-pollutant
   - Ventilation rate (tracer)
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify) PAH

C47

SUMMARY OF RESEARCH

INVESTIGATOR: D. Moschandreas, IITRI
PHONE: (312) 567-4310
PROJECT TITLE: Tracer Development
SPONSOR: Inhouse
FUNDING LEVEL:
EFFECTIVE DATES: 1983-1984
DESCRIPTION: To use perfluorcarbon tracer material to determine ventilation rates. Passive samplers will be used in conjunction with GC analysis.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field ___

2. Major Sources

3. Area
   - Characterization ___
   - Modeling ___
   - Monitoring ___
   - Instrument Development ✓
   - Health Effects ___
   - Risk Assessment ___
   - Control Technology ___

4. Special Facilities
   - Chamber ✓
   - Research House ___
   - Other (Specify) ___

5. Pollutants
   - CO ___
   - CO_2 ___
   - NO_x ___
   - SO_2 ___
   - Radioactivity ___
   - Formaldehyde ___
   - Other organics ___
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ___
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ✓
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C48

SUMMARY OF RESEARCH

INVESTIGATOR: N.L. Nagda, Geomet
PHONE: (301) 424-9133
PROJECT TITLE: Exposure to CO
SPONSOR: EPRI
FUNDING LEVEL:
EFFECTIVE DATES: 6/82-12/83
DESCRIPTION: The study goal was to characterize 24-hour exposure of three population subgroups to CO. Exposure was approximately 200 person days. CO levels in microenvironments were quantified and related to total expsoure to housewives, office workers, and construction workers.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ___
Field ✓

2. Major Sources

3. Area

Characterization ✓
Modeling ___
Monitoring ✓
Instrument Development ___
Health Effects ___
Risk Assessment ___
Control Technology ___

4. Special Facilities

Chamber ___
Research House ___
Other (Specify) ___

5. Pollutants

CO ✓ CO_2 ___
NO_x ___ SO_2 ___
Radioactivity ___
Formaldehyde ___
Other organics ___
Asbestos or other fibers ___
Tobacco smoke ___
Respirable particulates/TSP ___
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ___
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ___

C49

SUMMARY OF RESEARCH

INVESTIGATOR: N.L. Nagda, Geomet

PHONE: (301) 424-9133

PROJECT TITLE: Monitoring and Modeling of Energy Use, Infiltration, and IAQ

SPONSOR: EPRI

FUNDING LEVEL:

EFFECTIVE DATES: 8/82-8/84

DESCRIPTION: A controlled study in two unoccupied identical single family homes simulates occupant acitivies. The goal is to describe the fundamental relationships between energy use, infiltration, and indoor air quality. Both single- and multiple-zone models are used. The following are monitored as a function of ambient conditions, season, heat exchange, and HVAC: CO, NO_2, IP, RN, RN progeny, HCHO, SF_6 (tracer), and energy consumption.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ✓

Field ✓

2. Major Sources

Domestic

Particle board

Gas stove

Woodstove

3. Area

Characterization ✓

Modeling ✓

Monitoring ✓

Instrument Development ___

Health Effects ___

Risk Assessment ___

Control Technology ✓

4. Special Facilities

Chamber ___

Research House ✓*

Other (Specify) ✓

Mobile Lab

*2-325 m^3

5. Pollutants

CO ✓ CO_2 ___

NO_x ✓ SO_2 ___

Radioactivity ✓

Formaldehyde ✓

Other organics ___

Asbestos or other fibers ___

Tobacco smoke ___

Respirable particulates/TSP ✓

Odor ___

Ozone ___

Airborne Biological ___

Multi-pollutant ___

Ventilation rate (tracer) ✓

Metals ___

Pesticides ___

PCB's ___

Other (Specify) ___

C50

SUMMARY OF RESEARCH

INVESTIGATOR: N.L. Nagda, Geomet
PHONE: (301) 424-9133
PROJECT TITLE: Exposure to Respirable Particulates
SPONSOR:
FUNDING LEVEL:
EFFECTIVE DATES: 11/83-5/84
DESCRIPTION: Evaluate current techniques for measuring respirable particulates in microenvironments.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field ✓
2. Major Sources
3. Area
   - Characterization
   - Modeling
   - Monitoring ✓
   - Instrument Development ✓
   - Health Effects
   - Risk Assessment
   - Control Technology
4. Special Facilities
   - Chamber
   - Research House ✓
   - Other (Specify) ✓
   - Mobile Lab - Ra, Criteria Pollutant, SF_6 (tracer)
5. Pollutants
   - CO
   - CO_2
   - NO_x
   - SO_2
   - Radioactivity
   - Formaldehyde
   - Other organics
   - Asbestos or other fibers
   - Tobacco smoke
   - Respirable particulates/TSP ✓
   - Odor
   - Ozone
   - Airborne Biological
   - Multi-pollutant
   - Ventilation rate (tracer)
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify)

C51

SUMMARY OF RESEARCH

INVESTIGATOR: R.A. Wadden, School of Public Health, Univ. of Illinois

PHONE: (312) 996-0810

PROJECT TITLE: Indoor Air Pollution Research

SPONSOR: Inhouse

FUNDING LEVEL:

EFFECTIVE DATES: 1974-ongoing

DESCRIPTION: Historical work has been comprised of small projects conducted by graduate students. Professors Wadden and Scheff have taught an APCA-sponsored short course in Indoor Air Quality. Their recent book evolved from notes for that class. (R.A. Wadden and P. Scheff. Indoor Air Pollution: Characterization Prediction and Control Wiley Interscience, 1983.)

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field ✓

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ✓
   - Monitoring ✓
   - Instrument Development
   - Health Effects
   - Risk Assessment
   - Control Technology ✓

4. Special Facilities
   - Chamber
   - Research House
   - Other (Specify) ✓
   - EAA, CNC, Nebulizers
   - Standard measurement systems

5. Pollutants
   - CO ✓
   - CO_2 ✓
   - NO_x ✓
   - SO_2 ✓
   - Radioactivity
   - Formaldehyde ✓
   - Other organics ✓
   - Asbestos or other fibers
   - Tobacco smoke ✓
   - Respirable particulates/TSP ✓
   - Odor
   - Ozone ✓
   - Airborne Biological ✓
   - Multi-pollutant
   - Ventilation rate (tracer) ✓
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify)

C52

SUMMARY OF RESEARCH

INVESTIGATOR: D. Zerba, Pacific Power and Light
PHONE: (503) 243-4876
PROJECT TITLE: Residential Ventilation
SPONSOR: PPL (Battelle Northwest is main contractor)
FUNDING LEVEL:
EFFECTIVE DATES: 1980-1985
DESCRIPTION: The main goal is to study ventilation rate in three field houses located in Oregon. The houses range from 1100 to 1500 ft^2: one is conventional; one is energy conserving; and one is a control. The study will last for two years with outdoor meteorological parameters, indoor temperature, and ventilation rate monitored. The houses will be modified for the second year: house 1 will be weatherized; house 2 will have an air to air heat exchanger; and house 3 will go from unoccupied to occupied.

CATEGORIZATION OF RESEARCH

1. Study Type
Laboratory ___
Field ✓

2. Major Sources

3. Area
Characterization ✓
Modeling ___
Monitoring ✓
Instrument Development ___
Health Effects ___
Risk Assessment ___
Control Technology ___

4. Special Facilities
Chamber ___
Research House ___
Other (Specify) ___

5. Pollutants
CO ___
CO_2 ___
NO_x ___
SO_2 ___
Radioactivity ___
Formaldehyde ___
Other organics ___
Asbestos or other fibers ___
Tobacco smoke ___
Respirable particulates/TSP ___
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ✓
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ___

C53

SUMMARY OF RESEARCH

INVESTIGATOR: J. Quackenboss, University of Wisconsin
PHONE: (608) 263-6928
PROJECT TITLE: Weatherization and Indoor Air Quality Study
SPONSOR: Wisconsin Power & Light/cooperation with Harvard Univ.
FUNDING LEVEL: $224,000
EFFECTIVE DATES: 8/82-7/84
DESCRIPTION: Indoor Air Quality is being examined on 50 homes in South Central Wisconsin before and after weatherization. Each home will be sampled 7 times. Seasonal variability will be addressed. Wisconsin Power and Light will determine the extent of retrofit. Passive and active samplers will be involved. An acute symptoms checklist will be maintained by each participant. Questionnaires designed to describe homes, activities and gas equipment use will be employed.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ___
   - Field ✓

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling ✓
   - Monitoring ✓
   - Instrument Development ___
   - Health Effects ✓
   - Risk Assessment ✓
   - Control Technology ___

4. Special Facilities
   - Chamber ___
   - Research House ___
   - Other (Specify) ✓
     Monitoring Module

5. Pollutants
   - CO ✓
   - CO_2 ✓
   - NO_x ✓
   - SO_2 ___
   - Radioactivity ✓
   - Formaldehyde ✓
   - Other organics ✓
   - Asbestos or other fibers ___
   - Tobacco smoke ___
   - Respirable particulates/TSP ✓
   - Odor ___
   - Ozone ___
   - Airborne Biological ___
   - Multi-pollutant ___
   - Ventilation rate (tracer) ✓
   - Metals ___
   - Pesticides ___
   - PCB's ___
   - Other (Specify) ___

C54

SUMMARY OF RESEARCH

INVESTIGATOR: K. Jones, R.F Weston
PHONE: (215) 692-3030
PROJECT TITLE: Indoor Air Quality Study Related to the Use of Kerosene Space Heaters
SPONSOR: National Kerosene Heaters Association and Kerosun
FUNDING LEVEL:
EFFECTIVE DATES: 1/83-3/83
DESCRIPTION: A one month intensive monitoring effort was conducted in a single-family residence to collect data on emissions from a radiant and a convective kerosene heater. Extensive instrumentation including dosimeters and active and passive monitors were employed. The results were evaluated with respect to pollutant exposure and to validate a multi-compartment indoor air quality model.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory	
Field	✓

2. Major Sources

Kerosene heaters

3. Area

Characterization	✓
Modeling	✓
Monitoring	✓
Instrument Development	✓
Health Effects	
Risk Assessment	
Control Technology	✓

4. Special Facilities

Chamber	
Research House	
Other (Specify)	✓

Mobile GC/MS

5. Pollutants

CO	✓	CO_2	✓
NO_x	✓	SO_2	✓
Radioactivity			
Formaldehyde			
Other organics			
Asbestos or other fibers			
Tobacco smoke			
Respirable particulates/TSP	✓		
Odor			
Ozone			
Airborne Biological			
Multi-pollutant			
Ventilation rate (tracer)	✓		
Metals			
Pesticides			
PCB's			
Other (Specify)	✓		

O_2

C55

SUMMARY OF RESEARCH

INVESTIGATOR: G. Adams, Niagara Mohawk

PHONE: (315) 428-6657

PROJECT TITLE: Residential and Commercial Indoor Air Quality

SPONSOR: Niagara Mohawk and NYERDA; Contractor W.S. Fleming

FUNDING LEVEL:

EFFECTIVE DATES: 1/82-12/84

DESCRIPTION: Approximately 40 homes were initially monitored for Ra, CO, CO_2, NO_2, HCHO, and RSP, primarily using passive monitors. Five homes have selected for more intensive continuous monitoring.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory	
Field	✓

2. Major Sources

3. Area

Characterization	✓
Modeling	
Monitoring	✓
Instrument Development	
Health Effects	
Risk Assessment	
Control Technology	

4. Special Facilities

Chamber	
Research House	
Other (Specify)	

5. Pollutants

CO	✓	CO_2	✓
NO_x	✓	SO_2	
Radioactivity			✓
Formaldehyde			✓
Other organics			
Asbestos or other fibers			
Tobacco smoke			
Respirable particulates/TSP			✓
Odor			
Ozone			
Airborne Biological			
Multi-pollutant			
Ventilation rate (tracer)			
Metals			
Pesticides			
PCB's			
Other (Specify)			

C56

SUMMARY OF RESEARCH

INVESTIGATOR: John Yocum, TRC
PHONE: (203) 289-8631
PROJECT TITLE: Evaluation of Indoor Air Quality Data for Making Risk Assessments
SPONSOR: EPRI
FUNDING LEVEL:
EFFECTIVE DATES: 1982-1983
DESCRIPTION: Available information on NO_2, Rn, Tobacco Smoke, and HCHO was examined. Reported results on health effects, exposure, air exchange, pollutant levels, decay, and modeling were examined to determine if a risk assessment can be performed. This work was a cooperative effort between TRC and Harvard. Results suggest that it is unlikely existing data can support a risk assessment.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ___
Field ___

2. Major Sources

3. Area

Characterization ___
Modeling ___
Monitoring ___
Instrument Development ___
Health Effects ___
Risk Assessment ✓
Control Technology ___

4. Special Facilities

Chamber ___
Research House ___
Other (Specify) ___

5. Pollutants

CO ___ CO_2 ___
NO_x ✓ SO_2 ___
Radioactivity ✓
Formaldehyde ✓
Other organics ___
Asbestos or other fibers ___
Tobacco smoke ✓
Respirable particulates/TSP ___
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ___
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ___

C57

SUMMARY OF RESEARCH

INVESTIGATOR: John Yocum, TRC
PHONE: (203) 289-8631
PROJECT TITLE: IAQ Work at TRC
SPONSOR:
FUNDING LEVEL:
EFFECTIVE DATES:
DESCRIPTION: Representative work that has been performed at TRC: characterize emissions from office machines, kerosene heaters, gas stoves, and other combustion sources; did first IAQ work; studied indoor-outdoor relationships; and use a mobile real time mass spectrometer (Trace Atmospheric Gas Analyzer, TAGA) to identify chemical responsible for various "sick building" compliants.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ✓
Field ✓

2. Major Sources

3. Area

Characterization ✓
Modeling
Monitoring ✓
Instrument Development
Health Effects
Risk Assessment ✓
Control Technology

4. Special Facilities

Chamber
Research House
Other (Specify) ✓
TAGA; Standards Lab; Odor Lab

5. Pollutants

CO ✓ CO$_2$ ✓
NO$_x$ ✓ SO$_2$ ✓
Radioactivity
Formaldehyde ✓
Other organics
Asbestos or other fibers ✓
Tobacco smoke ✓
Respirable particulates/TSP ✓
Odor ✓
Ozone ✓
Airborne Biological
Multi-pollutant
Ventilation rate (tracer) ✓
Metals
Pesticides
PCB's
Other (Specify)

C58

SUMMARY OF RESEARCH

INVESTIGATOR: Enno Toomsalu, Underwriters Lab., Inc.
PHONE: (312) 272-8800
PROJECT TITLE: Kerosene Heater Certification
SPONSOR: Various Manufacturer
FUNDING LEVEL:
EFFECTIVE DATES: Ongoing
DESCRIPTION: Duct kerosene heat emissions and sample exhaust measurements. Hundreds of units were tested, and about 90% comply with UL647.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling
   - Monitoring
   - Instrument Development
   - Health Effects
   - Risk Assessment
   - Control Technology

4. Special Facilities
   - Chamber
   - Research House
   - Other (Specify) ✓

5. Pollutants
   - CO ✓
   - CO_2 ✓
   - NO_x
   - SO_2
   - Radioactivity
   - Formaldehyde
   - Other organics
   - Asbestos or other fibers
   - Tobacco smoke
   - Respirable particulates/TSP
   - Odor
   - Ozone
   - Airborne Biological
   - Multi-pollutant
   - Ventilation rate (tracer)
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify)

C59

SUMMARY OF RESEARCH

INVESTIGATOR: Warren Porter, CPSC
PHONE: (301) 245-1445
PROJECT TITLE: Evaluation of Kerosene Heater Emissions
SPONSOR: CPSC
FUNDING LEVEL:
EFFECTIVE DATES: Ongoing
DESCRIPTION: Kerosene heaters were placed in 25 cubic meter test chambers.

CATEGORIZATION OF RESEARCH

1. Study Type
   - Laboratory ✓
   - Field

2. Major Sources

3. Area
   - Characterization ✓
   - Modeling
   - Monitoring
   - Instrument Development
   - Health Effects
   - Risk Assessment
   - Control Technology

4. Special Facilities
   - Chamber ✓
   - Research House
   - Other (Specify)

5. Pollutants
   - CO ✓
   - CO_2 ✓
   - NO_x ✓
   - SO_2 ✓
   - Radioactivity
   - Formaldehyde
   - Other organics ✓
   - Asbestos or other fibers
   - Tobacco smoke
   - Respirable particulates/TSP
   - Odor
   - Ozone
   - Airborne Biological
   - Multi-pollutant
   - Ventilation rate (tracer)
   - Metals
   - Pesticides
   - PCB's
   - Other (Specify)

C60

SUMMARY OF RESEARCH

INVESTIGATOR: Kathy Blair, PFS Corporation

PHONE: (608) 221-3361

PROJECT TITLE: Kerosene Heater Certification

SPONSOR: Various Manufacturer

FUNDING LEVEL:

EFFECTIVE DATES: Ongoing

DESCRIPTION: Duct kerosene heat emissions and sample exhaust measurements. Acceptable units are listed with PFS and carry a seal of approval.

CATEGORIZATION OF RESEARCH

1. Study Type

Laboratory ✓
Field ___

2. Major Sources

3. Area

Characterization ✓
Modeling ___
Monitoring ___
Instrument Development ___
Health Effects ___
Risk Assessment ___
Control Technology ___

4. Special Facilities

Chamber ✓
Research House ___
Other (Specify) ___

5. Pollutants

CO ✓ CO_2 ✓
NO_x ___ SO_2 ___
Radioactivity ___
Formaldehyde ___
Other organics ___
Asbestos or other fibers ___
Tobacco smoke ___
Respirable particulates/TSP ___
Odor ___
Ozone ___
Airborne Biological ___
Multi-pollutant ___
Ventilation rate (tracer) ___
Metals ___
Pesticides ___
PCB's ___
Other (Specify) ___

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16. ABSTRACT The report reviews indoor air quality research in an effort to define the state-of-the-art. Several approaches were taken: (1) about 150 recent journal articles, symposium presentations, and bibliographic reports were reviewed and are presented in an annotated bibliography, arranged by subject; (2) about 30 prominent researchers in indoor air quality were contacted, and contacts are summarized; and (3) significant articles (prior to 1980) were reviewed and are listed in a separate unannotated bibliography. The information in the annotated bibliography and contact summaries is summarized. The report briefly discusses the quality and apparent deficiencies of the reviewed data base of articles, reports, and books.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS		b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group	
Air Pollution	Monitors	Pollution Control	13B	14G
Reviews	Measurement	Stationary Sources	05B	14B
Residential Buildings		Indoor Air Quality	13M	
Air Conditioning			13A	
Ventilation				
Mathematical Modeling			12A	

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