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Report to Congress on Indoor Air Quality

Volume I: Federal Programs Addressing Indoor Air Quality

Issued under Section 403(e), Title IV of the Superfund
Amendments and Reauthorization Act of 1986 (SARA)

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TABLE OF CONTENTS

EXECUTIVE SUMMARY AND RECOMMENDATIONS

VOLUME I: FEDERAL PROGRAMS ADDRESSING INDOOR AIR QUALITY

I. Introduction

A. Purpose.....	1
B. Organization.....	1
C. Background.....	1

II. EPA Indoor Air Activities

A. Policy and Program Development Activities under Title IV..	3
1. Policy Development	
2. Information Dissemination	
3. Coordination	
B. Research and Development Activities under Title IV.....	16
C. EPA Regional Office Activities.....	22
D. Addressing Indoor Air Quality at EPA's Headquarters Complex.....	22
E. Actions to Address Specific Problem Pollutants.....	25
1. Radon.....	25
2. Asbestos.....	37
3. Environmental Tobacco Smoke.....	42
4. Formaldehyde.....	44
5. Chlorinated Solvents.....	45
6. Pesticides.....	46

III. Activities Conducted by other Federal Agencies

A. Consumer Product Safety Commission	48
B. Department of Energy	53
C. Department of Health and Human Services	61
D. General Services Administration.....	68
E. Tennessee Valley Authority	69
F. Occupational Safety and Health Administration	73
G. Department of Transportation.....	74

Appendix

VOLUME II: ASSESSMENT AND CONTROL OF INDOOR AIR POLLUTION

I. Assessing the Health and Economic Impacts of Indoor Air Pollution

Chapter 1. Building Systems & Factors Affecting Indoor Air Quality.....	1-1
Chapter 2. Significant Pollutants, Sources, and Health Effects.....	2-1
Chapter 3. Measuring and Modeling Indoor Air Pollution.....	3-1

Chapter 4. Health Impacts.....	4-1
Chapter 5. Economic Impacts of Indoor Air Pollution.....	5-1

II. Controlling Indoor Air Pollution

Chapter 6. Methods and Strategies of Control.....	6-1
Chapter 7. Existing Indoor Air Quality Standards.....	7-1
Chapter 8. Federal Authorities Applicable to Indoor Air Quality.....	8-1
Chapter 9. Indoor Air Pollution Control Programs.....	9-1
Chapter 10. Indoor Air Quality Policy Issues.....	10-1

VOLUME III: INDOOR AIR POLLUTION RESEARCH NEEDS STATEMENT

I. Overview of Indoor Air Pollution Research Needs

A. Purpose of the Indoor Air Research Program.....	1
B. The Indoor Air Research Setting.....	2
C. Radon.....	4
D. Summary of Research Needs.....	5

II. Research Needs

A. Risk Assessment.....	11
B. Exposure Assessment and Modeling Needs.....	15
C. Source-Specific Needs.....	18
D. Control Techniques.....	35
E. Building System Needs.....	38
F. Crosscutting Research.....	40
G. Technology Transfer.....	41

III. Additional Reading..... 43

VOLUME I: FEDERAL PROGRAMS ADDRESSING INDOOR AIR QUALITY

I. INTRODUCTION

A. PURPOSE

The purpose of this report is to fulfill the requirement of Section 403(e) of the Superfund Amendments and Reauthorization Act of 1986 (SARA) that the Environmental Protection Agency (EPA) submit a report to Congress within two years of enactment describing the activities carried out under Title IV and making appropriate recommendations.

B. ORGANIZATION

The Report consists of several components. This component, **Volume I**, is a description of the activities which have been conducted by various EPA offices within the past two years to address indoor air quality issues as well as similar descriptions from other Federal agencies. This material reflects both those activities explicitly mandated by Title IV as well as ongoing activities which impact indoor air quality. **Volume II** of the report describes the current situation with respect to assessment and control of indoor air pollution in the United States, including information pertaining to the risks of indoor air pollution, the economic impacts of indoor air pollution control methods, a description of current legislative authorities that can be brought to bear on the problem, and State and local government and private sector programs addressing various facets of the indoor air issue. The volume concludes with a discussion of the policy issues to consider in fashioning a comprehensive Federal response to indoor air quality. **Volume III** reflects interagency perceptions of the near and long term research needs which exist to better characterize the range of indoor air quality concerns and identify technologically sound mitigation strategies.

C. BACKGROUND

In 1970, when the Clean Air Act was passed to address the problems of urbanization, industrial development and the increasing use of automobiles, the Act was interpreted as applying only to the air external to structures. As a result, most Federal programs concerned with reducing exposure in enclosed spaces (for example, residences, public or commercial buildings, or transportation vehicles) have singled out only a handful of individual pollutants for action or control under various Federal statutes. To date, no comprehensive legislation to address many of the issues raised by indoor air pollution has been enacted.

In the early 70's, formaldehyde was identified by the Consumer Product Safety Commission as the source of acute irritant reactions and a cancer hazard in individuals whose homes were insulated with urea-formaldehyde foam

insulation (UFFI) or constructed of large amounts of particleboard and/or plywood. Programs to address another major indoor air pollutant -- asbestos -- have been in operation for some time and two major laws have been enacted by Congress to provide loans and grants to schools with severe asbestos hazards and financial need, and to provide a regulatory framework for asbestos control in schools. To date, the primary focus of the asbestos program has been in schools, because the respiratory systems of young children are particularly vulnerable, because of the common use of asbestos materials in schools, and because the long anticipated lives of the student population may provide the 20-40 year latency period in which asbestos-related diseases develop. In the late 1970's and early 1980's, concern over naturally occurring radon began to rise and in 1984, when extremely high levels of radon were found in homes in the Reading Prong geological formation in Pennsylvania, New Jersey, and New York, radon became a major indoor air pollution program.

In the early 1980's, however, research by EPA and others began to demonstrate that for many pollutants, indoor levels were often higher than outdoor levels and that coupled with the extremely high percentage of time spent indoors (approximately 90% for most people), gave rise to increased concern that indoor air pollution may pose higher risks to the population than previously thought.

In 1984, Congress began appropriating approximately \$2 million a year for EPA to conduct indoor air research. However, considerable debate and uncertainty continued among the various federal agencies over the appropriate government role in the indoor air arena.

In 1986, following years of increasing concern over the potential risks to human health of pollutants in indoor environments, Congress enacted Title IV of the Superfund Amendments and Reauthorization Act (SARA) to establish an effective research effort aimed at characterizing the extent of the indoor air pollution problem and to begin to take steps to enhance the quality of the indoor air. Title IV, the Radon Gas and Indoor Air Quality Research Act, for the first time gave EPA clear authority to begin to address indoor air quality problems on a more comprehensive basis. SARA Title IV directs EPA to: 1) conduct research on all facets of the indoor air quality issue; 2) to disseminate information on indoor air quality problems and solutions; 3) to establish two advisory committees to assist EPA in carrying out the mandate of Title IV; and 4) to submit two reports to Congress describing in the first report EPA's plans for implementing Title IV and in the second report, describing the activities carried out under Title IV and making whatever recommendations the Agency deems appropriate.

In June 1987, EPA submitted to Congress the EPA Indoor Air Quality Implementation Plan describing its plans for fulfilling the mandate of SARA Title IV. In that report, EPA described two overall goals in addressing indoor air quality problems: to adequately characterize and understand the risks to human health which pollutants pose in indoor environments and to reduce those risks by reducing exposure to indoor pollutants. The Agency said that it would pursue those goals through the implementation of the following policy objectives:

1. The Agency will conduct research and analysis to further refine its assessment of the nature and magnitude of the health and welfare problems posed by individual air pollutants as well as pollutant mixtures indoors.

2. The Agency will identify and assess the full range of mitigation strategies available to address high priority indoor air problems.

3. For identified high risk, high priority problems, the Agency will adopt and execute appropriate mitigation strategies. These strategies may involve one or more of the following:

- issuing regulations (under existing regulatory authorities (e.g. TSCA, FIFRA, Safe Drinking Water Act);
- building State and local government and private sector capability to address indoor air quality problems through non-regulatory programs of information dissemination, technical assistance, guidance, and training;
- referring problems to other Federal agencies with appropriate statutory authority (e.g. CPSC, HUD);
- requesting separate indoor air regulatory authority from Congress if deemed necessary.

This Report to Congress describes the progress made as EPA seeks to fulfill its obligations under Title IV of SARA.

II. EPA INDOOR AIR ACTIVITIES

As described in the June 1987 Implementation Plan, EPA has for several years been actively involved in pursuing indoor air problems under a variety of statutes, utilizing both regulatory and non-regulatory tools. Many different EPA offices have played and will continue to play significant roles as EPA continues to develop an effective indoor air quality program. This section of the report describes EPA's efforts to develop an effective, coordinated response to indoor air quality issues.

A. POLICY AND PROGRAM DEVELOPMENT ACTIVITIES UNDER TITLE IV

1. Policy Development

Indoor Air Division

In early 1986, the Office of Air and Radiation established a small three person indoor air quality staff to begin to identify and fill the gaps in the Agency's response to human exposures to air pollutants indoors. Since that time, additional staff and financial resources have been allocated to indoor air issues and in September 1988, the indoor air staff was elevated to

Division status as part of an office-wide reorganization. The Indoor Air Division is currently comprised of 6 full time employees whose functions are to:

- Evaluate various policy options and develop a national indoor air quality policy and program;
- Assist in setting the research agenda to ensure that research conducted is policy-relevant;
- Coordinate the indoor air quality activities of the various EPA program offices and to stay abreast of other Federal agencies, State, local and private sector activities addressing various facets of the indoor air quality problem; and
- Develop and disseminate information to the general public, building owners and managers, architects, health care professionals, state and local government agencies, industry, the public interest community, and other interested groups.

Indoor Air Policy Forum

In September 1987, EPA and the National Council for Clean Indoor Air (NCCIA) convened a conference designed to assist EPA in identifying and assessing appropriate options for the Federal government in preventing and abating indoor air pollution. The Forum was attended by over 100 representatives from industry, consumer and health groups, State and Federal agencies, legislators and Congressional staff. The Forum addressed the relative roles of the public and private sectors on five specific issues: (1) sick building syndrome; (2) information and services for homeowners and consumers; (3) ventilation and ventilation efficiency; (4) commercial and consumer product emissions; and (5) indoor air quality standards. A brief summary of the issues and options identified follows.

(1) Policy Options to Address the Problems of "Sick Buildings"

Indoor air quality problems caused at least in part by the way in which buildings are designed and operated pose far more significant problems than had been previously recognized by various levels of government. To date most programs have been directed toward protecting public health from the effects of particular pollutants such as radon, asbestos, or formaldehyde. The effects of building related indoor air quality problems may be felt by both employees and employers. For employees, there is the increased risks of health problems; for the employer, there is the possibility of reduced employee productivity. While no reliable quantification of the incidence of Sick Building Syndrome in the U.S. exists, a committee of the World Health Organization has suggested that up to 30% of new and remodelled buildings may experience indoor air quality problems. These problems may be caused by a number of factors including poor building design, inadequate ventilation, or pollutants emitted from sources inside or originating outside the building.

Conference participants noted that some companies and individuals in the private sector have developed considerable expertise in diagnosing and abating indoor air quality problems in buildings. The challenge for both government and industry, however, is to improve the tools and develop commonly-accepted methods for undertaking these tasks. Some specific needs that were mentioned include better occupant health survey tools, less-expensive monitoring devices, and standardized building investigation procedures. Efforts to improve and standardize these techniques are already underway in many places, including private research facilities, standard-setting organizations, and individual companies, but the task is large and needs active leadership from the Federal government.

Less attention has been paid to preventing indoor air quality problems before buildings are built than has been given to remediating problems after they have occurred in existing buildings. To date attention has therefore generally been directed at identifying design features in existing buildings which may be the cause of indoor air problems. Forum participants noted that while these past efforts can be helpful to architects and builders of new buildings, a systematic method of identifying building design features that can promote indoor air quality is needed.

Options to address "sick buildings" included the following:

- Developing techniques for diagnosing and remediating "sick building syndrome" in existing buildings.
- Identifying building design features which prevent indoor air problems from occurring in new or remodelled buildings.
- Encouraging the development of programs to disseminate information on "sick buildings" to the public.
- Developing model building codes for designing buildings for healthful indoor air quality.
- Developing training programs and model accreditation programs for contractors who do indoor air quality building investigations.
- Using Federal buildings as models for developing and demonstrating techniques that prevent and abate indoor air quality problems.

(2) Policy Options for Providing Information Concerning Indoor Air Quality to Homeowners and Consumers

While limited to only one pollutant and focusing only on residential development to date, EPA's information dissemination program to homeowners concerning risks of radon and the benefits of remediation techniques was widely viewed as evidence of the potential effectiveness of a broader indoor air public information program. Such an information program can stand alone, as it has in the radon case, or it can become part of a regulatory program.

Participants identified three potential information dissemination actions, which are to:

- Establish an indoor air information clearinghouse.
- Develop information to disseminate directly to the public and to others in the public and private sector who also interact with the public.
- Increase the capacity of States to respond to public inquiries and offer indoor air quality services.

(3) Policy Options for Improving Ventilation and Ventilation Efficiency

There was wide agreement among participants at the policy forum that altering ventilation standards and practices should be central to the strategy for controlling and preventing indoor air pollution. Consideration of health should become at least equal, and perhaps paramount, to energy conservation in setting ventilation standards. Ventilation standards could become an effective means of controlling multiple pollutants simultaneously as well as cost effectively.

Forum participants noted that professional standard setting organizations such as the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) have played a valuable role in initiating actions to improve ventilation practices in new and existing buildings. In addition, state and local governments have traditionally controlled building practices through building codes. A significant aspect of any program to improve ventilation practices would include expanded technical assistance to these public and private sector organizations.

The federal government can provide leadership by setting an example in its own buildings. A federal commitment to require improved standards and practices in federally owned or leased buildings would facilitate their adoption in the private sector.

The following options for federal action were identified:

- Encouraging development of protocols for the design, operation, and maintenance of ventilation systems.
- Providing training and technical assistance for building owners and managers on best operating procedures for ventilation systems.
- Working with states to develop certification, licensing, or competency testing procedures for building owners and managers.
- Expanded research to improve ventilation methods and equipment.

(4) Policy Options for Controlling Emissions from Commercial and Consumer Products

Some commercial and consumer products that can cause indoor air pollution are already subject to Federal regulation under a variety of statutes including the Consumer Product Safety Act (CPSA), the Federal Insecticide Fungicide and Rodenticide Act (FIFRA), the Toxic Substances Control Act (TSCA), and other health and environmental statutes. A number of potential Federal policy options to reduce human exposure to emissions from commercial and consumer products were identified by Forum participants. These included:

- Developing standard methods for characterizing emissions from commercial and consumer products and assessing their risk.
- Developing voluntary or mandatory product standards for products that pose risks to public health.
- Developing materials and methods for disseminating information to the public about particular products.

(5) Policy Options Related to Establishment of Indoor Air Pollutant Standards

To protect outdoor air quality, EPA sets and then enforces air quality standards that limit the level of certain pollutants in the air. Conference participants noted that one way to construct an indoor air program is to replicate this process for indoor air. There was some support for following this procedure, at least for a limited number of pollutants.

Some conference participants noted, however, that there are many differences between the problem of achieving healthful air outdoors and indoors which would make an indoor air program that depends on setting regulatory standards for individual pollutants both cumbersome and wasteful. For example, except for the half dozen or so indoor air pollutants for which there are already existing government programs, there is little information about which of the hundreds of pollutants indoors may pose the most serious potential health problems. A program to set and enforce standards for individual pollutants would take years to set up and implement. Finally, remediation techniques such as improved ventilation may provide across-the-board relief against a whole soup of pollutants. Factoring indoor air considerations into building design and operation practices, ventilation standards, and state and local building codes may be a more cost-effective and timely approach to mitigating indoor air health risks than would a pollutant-by-pollutant regulatory program. Such an approach would need to be complemented by regulation of specific known high risk sources and pollutants.

There was a fairly strong consensus among policy forum participants that if indoor air quality standards were set, the government would have to recognize the distinction between private homes and other spaces such as offices and public areas. There was strong opposition to governmental

regulation of activities within private homes. Even in the rare cases where government has required homeowners to take specific actions, such as installing smoke detectors, action is rarely taken to enforce such statutes in cases of noncompliance. There is a long tradition, on the other hand, of health and safety regulation in commercial and public buildings.

Despite the drawbacks of setting up an indoor program that consisted wholly, or in part, of regulatory indoor air quality standards, there was general agreement that the Federal government, through EPA, could play a useful role in informing the public and state and local government policy-makers about the risks of various indoor air pollutants. Given the need for information about individual pollutants, conference participants pointed out the need for information on the health effects that individual pollutants can cause at various concentrations. Some participants also argued that the government should set "target" concentrations, based on health or technological considerations, that would not be standards but would provide goals for prevention and mitigation actions.

Thus, the two options identified were:

- Setting pollutant-by-pollutant regulatory standards.
- Developing guidance on health effects of individual pollutants that the public and private sectors can use as they wish.

Report on Assessment and Control of Indoor Air Pollution

As an appendix to the June 1987 EPA Indoor Air Quality Implementation Plan, the Office of Research and Development prepared a detailed Information Assessment of the available knowledge about the primary sources of indoor air pollution. This document is an important tool for understanding the current state of scientific knowledge about indoor air pollutants and in identifying research gaps and needs. In order to place the information on specific sources and pollutants into context, the Indoor Air Staff initiated an effort to develop a broader review of the indoor air issue from a policy perspective. Volume II of this Report to Congress attempts to provide this overview of the indoor air issue by summarizing the current state of knowledge with respect to:

- The role of building systems in determining indoor air quality;
- The significant indoor air pollution sources, pollutants, and their associated health effects;
- The tools available to measure and model indoor air pollution;
- The risks to health posed by major indoor air pollutants;
- The economic effects of indoor air pollution;
- The methods and strategies available for controlling indoor air quality;
- The existing standards available to address indoor air quality problems;
- The various federal, state, and local government and private sector programs in place to address indoor air quality problems; and

- A description of existing Federal legislation that can be brought to bear on various aspects of indoor air quality.

Survey of Private Sector Diagnostic and Mitigation Services

As recognition of the indoor air pollution issue has increased in the general public, the demand for assistance in diagnosing and mitigating indoor air quality problems in specific residences and buildings has risen. At this juncture, the only Federal agency with extensive experience in investigating problem buildings is the National Institute of Occupational Safety and Health (NIOSH) of the Department of Health and Human Services. Although NIOSH has investigated more than 550 buildings, they are unable to provide services to the vast majority of building owners and managers and have little or no experience in homes, schools, or other special use buildings. State and local governments also have extremely limited capability to respond to requests for assistance from the public. As a result, the private sector is the only practical source of assistance for the public in most situations.

In order to begin to assess the adequacy of the private sector response to indoor air quality problems, EPA recently undertook a survey designed to identify the types of indoor air quality diagnostic and mitigation services available to the public. The voluntary survey was approved by OMB and commenced in August 1988. Through a combination of direct mail to several thousand firms potentially involved in indoor air quality work as well as advertisements in several key newsletters and journals, EPA hopes to develop a comprehensive database of firms that provide these services. A report on the survey effort analyzing the scope of private sector services is under development.

Policy Chapter for Total Exposure Research Strategy

In 1987, a Total Exposure Research Council was formed in response to the Science Advisory Board's recommendation that total exposure research be more fully integrated in the agency's environmental management. The Council was comprised of individuals across the Agency and developed a total human exposure research strategic plan covering both short and long term research needs. Since indoor air pollution constitutes a major element of total human exposure to environmental contaminants, the indoor air program has actively participated in the development of the research strategy.

2. Information Dissemination Activities

As a non-regulatory program, the most critical element of an effective response to indoor air quality problems is the aggressive development and dissemination of information to appropriate audiences on the risks, prevention and mitigation of indoor air problems. EPA's indoor air program has begun to develop a wide range of information materials for both general audiences as well as targeted, more technically-oriented groups. Short descriptions of the information dissemination activities completed or underway by the Indoor Air Division are provided below.

Booklet for the General Public

In an effort to raise public understanding of indoor air quality risks and risk reduction strategies, EPA, in cooperation with the Consumer Product Safety Commission (CPSC) developed The Inside Story: A Guide to Indoor Air Quality, a 32 page booklet on indoor air quality in residences. The booklet, which is now being distributed nationwide, describes the pollutants most commonly found in homes and suggests practical steps which the public can take to reduce their exposure to indoor air pollutants. The booklet also briefly describes indoor air quality problems and solutions in office settings. The booklet's initial print run of approximately 75 thousand copies is being distributed through a variety of channels, including a number of non-profit organizations and trade and industry associations as well as the Consumer Information Center in Pueblo, Colorado.

Directory of State Indoor Air Contacts

At the State level, as in the federal government, responsibility for indoor air quality issues is divided among many different state agencies, including air pollution control boards, health departments and state agriculture, labor, and consumer protection agencies among others. As a result, it is frequently difficult, if not impossible, for the public or others to find the appropriate state contact. The Public Health Foundation (PHF), as part of a cooperative agreement with EPA, was asked to undertake an effort to identify the key state contacts for 16 different issues related to indoor air quality. With the cooperation of a substantial number of organizations and individuals, a Directory of State Indoor Air Contacts was compiled by the PHF and published by EPA to assist the public and individuals in federal, state, and local agencies as well as researchers and others in the private sector.

Indoor Air Fact Sheet Series

In an effort to provide timely information to the public on issues of particular interest, OAR initiated a series of short publications designed to provide readers with a basic understanding of indoor air issues. To date, four such fact sheets have been produced and distributed on the following topics:

- EPA and Indoor Air Quality
- EPA's Indoor Air Quality Implementation Plan
- Ventilation and Air Quality in Offices
- Sick Buildings

OAR intends to continue this series and contemplates future fact sheets on issues such as indoor air quality impacts of combustion devices, the phenomenon of chemical sensitivity, and environmental tobacco smoke (ETS).

Chart of Federal Indoor Air Quality Activities

In March 1988, EPA published a compilation of the indoor air quality projects and activities underway across the Federal government. The publication is called Current Federal Indoor Air Quality Activities. Prepared with the close cooperation of several EPA offices and all of the members of the Interagency Committee on Indoor Air Quality (CIAQ), the publication provides a brief description of each of the projects underway in those agencies, along with the project's status, estimated completion date and the name and telephone number of an appropriate contact. The purpose of the publication is to enhance coordination across the federal establishment, reduce duplication, and provide a directory of federal indoor air quality contacts for interested members of the general public. EPA intends to update the publication at least yearly, and perhaps more frequently, if resources allow.

Indoor Air Quality Training Manual

EPA's Indoor Air Quality Implementation Plan stressed the need to begin to develop state and local government capacity to respond to indoor air quality problems effectively. While the Directory of State Indoor Air Contacts will help facilitate coordination across state agency lines, there is a major need to begin to educate personnel in state and local government agencies on the comprehensive nature of indoor air quality issues. EPA's indoor air program has entered into an interagency agreement with the Public Health Service (PHS) and the National Environmental Health Association (NEHA), to produce a self-paced training manual on indoor air quality for state and local personnel. The training manual will include a companion reference guide and will be designed to introduce state and local personnel to the basic concepts of indoor air quality and begin to prepare them to respond to requests for assistance from the public. The introductory course should be available for distribution in late FY 1989.

Manual on Prevention of Indoor Air Problems in Commercial and Public Buildings

Indoor air quality problems in private residences can often be ameliorated by the actions and choices of the occupants themselves. In contrast, people in the U.S. workforce who spend substantial portions of each day in modern office buildings have far less control over their environments. These environments are controlled in the pre-occupancy phase by the design engineer, architect, and interior designer who design the HVAC and other systems that influence indoor air quality in a structure. The building owner and/or manager plays the major role in the operation and maintenance of the building. As a result, design professionals and building owners and managers are the most critical influences on air quality in public and commercial buildings. A major program is needed to educate these professionals on the implications of various design and operational actions on indoor air quality in terms of occupant health, comfort and productivity.

EPA has begun work on a comprehensive technical manual on the prevention of indoor air quality problems in commercial and public buildings. The manual is being written by a number of indoor air quality experts, including an architect who specializes in indoor air quality issues, a representative of a private sector firm that provides indoor air quality diagnostic services, and an occupational medicine physician. The manual will undergo thorough technical review by a variety of organizations and should be available in 1989.

Environmental Tobacco Smoke Handbook on Workplace Smoking Policies

Both the Surgeon General and the National Research Council (NRC) of the National Academy of Science (NAS) issued reports in 1986 that concluded that exposure of nonsmokers to the second hand smoke from burning tobacco products was a cause of lung cancer in healthy non-smokers and increased the incidence of respiratory illness in the children of smokers. There is a need to provide policy-makers in both government and the private sector with an understanding of both the technical basis for these conclusions as well as a complete understanding of the technical and policy options available for reducing or eliminating the exposures of non-smokers to environmental tobacco smoke in the workplace or public settings.

EPA, in cooperation with the key smoking related agencies of the Department of Health and Human Services, including the Surgeon General's office, the Office of Smoking and Health (OSH), the National Cancer Institute (NCI), the Centers for Disease Control (CDC) and the National Heart, Lung and Blood Institute (NHLBI) has undertaken an effort to develop a manual on the mitigation of environmental tobacco smoke exposures. Technical material has been prepared by approximately a dozen experts on various aspects of environmental tobacco smoke issues. This material will be edited and consolidated into a concise handbook for use by the public and private sectors in making informed choices about the environmental tobacco smoke issue.

3. Coordination

SARA Title IV also mandates a comprehensive effort to coordinate the indoor air activities of various levels of government and the private sector. Both the Office of Research and Development (ORD), which has primary responsibility for implementing the research provisions of SARA Title IV, and the Indoor Air Division conduct a broad range of activities designed to enhance coordination among the diverse government, academic, and private sector interests involved in characterizing indoor air quality problems and identifying and implementing solutions.

Within EPA

EPA has limited authority under several statutes to address indoor air pollution, and several offices within EPA have indoor air related programs and responsibilities. Programs to address specific problem pollutants such as radon and asbestos are located in separate EPA offices as are other programs

with responsibility for regulating toxic chemicals and pesticides, including indoor air exposures. Some of the EPA offices, in addition to the Indoor Air Division and the Office of Research and Development, that administer programs with the most implications for indoor air quality include:

- the Office of Radiation Programs which runs the radon action program;
- the Office of Toxic Substances which runs the asbestos program and which regulates new and commercial substances;
- the Office of Pesticide Programs which regulates pesticides; and
- the Office of Drinking Water which regulates pollutants in drinking water.

One of the responsibilities of the Indoor Air Division within the Office of Air and Radiation is to coordinate the programs within EPA that make policies which affect indoor air quality. The Indoor Air Division implements this coordination function in several ways.

First, materials developed by the Indoor Air Division integrate the multiple pollutants and programs affecting indoor air quality to reflect the multi-pollutant and multi-dimensional nature of the problem. For example, The Inside Story: A Guide to Indoor Air Quality, describes all of the major indoor air pollutants found in homes, including radon and asbestos. Participation in the preparation, review and clearance of materials is requested and received from appropriate offices.

Second, indoor air staff members participate on all Agency workgroups with indoor air exposure implications, including the Radon Management Work Groups and the Integrated Chlorinated Solvents Work Group. This participation led, in the case of the work on chlorinated solvents, to a study evaluating ways for consumers to reduce their exposure to perchloroethylene from dry cleaned clothes. The study was conducted by the Office of Research and Development in its test chambers and test house.

Third, the Indoor Air Division seeks opportunities to add components to ongoing indoor air projects or programs that will yield information on other pollutants and efficiently utilize scarce resources. For example, an 8-home study of radon mitigation techniques that was being conducted by the Office of Research and Development was expanded at the instigation of the Indoor Air Division to assist the Office of Pesticide Programs in obtaining some data on whether or not radon reduction techniques are effective at reducing chlordane levels.

Within the Federal Government

SARA Title IV Section 403 (c) charges EPA with the responsibility for coordinating Federal indoor air activities and specifically requires EPA to set up an advisory committee comprised of Federal agencies. The Interagency

Committee on Indoor Air Quality (CIAQ), created by Congress in 1983, serves as that advisory committee. When the CIAQ was established, it was given the responsibility to: coordinate Federal indoor air quality research; provide liaison and the exchange of information among Federal agencies, with State and local governments, the private sector, the general public, and the research community; and to develop Federal responses to indoor air quality issues.

In 1987, EPA and the other co-chair organizations (the Consumer Product Safety Commission (CPSC), the Department of Energy (DOE), and the Department of Health and Human Services (DHHS) undertook an effort to reevaluate the role and function of the CIAQ and prepared options on a number of structure and operational issues facing the interagency committee. The CIAQ approved an operating paper entitled Structure and Operation of the Interagency Committee on Indoor Air Quality at its January 1988 meeting.

This paper states that EPA, CPSC, DOE, and DHHS will continue to be co-chair agencies and that EPA will take the lead in organizing the CIAQ meetings; that membership is open to all Federal agencies; that there will be four meetings each year; and that CIAQ decisions will be made by consensus of all members, whenever possible, or by voting where consensus is impossible. Between quarterly meetings, the co-chairs are empowered with decision-making authority. Individual agencies reserve full autonomy in decisions about participating in interagency activities and in the use of their own resources. This paper also established a more clearly defined method for creating ad hoc and standing work groups and for disbanding those groups when their work is done.

Some recent CIAQ accomplishments include: 1) the preparation of the publication, Current Federal Indoor Air Quality Activities, 2) the creation of a radon subcommittee that now operates under its own charter; 3) the inclusion of questions in the National Health Assessment and Nutrition Examination Survey (NHANES-III) that may provide important information on the effect of some indoor air sources on health; and 4) interagency participation in the development of the research needs document (presented as Volume III of this Report). In addition, the CIAQ has provided a forum for presentations about current activities by such organizations as the Electric Power Research Institute, the Gas Research Institute, the National Institute of Building Sciences, the Kennedy Institute (in Baltimore), and the EPA Office of Research and Development.

In addition to working through the CIAQ, EPA works with other Federal agencies on specific projects. For example, The Inside Story: A Guide to Indoor Air Quality is the product of a cooperative effort between EPA and CPSC. In addition, EPA and CPSC are now jointly planning a major kerosene heater research study.

EPA also provides assistance to other Federal agencies with indoor air related issues. For example, EPA staff participated on the Department of Transportation committee overseeing an ETS airliner cabin study and commented on GSA's proposed indoor air quality guidelines.

Within the Scientific and Technical Communities

SARA Title IV Section 403 (c) also mandates that EPA form an advisory committee comprised of individuals from the scientific and technical communities, as well as other interested groups. The Indoor Air and Total Human Exposure Panel of the EPA Science Advisory Board serves this advisory function. The panel submitted comments to Congress in November 1988 on EPA's 1987 Indoor Air Quality Implementation Plan.

Another important set of contacts with the scientific and research community consists of EPA participation in the work of various technical organizations. EPA staff serve on the working committees of many organizations, including the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the American Society for Testing Materials (ASTM), the American Industrial Hygiene Association (AIHA), and the Air Pollution Control Association (APCA). Frequently, they also serve on committees that organize technical sessions, such as the annual IAQ conferences sponsored by ASHRAE or the indoor air sessions sponsored by APCA. Staff has also advised several committees of the National Research Council of the National Academy of Sciences and has served on a World Health Organization committee.

Finally, EPA staff members speak at conferences or submit papers to journals. Over the past few years, EPA staff members have had papers accepted in peer-reviewed journals on many topics, including environmental tobacco smoke and methodologies for measuring human exposure to pollutants. EPA has also been actively involved in risk assessment activities carried on outside the Agency. For example, staff participated in a risk assessment forum sponsored by the Harvard School of Public Health in December 1988.

With State and Local Governments

EPA has worked primarily with organizations that represent air pollution control and health agencies, since these are the agencies most likely to have or to develop broad indoor air responsibilities in state and local governments. Materials developed under the information dissemination program are routinely sent to selected state and local officials for review. Indoor Air Division staff consulted with the Association of Local Air Pollution Control Officials (ALAPCO) as it developed its indoor air policy statement. In addition, EPA staff wrote articles on the EPA indoor air program and the research program for a newsletter produced by the Association of State and Territorial Health Officials.

The most important cooperative effort to date with State and local agencies was the development of the Directory of State Indoor Air Contacts. The Public Health Foundation, founded by the Association of State and Territorial Health Officials, produced the directory under a cooperative agreement with EPA. The directory is the first attempt to identify contacts with many types of indoor air related responsibilities in a diverse number of State and local agencies.

Organizations representing state and local officials that assisted the Public Health Foundation in the development of the directory include: the State and Territorial Air Pollution Program Administrators, the Association of Local Air Pollution Control Officials, the National Governors Association, the Association of State and Territorial Health Officials, the Conference of Radiation Control Program Directors, the Association of American Pesticide Control Officials, the National Conference of States on Building Codes and Standards, the Association of State Drinking Water Administrators, and the National Association of State Energy Officials.

With the Private Sector

EPA has undertaken several efforts to involve private sector organizations in the Agency's work on indoor air quality and to support related activities sponsored by private sector organizations. Drafts of publications such as the Indoor Air Fact Sheets and The Inside Story: A Guide to Indoor Air Quality are sent to people in the private sector with expertise for review.

Over the past three years, EPA has cosponsored three indoor air quality conferences with the Consumer Federation of America. These conferences have drawn together hundreds of people with widely different interests and backgrounds. In 1987, EPA cosponsored an indoor air quality Policy Forum with the National Council on Clean Indoor Air (see the section on Policy Development). In 1988, EPA participated in a symposium on the health impacts of indoor air pollution sponsored by the American Lung Association. EPA also provides speakers to dozens of indoor air related conferences and meetings each year.

As these brief descriptions of EPA's coordination and liaison activities indicate, the Indoor Air Division puts a high priority on its responsibility to maintain open communication with other organizations and to support efforts of common interest, where appropriate opportunities and sufficient financial resources exist.

B. RESEARCH AND DEVELOPMENT ACTIVITIES UNDER TITLE IV

Under SARA Title IV, EPA is directed to undertake a comprehensive effort of research and development, including the coordination of government and private efforts, and to disseminate information to the public regarding indoor air control techniques and mitigation measures. The primary objective of ORD's indoor air pollution research program is to gain information in order to reduce exposure to indoor air pollutants known to cause health risks. The first step in achieving this goal is the identification and characterization of the health risks in the indoor environment. Once the risks have been evaluated, exposure reduction techniques must then be evaluated on the basis of their practicality, cost, and effectiveness. In order to reduce indoor air pollutant exposures that pose adverse health risks, EPA must also encourage the active participation of the public, industry, professional associations, and federal, state, and local governments. Technology transfer is an

important part of the research program, and information on some health risks is sufficient to notify the public of the risks and mitigation procedures.

1. Research Management and Coordination

EPA's indoor air research program is a coordinated effort among the four EPA laboratories: the Health Effects Research Laboratory, the Atmospheric Research and Exposure Assessment Laboratory, the Air and Energy Engineering Research Laboratory, and the Environmental Criteria and Assessment Office. In October 1986, EPA established a matrix-managed research program which emphasizes risk assessment for indoor environments; development of indoor pollutant sampling and analysis methodologies; indoor air quality models; materials testing methods; research test house experiments; and investigations of special complaint buildings. The programs current health related research focuses on the effects on children exposed to environmental tobacco smoke; human exposure to emissions from unvented heaters; the neurotoxic effects of mixtures of VOC's often associated with sick building syndrome, risk assessment methodology development, and the effects of biological contaminant exposure.

EPA's indoor air research program supports both the policy needs of EPA's indoor air program division and the technical needs of state and local governments. EPA's researchers also work with other Federal agencies to identify the most important indoor air research needs and to develop a research strategy to address these needs. In a recent meeting sponsored by the National Governors' Association, the following research needs were identified:

- Information on biological contaminants and their effects.
- Protocols for assessment and standardized analysis.
- Guidelines and standards for indoor air quality.
- Assessment of carcinogenicity of pollutants found indoors.
- Evaluation of risks of newly built homes and office buildings.
- Evaluation of the effectiveness of building "bakeout" procedures.
- Information on the maintenance of air handling systems.
- Establishment of a "clearing house" for the receipt and dissemination of information.
- Assessment of the effects of environmental tobacco smoke.

Much of this work is already underway and will be the focus of EPA research in the next few years.

2. Research Activities and Accomplishments to Date

Major accomplishments of EPA's indoor air research program include:

Exposure Assessment and Risk Characterization

Information and Risk Assessment

An information assessment identifying the hazards of indoor environments was completed in 1987 and submitted to Congress as part of EPA's Indoor Air Quality Implementation Plan. The document serves as the first step in a risk assessment in that it provides a preliminary hazard identification of indoor pollutants. The assessment also discusses current monitoring methods and mitigation techniques.

A comprehensive bibliographic database for indoor air pollution has been established by EPA at Research Triangle Park, NC. The citations of all indoor air research publications known to EPA are published twice yearly. The reference bibliography is an ongoing project and is intended to be a complete list of all published information which pertains to indoor air pollution. Health effects, monitoring methods, exposure levels, mitigation techniques, office buildings, and specific individual pollutants are some of the key word categories which can be searched in the bibliography. This project is useful to federal, state, and local agencies; the private sector; and indoor air quality researchers.

A risk assessment methodology is currently being developed to determine the risks of common indoor air pollution scenarios, such as human exposure to environmental tobacco smoke, radon, and the emissions of unvented heaters.

Special Reports

Special reports are currently being prepared on specific indoor air pollution topics. One report, to be completed in the upcoming year, will summarize the current state of knowledge on the prevalence, sources, and effects of biological contaminants (molds, mold spores, mildew, bacteria, viruses, and insect and animal parts and excreta) in the indoor environment. The health effects to be studied include the pathogenicity, allergenic potential, and toxicity of these pollutants. This report will also discuss current sampling methods and review the research needed in this area, such as standardized measurement protocols. The allergenic potential of these pollutants will also be quantified so that a correlation can be made between concentration and disease potential.

Other reports are currently being prepared which address subjects such as odors and the stress and annoyance of odorous compounds and the health consequences of cleaning and maintenance practices in the indoor environment.

Source Characterization and Mitigation

Kerosene Heaters

Recent research, which builds upon previous kerosene heater work by CPSC, has indicated the possibility of adverse health effects from exposure to emissions, in addition to carbon monoxide (CO) and nitrogen dioxide (NO₂), from kerosene and other unvented space heaters. This research has shown that kerosene space heaters are a significant source of indoor fine particles. Modeled emissions data from these sources indicate that indoor particle levels may exceed outdoor standards. In addition, these emissions include high sulfate and acidic ion concentrations. Similar concentrations have been reported to cause pulmonary irritancy in humans. Finally, high concentrations of volatile and semi-volatile organic compounds, some of which appear to be volatilized kerosene fuel, have also been identified. Some of these are highly mutagenic nitro-aromatic compounds. Additional research will be conducted to verify and expand on these preliminary findings.

Small Chambers

Research devoted to characterizing emissions from materials has developed procedures for small chamber testing of emissions from building materials and consumer products. These studies can be used to develop emission characteristics and to provide information on the emission rates and composition of organic vapors over a range of environmental conditions (temperature, humidity, and air exchange rates). In addition, this research will enable the evaluation of different indoor air quality control strategies, e.g., increasing ventilation rates and temperatures during unoccupied periods to increase the off-gassing of pollutants. Materials studied to date have included caulking, floor adhesive, moth repellent, particleboard, wood stain, wood floor wax, polyurethane, dry cleaned fabrics, carpet, and office partitions.

This information has been included in an indoor air source emissions data base maintained by EPA. The data base provides information on different indoor air pollutant sources and their emission characteristics.

Currently EPA is in the process of developing guidelines for the use of small chamber emission testing. It is envisioned that such testing may become a standard method for manufacturers to characterize the emissions from different materials, thereby enabling manufacturers to develop and market low-emitting products.

Test House

Through research in a well-characterized test house, EPA has studied pollutant sources, sinks, and transport in field settings. The research test house has been used to study indoor pollutant concentrations originating from moth crystals, caulking compounds, kerosene heaters, and cleaning solvents from dry cleaning. Future research test house experiments are planned which will make use of the provisions of the Federal Technology Transfer Act to

facilitate cooperation with private industry in the testing of products and indoor air quality control strategies.

Indoor Air Pollutant Control Techniques

Indoor air pollutant control studies have examined the effectiveness of activated carbon for the control of typical indoor concentrations of volatile organic compounds (VOCs) and the generation of ozone from various electrostatic devices. This research indicates that activated carbon devices are ineffective in removing VOCs. The prediction of ozone generation from a wide range of electrostatic air cleaners is the subject of a second study. This study is needed to provide homeowners and building managers the information they need to compare the relative merits of different indoor air control techniques.

Another control study underway evaluates the effectiveness of air cleaners in the removal of indoor particles. Particles arise from many sources and activities, including smoking, cooking, combustion appliances, decay of building materials, and outdoor soil infiltration. Respirable particles can have serious health consequences, including irritation and chronic lung disease. The current study is examining the effectiveness of filters and electrostatic air cleaners to remove small particles.

Monitoring and Models

Measurement Methods

A compendium of indoor air measurement methods has been compiled to assist in the standardization of monitoring methods for indoor pollutants. The methods described include techniques for measuring pollutants in both home and office settings. Monitoring methods have been recommended for VOCs, nicotine, carbon monoxide, carbon dioxide, nitrogen dioxide, formaldehyde, particles, air exchange rates, and pesticides.

Passive samplers and personal monitoring devices have also been a focus of EPA research. Passive samplers are used to make time-integrated measurements of pollutant levels in different indoor environments. Passive samplers are available for radon, formaldehyde, nitrogen dioxide, nicotine, and VOCs. A passive sampler for carbon monoxide is under development. Personal monitors are usually worn by individuals as they go about their daily activities, and are used to measure time-integrated personal exposures. EPA research has emphasized the development of personal monitors for volatile organic compounds, semi-volatile organic compounds, nicotine, respirable particles, and acid aerosols.

Semi-volatile organic compound measurement research has been initiated to develop sampling methods and analysis techniques for these compounds (SVOCs). These compounds are emitted from building materials and are also products of combustion. Some of these compounds are known to be carcinogenic and cause neurotoxic effects. In addition, a sampling method has been developed to measure exposures of VOCs which may result from personal

activities, such as cleaning, painting, and refinishing; combustion sources; and automotive fuels and evaporative emissions.

Indoor Air Quality Modeling

Advances in indoor air quality models have been made through EPA research which built upon work conducted by the Lawrence Berkeley Laboratory. In collaboration with DOE and CPSC, EPA has supported the National Institute of Standards and Technology (NIST, formerly NBS) on the development of an advanced mathematical model to predict indoor air pollution concentrations in large complex buildings. During FY 1989, researchers will enhance the model so that it can be used by building professionals such as architects, engineers, and building managers. EPA has also developed a more simplified indoor air quality model. This model has been validated for a limited range of conditions using the research test home. Both models can evaluate the effects of indoor air pollutant sources, sinks, interzonal air flows, and HVAC systems on indoor air quality, and aid in the development of effective control strategies.

Building Studies and Special Investigations

EPA has undertaken a long-term series of studies of human exposure known generically as the TEAM (Total Exposure Assessment Methodology) Studies. The goal of these studies is to determine the actual exposure of people to volatile organic compounds (VOCs) and pesticides during their normal daily activities. The major finding from the study of VOCs was that in every city studied (both rural and urban), personal exposures and indoor air concentrations exceeded outdoor air concentrations for essentially all of the 15 or so prevalent organics. Although the analysis of the pesticides study has not yet been completed, it is anticipated that one major finding will be that exposure to many of the pesticides are mainly through the indoor environment. Exposures to other pesticides occurs mainly through food intake.

EPA has also measured indoor pollutant concentrations in ten public access buildings, including schools, homes for the elderly, and office buildings. The buildings were not ones in which occupants have complained about indoor air quality and are therefore likely to be fairly representative of other buildings of their type. The results of this research showed that new buildings may have levels of some VOCs that start out as much as 100 times outdoor levels and gradually decrease to 2 to 4 times outdoor levels. Related studies show that building materials including surface coating such as paints and adhesives, vinyl and hard rubber moldings, carpet, and particle board emit in large quantities the same chemicals found at elevated levels in the new buildings. Thus it appears that building materials can cause high concentrations of a number of organic chemicals in new buildings for a period of months.

In addition, along with DOE, NIST, and NIOSH, EPA has initiated an investigation of complaints of indoor air pollution in the Library of Congress Madison building. This study will include a survey of occupants and simultaneous measurements of both pollutant levels and ventilation rates. EPA

will work with the other Federal agencies to characterize the indoor environment of the Madison building and attempt to determine the causes of the occupant complaints.

EPA researchers also responded to the immediate needs of their own agency in the investigation of occupant complaints at the EPA Headquarters building (Washington, DC). This support has included taking air samples, testing the off-gassing of materials (carpeting and partitions), and reporting on the results from these studies to EPA management and employees. As part of this research effort, EPA researchers enhanced measurement protocols for SVOCs (e.g., 4-phenylcyclohexene, which has been characterized as "the essence of new carpet.")

Health Effects Research

EPA health effects research has demonstrated that cotinine, a metabolite of nicotine, can be used as a biological marker of exposure to nicotine from environmental tobacco smoke (ETS), especially in children. A laboratory chamber study will soon be initiated to evaluate cotinine for ETS dosimetry. This study will provide information on the uptake and clearance of nicotine from ETS for non-smokers of different ages, sex, and genetic background. An estimate of the dose received from exposure to ETS can be made by measuring nicotine and cotinine in body fluids.

Human responses to VOC mixtures are also a subject of current research. This research is a replication and extension of a study conducted in Denmark which demonstrated that exposures to mixtures of VOCs can produce behavioral and sensory irritant effects, even though each individual compound is below the known threshold for neurological effects. This study is needed to evaluate one of the suspected causes of sick building syndrome, and to provide state and local governments with information on the effects of VOC exposures on health and productivity.

C. EPA REGIONAL OFFICES

The EPA regional offices have been involved in the Agency's indoor air program. Three FTE's from the total regional office workforce have been allocated for indoor air activities and a staff person has been designated in each regional office to act as the indoor air contact. The responsibilities of the regional offices are to: 1) attempt to respond to public inquiries; 2) distribute EPA information materials; and 3) provide assistance to state and local governments in the region. In addition, some regional offices have undertaken special indoor air projects.

Region I has sponsored indoor air conferences in 1986 and 1988. The purpose of both conferences was to facilitate discussion among EPA and state officials about state and regional concerns regarding indoor air problems. EPA headquarters staff were invited to both conferences to describe the national indoor air program and current projects. Starting in 1989, Region I will hold meetings on a regular basis with appropriate state agencies. The

Regional Administrator recently sent a letter to each of the governors of the New England states requesting that appropriate state agency representatives be designated to participate on the workgroup. The purpose of the workgroup will be to transfer information and to discuss major indoor air quality issues in the region. Region I also participates in the Massachusetts Special Legislative Commission on Indoor Air Pollution.

Region X has proposed, and headquarters intends to support, a pilot regional indoor air program. The program will be conducted from the regional office and will focus on information dissemination activities and on supporting state efforts to address indoor air quality.

D. ADDRESSING INDOOR AIR QUALITY AT EPA HEADQUARTERS FACILITIES

During 1988, EPA headquarters became a case study of indoor air quality problems in modern office buildings as it became the subject of significant occupant complaints of inadequate ventilation and poor indoor air quality. While non-specific complaints had been prevalent in the building for many years, the increase in complaints coincided with a major renovation effort being undertaken to upgrade the headquarters facility with new carpeting, partitions, paint and other improvements to the physical environment.

Approximately six EPA employees have been advised by their physicians not to reenter the building. Some of these employees exhibit signs of a heightened sensitivity to the air pollutants present in the complex. A significantly larger number of employees have complained of symptoms which most associate with the renovation work. Other employees have expressed concerns that pre-date the current episode and which raise the issue of long-term problems.

The General Services Administration (GSA) has delegated authority to manage the EPA headquarters facility at Waterside Mall Complex to the EPA Office of Administration (OA). EPA must work in concert with the owner and manager of the building, Town Center Management, in carrying out this responsibility. In April 1988, OA requested assistance from the Indoor Air Staff of the Office of Air and Radiation as well as the Office of Research and Development. Since that time, both offices have been heavily involved in efforts to address EPA's own indoor air quality problems and have provided detailed advice both on appropriate steps to take and experts to consult, as well as providing technical support through ORD's laboratory facilities. In April, the Agency also instituted a moratorium on the installation of new carpeting pending an investigation of the potential sources of the problem(s).

Initial air testing early in the year for 98 chemicals, many of which were volatile organic compounds (VOCs), was undertaken by EPA's Environmental Response Team (ERT) from Edison, New Jersey. These compounds were identified for testing based on available information on compounds which are typically found in indoor air. This initial round of testing found approximately thirty compounds in the low parts per billion (ppb) range. These levels were below thresholds which have been found to pose significant risks to health for

individual compounds.

Subsequent to this testing, the National Federation of Federal Employees (NFFE) brought to management's attention work conducted by a researcher at the University of Arizona which identified a previously unknown compound, 4-phenylcyclohexene (or 4-PC for short), as an unintentional by-product of the reaction of 1,3, butadiene and styrene used in latex-backed carpeting. This study had been submitted to the Office of Toxic Substances (OTS) under the OTS Chemical Screening Program. The toxicological properties of 4-PC and its potential to produce health effects have not been adequately studied. A second and third round of chemical air testing for chemicals was conducted by ERT and by the Office of Research and Development (ORD), this time with 4-PC identified as a target compound, among others. Levels of 4-PC were found in several renovated spaces. The highest reading measured was 5 ppb. At the same time, ORD conducted emission chamber tests on both the carpeting and the wall partitions to identify the content and rate of off-gassing from these materials. No 4-PC or significant levels of formaldehyde or other pollutants were found to be off-gassing from the partitions. The study also indicated that the emission rate of 4-PC from the carpeting decreased over time. ORD modeling results indicated, assuming an air exchange rate of one air change per hour (ACH), room concentrations of 4-PC would be at or below about 1 ppb after approximately 60 days after installation. These results are in general agreement with both the monitoring data from the EPA building as well as the Arizona study.

At the same time, EPA hired an engineer to conduct an in-depth analysis of 6 of the approximately 40 air handling units in the complex to assess their operating parameters and determine the amount of outside vs. recirculated air entering the building. The ventilation engineer also looked at several individual rooms to try to assess the effectiveness of the distribution of air in these spaces. The evaluation determined that the air handling units are generally meeting the lease requirements of 10% outside air. However, there are a number of problems related to the air handling equipment (e.g., higher than normal chiller temperatures, poorly designed supply air diffusers) as well as our high per-office occupancy rates and increased thermal loading from the computer equipment which adversely impact the ability of the ventilation system to provide adequately conditioned air to all spaces all of the time. Similar engineering analyses are to be performed on the remaining air handlers in the complex to evaluate their effectiveness. These analyses should be completed by spring 1989. In conjunction with this evaluation, the outside air intake in cubic feet per minute (cfm) per occupant, a standard unit of measure for ventilation will also be calculated. This should provide information on whether and where there are air handling units which are serving overcrowded spaces or where air distribution to individual spaces is not sufficient.

EPA management also took other steps to try to improve the quality and efficiency of the ventilation systems at the WSM complex. First, in an effort to improve the air quality on Monday mornings, when many people complained of stuffy and uncomfortable thermal conditions, EPA arranged with Town Center Management for extended hours of operation of the air handling system to

increase the intake of outside air and to condition that air. Second, the Agency invested approximately \$100,000 in hardware improvements to the ventilation system, and an additional \$300,000 in improvements have been funded. These include raising the stacks on exhaust pipes which are too close to air intakes, reconnecting duct work, modifying air diffusers, and installing additional air conditioners, dehumidifiers and other needed equipment. New and more effective air diffusers will be installed in all future spaces which undergo renovation.

The Office of Administration provided assistance to the individuals who have filed Workers' Compensation claims and the Agency also retained the services of an occupational medicine specialist to provide free medical consultations, including lab tests, for employees who are experiencing problems which they believe to be related to the building environment.

A number of employees and union representatives requested that a health survey be conducted of EPA employees and that a full scale epidemiology study be conducted to study potential patterns of illness or unusual symptoms over time. A scientifically designed survey instrument has been developed in a joint effort by the J.B. Pierce Foundation associated with Yale University, the National Institutes of Occupational Safety and Health (NIOSH), and EPA's Office of Research and Development. While this survey was originally designed to be used as a pilot in a study of the Library of Congress building, the survey instrument has been modified and the study expanded to include EPA's headquarters complex. The questionnaire is designed to ensure strict respondent confidentiality. Since the survey must be conducted during peak heating or cooling seasons ("worst case" conditions) and to allow time for needed modifications, the survey will be conducted in the Winter of 1989.

Other key decisions which have been made by management include:

- Not to use in the headquarters facility any additional yardage of the carpeting now in stock and to take steps to ensure that floor covering materials used in future renovations do not contain 4-phenylcyclohexene (4-PC) or any other compound that could lead to pollutant levels that are known to pose health problems.
- To leave the carpeting which has already been laid undisturbed since levels of 4-PC have decreased to approximately 1 part per billion (ppb) or below and to avoid increasing the levels of 4-PC and other pollutants (e.g., dust) in the air in the removal process.
- To conduct a survey of other sources of indoor air pollution that may be present in the complex (including biological contaminants) and to identify source reduction strategies.
- To develop a long range plan for improving and maintaining indoor air quality at all EPA Headquarters sites. The outline for this plan was developed by the Indoor Air Staff in OAR.

- To hire an indoor air quality oriented architect to draft a major indoor air component to be incorporated into the technical facility requirements for the new EPA Headquarters building.

E. ACTIONS TO ADDRESS SPECIFIC PROBLEM POLLUTANTS

1. Indoor Radon

Following the discovery of extremely high levels of indoor radon and the recognition of a potentially widespread threat to human health, the U.S. Environmental Protection Agency (EPA) initiated a variety of activities devoted to determining the extent of the radon problem and reducing the potential for exposure. In 1987, the Agency prepared a status report required under Title IV of the Superfund Amendments and Reauthorization Act of 1986. The status report described activities of the Radon Action Program formulated by EPA to address the issue of radon. The current report briefly summarizes the history, content, progress, accomplishments, and future directions of EPA's Radon Action Program and describes some of EPA's other radon-related activities.

History of the Radon Problem

Isolated incidents of elevated indoor radon levels were reported in the 1960s and 1970s in houses built with materials contaminated with uranium mine tailings and in several houses built on reclaimed phosphate lands. It was not until early 1985 that naturally occurring indoor radon problems were reported. At that time, extremely high radon levels were discovered in houses located along a geological formation known as the Reading Prong which extends from Pennsylvania, through New Jersey, and into New York. Numerous homes were found with levels of radon as high as 130 times the Federal occupational exposure standard for underground uranium miners. Of 20,000 samples taken by the State of Pennsylvania in the Reading Prong area, more than 60% reported levels above 4 pCi/L, the action level recommended by EPA. More than 20% were over 20 pCi/L and some were as high as 2000 pCi/L. In terms of cancer risk, regular exposure to 4 pCi/L is the equivalent of smoking about one half of a pack of cigarettes a day, or enough to cause cancer in 13 to 50 of every 1000 persons exposed to that level for a lifetime; exposure to 20 pCi/L is equivalent to smoking about one and one half packs of cigarettes per day or enough to cause cancer in 60 to 210 of every 1000 persons exposed.

Since the findings in the Reading Prong, radon problems have been identified in nearly every state. In 17 states surveyed under the EPA State Survey Program, one out of every four homes tested had elevated screening levels of radon. Available data suggest that up to 10% of the approximately 85 million homes in the United States may have radon levels reaching or exceeding 4 pCi/L.

In 1986, EPA and the Nuclear Regulatory Commission (NRC) engaged the National Academy of Sciences to evaluate the currently available health data related to radon. A report summarizing this examination was published in 1988

(NRC 1988). The results of this study confirmed EPA's risk estimates and indicated that radon exposure presents a real and substantial lifetime risk of fatal lung cancer at levels found in many homes. Another equally important finding by the NAS, is that reducing radon levels in homes will reduce the risks of fatal lung cancer associated with previous radon exposure. The reduction in risk is analogous to the reduction in risk which is experienced by a smoker who quits smoking.

Reducing radon levels and, thereby, the risks associated with exposure requires identifying and remediating buildings with radon problems. Radon problems in buildings depend upon factors such as the characteristics of the soil on which the structures are built and on the construction features of the buildings. Concentrations of radon may vary significantly from building to building even in the same area. The location of individual buildings with possible radon problems is best accomplished through programs managed at the state and local levels. EPA, therefore, is targetting its radon efforts to ensure that information and expert technical assistance is available to States and homeowners to enable them to assess the risks and choose appropriate actions for their specific situations.

Development of the Radon Action Program

In 1985, EPA established the Radon Action Program to develop and disseminate information and expertise related to radon and encourage the development of State programs and private sector capabilities in these areas. The Program is divided into 4 major elements:

1. Problem Assessment -- to determine the distribution and levels of radon exposure and the associated health effects;
2. Mitigation and Prevention -- to develop methods for reducing radon levels in existing structures and for preventing radon entry in new construction;
3. Capability Development -- to develop the capacity within the States and the private sector to diagnose and remedy radon problems in homes; and
4. Public Information -- to provide information to the public regarding the risks associated with exposure to radon and methods for reducing those risks.

Accomplishments of the Radon Action Program

EPA initiated several activities to accomplish the objectives of the Radon Action Program and presented these activities in detail in the Title IV Report to Congress. The sections below briefly describe the progress and accomplishments of the Agency since that report. Each section corresponds to one of the four Program elements.

Problem Assessment

EPA initiated activities in the area of Problem Assessment to gather information regarding the extent of the radon problem. These activities include identifying homes with high radon levels, identifying geographic areas with high radon exposure potential, and determining human health risks associated with radon exposure. Several specific activities are described below.

Standardization of radon measurement methods. A number of devices are currently available for measuring radon concentrations. In order to promote consistency and ensure accuracy, EPA has evaluated numerous measuring devices and has prepared standardized measurement procedures for nine different measuring devices considered acceptable for making radon measurements. Standardized procedures for seven of these devices were issued in 1986, along with a document EPA prepared to provide guidance for placement of the devices within the home. Currently, EPA is revising these procedures to include new developments in radon measurement technology and is producing additional standardized procedures for new measuring devices. The new procedures are expected to be released in the near future.

National survey. In order to determine the distribution of annual average radon concentrations and exposures in houses across the country, EPA has undertaken a national survey of radon in residences. In this survey, radon measuring devices will be placed in 5,000 to 7,000 randomly selected residences throughout the U.S. and will remain in place for one year. EPA has prepared the questionnaire to be used in the survey and has submitted an information collection request to the Office of Management and Budget. A pretest study will be completed in early 1989, the full survey will begin in March 1989, and the results should be available in FY 91. In addition to the residential survey and in accordance with SARA, EPA is planning to conduct a survey of schools and workplaces. The development of interim guidance for measuring radon levels in schools is nearing completion.

State surveys. Information from the national survey is useful for determining the annual average radon concentration across the U.S. but is not sufficiently detailed to identify particular areas of high risk within states. Therefore, upon request, EPA is assisting states in developing their own surveys to identify high risk areas. In the State surveys, the measurements generally are taken for much shorter periods of time. However, some homes in each state receive long-term detectors to help EPA determine correlations between the two measurement techniques.

To date, EPA has assisted 17 states and the Indian Nations in EPA's Region V in conducting statistically valid radon surveys. Results from the first ten states surveyed were released in August 1987 and indicate that in each state surveyed, homes were found that had radon levels exceeding 4 pCi/L. One out of every five homes surveyed that year had elevated radon levels. Some of the highest readings were found in states reporting the lowest overall occurrence of radon problems. Results of the surveys from seven additional

states and the Indian Nations were released this year. One of three homes surveyed had elevated radon levels.

The results of these surveys confirm the need for the states to thoroughly test their own regions because areas of high risks may exist even in states in which the frequency of radon problems is very low. Based on these findings, EPA and the Public Health Service have recommended that most homes be tested. EPA will continue to aid States in the survey effort and is assisting a new group of 8 states and Indian Nations in Regions 6, 7, and 8 in its 1989 Survey program.

Development of geological maps indicating potential high radon risk areas. EPA is cooperating with the United States Geologic Survey (USGS) to develop geological maps that indicate areas of potential radon problems in specific regions and throughout the nation. These maps are based on geological data, modifications of the National Uranium Resource Evaluation data, and some indoor radon measurement data. The most recent version of the national map includes information obtained from the 10-State survey and from some commercial measurement companies. Additionally, EPA is working with the USGS to conduct land evaluation studies to identify more precisely those geological features which are most useful as indicators of high radon levels.

Development of methods for predicting potential high risk areas. As a means of determining the radon potential of a specific parcel of land, such as a plot being considered for development, EPA is investigating new methods for measuring soil gases as an indicator of potential radon problems.

Mitigation and Prevention

In the areas of Mitigation and Prevention, EPA is developing cost-effective methods for reducing radon levels in existing structures and for preventing radon entry in new construction. EPA has established programs for transferring these new technologies to the states and the private sector. EPA is working with the National Association of Homebuilders (NAHB) and nationwide building standard and code organizations to have radon resistant construction practices incorporated into model building codes.

Development of techniques for reducing and preventing elevated radon levels. EPA is working closely with the states and private sector organizations to develop and demonstrate techniques for reducing indoor radon levels. EPA has completed demonstration projects in Pennsylvania, New Jersey, and New York; mitigation techniques were successfully demonstrated in over 70 homes. Post-mitigation monitoring results indicate that the levels in most of the demonstration homes were reduced by more than 90 percent. In many cases, mitigation techniques reduced radon levels by more than 98 percent. EPA currently is demonstrating mitigation techniques for existing homes in Maryland, Ohio, Tennessee, Alabama, and Florida. Future programs are being planned for the mid-Western and Western regions of the country.

In addition to improving mitigation techniques for residences, EPA is developing techniques that will be useful for remediating radon problems found

in schools and other types of structures. Protocols are being developed to aid researchers and state and private contractors in evaluating the effectiveness of different mitigation approaches.

Transfer of mitigation technologies to the states and private sector.

EPA initiated the House Evaluation Program (HEP) to provide training to state and private sector personnel in radon diagnosis and mitigation and to encourage states to develop their own programs in these areas. As part of this program, state personnel, in cooperation with EPA, evaluate houses with known radon problems and determine the source of the problem. Once the source of the problem is identified, the homeowner is provided with several mitigation designs. The homeowner decides whether or not to undertake the mitigation work, selects the contractor to do the work, and pays for the work to be done. Through these activities, the states and the private sector receive experience in radon diagnosis and mitigation methods. In addition, data from the remediated houses are used to determine the effectiveness and average cost of different mitigation procedures. Over 80 State and local officials received training in diagnosis and mitigation design under the traditional HEP. The program evaluated over 160 houses in Pennsylvania, New Jersey, New York, Tennessee, Ohio, Virginia, and through the National Park and Indian Health Services.

In 1988, EPA offered states the option of participating in the traditional version of the HEP or a new and expanded version of the program. The new program offers training in not only house diagnosis and mitigation, but also in the installation of mitigation technologies. Over the next year, the new HEP program will offer complete diagnostic, mitigation design, and mitigation installation training to about 70 people in each of the eight new states.

The evaluation of the effectiveness of radon resistant features in new construction. To reduce the risks from radon exposure, EPA has emphasized preventing radon entry in newly constructed homes. To this end, EPA is developing radon resistant construction features for use in new homes and has issued interim guidance for new home builders. EPA also established the New House Construction Evaluation Program to evaluate the effectiveness of these and other features being adopted by homebuilders.

Cooperation with NAHB and building standard and code organizations to incorporate radon resistant construction techniques in building codes. EPA is working closely with the housing industry, particularly the NAHB, to encourage home builders to include radon resistant techniques in new construction activities. However, to ensure a permanent and wide-reaching effect, EPA is working with the national standard and model building code organizations to incorporate radon resistant construction techniques into national building codes.

Capability Development

EPA operates a number of programs to train radon professionals and to evaluate the capabilities of state and private sector companies dealing with

radon problems. The Radon Diagnosis and Mitigation Training and the National Radon Measurement Proficiency programs develop and evaluate radon assessment and mitigation capabilities. During 1989, EPA will develop the Contractor Proficiency Program to evaluate private sector mitigation services, and will establish three Regional Radon Training Centers.

Training in radon diagnosis and mitigation. To provide training in assessment and mitigation, EPA, in conjunction with the State of New York, created the diagnosis and mitigation training course entitled "Reducing Radon in Structures". This course has been offered to over 2,000 Federal and State officials and private contractors from across the country. EPA recently revised and expanded the content of the course to reflect new technologies produced by current research programs. The new course includes information concerning new ways to evaluate and mitigate different kinds of structures. EPA has made videotapes of the course available to the states and several states have used the materials to conduct their own courses. EPA has also conducted a course to train new instructors.

A new FY 90 initiative will establish three Regional Training Centers. The Centers will provide a variety of courses in radon health effects, measurement, and mitigation. The Centers will be located at universities.

Establishment of programs to evaluate radon measurement services. As the number of companies providing measurement services increases, it is important to ensure the reliability and accuracy of the test results. At the request of the States, EPA established the Radon Measurement Proficiency Program (RMP) to assess the capabilities of private radon measurement companies and non-commercial laboratories. Under this program, companies offering measurement services voluntarily demonstrate their measurement capabilities. EPA provides lists of successful participants to the States who distribute them to homeowners upon request. The latest Cumulative Proficiency Report was issued in October 1988.

The RMP Program has grown substantially since it began in 1986. In 1986, 35 companies were on the list, in 1987, 250, and for the latest test round, the report lists over 800 companies. Lists of successful participants are currently distributed by all 50 states. Participation in the program remains voluntary; however, several states use the proficiency evaluations as a basis for regulating measurement companies. Other states are considering similar programs.

EPA will develop a Mitigation Contractor Proficiency Program (CPP) during 1989. This program also will be voluntary and will test the proficiency of mitigation companies constructing and implementing measures to reduce radon levels. The program should be operational in 1990. EPA will send states lists of proficient companies for distribution to the public. States also may base mitigator certification programs on the CPP.

Public Information

Although public concern about the health risks associated with indoor radon has increased over the last few years, relatively few homeowners (2%) have acted to identify or correct radon problems. As a result, EPA views the development and dissemination of public information as a high priority. EPA is committed to providing the States and the public with current information regarding the risks associated with radon exposure and available methods for reducing those exposures.

EPA is using numerous approaches to disseminate information to the public. Action guidelines for measurement and mitigation have been developed to assist citizens in determining if there is a problem in their home and to present possible courses of action available. EPA has developed, published, and distributed public information documents covering a wide range of radon related problems. Presentations on radon have been given to hundreds of national organizations, Congressional members, civic groups and others. Radon-related outreach activities have been conducted in coordination with other national organizations, and risk communication research projects have been initiated to evaluate the effectiveness of some of these communication activities.

One principal way EPA is educating the public on radon and the health risks associated with exposure is by providing documents summarizing a wide array of information. Since 1986, EPA has developed and distributed several publications, including:

- "A Citizen's Guide to Radon" -- published in August 1986 in cooperation with the Centers for Disease Control. This pamphlet provides information on radon such as where it is found, what adverse health effects are associated with exposure, and how to reduce the risk of these effects. It provides information to homeowners to aid in detecting problems and determining if further action is necessary.
- "Radon Reduction Methods: A Homeowner's Guide" -- originally published in 1986, this booklet has been revised to include the latest information concerning successful mitigation methods. This booklet discusses ten methods successfully tested by EPA or other groups and presents information regarding their cost, installation, limitations, and reduction efficiencies.
- "Radon Reference Manual" -- published in 1987. This manual is intended to assist public officials in responding to questions about EPA's pamphlet, "A Citizen's Guide to Radon." Each section in this manual corresponds to a section in the pamphlet and presents material that is more technical and detailed.
- "Removal of Radon From Household Water" -- published in 1987. This pamphlet discusses the various methods which can be used to prevent radon trapped in water from being released into the air

where there is a much greater potential for adverse health effects. Numerous control methods are mentioned, and the Granular Active Carbon Tank is discussed in detail. This method of removing radon gas from water has been found to be the least costly and is the most extensively tested.

- "Radon Reduction in New Construction" -- published in 1987 in cooperation with the National Association of Home Builders Research Foundation, Inc. This pamphlet introduces several methods that can be used during the construction process to decrease the amount of radon that enters the house and to facilitate easy removal of radon after construction is complete. Various methods for reducing the number of radon entry pathways and the vacuum effects are discussed. This booklet has been provided to the states and their homebuilders associations for distribution to the public.
- "Summary of State Radon Programs" -- published in 1987. This booklet, which examines the development of state programs, was compiled to promote communication between the states regarding the organization and administration of their specific programs and to assist any states that are currently attempting to develop their own program. Program activities are summarized in the text and a detailed description of each State's program is provided in the appendix.
- "Radon Reduction Techniques for Detached Houses: A Technical Guidance" -- Second Edition. This detailed technical manual is for professional mitigators, researchers, State and local officials, and do-it-yourselfers. The manual is based largely on the results of EPA research findings and is regarded as "state-of-the-art" information regarding radon mitigation.
- "Key Elements of a State Radon Program" -- published in 1988. This report describes "Key Elements" of state radon programs and illustrates the implementation of the key elements using examples from existing state radon programs.

In addition to providing these publications, EPA is working with the American Medical Association to educate health care professionals on the risks associated with indoor radon. AMA and EPA are developing a brochure and will be conducting a series of six workshops for health care professionals. Also, EPA and the National Conference of State Legislators (NCSL) will conduct two regional workshops on radon for State legislators in February 1989.

EPA also has initiated several risk communication studies to examine the effectiveness of the Agency's communication activities. Studies are underway in Maryland, Pennsylvania, New Jersey and New York. These studies are examining alternative ways of presenting radon risk information, community reaction to radon risk, and the effectiveness of intensive information campaigns.

EPA recently was accepted by the Advertising Council for an advertising campaign. The Agency will work closely with the Council to develop a national campaign to increase public awareness of radon.

Other Accomplishments

EPA is actively participating in several important activities related to radon in addition to those under the Radon Action Program. Some of these activities are described below.

Radon in Water

In addition to soil, radon may also be found in groundwater and can enter the home through the water supply. In accordance with the Safe Drinking Drinking Act, EPA is working to develop a set of enforceable drinking water standards for radon and other radionuclides. Information regarding the risks of exposure and the methods and costs for detecting and treating radon in water was compiled and presented in an advance notice of proposed rulemaking published in September of 1986. A proposed rule is anticipated in approximately a year. The rule will identify requirements for acceptable analytical methods to measure radon in water and features enabling states to determine when water systems are in compliance. Treatment techniques that will effectively remove radon and that can be used to meet the standard or that must be installed to obtain a variance will be listed.

In preparation for the proposed drinking water regulations for radon, the Office of Drinking Water surveyed 1,000 public water systems for radon. This survey, the National Inorganics and Radionuclides Survey (NIRS), found levels of radon from 100 to 25,700 pCi/L in the water (i.e. about 0.01 to 2.5 pCi/L air), with a median of 289 pCi/L (water) and a mean of 881 pCi/L (water). It is the Agency's estimation that over 20,000 of the 45,000 community ground water systems have radon levels above 200 pCi/L in their water.

Federal Cooperation

EPA is working closely with several federal agencies in dealing with the radon problem. EPA, with the Department of Energy, co-chairs the Radon Workgroup of the Committee on Indoor Air Quality. The Workgroup is actively coordinating Federal programs related to indoor radon. Workgroup members currently are compiling an inventory of all Federal projects involving radon that will be published in January 1989. Participation of all Federal Agencies in the Workgroup is encouraged and over 20 agencies are represented.

The Superfund Amendments and Reauthorization Act of 1986 requires that EPA form an advisory group composed of Federal agencies. To accomplish this, EPA chose the existing Radon Workgroup of the CIAQ. This approach allows EPA to draw on specific expertise among the member agencies and keeps the agencies coordinated in the radon effort. Several of the cooperating agencies are listed below.

Department of Energy (DOE). In 1987, EPA finalized a Memorandum of Understanding (MOU) with DOE. Under this MOU, DOE assumes responsibility for conducting basic research related to radon, focusing on issues related to public health. EPA coordinates applied research, technical studies, and operational programs involving the states and the private sector.

Housing and Urban Development (HUD). EPA has furnished HUD with information related to radon and has provided radon diagnostic and mitigation training to HUD personnel. HUD requested technical assistance from EPA on a project in Bethlehem, Pennsylvania and reviewed two EPA publications, "The Citizen's Guide to Radon" and "Radon Reduction in New Construction."

National Park Service (NPS). EPA is assisting the National Park Service in assessing and remediating radon problems in NPS buildings. To date, 3600 dwellings have been surveyed. One hundred and ten of the dwellings needing mitigation are being remediated this year. The remainder will be addressed next year.

Department of Defense (DOD). EPA has assisted DOD in conducting radon surveys and has provided diagnosis and mitigation training for DOD personnel. EPA also worked with DOD to develop their Radon Assessment and Mitigation Policy. Currently, all three services and the Coast Guard have radon programs in place.

General Services Administration (GSA). EPA and GSA are currently cooperating in the development of protocols for measuring radon in workplaces. Under this project, GSA's buildings are serving as test sites. The resulting protocols will be available to other agencies wishing to conduct a workplace survey. Sampling is expected to begin in FY 89.

Conclusions

Summary

Since the severity of the potential health hazards associated with exposure to indoor radon were first identified in 1984, EPA has made great strides toward understanding and addressing the radon issue. From the outset, EPA recognized that states, through state and local agencies, are best able to address many of the radon-related problems of their citizens. EPA developed the Radon Action Program and works closely in partnership with the states to provide necessary assistance.

Through the Radon Action Program, EPA and the states have informed the public of the dangers associated with radon exposure. Over two million homes have been measured. EPA has worked to develop national and state surveys to establish the extent of the radon problem in homes and is now focusing on schools and workplaces. The federal government has taken the lead in developing needed assessment and mitigation techniques to be used in all the states. EPA has researched ways of eliminating and preventing radon problems and has developed training programs for passing this new information on to

state and local officials and contractors, enabling them to assist homeowners. The states are responding by taking the lead in assessing local situations and assisting citizens with mitigation when necessary.

Future Goals

Congress recently enacted the Indoor Radon Abatement Act of 1988 (PL100-550) which enhances EPA's existing program and adds important new responsibilities. For the first time, EPA is authorized to provide funds to help States develop self-sufficient radon programs. The Act includes eight major provisions. These provisions are listed below.

National Goal. The Act establishes a long-term goal that indoor air be as free from radon as the ambient outdoor air. This provision is intended to encourage the development of technology that will enable radon reductions significantly below EPA's current 4 pCi/L guideline.

State Program Development Grants. The Act authorizes \$10,000,000 annually for three years for EPA to administer grants to help States establish radon programs. Eligible activities include radon surveys, development of public information materials, and demonstration and mitigation projects. The Act requires a declining Federal share in the program over three years from 75% in the first year to 60% in the second and 50% in the third and final year.

Study of Radon in Schools. The Act authorizes \$1,500,000 for EPA to study radon in the nation's schools and demonstrate mitigation techniques in school buildings.

Proficiency Programs. The Act authorizes \$1,500,000 for EPA to establish and operate proficiency programs for radon measurement and mitigation firms. The program would be funded through a user-fee system.

Regional Training Centers. The Act authorizes \$1,000,000 a year for three years for EPA administered grants to colleges and universities for the development of three regional radon training centers. The centers would provide training to Federal and State officials, professional and private firms, and the general public regarding radon risks, measurement, and mitigation.

Model Construction Standards. The Act requires EPA to develop draft model construction standards and techniques by June 1, 1990. The standards and techniques should take into account geographic differences in construction type, geology, weather, and other variables affecting new buildings.

Technical Assistance. The Act authorizes \$3,000,000 a year over three years for EPA to provide continued technical assistance in a variety of areas including measurement, mitigation, training, and public information.

Federal Building Studies. The Act requires that all Federal agencies that own buildings must conduct a study of those buildings to determine the

extent of radon contamination. The agencies are to coordinate with and provide their findings to EPA.

EPA has made much progress since 1986 but much remains to be done. The bill creates new opportunities for State program development and recognizes that a cooperative relationship between Federal and State efforts is the best way to effectively deal with this issue. State and local governments are in the best position to assume primary responsibility for assisting the public. However, there is also a unique and necessary Federal role, particularly with regard to questions of national problem assessment and technical assistance. EPA will continue to fulfill its leadership role in this area.

2. Asbestos

In the years since 1979, when EPA first instituted an asbestos technical assistance program, the asbestos program has grown into a major national program to reduce the risks to public health from asbestos. The severity of asbestos as a human health hazard is well established in occupational settings, although exposure and risk is less certain at prevailing or environmental levels. Studies of both laboratory animals and of asbestos workers and their families have clearly demonstrated that several life-threatening diseases, such as lung cancer, asbestosis, and mesothelioma, can be caused by exposure to airborne asbestos.

EPA efforts to address asbestos problems encompass the full range of regulatory, grant, and technical assistance activities. The primary focus has been in the Nation's schools because of the vulnerability of young children and their long expected life span. Congress has encouraged this focus by passing two asbestos laws for schools since 1984. Measures have also been taken to address the problem of asbestos in other settings including public and commercial buildings and homes. EPA has also promulgated several regulations limiting certain uses of asbestos, governing the demolition or renovation of buildings containing asbestos, and protecting abatement workers from unsafe asbestos exposures. A more detailed description of these actions follows.

Reducing Exposure to Asbestos-Containing Materials in Schools

Three laws give EPA authority to control asbestos in schools: the Asbestos Hazard Emergency Response Act (AHERA), the Asbestos School Hazard Abatement Act (ASHAA), and the Toxic Substances Control Act (TSCA). Together these laws direct EPA to establish a comprehensive program to control asbestos-containing materials in schools and a loan and grant program to assist eligible school districts in abating asbestos problems in their schools. These laws are administered within EPA by the Hazard Abatement Assistance Branch (formerly the Asbestos Action Program), located within the Office of Toxic Substances. The principal actions taken by EPA to reduce risks from asbestos exposure in schools include:

Asbestos-Containing Materials in Schools Rule. AHERA requires EPA to establish a framework of regulatory standards for managing asbestos in

schools. In October 1987, EPA published the AHERA schools rule on proper asbestos inspection, management planning and appropriate response actions. This rule now represents the "state of the art" in asbestos management and may serve in part as a voluntary model for public and commercial building owners, as well as a regulatory standard for schools.

Model Accreditation Plan. AHERA required that EPA issue a model accreditation plan to provide for training and accreditation of persons who inspect school buildings, develop management plans, or design or conduct response actions. EPA published the model plan on April 30, 1987. At least 18 states have passed legislation for contractor accreditation programs similar to the EPA model.

Asbestos Loan and Grant Program. Congress passed the Asbestos School Hazard Abatement Act (ASHAA) in 1984. This law established an EPA-managed program of loans and grants to schools with severe asbestos hazards and financial need. Since 1985, EPA has awarded nearly \$160 million to approximately 640 school districts and private schools for about 1,800 individual asbestos abatement projects, mostly removals. This program has eliminated more than 13 million exposure hours to students, teachers, and school workers each week.

Asbestos Inspection and Management Planning Assistance Program (AIMPAP). Under the 1987 ASHAA appropriation, EPA was authorized to provide up to \$5 million to states to be used by financially needy local school districts and private schools for inspections and development of management plans. In 1988, Congress authorized an additional \$15 million for this purpose. EPA established AIMPAP to provide these funds to schools through approved state programs. Unlike other EPA grants to States, this money is not to be used for State administrative purposes; it must be passed on for school inspections and management planning. In two years, \$20 million has been awarded to 31 recipients.

Guidance Documents. EPA has developed several technical assistance materials on asbestos. The most widely circulated of these publications, entitled Guidance for Controlling Asbestos-Containing Materials in Buildings, outlines a systematic approach for building owners to follow in identifying asbestos hazards and controlling exposure. (The current version is known as "the Purple Book;" earlier versions were known as the "Blue Book.") Within the past two years, EPA has also published guidance documents on respiratory protection with the National Institute of Occupational Safety and Health and on preventing asbestos disease among auto mechanics because asbestos is frequently found in brake linings. Another document, currently in draft, gives guidance on establishing a special asbestos-control operations and maintenance program. In addition, EPA serves as a clearinghouse for a variety of other important guidance documents on asbestos.

Asbestos Information and Training Centers. EPA has funded the opening of five asbestos information and training centers located at Tufts University near Boston, Georgia Tech in Atlanta, the University of Kansas in Kansas City, the University of Illinois School of Public Health in Chicago, and the

University of California at Berkeley. These centers were provided Federal funds in decreasing amounts over a three-year period, after which they became financially self-sufficient from course fees and other marketable program activities. The centers sponsor technical symposia, conferences and offer EPA-approved training courses for AHERA accreditation of building managers, asbestos abatement contractors, school officials, architects, maintenance personnel and abatement workers.

In addition, a few satellite training centers were given smaller grants for one or two years to provide training only. These satellite centers are located at the University of Utah in Salt Lake City, the University of Texas at Arlington, Rutgers Medical School in Piscataway, New Jersey, Drexel University and Temple University in Philadelphia. Although center funds expired in 1988, EPA is discussing unfunded agreements with university centers and satellites to sustain AHERA-accredited training. More than 25,000 persons have taken courses at EPA-funded centers since the first one opened in 1985.

Accreditation Training. EPA centers do not offer the only available training courses. Several other universities offer accreditation programs, as do some private organizations such as the American Wall and Ceiling Institute and the Illinois Laborers' Training Center. Course materials presented by these programs for AHERA accreditation purposes must be designed in accordance with the EPA Asbestos Plan and receive EPA approval, usually after a course audit.

As of January 13, 1989, EPA has approved 330 public and private training providers nationwide for 722 individual asbestos management or abatement courses. These approved courses include 250 courses for abatement workers, 169 for abatement contractors or supervisors, 121 for asbestos inspectors and management planners, as well as 161 "refresher courses". To become accredited, individuals must attend the two- to five-day sessions and pass an examination. To remain accredited, annual attendance is required in an approved "refresher" course.

Grants to States for Certification, Training and Accreditation Programs. In 1985, EPA began to give grants to states to encourage the passage of legislation which would establish qualifications for contractors and standardize training requirements for abatement workers and supervisors. In a related activity, EPA gave grants to both the Maryland Department of Health and Hygiene and the National Conference of State Legislators (NCSL) to develop model state legislation on asbestos contractor certification and accreditation. From 1985 to 1987, about \$2.5 million was provided to nearly 40 States to establish contractor certification programs. Due in part to EPA's efforts, at least 30 States currently have some type of contractor licensing and certification programs in effect. (Not all of these programs, however, meet the new AHERA accreditation standards which they are required to do over the next couple of years.)

EPA is now focusing on the need for developing the competency of professionals other than contractors who are involved in asbestos work. Under the AHERA Model Accreditation Plan, all States must over the next couple of

years establish accreditation programs for persons who conduct inspections, develop management plans, and design or conduct response actions in schools. In 1988, EPA distributed about \$1 million to 17 States for the purpose of initiating inspector training and accreditation programs.

Reducing Exposure to Asbestos-Containing Materials in Public and Commercial Buildings

Many of the technical assistance projects described above will also be of help to those concerned with exposure to asbestos in commercial and public buildings. Other activities which EPA has undertaken and which are aimed directly at reducing risks from exposure to asbestos-containing materials in commercial and public buildings include:

Public and Commercial Buildings Study. In addition to its requirements concerning schools, AHERA mandated that EPA conduct a study to determine the extent of danger to human health posed by asbestos in public and commercial buildings and to make recommendations about appropriate means to respond to any such danger. Among other things, the study was to address specifically whether public and commercial buildings should be subject to the same inspection and response actions that AHERA required for school buildings.

In the study, which EPA submitted to Congress in February 1988, EPA estimates that 20 percent of the total number of public and commercial buildings in our country today, or some 700,000 buildings, contain friable asbestos-containing material. Of the buildings with friable asbestos, three-fourths have some damaged material and half have significantly damaged material.

The report made four recommendations with respect to public buildings: 1) to enhance the nation's technical capability by increasing the number of trained and accredited professionals qualified to perform inspections and abatement work and by helping building managers to make the right control and abatement choices; 2) to focus attention on thermal system insulation asbestos which is more prevalent and more often deteriorated than other types of friable asbestos; 3) to better coordinate Federal and State asbestos efforts to avoid high peak exposures associated with improper or poorly timed asbestos removal actions; and 4) to objectively assess the effectiveness of the AHERA school rule and current activities. EPA has advised Congress that additional Federal regulation of public and commercial buildings should be addressed in about three years, after EPA and building owners have had more experience with the AHERA school rule, after there is an assessment of the supply of trained professions, and after further study of the problem of asbestos management in public and commercial buildings is completed.

Air Monitoring Study. EPA has conducted a field study to compare airborne asbestos fiber concentrations in outdoor ambient air with those prevailing in Federal buildings which contain asbestos materials. The study, which involved about 43 Federal buildings in six cities across the country, presented results which indicate very low prevailing levels (.00073 f/cc mean) in those buildings with asbestos, even with damaged asbestos-containing

materials. Further, no statistically significant difference was generally found between levels in these asbestos-containing Federal buildings and levels taken outdoors. Study results, however, cannot be considered representative of prevailing levels in all public and commercial buildings, or even Federal buildings, due to study design limitations.

Federal Asbestos Program. For some time, EPA has sponsored the Federal Asbestos Task Force (FATF), a working group of Federal agencies, such as the Occupational Safety and Health Administration (OSHA) and the Consumer Product Safety Commission (CPSC), with asbestos control program responsibilities. Several joint Federal agency asbestos projects have resulted from this coordination effort. For example, EPA and CPSC have jointly developed an Asbestos in Homes booklet. EPA and the General Services Administration (GSA) have begun a program to better control asbestos in Federal buildings and some GSA buildings have employed operations and maintenance programs which were developed in conjunction with EPA.

Other Asbestos Regulatory Activities

National Emission Standards for Hazardous Air Pollutants (NESHAPs) for Asbestos. Under Section 112 of the Clean Air Act which authorizes EPA to set standards to reduce risks from hazardous air pollutants, EPA has issued several asbestos-related regulations. One set of regulations prohibits the manufacture of some asbestos-containing spray-on insulation and molded pipe insulation. Another set of regulations specifies workplace procedures to use in demolitions and renovations where asbestos is present. EPA has proposed revisions to these regulations that will more clearly define the responsibilities of those involved in demolitions and renovations and that will increase EPA's ability to enforce the asbestos NESHAPs regulations.

Worker Protection Rule. Section 6 of the Toxic Substances Control Act (TSCA) authorizes EPA to prohibit the commercial use of substances found to be hazardous. Under TSCA Section 6, EPA has issued a rule extending the coverage of the worker protection rule issued by the Occupational Safety and Health Administration to State and local employees who perform asbestos abatement activities and who are not covered by state programs.

Ban and Phase Out Rule. Section 6 of the Toxic Substances Control Act (TSCA) also authorizes EPA to prohibit the manufacture, processing, or distribution of substances found to be hazardous. Under this section, EPA has issued a proposed rule to ban certain asbestos products and phase out others. Comments have been received on the proposed rule and the final rule is being considered.

3. Environmental Tobacco Smoke

In 1986, in coordination with the Office on Smoking and Health (OSH) of the Department of Health and Human Services, EPA requested the National Research Council (NRC) to evaluate methods for assessing exposure to ETS, and to review the literature on the health consequences of such exposures. In

response, the NRC Board on Environmental Studies and Toxicology established an independent Committee on Passive Smoking composed of 11 scientists. The Committee was charged with reviewing the existing scientific literature and to identify the current state of knowledge with respect to established facts, and to make recommendations for future research to remove areas of uncertainty.

The NRC reported to EPA that there were both acute and chronic health effects from ETS, leading to serious respiratory conditions in sensitive populations, and to lung cancer in healthy adults. Concurrently, the Surgeon General independently reported identical scientific conclusions in his 1986 Report on Involuntary Smoking. The Surgeon General also concluded that "a substantial number of the lung cancer deaths that occur among nonsmokers can be attributed to involuntary smoking." In addition, he made several public policy recommendations regarding the necessity for restrictions on smoking in public, including the workplace. At the same time, but independently of the other two efforts, the Task Force on Environmental Cancer and Heart and Lung Disease, an interagency group established by Congress via the Clean Air Act Amendments of 1977, held a Workshop on the Contribution of Airborne Pollutants to Respiratory Cancer. The Task Force Report also considered indoor air pollutants, and particularly, ETS. The Task Force report concluded that data indicate that the greater number of lung cancers in nonsmoking women is probably related to environmental tobacco smoke."

Accordingly, EPA moved to establish a research program to remove the scientific uncertainties identified by the NRC, and a risk assessment and information program to provide the public with an understanding of the hazards and reliable methods for risk mitigation. EPA has no regulatory authority in this area. However, in its own facilities, under the GSA Guidelines on Smoking in Federal Buildings, EPA adopted a policy which restricted all smoking to a only a few separately ventilated rest rooms with one-pass ventilation, and made available smoking-cessation clinics.

Risk Assessment and Information Dissemination Efforts on ETS

ETS Fact Sheet -- The 5th in a series of brief summaries of indoor air facts designed to inform the general public about the causes of indoor air pollution and its remedies, this fact sheet discusses the fact that ETS is one of the most significant indoor air pollutants, presents the current scientific consensus about the carcinogenic effects of ETS in adults and respiratory effects in children, describes what ETS is, places ETS in perspective as the predominant source of respirable particle air pollution indoors, describes the presence of certain tobacco combustion products commonly found in nonsmokers' body fluids, discusses how difficult it is to remove ETS by ventilation, and how easy by source control, and supports the policy recommendations on ETS promulgated by the Surgeon General.

ETS Handbook on Workplace Smoking Policies -- In cooperation with the National Cancer Institute, the National Heart, Lung, and Blood Institute, the Office on Smoking and Health, and the Office of Disease Prevention and Health Promotion of the Public Health Service, EPA is producing a 100 page Handbook for Understanding, Assessing, and Mitigation of Exposure to ETS, directed

primarily at the non-industrial workplace. It will be an authoritative easy-to-read summary of what is known about the health effects and mitigation of ETS exposures in commercial buildings at the present time.

ETS Reference Manual -- Similar in concept to the ETS Handbook, the Reference Manual will consist of more lengthy and more technical expositions of the nature of ETS, its transport indoors, its health effects and its mitigation, designed for individuals who must make technical judgments concerning ETS in buildings, such as industrial hygienists, architects, ventilation engineers, occupational health physicians, and the like.

ETS Lung Cancer Risk Assessment -- EPA has undertaken a formal risk assessment of lung cancer from ETS according to EPA's Cancer Risk Assessment Guidelines as published in the Federal Register. The Indoor Air Program, in cooperation with the Office of Research and Development's Carcinogen Assessment Group (CAG) is performing a hazard assessment of passive smoking epidemiology and biochemical nature of ETS; exposure assessment of nonsmokers exposures; including factors affecting transport in occupied structures; dose-response assessment, in order to develop an exposure response relationship and unit risk; and risk characterization of ETS, which will yield projected U.S. mortality from lung cancer from passive smoking. The 9 currently published risk assessments of ETS, which average 3000 ± 1800 lung cancer deaths per year, will be reviewed and evaluated.

ETS and Radon -- It has been established that the risks of radon gas to smokers is 10-fold as high as to nonsmokers. Accordingly, the inter-relationship of ETS and radon gas will be explored to determine whether there is a synergy between lung cancers in nonsmokers who are co-exposed to radon and ETS.

ETS Non-cancer Risk Assessment -- The Task Force on Environmental Cancer and Heart and Lung Disease report on Passive Smoking stated the "effects of environmental tobacco smoke on the cardiovascular system, especially among high risk individuals, may be of greater concern than that of cancer." Accordingly, the studies linking ETS and heart disease mortality and respiratory disease mortality in nonsmokers will be reviewed, and a risk assessment performed where possible.

4. Formaldehyde

In 1984 EPA designated formaldehyde for priority attention under the provisions of the Toxic Substances Control Act (TSCA) Section 4(f). Agency concern was for widespread, potentially-significant cancer risk that was posed to two large, indoor populations: occupants of homes containing significant amounts of urea-formaldehyde (UF) pressed wood products and garment workers exposed because of off-gassing from durable press textile finishes. These two concerns became the subject of a May, 1984 Advance Notice of Proposed Rulemaking (ANPR) which initiated an EPA regulatory investigation.

In 1986, EPA terminated its investigation of garment workers because OSHA had by that time undertaken efforts to revise its formaldehyde workplace

standard. In 1987, OSHA issued a final occupational standard that: (1) regulates formaldehyde as a potential carcinogen (previously, it was regulated only as irritant), (2) lowers the Permissible Exposure Limit (PEL) from 3 to 1 ppm (8 hour, Time Weighted Average), and (3) contains hazard communications provisions.

In 1985, EPA'S Science Advisory Board (SAB) reviewed the risk assessment document used by EPA to support its TSCA section 4(f) decision; the Office of Toxic Substances (OTS) subsequently refined the assessment and augmented it with new results obtained from epidemiological studies and from an expert panel's review of pharmacokinetics data. EPA issued its Agency-consensus risk assessment of formaldehyde in April 1987 that formally classified formaldehyde as a "probable human carcinogen."

EPA's investigation is currently focused on developing the technical basis for decision making on the need for, and nature of, additional Federal regulations affecting formaldehyde emissions from UF pressed wood (particleboard, hardwood plywood paneling and medium density fiberboard). These products are probably the most significant sources of formaldehyde present in indoor settings. (Controllable indoor emissions from textiles, for example, are believed to be much less significant.) EPA has been studying the potential costs and residential air quality impacts of a range of possible controls on pressed wood products, including product emission standards, use limitations, production restrictions, and labeling. This information will be used to determine whether or not an "unreasonable risk" exists. If so, EPA can refer the issue to other Federal agencies or take action itself under TSCA. A decision on which actions EPA will take with respect to formaldehyde is likely to be made in 1989.

In 1985, HUD set emission standards for particleboard and hardwood plywood used in mobile (manufactured) home construction. HUD's rule although applicable only to wood used in building mobile homes, is thought to have resulted in lowered emissions from these types of building products, as they are generally produced and sold today.

In 1986, CPSC denied a petition by the Consumer Federation of America to regulate formaldehyde emissions from all pressed wood products. Instead, the commission directed its staff to pursue the revision of voluntary, national consensus standards (ANSI) for pressed woods to include formaldehyde emission provisions.

5. Chlorinated Solvents

The Interagency Integrated Chlorinated Solvents Project was formed in 1985, at the time that an Advance Notice of Proposed Rule-Making (ANPR) was announced for methylene chloride. This interagency committee is chaired by the EPA Office of Toxic Substances and includes representatives of seven major EPA offices (OPTS, OAR, OGC, ORAD, OPPE, OW, OSWER), CPSC, OSHA, and the Food and Drug Administration (FDA). The Project is addressing the risks from four chlorinated solvents, including methylene chloride, perchloroethylene, trichlorethylene, and 1,1,1-trichloroethane. Currently, four use categories

for chlorinated solvents are being analyzed: dry cleaning, solvent cleaning, aerosols, and paint stripping. Preliminary risk assessments and economic analyses are being performed for each category to determine the most appropriate control options available to these agencies. Regulatory options selection papers are being developed for use by the EPA Administrator in determining the most appropriate direction for EPA to take in reducing risks from these chemicals; the analyses are also available for decision-making in other Federal agencies. Factors evaluated in determining the merits of the options under considerations are risk reduction, intermedia and interpersonal risk transfer, costs and efficiency, the validity and uncertainty of the data used and the need to develop further data, and the extent to which the options provide an integrated approach to risk management.

Consumer risks, and resulting indoor air risks, are being evaluated for three of the categories under the Chlorinated Solvents Project (i.e. dry cleaning, aerosols, and paint stripping). For the dry cleaning category, a concern is the possible carcinogenic risks resulting from emissions of perchloroethylene from dry-cleaned clothing. Although limited data are available, preliminary data from studies done in chambers and a test home by the EPA Office of Research and Development substantiate previous data by PEDCO Environmental, Inc. showing that elevated levels of perchloroethylene are present in indoor air after dry-cleaned clothing is introduced into the home. Additional studies are needed to more adequately evaluate the risks to consumers from this scenario and the methods which may be used to reduced these risks. The Chlorinated Solvents Project is currently working with the dry cleaning industry on a design for industry studies to evaluate what actions the drycleaning industry can take to decrease the residual levels of perchloroethylene in dry-cleaned clothing before consumers pick it up. The Integrated Chlorinated Solvents Project will wait for the completion of these industry studies before formalizing options to reduce consumer exposure to perchloroethylene.

Under the aerosols and paint stripping categories, the Integrated Chlorinated Solvents Project is evaluating the possible carcinogenic risks from use of consumer products containing methylene chloride and/or perchloroethylene in the home. The options being evaluated are advisories to consumers, labeling of products containing perchloroethylene, or prohibition of the use of certain products containing chlorinated solvents. The Integrated Chlorinated Solvents Project expects to present these options to the EPA Administrator in mid-1989. (For a discussion of the CPSC labeling requirements for methylene chloride-containing products, see the section describing CPSC activities in Volume I.)

6. Pesticides

The Federal Insecticide, Fungicide, and Insecticide Act (FIFRA) provides EPA with the authority to control pesticide exposure by requiring that any pesticide must be registered with EPA before it may be sold, distributed or used in this country. As a pre-condition for registration, an applicant must be able to demonstrate that the pesticide in question will not cause "unreasonable adverse effects" (as defined by the Act) to people or the

environment. When evidence arises that indicates that a registered pesticide product might cause unreasonable adverse effects, EPA may initiate a review process to determine if cancellation or some other regulatory action is warranted, based on a consideration of both the risks and benefits of the pesticide in question.

Whenever deemed necessary by EPA, the Agency may require supplementary data to support an existing registration under FIFRA Section 3(c)(2)(B). Failure by the registrant to fulfill such requirement may result in the suspension of the product's registration by EPA. It is under this authority that the Agency requires indoor air monitoring data for those pesticides found to hit "triggers" for acute or chronic toxicity.

Within EPA, the office which administers FIFRA is the Office of Pesticide Programs (OPP). Some of the more important chemical-specific actions taken by OPP in recent years with implications for indoor air quality are the following:

Cyclodiene Termiticides -- EPA has taken a series of actions which have led to the withdrawal from the marketplace of a family of termiticides known as the "cyclodienes" (chlordane, heptachlor, aldrin, and dieldrin).

Short-term effects to high levels of these pesticides are associated with such symptoms as headaches, dizziness, muscle twitching, weakness, tingling sensations, and nausea. Potential long-term effects include damage to the liver and the central nervous system, as well as increased risk of cancer. For a long time it was thought that these chemicals, when correctly applied to the soils surrounding homes or into the house foundations, would not cause significant exposure to the household occupants. However, recent studies demonstrate that air samples taken even in homes where chlordane is properly applied may contain measurable chlordane residues.

In 1987, EPA entered into a Memorandum of Understanding with Velsicol, the only manufacturer of chlordane and heptachlor, which banned their sale until an application method is demonstrated that will not result in any measurable exposure to household occupants. To comply with a 1988 court order (National Campaign Against the Misuse of Pesticides v. EPA), EPA has issued an order halting the sales and uses of existing stocks of chlordane and heptachlor after April 15, 1988. Manufacturers of aldrin and dieldrin ended all sales voluntarily. Alternative termiticides are on the market.

Lindane -- Lindane was formerly used as a general purpose insecticide against indoor pests. Because of concerns over the potential long-term risks of cancer, EPA cancelled the registrations of all indoor fumigating devices containing lindane, effective May 1986.

Wood Preservatives -- In 1984, EPA took several actions to protect the public from unsafe exposures to the three common wood preservatives. The Agency banned all indoor uses of pentachlorophenol and creosote with certain limited exceptions; it prohibited the use of pentachlorophenol on logs used in log home construction; and it required that sealers be applied to wood used

indoors that had previously been treated with these chemicals. In 1986, the manufacturers of wood preservatives signed a voluntary agreement with EPA setting up a consumer awareness program.

Other Indoor Use Pesticides -- On an as-needed basis, EPA requires registrants of indoor use pesticides to submit exposure data. Toxicity triggers include high acute toxicity, developmental toxicity, carcinogenicity, etc. Recent examples include the insecticides DDVP and propoxur.

Inerts Policy -- Pesticide formulations often include one or more "inert" ingredients, as well as an active ingredient intended to control certain targeted pests. Typically, the inert serves as a solvent or as a carrier for the active ingredient; and in other cases as an attractant for the target pest. Unlike the active ingredient, the inert is not toxic to the target pest, but nonetheless may cause health effects in humans. For example, while methylene chloride is used as an inert ingredient in some pesticides, CPSC is issuing special labeling requirements for some consumer products containing this chemical due to its potential to cause a variety of health effects.

In 1987, EPA identified 57 inerts which have known toxic effects (including methylene chloride), or which are structurally similar to other compounds with known toxicity. EPA is in the process of requesting additional health and environmental effects data from the registrants. The first round of these requests was issued in 1988 for 8 chemicals, and the remainder will be sent out in early 1989.

Anti-Microbials Program -- In order to better assess the potential health hazards associated with the use of anti-microbials, EPA decided to begin calling in chronic toxicity data for these chemicals. On the premise that exposure to these chemicals is episodic and brief at most, the Agency heretofore only required data on acute toxicity. Since many anti-microbials are used as cleaning and disinfecting agents inside buildings, however, the potential for indoor air to be a significant route of exposure must be considered. The first round of data is expected to be submitted by the end of 1988.

Review of Pesticide Labeling Requirements -- EPA is engaged in a review of current pesticide labeling practices to determine whether the Agency should revise its labeling requirements. The review began with a look at agricultural chemicals, but the need to extend the review to pesticides sold directly to consumers became apparent soon after the project started. The goal of better labeling is to reduce the risks to human health from unnecessary exposures. A report on this project, which will identify ways in which labels could be reformatted to convey essential information in a manner most likely to be read and understood by the user, is in preparation.

Public Information Activities -- EPA has recently issued two publications about pesticides, Termiticides: Consumer Information and A Citizen's Guide to Pesticides for the public. In addition, EPA maintains a

national toll-free hotline to answer questions about pesticides. The number of this hotline is (800) 858-PEST; in Texas, it is (806) 743-3091.

III. ACTIVITIES CONDUCTED BY OTHER FEDERAL AGENCIES

Although EPA was given primary responsibility for implementation of SARA Title IV, a variety of Federal agencies have been actively involved, and have made major contributions, in the indoor air quality field for several years. While the missions and activities of some of these agencies may appear duplicative, many of the activities conducted by these agencies are carried out as cooperative efforts which involve several agencies. Currently, considerable effort is being expended by Federal agencies to minimize duplication of effort and to maximize cooperative and joint efforts which make appropriate use of each agency's relative strengths and expertise.

A. CONSUMER PRODUCT SAFETY COMMISSION (CPSC)

Authority for Indoor Air Quality Activities

Many of the sources of indoor air pollution fall under the jurisdiction of the Consumer Product Safety Commission (CPSC). The Consumer Product Safety Act (CPSA) and the Federal Hazardous Substances Act (FHSA) provide the Commission with ample regulatory authority to allow for the regulation of the products that may contribute to unhealthy indoor air. However, the CPSC does not establish requirements or standards for the air in homes or other buildings.

CPSC has jurisdiction over the products and appliances and many of the building materials contributing to indoor air pollution. The provisions of the CPSA and the FHSA provide the authority for the Commission, in appropriate cases, to: (1) ban a product, (2) establish mandatory safety standards for products, (3) recall products for repair, replacement, or refund, (4) mandate warning labels for products, and (5) cooperate in the development of voluntary product standards in order to address indoor air quality hazards.

The CPSA established the CPSC as an independent regulatory agency and authorizes the Commission to eliminate or reduce unreasonable risks of injury associated with consumer products. The CPSA defines the term "consumer product" to mean any article which is produced or distributed for sale to a consumer or for the personal use of a consumer in or around the home, in schools, recreation, or otherwise, with certain specified exceptions. The CPSA also gives the Commission responsibility for the administration of four other statutes, including the FHSA.

The FHSA specifies labeling requirements for household products that are "hazardous substances", as that term is defined in the FHSA. The FHSA defines the "hazardous substances" as including certain household substances or mixtures of substances which are toxic, corrosive, flammable, combustible, irritants, strong sensitizers, or substances that generate pressure through decomposition, heat, or other means. The FHSA requires labeling for hazardous substances and also bans the sale of any toy or children's article that

contains or consists of a hazardous substance. Additionally, the FHSA authorizes the Commission to establish specific labeling requirements for household products containing hazardous substances if no labeling which could be required under the FHSA would adequately protect the public health and safety.

History of CPSC Involvement in Indoor Air

The Consumer Product Safety Commission activities in the area of indoor air quality have involved the determination and reduction of health risks posed by the use of structural materials, combustion sources (vented and unvented), consumer products, and chemicals used in the home and in schools. Thus, a major emphasis of CPSC's efforts has been to conduct applied research to provide the technical basis for the development of voluntary standards and to disseminate information to the public.

Indoor Air Quality was a Commission priority project from FY 82-84. Initial work included understanding the health risks associated with: formaldehyde foam building materials and insulation; carbon monoxide, nitrogen dioxide, and other pollutants from unvented combustion appliances, such as unvented gas space heaters, kerosene heaters, and woodstoves; and asbestos released from consumer products. More recent efforts have emphasized methylene chloride, perchloroethylene, and other organic chemicals from consumer products. In 1986, the Commission also began investigating health hazards associated with airborne biological contaminants, both allergens and pathogens, from products such as humidifiers, vaporizers, and air conditioners. Current examples of voluntary standards include efforts to ensure reduction of emissions of potentially hazardous pollutants from kerosene heaters, as well as from pressed wood products.

The ability to characterize empirically source emissions and to predict in-home pollutant levels through modeling has been developed. Source emissions for given appliances have been studied but not the mechanisms and factors which would guide the design of "clean" appliances. Predictive models appear accurate enough for health assessments but do not address specific individual residences. The development of emission measurement and modeling techniques and the concurrent refinements in the scientific understanding of the levels at which the combustion pollutants and formaldehyde can cause adverse health effects will enable completion of voluntary standards efforts in these areas during FY 1988. Public information efforts include a fact sheet on kerosene heaters and a safety alert and video news feature on methylene chloride.

Major Accomplishments

The Commission has:

- o Conducted an evaluation of the health risks associated with formaldehyde which served as the basis for regulatory activity concerning Urea-Formaldehyde Foam Insulation and for a voluntary standards effort to limit formaldehyde emissions from building materials.

o Evaluated the health effects associated with carbon monoxide and nitrogen dioxide and initiated a voluntary standard effort to limit the emission of these pollutants from unvented combustion appliances such as gas space heaters and kerosene heaters.

o Banned asbestos-containing patching compounds and artificial emberizing material in 1978, and began an evaluation of other asbestos-containing materials for their contribution to indoor air pollution. In cooperation with industry, voluntary standards were established to eliminate asbestos in consumer products. In 1982, the Commission published the "Asbestos in Homes" booklet in cooperation with EPA. In 1986, an enforcement policy was issued requiring labeling on all remaining asbestos-containing products. In addition, a pilot study of 45 homes was initiated to determine if deteriorating in-place asbestos products may cause a health risk. Completion of the study is scheduled for early 1989.

o Initiated, in FY 1986, chamber and field studies to determine the levels and types of airborne microbes released during normal use of specific consumer products such as humidifiers and vaporizers. The chamber studies are being conducted at the Oak Ridge National Laboratory in two phases. The first phase will determine the growth and dispersion of biological pollutants from a variety of humidifiers. The second phase will correlate levels of pollutants in the reservoir of humidifiers with levels measured in the room. These studies will be completed during FY 1989. The majority of the field studies are being conducted by Dr. Harriet Burge of the University of Michigan in cooperation with Harvard School of Public Health's Six-City Study. In-home measurements of biological pollutants and their possible correlation with health effects will be completed in FY 1989.

o A cooperative effort with Underwriters Laboratories (UL) and the National Kerosene Heaters Association was initiated in FY 1985 to establish a standard test method to measure emissions from kerosene heaters. UL conducted tests comparing the hood and probe methods, and the CPSC's engineering laboratory compared the hood and chamber methods. In FY 1987, CPSC established a hood testing methodology which has been proposed to the task group as an appropriate method for measuring emissions from kerosene heaters. An amendment to a voluntary standard to limit NO₂ emissions from kerosene heaters should be proposed in FY 1989.

o Sponsored a portion of a study, beginning in FY 1986, at Oak Ridge National Laboratories to measure nitrogen dioxide levels in 50 homes that use kerosene heaters. These monitoring data will be correlated with any observed health effects in children living in the homes by researchers from the Harvard School of Public Health, sponsored by the National Institute of Environmental Health and Safety. A final report on the results of these correlations is expected by the spring of FY 1989.

o Completed an in-home field study to determine pollutant levels in 25 homes using unvented gas space heaters. Staff is currently evaluating the data. The final hazard analysis for unvented gas space heaters based upon

these data and data from previous chamber tests will be made in FY 1989. This information will be discussed with industry, and efforts will continue to develop voluntary standards to reduce health risks from pollutant emissions from unvented gas space heaters.

- o Evaluated data on emissions from coal and wood-burning stoves and gas stoves.

- o Evaluated control strategies for carbon monoxide deaths from gas heating systems.

- o Tested carbon monoxide detectors and fuel gas detectors to determine their reliability as new safety devices for consumer use.

- o Developed a voluntary standard, which became effective in FY 1987, requiring an automatic shut-off device for new central furnaces that is triggered when products of combustion are not properly vented to the outside.

- o Completed studies, in 1986, on emissions from pressed wood products under a variety of conditions. Although the assessment is limited in that it does not include formaldehyde contributions from furniture, shelving, and cabinetry, it was the most comprehensive work at that time to estimate the health risks to consumers from formaldehyde emitted from pressed wood. The consumer exposure assessment reveals that an estimated 24 percent of new single-family detached houses use some urea formaldehyde pressed wood material in their construction. Based on a number of limiting assumptions, the Commission staff estimates that the excess cancer risk (based on 95 percent upper confidence limit) due to formaldehyde emitted from U.F. pressed wood, ranges from 19 to 143 per million people exposed, depending on the type and amount of pressed wood used to construct a home. Based on the average number of single-family detached housing starts in 1983 and 1984 (about 900,000), we estimate that up to 34 excess cancers may occur annually from the use of pressed wood in home construction. Further, the Commission staff estimates that about 9.2 percent of all new single-family detached houses would have an initial formaldehyde level in excess of 0.1 ppm, and 6.6 percent would have 5-year averages above 0.1 ppm. A voluntary standards effort is underway with the National Particleboard Association and the Hardwood Plywood Manufacturers Association to develop adequate national consensus standard to limit formaldehyde release from pressed wood.

- o Conducted, in FY 1986 and FY 1987, chamber and model house exposure studies and an evaluation of consumer use surveys describing exposure to household products that contain methylene chloride. An assessment of the indoor air exposure from product use was made. The staff estimated that over 176 excess cancers will be caused by the use of methylene chloride in products under CPSC jurisdiction. The Commission voted on July 31, 1987, to issue a "Statement of Enforcement Policy" concerning products containing methylene chloride. The enforcement policy states that methylene chloride is considered to be a hazardous substance under the FHSA and that such products are therefore required to be properly labeled to indicate that these products may pose a carcinogenic risk to humans.

Approximately \$10,000 will be used for graphics and printing costs associated with these materials.

Testing will be conducted in the CPSC Engineering Sciences Laboratory in cooperation with the Directorate for Health Sciences (HS) to complete the remaining necessary work for development of an NO₂ emission standard. This testing will also address the newly emerging concern over acid aerosol emissions. Efforts on acid aerosols emissions will also be coordinated with EPA. These efforts are expected to result in modification of the UL 647 voluntary standard on kerosene heaters. This work will also be used to approach American National Standards Institute to modify the voluntary standard on UVGSH to address NO₂ emissions. Funding of \$125,000 has been allocated to resolve these questions regarding combustion appliances.

4. Nitrogen Dioxide Health Effects

The staff position on the health effects associated with exposure to NO₂ is based upon review of the literature and support of that position by the expert review of this literature by the EPA's Clean Air Scientific Advisory Committee (1986). The health effects are based to a large extent on animal studies, controlled human studies and epidemiological studies that have used the presence of gas ranges as a surrogate measure for NO₂. Many of these controlled human and epidemiological studies have produced inconsistent evidence regarding the health effects of such exposures, in part due to limited or no actual measurement of NO₂ levels during the studies.

During 1986, CPSC funded a study at EPA/University of North Carolina using a small controlled human exposure group of adult asthmatics and children, populations potentially sensitive to effects of NO₂, to determine if there were any biological indicators which could be used to demonstrate exposure to NO₂. The results of these studies did not provide verification of a biological indicator that could be used in human epidemiological studies. Staff is proposing using limited funding of \$20,000 as seed money to cooperate with industry and other government agencies to fund a monitoring and epidemiological study on the health effect of NO₂. A sensitivity analysis has been conducted for an industry group, which identified a population exposed to levels of NO₂, from the use of UVGSH in their homes, that are expected to cause health effects. This study help to resolve the questions on the correlation of NO₂ concentrations with human health effects.

5. Carpets

A long-suspected indoor air quality problem is being given increased attention in regard to the potential chemical sensitization and allergic reactions from carpet emissions. Staff is proposing that CPSC begin to develop a capability to identify these emissions. The Directorate for Economic Analysis will use \$20,000 to conduct a market survey to identify materials being used in carpeting and adhesives. HS will conduct a pilot study to screen and identify potential chemical emissions from carpeting and

adhesives through extraction techniques and some chamber work. A chamber will be purchased for \$10,000 to conduct these emission characterizations. The Directorate for Epidemiology will obtain information on consumer complaints associated with carpeting using their IDI system and \$3,000 for follow-up telephone interviews. Based upon the results of these activities further efforts will be recommended for FY90.

Long-Term Role

CPSC staff believes that the long-term indoor air quality role of the Commission is to address identified indoor air hazards through the development of voluntary and mandatory product standards and through public information efforts. The Commission is not a primary research agency. Therefore, it looks to major research agencies and institutions to develop information to define the hazards of pollutant exposures and to provide at least preliminary information on sources of these pollutants. When consumer products are identified as potential contributors to indoor air hazards, CPSC will consider undertaking research necessary to define the extent of consumer exposure and to assess the extent of risk presented by consumer use of such products. If appropriate, mandatory or voluntary standards development activities will be undertaken to reduce or eliminate the identified hazard. Product bans and other regulatory alternatives may be implemented, as necessary. Action to address indoor air quality hazards will be taken in the context of applicable standards and other product related hazards. In addition, it is expected that the Commission will play a major role in conveying information to consumers on products which affect indoor air quality through a variety of public information avenues.

B. DEPARTMENT OF ENERGY (DOE)

Authority for Indoor Air Activities

The Atomic Energy Act of 1946 (P.L. 79-585) provided the initial charter for a comprehensive program of applied and basic radiobiological research. This Act authorizes the Department of Energy (DOE) to conduct research and development related to the utilization of fissionable and radioactive materials for medical, biological and health purposes. It also provided for the protection of health during the same research and development activities. The Atomic Energy Act of 1954 (P.L. 83-703), as amended, authorized the Atomic Energy Commission "... to conduct and support research and development activities, including authority to conduct research on the biologic effects of ionizing radiation..." for "... the protection of health and the promotion of safety during research and production activities..." and for "... the preservation and enhancement of a viable environment..."

The Energy Reorganization Act of 1974 (P.L. 93-438) specifically provided that the responsibilities of the Administrator of the Energy Research and Development Administration (ERDA- DOE's predecessor), shall include "... engaging in and supporting environmental, biomedical, physical, and safety

research related to the development of energy sources and utilization technologies ..."

The Federal Nonnuclear Energy Research and Development Act of 1974 (PL 93-577) authorized the vigorous conduct of a comprehensive, national program of basic and applied research and development of all potentially beneficial energy sources and utilization technologies within ERDA. In this Act, Congress authorized and directed ERDA to design and analyze research to consider the environmental and social consequences of a proposed program.

The Department of Energy Organization Act of 1977 (P.L. 95-91) authorized DOE to provide for the functions of ERDA. One of the stated purposes of the Act was to "assure incorporation of national environmental protection goals in the formulation and implementation of energy programs, and to advance the goals of restoring, protecting, and enhancing environmental quality, and assuring public health and safety." Another section of the Act directed DOE to conduct "... a comprehensive program of research and development on the environmental effects of energy technologies and programs."

History of Involvement in Indoor Air

The U.S. DOE has had major involvement in the indoor air quality field. DOE has historically been the major contributor to radiation research, and provided the information upon which most international occupational radiation standards are based. The Department has unique interdisciplinary strengths at its laboratories, combining engineering, environmental and health studies. This radiation expertise has been utilized in the conduct of indoor radon research since 1977. The objectives of this research are to: (1) understand the mechanisms and determine the rates at which radon enters building; (2) develop predictive techniques to identify regions of the country and building characteristics which would likely result in high indoor radon concentrations; (3) assess the health effects associated with radon exposures; and (4) develop and evaluate methods to measure and reduce indoor radon concentrations. In addition, DOE's Remedial Action Program monitors and applies corrective actions at former uranium mill tailing sites and certain government-owned or government-utilized facilities. The second reason for DOE's involvement in the indoor air quality field is to conduct research to understand the relationships between energy conservation and the build-up of indoor pollutants. Monitoring results have shown that, while there is no direct correlation across homes between air exchange rates and indoor pollutant levels, energy conservation measures can elevate existing indoor air quality problems.

DOE has two major policies with respect to indoor air quality:

- o To eliminate potential hazards to the public and environment from radioactive contamination remaining at facilities and sites previously used in the nation's atomic energy programs; and

- o To develop information to ensure the maintenance of healthful indoor environments with continuing use of energy conservation measures in buildings.

The Department's interests in indoor air quality can be divided into four areas:

- o Research and development;
- o The DOE Remedial Action Program;
- o Health risk assessment; and
- o Committee on Indoor Air Quality (CIAQ) participation.

DOE research is conducted in the areas of source characterization, measurement methods, field studies, health effects, and controls. The primary focus of this work is on radon, organics, and combustion-related pollutants.

The DOE Remedial Action Program has helped advance the state of knowledge regarding radon control, mitigation methods, and measurement techniques. Through continued basic research and the conduct of remedial activities, DOE will help to better define the extent of radon exposure and associated risks in residences across the U.S. and to develop means to minimize this exposure.

The continuing assessment of the nature and extent of the potential health risk to the nation posed by exposure to indoor air pollutants is the third program area. An important goal of this DOE program is to provide health effects information to aid in public policy decisions.

Finally, the efficient conduct of the first three programs requires coordination with other organizations involved in indoor air quality activities. The principal purposes of the CIAQ are to develop a national policy on IAQ, to coordinate IAQ research, and to assist Federal, State and local agencies in defining and alleviating IAQ-associated problems. As a co-chair of the CIAQ, DOE research plans and results are coordinated with those of the other federal agencies.

Major Accomplishments

There are five DOE organizations involved in indoor air quality (IAQ) activities:

- o Office of Conservation and Renewable Energy (CE);
- o Office of Energy Research (ER);
- o Office of Nuclear Energy (NE);
- o Office of Environment, Safety and Health (EH); and
- o Bonneville Power Administration (BPA).

Office of Conservation and Renewable Energy (CE)

CE research focuses on the relationship between air exchange and indoor air quality (IAQ), the impacts of outdoor sources (e.g., radon from soil), indoor activities and building materials in IAQ, and development of control techniques and measurement methods. Major accomplishments of CE include developing a computerized data base of indoor air quality field measurement results in the U.S. and Canada (co-funded with the Electric Power Research Institute and the Gas Research Institute), and support in the design of a national multipollutant field survey to determine the effects of present and future efforts to conserve energy through reduced ventilation or air leakage. Research efforts devoted to infiltration and ventilation studies in residential buildings have contributed significantly to the development of infiltration measurement techniques, air leakage characterization of buildings, and infiltration modeling to assess the impact of reduced infiltration rates on energy requirements and indoor air quality. Research in commercial buildings has involved investigations of "sick building syndrome" and the development of techniques to assess both ventilation rates and ventilation effectiveness in commercial buildings. CE's indoor radon research projects have aided in the furthering of the understanding of geologic/geographic radon source potential, radon entry mechanisms, radon progeny behavior within buildings, and radon source potential of soils. The lead office with respect to the CIAQ is CE.

Office of Energy Research (ER)

Health effects and exposure studies to determine the risk associated with exposures to indoor radon are the focus of ER's IAQ research program. Reducing the major uncertainties attendant to this issue will be a significant contribution to public health and policy.

Because of the increasing public concern over the potential health effects of exposures to radon and radon progeny in homes and other buildings, ER substantially expanded its radon-related research program beginning in 1987. The program now includes 60 research projects carried out at university and contractor operated laboratories. A part of the ER effort continues at the DOE Environmental Measurements Laboratory (EML) in New York City. This laboratory has played a special role as a primary reference laboratory for radon and radon progeny measurements, both nationally and internationally for many years.

Overall, ER-supported studies on radon are part of a much larger research program that deals with all types of ionizing radiation. The total research program involves several hundred scientists and facilities for conducting radiation-related research and has been the primary radiation effects program in the world. This program supports basic research into the means by which radiation exposures occur in work places and the general environment, factors that affect interactions of ionizing radiation with matter, radiation dosimetry, and the biological effects of ionizing radiation. Unique capabilities have also been developed to conduct studies on the effects

of combined exposures to radiation and chemically toxic substances such as cigarette smoke.

Office of Nuclear Energy (NE)

The DOE Remedial Action Program is one of the responsibilities of NE. The Remedial Action Program has been organized into four separate subprograms. The Grand Junction Remedial Action Program (GJRAP) is responsible for correction of elevated indoor radon levels associated with the disposition of uranium mill tailings in the Grand Junction, Colorado area. Cleanup of an estimated 600 structures was completed in 1988. The Uranium Mill Tailings Remedial Action Program (UMTRAP) is responsible for stabilizing 24 designated uranium mill tailings sites in 9 western states and one at Canonsburg, Pennsylvania, as well as clean-up of an estimated 5,000-6,000 contaminated properties in the vicinity of processing sites. Cleanup at the Canonsburg and Shiprock, New Mexico, sites is complete. Cleanup is also near completion at the Salt Lake City, Utah, and Lakeview, Oregon, sites, and cleanup has been started at the Durango, Colorado site. In addition, cleanup is complete at 1,000 of the contaminated properties. The Formerly Utilized Manhattan Engineering District/AEC Sites Remedial Action Project (FUSRAP) is responsible for the identification and disposition of facilities that were formerly used in government nuclear programs and then released for unrestricted use, but which have radioactive contamination above current limits. There are currently 29 designated sites, 9 of which have been completed. The Surplus Facilities Management Program (SFMP) is responsible for disposition of facilities radioactively contaminated by the DOE. There are 33 active civilian projects at 17 sites currently in inventory to be decommissioned. The mobile gamma scanning capabilities of NE were used to identify areas with elevated gamma radiation levels in the Reading Prong region of Pennsylvania.

Office of Environment, Safety and Health (EH)

Within EH there are several areas of indoor air accomplishments: 1) aerial radiation surveillance; 2) IAQ information dissemination 3) policy support; and 4) support of IAQ research. The Aerial Measuring System (AMS) has been extensively used to prepare background radiometric maps of most nuclear facilities in the U.S. In addition to radiation monitoring, AMS has aerial photography and infrared sensing capabilities. On occasion, aerial radiation surveillance has been conducted to assist public health officials in identifying areas having gamma radiation readings above background levels. This information is then used to conduct more detailed surveys with ground-based equipment.

Another accomplishment within EH is the synthesis of information on specific indoor air quality topics and development of information handbooks for use by state and local public health officials, policy analysts, concerned tradespeople such as builders and architects, and homeowners and consumers. Handbooks on the subject of combustion sources, indoor radon, and building system characteristics have been completed. These reports provide a comprehensive review and reference source on pollutant emissions, indoor

concentrations (and factors influencing those concentrations), health effects, monitoring methods, and mitigation/control techniques.

EH has assisted in the review of IAQ-related environmental impact statements, research programs and plans, proposed Congressional legislation, etc., in order to develop a DOE response.

Responding to the need for more comprehensive indoor pollutant exposure data, EH has co-funded a project to design a combustion sources concentration model which will attempt to determine the nature of the distribution of indoor concentrations of combustion pollutants in single family dwellings. Of particular interest are the factors which are dominant in high concentration homes. In addition, EH completed a review of current data on emission rates resulting from the use of kerosene heaters, wood stoves and fireplaces. EH has also co-funded research of indoor air quality control techniques which examined pollutant-specific control strategies.

In addition, EH provides policy support through: participating in the CIAQ; representing DOE on the Policy Subpanel of the Committee on Interagency Radiation Research and Policy Coordination (CIRRPC); and conducting analyses of regulatory/legislative initiatives related to indoor air.

Bonneville Power Administration (BPA)

BPA has been involved in IAQ issues since 1980. IAQ became an issue of concern for BPA when it began to evaluate the potential environmental effects of a proposed regionwide residential weatherization program. Since that time BPA has conducted several millions of dollars of research related to the implementation of its energy conservation programs.

In 1982 BPA prepared an Environmental Assessment on the potential IAQ effects of implementing an energy conservation program in the commercial and institutional buildings sector. Several studies were conducted to gain better knowledge of the effects on IAQ from installing conservation measures, including changes in the operation of the HVAC system. In 1984 BPA completed an Environmental Impact Statement (EIS) on retrofit weatherization of residential structures in the Pacific Northwest. The EIS was supported by numerous IAQ studies on radon, formaldehyde, combustion by-products, and other common pollutants introduced by occupants of the homes. A second EIS is being prepared on energy conservation in new home construction. IAQ is the major focus of the analysis and incorporates many of the new studies completed for BPA.

Ongoing IAQ research related to BPA's energy conservation programs will continue. The focus of the research has changed direction from an emphasis on characterizing pollutants and their related health effects to developing better mitigation techniques to alleviate or minimize adverse IAQ effects.

To date BPA has done radon monitoring on 26,849 homes as part of the Bonneville residential weatherization retrofit program. A quarterly report is

published to provide an update on the radon monitoring results. The report includes a map and listing of the data.

Specific actions being taken by BPA related to IAQ are:

- o Providing IAQ information to residential homeowners, builders, and utilities;
- o Requiring the offering of radon monitoring to residential homeowners;
- o Established a 5 pCi/l action level for radon in homes built under BPA's programs with shared cost on mitigation for homes over the action level;
- o Controlling radon pollutant sources by requiring radon monitoring and mitigation or radon mitigation preparation in new residential structures;
- o Controlling formaldehyde pollutant source by requiring use of low-formaldehyde structural products in residential construction;
- o Requiring whole-house mechanical ventilation in new residential structures to control moisture, odors, and provide overall comfort;
- o Investigating radon mitigation systems; and
- o Conducting other radon related research on monitoring procedures and geological correlations.

FY 89 Plans

Office of Conservation and Renewable Energy (CE)

In FY 89 CE plans to:

- o Continue to quantify indoor radon entry rates and the factors which affect them; assess the variability of ambient radon levels; and develop and evaluate energy-efficient radon mitigation technologies for both new and existing structures.
- o Continue to develop and evaluate energy-efficient and cost effective source control and ventilation techniques to maintain acceptable indoor air quality, including laboratory and field measurements of ventilation effectiveness.
- o Continue to conduct measurements of indoor air quality, infiltration, and ventilation performance in two large office buildings, including volatile organic compound measurements.
- o Complete field evaluation of multi-tracer gas techniques for measuring the impact of multizonal air flows on IAQ.
- o Continue participating in collaborative efforts to issue voluntary industry consensus standards related to IAQ, infiltration, and ventilation, and continue participation in the interagency CIAQ.

Office of Energy Research (ER)

The Radon Research Program, significantly expanded in 1988 in response to increased national concern, will continue in FY 89. This program, in accordance with the DOE/EPA Memorandum of Understanding, will emphasize the basic scientific research needed to establish risk from exposure to indoor radon. Research will include identification of critical cells in the lung, improved dosimetry, and modeling of radon in soils and the studies of interactions between radon and smoking in lung cancer development.

Office of Nuclear Energy (NE)

GJRAP- In FY 89 it is expected that site remedial actions will continue to be conducted, vicinity properties surveys will be completed, and vicinity property remedial actions will continue to be conducted.

UMTRAP- In FY 89 it is expected that cleanup at Ambrosia Lake, NM will be 70% complete and 95% complete at Durango, Co. In addition, it is expected that 600 inclusion radiological surveys and 800 remedial actions will be completed at vicinity properties.

FUSRAP- In FY 89 it is expected that at 10 sites data collection and evaluation, and design work for site cleanup will be well underway. In addition it is expected that cleanup efforts at 2 sites will be certified complete. Also, efforts to identify disposal sites for remedial action wastes will continue through this period.

SFMP- In FY 89, remedial action will be initiated at 2 sites, continue at 14 sites, and be completed at one site. Work will be completed on the final two of the originally designated 48 Monticello vicinity properties. The Monticello vicinity properties project is the only SFMP project which addresses reduction of radon concentrations of indoor air.

Office of Environment, Safety and Health (EH)

In FY 89 EH plans to:

- o Continue work in the area of indoor exposure modeling, including:
1) expansion of the combustion exposure model to include SO₂ and organic pollutants/mutagens; 2) development of a radon exposure model; 3) identification of information gaps needed to develop an organics exposure model; and 4) designing cost-effective field studies to fill in the identified information gaps.
- o Update the 1985 publication, Indoor Air Quality Environmental Information Handbook: Combustion Sources.
- o Continue to provide on an as needed basis, aerial radiation surveillance capabilities.

- o Continue to provide policy support for indoor air quality issues relevant to DOE, as well as participation in the CIAQ and CIRRPC.

Bonneville Power Administration (BPA)

In FY 89 BPA plans to:

- o Continue to investigate ventilation rates in homes (PFT and blower door); effects on moisture control, and innovative whole-house systems;
- o Examine methods for testing and demonstrating mechanical systems in cooperation with other organizations;
- o Radon monitoring and mitigation; and
- o Radon vs house tightening investigations.

Long Term Role

The Department of Energy supports the continued efforts of the CIAQ to coordinate and provide direction regarding indoor air quality research. Within budget constraints, a major goal of DOE research is to provide improved understanding of potential health effects and to identify the factors which influence pollutant concentration in structures and to develop continuing monitoring and control methods which enable the construction of energy conserving homes without sacrificing indoor air quality. Similarly, the Department's Remedial Action Program will continue to address potential hazards from radioactive contamination remaining at facilities and sites previously used in the development of the nation's atomic energy program.

C. DEPARTMENT OF HEALTH AND HUMAN SERVICES (DHHS)

CENTERS FOR DISEASE CONTROL (CDC)

National Institute for Occupational Safety and Health (NIOSH)

NIOSH's authority for indoor air quality investigations is mandated in Section 20 of the Occupational Safety and Health Act, and the accompanying right-of-entry provisions of the Act. Sections 20(a)(2) and (a)(3) provide NIOSH the authority to develop criteria for toxic substances which are to be used by OSHA to formulate safety and health standards. Section 20(a)(6) provides NIOSH the authority to conduct health hazard evaluations at the request of authorized representatives of employees or employers. Sections 20(a)(1), (a)(4), and (a)(7) provide NIOSH the authority to conduct research, experiments and demonstrations relating to occupational safety and health.

Most of the activities in NIOSH that directly relate to indoor air quality involve requests for assistance from workers and employers. The NIOSH

response to their requests is accomplished, as mentioned above, through NIOSH's Health Hazard Evaluation Program. Since 1971, the NIOSH Health Hazard Evaluation Program has conducted approximately 550 indoor air quality investigations in a variety of office building environments. (In FY'88, there were approximately 40 health hazard evaluations/field studies completed in office buildings.) Generally, the major problems that have been found are contamination from inside the building, contamination from outside the building, contamination from the building fabric, microbial contamination, and inadequate ventilation. Also, it has been found that although it is not uncommon for more than one type of problem to exist in a single building, inadequacies in ventilation systems, or their operation, are the major contributor to indoor air quality problems.

As part of the health hazard evaluations, considerable data have been collected such that a guidance document "Guidance for Indoor Air Quality Investigations" has been published. This document is disseminated to employers and employees to help them in directly evaluating their indoor air quality problems.

In FY'89, it is expected that NIOSH will respond to a similar number of requests (as FY'88) from employers and employees to evaluate indoor air quality problems.

In regard to technical assistance, NIOSH also provides an 800 number for individuals or groups to contact in regard to occupational safety and health issues. In FY'88, NIOSH, via this mechanism, responded, with written material, to approximately 300 requests for information on indoor air quality. It is expected that in FY'89 this activity will continue at the same level.

In regard to NIOSH research and criteria development, there are numerous current and past projects (epidemiologic research, toxicologic research, analytical methods development, control technology/ventilation research, personal protective equipment research, psychological job stress research and criteria recommendations) that indirectly relate to indoor air quality issues. For example, these projects deal with substances and issues such as aldehydes, methyl alcohol, ammonia, acetic acid, microbials, fibrous glass, asbestos, various organic solvents, polychlorinated biphenyls, carbon dioxide, carbon monoxide, sulfur oxides, oxides of nitrogen, metals, pesticides, lighting problems, noise, other physical/work station problems, psychological responses to air contaminants, psychological responses to organizational factors, video display terminals, et al.

In FY'89, general research activities that cut across into indoor air quality issues will continue. Also, in FY'89, a new research initiative is being considered that, when completed, would be used to improve the tools for conducting indoor air quality investigations. Aspects of this research involve (1) developing improved analytical techniques for monitoring volatile organic compounds and more sensitive direct reading instruments, and (2) developing specific investigative techniques for evaluating (a) ventilation problems; (b) clinical and psychosocial parameters, via a well designed questionnaire; and (c) physical, chemical and biological exposures. Also in

FY'89, an add-on to NIOSH's training activities is being considered that would add indoor air quality educational materials into continuing education courses conducted by NIOSH training grantees and SHAPE/MINERVA participants.

Center for Environmental Health and Injury Control (CEHIC)

The Division of Environmental Hazards and Health Effects (EHHE), Center for Environmental Health and Injury Control (CEHIC), CDC, has authority for indoor air quality activities under its mandate to assist State and local health departments with preventing needless mortality and morbidity. EHHE and its organizational predecessors have been involved in indoor air quality issues for the past 10 years. The major accomplishments to date have been a national study of radon levels in National Park Service housing, investigations of asthma and other respiratory illness outbreaks associated with environmental exposures, and studies of cotinine as a biochemical marker of tobacco (passive) smoke in a variety of settings. FY'89 plans include continuing projects on passive smoking, radon, and environmental respiratory illness. EHHE's long-term role in indoor air quality is to continue to conduct studies that will more accurately determine the levels of indoor air pollutants and any associated adverse health effects, and to assist State and local health departments in appropriate settings.

EHHE is also actively participating in the cotinine measurements to be conducted by NHANES III.

Center for Chronic Disease Prevention and Health Promotion (CCDPHP)

The Office on Smoking and Health (OSH), CCDPHP, is the focal point for tobacco and health related activities in the Department of Health and Human Services. The mission of OSH is to prevent death, disease, and disability caused by tobacco use, and to coordinate a national program to reduce the prevalence of tobacco use in the overall population as well as in specific target groups. The OSH has long been active in the area of environmental tobacco smoke.

Major Accomplishments

Decision Makers Guide - A guide for setting up non-smoking policies at the worksite was produced in conjunction with the Office of Disease Prevention and Health Promotion, DHHS.

Secretarial Initiative - In 1985, OSH, under the aegis of Secretary Heckler, undertook a major effort to inform mothers of the risks of smoking during pregnancy. Two years later, with Secretary Bowen's endorsement, a second effort was made, with the additional message that babies should not be exposed to tobacco smoke. This latest initiative distributed public service announcements to television stations and over 2 million pieces of information to hospitals, the WIC and other maternal and child clinics, and the public.

Mortality Morbidity Weekly Report (MMWR) - In 1987, the OSH produced a major article on passive smoking for CDC's MMWR.

National Advisory Committee Meeting - The Interagency Committee on Smoking and Health (National Advisory Committee) which is chaired by the Surgeon General, and staffed by OSH, held a meeting to examine the progress made by Federal agencies in adopting the new GSA Regulations on smoking in Federal buildings.

Surgeon General's Report on Involuntary Smoking - In December 1986, DHHS released the Surgeon General's Report on Involuntary Smoking. This report, which was produced by OSH, is the most comprehensive scientific review of this subject ever undertaken. The report concluded that involuntary smoking is a cause of disease, including lung cancer, in healthy nonsmokers; the children of parents who smoke compared with the children of nonsmoking parents have an increased frequency of respiratory infection, increased respiratory symptoms, and slightly smaller rates of increases in lung function as the lung matures; and the simple separation of smokers and nonsmokers within the same air space may reduce, but does not eliminate, the exposure of nonsmokers, to environmental tobacco smoke.

During FY'89, the OSH anticipates that involuntary smoking activities will continue at the present level.

National Center for Health Statistics (NCHS)

The National Center for Health Statistics is the Federal government's principal health statistics organization. The legislative mandate for the Center is to collect, analyze, and disseminate health data for the United States population pertaining to all aspects of health and health behavior, including environmental, social, and other health hazards. Information is obtained from surveys, including population surveys (both interview and examination) and record based surveys (including vital records, hospital discharge records, and physician-based ambulatory care records).

Special emphasis in specific health areas are developed through interagency agreements. In the past, NCHS has had interagency collaborations with the Environmental Protection Agency, the National Institutes of Environmental Health Sciences, the National Cancer Institute, and the Office on Smoking and Health, CDC, to collect data related to environmental health issues.

In 1987, the National Health Interview Survey (NHIS) supplement included questions on workplace exposure to environmental tobacco smoke. The interviews were completed in January, 1988 and the data edits have been progressing. This study was conducted in collaboration with the National Cancer Institute. The 1988 NHIS includes information on general exposure to environmental tobacco smoke. This supplement was developed in collaboration with the Office on Smoking and Health.

In FY 1988, the Environmental Protection Agency and NCHS evaluated the feasibility of including radon tests in the home interview portion of the

National Health and Nutrition Examination Survey (NHANES) scheduled to begin in the fall of 1988. These assessments were determined to be unreliable and the equipment too cumbersome given the many other components of the survey.

The public use tapes for NHIS, 1987 will be finished and made available during the first quarter of FY 1989. The collection of the 1988 NHIS supplement will be completed in January, 1989 and editing of the tapes will proceed.

NCHS will continue to encourage interagency collaborations to assess issues of health related to indoor air quality. The extent to which these can be incorporated in the surveys conducted by NCHS depends on the balance of the time required to fulfill the mandated survey objectives and the respondent burden.

NATIONAL INSTITUTES OF HEALTH (NIH)

NIH supports and conducts a wide range of work that provides the biomedical research tools needed to address the health aspects of the indoor quality issue, including long standing study of lung, allergy and infectious disorders and diseases and the toxicology of environmental and industrial pollutants. Specific indoor air health concerns receiving increasing attention include: radon in households, exposure to passive smoking, the combustion by-products of heating and cooking, and the pollutants derived from building materials and furnishings. Most indoor air exposures are to complex mixtures of possibly hazardous substances at rather low concentrations, over long periods of time, to people of varying susceptibilities. The answers to these questions require significant advances in basic biomedical research.

National Institute of Environmental Health Sciences (NIEHS)

A significant body of data has emerged in the past several years that has given rise to concern about air quality indoors. The quality of air in factories and industrial buildings has long been recognized as a potential health hazard. Now, reports of illness caused by contaminants found in homes and offices, particularly those that have been "tightened" for energy efficiency, create concern that the places where people spend most of their time may be unhealthy. NIEHS has traditionally provided the basic and applied health related research necessary to identify and understand such environmental health hazards. The Institute has expertise in pulmonary pathobiology, inhalation toxicology and the epidemiology of environmental health risks that it is applying to study of the indoor air problem. Since its inception, NIEHS has devoted significant scientific and fiscal resources to study of the relationship between physical and chemical factors in the environment and pulmonary disease. To a large degree, this work provides the research tools essential to understanding the problem of indoor air contamination.

Among its relevant epidemiology studies, NIEHS has supported, since 1974, a continuing major air pollution study at Harvard University (the so called Six City Survey), which has developed the largest data base of indoor

air quality and respiratory health data ever collected. Studies also are underway investigating the health risks of radon exposure and passive smoking. A contract is about to be awarded focusing on the relationship between active and passive smoking and radon pollution in the etiology of lung cancer and other potential cancer sites.

NIEHS conducts toxicological studies on a number of chemicals or classes of compounds considered to be of particular concern in the indoor environment. Among them are: sulfur oxides; nitrogen oxides; asbestos and other fibers; metals, including lead, nickel and copper; solvents; and pesticides.

National Institutes of Allergy and Infectious Diseases (NIAID)

NIAID has had a long standing interest in the study of indoor air pollution, particularly the involvement of organic materials. One of NIAID's grants is in its 17th year. However, the involvement of allergists in the problem long precedes that date.

Methodologies designed for both indoor and outdoor allergens have made possible precise identification and quantification of several relevant allergens, including house dust, mite particles and indoor mold spores. With mites, for example, an association to asthma has been demonstrated. Asthmatic hyper-reactivity has been shown to be diminished in asthmatic patients maintained in mite-free environments.

Goals for future work in this area are to: make allergen sampling techniques generally available (such information will facilitate treatment regimens and the monitoring of decontamination efforts); elucidate the role of mites and cockroaches in the pathogenesis of asthma; and determine the role of immunotherapy in treatment of mite allergic asthmatics.

National Cancer Institute (NCI)

NCI has a number of studies relevant to indoor air. The following are highlights of these activities.

NCI is emphasizing the assessment of the role of indoor radon exposure in lung cancer risk. Based on newly-developed risk models, using data from earlier NCI studies of underground miners, it is estimated that radon may contribute to up to 10% of all lung cancers in the U.S. More precise estimates will be made based on data from ongoing case control studies of lung cancer in New Jersey, Missouri, Sweden, and China. These studies include detailed measurements of indoor radon levels.

A study in Shenyang, China is investigating the risk of lung cancer from indoor air pollution. Initial data suggests a rising risk associated with duration of exposure to coal burning stoves, which generate high levels of polycyclic hydrocarbons. Exposures to volatile from high temperature wok cooking were implicated in the high risk of cancer among non-smoking women in Shanghai.

Several case control studies have evaluated the possible association of lung cancer with passive smoking. In Shanghai the risks among non-smoking women tend to rise with increasing years of living with a smoking husband. These findings resemble earlier studies of lung cancer among non-smoking women in the U.S. and Japan, whose risk increased in proportion to the number of cigarettes their husbands smoked.

National Heart, Lung and Blood Institute (NHLBI)

A major focus of research on indoor air quality supported by the Division of Lung Diseases, NHLBI, is concerned with the health effects of passive cigarette smoking on the respiratory health of children. Several ongoing prospective epidemiological studies are assessing the effects of parental smoking on lung growth and occurrence of respiratory illness among children in random population samples in East Boston, Massachusetts and Tucson, Arizona. Investigators also are studying the effects of maternal smoking on neonatal lung function by means of recently developed infant lung function testing methods.

A demonstration and education project in North Carolina seeks to determine whether or not a health education program will reduce the frequency and severity of lower respiratory illness in the first year of life by decreasing infants' exposures to passive smoking.

National Institute of Dental Research (NIDR)

The dental community is concerned with the potential health risk of exposure to nitrous oxide, a commonly used dental anesthetic gas. Although the effects of this gas on the quality of the air indoors has been established, questions remain about possible reproductive health effects. NIDR is supporting a study investigating the hypothesis that nitrous oxide affects ovulation of occupationally exposed females.

HEALTH RESOURCES AND SERVICES ADMINISTRATION (HRSA)

The Division of Federal Occupational and Beneficiary Health Services is involved in developing asbestos protocols for medical tracking procedures, environmental tracking procedures, education strategies, respirator approval, computerizing clinical and environmental data, epidemiological data assessment, and analytical contracts for asbestos analysis. In addition, HRSA provides technical assistance to Federal agencies on asbestos issues and conducts workplace radon monitoring.

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRIES (ATSDR)

ATSDR activities concerning indoor air quality are limited to the investigation of causes of contamination if they are related to hazardous wastes in the environment. This activity is ongoing.

D. GENERAL SERVICES ADMINISTRATION

Authorization

The General Services Administration is charged with providing workspace for 955,000 Federal employees housed in 232 millions square feet of space in 1,700 government-owned and 4,700 government-leased buildings. In addition to acquiring the space, GSA has regulations governing the management of the workspace. GSA is also authorized to delegate to other agencies real property management responsibilities in single-tenant facilities.

History of Involvement in Indoor Air

GSA re-emphasized its efforts to provide safe and healthful indoor air quality in Federal buildings with programs that addressed specific pollutants. In 1979 GSA began to implement an asbestos program and in 1987 the Agency implemented a policy for controlling smoking. In 1988 GSA developed a broad indoor air program and a radon gas program. These policies apply to all GSA-controlled space, which includes owned, operated, leased and delegated buildings. Because GSA is not a health or regulatory agency, its programs are designed to comply with applicable regulations and guidelines issued by regulatory and standard-setting agencies. GSA issues consensus regulations with respect to Federal property management based upon guidance and regulations issued by other agencies.

Major Accomplishments

The GSA asbestos program calls for inspecting all buildings for asbestos-containing materials, implementing building operation and maintenance plans for such materials, and controlling and abating asbestos-containing materials which are damaged, subject to damage, or affecting other repair or renovation work. In addition, no new space with asbestos-containing material is to be introduced into the inventory of government-owned property through purchase, transfer, exchange, or construction. GSA will also avoid leasing space with asbestos-containing materials and, if asbestos-free space is unavailable, control or abatement actions are required prior to the signing of the lease.

GSA issued regulations to control smoking in GSA-controlled space. The program identifies areas of GSA buildings where smoking is prohibited and areas and areas which may be designated as smoking areas by agency heads. Individual tenant agencies are responsible for implementation of the smoking regulations which govern the GSA-controlled space they occupy.

The GSA radon program requires that all GSA controlled space will be assessed for radon on a one-time basis. The radon measurements will be performed over a 3 month time period to identify those buildings which require response actions. Response actions will be initiated in buildings, or portions thereof, where radon measurements exceed the EPA radon action level for homes of 4 picocuries per liter.

The GSA indoor air program has two components to address indoor air quality concerns. The first component is an on-going program, conducted from the GSA field offices. Under this component, the GSA field staff is charged with providing prompt response to occupant complaints. Controls are to be implemented as necessary to correct problems that are identified. If corrective actions are not apparent, indoor air quality studies may be conducted by GSA or the tenant agency to fulfill the Federal government's OSHA responsibilities as an employer. GSA field staff must report any findings from these studies to the field office manager.

The second component is a pro-active program, starting in 1989, that requires all GSA-controlled space to be assessed for indoor air quality concerns during the Safety and Environmental Management surveys which are conducted on a four year cycle. As part of its indoor air quality policy, GSA issued specifications for these indoor air quality assessments. All buildings are to be operated in accordance with FPMR requirements, but exceptions to address indoor air quality inadequacies are permitted. Elements of the assessments include the following actions:

- o reviewing the building operation and occupant activities records;
- o evaluating occupant complaints;
- o walking through the building to identify contamination sources;
- o sampling for key indicator contaminants (i.e., carbon monoxide, carbon dioxide, and formaldehyde, when necessary);
- o taking corrective actions if samples indicate poor indoor air quality, with an emphasis on eliminating the source of the problem;
- o evaluating the effectiveness of corrective actions.

In addition, special assessments will be made in relation to new construction and repairs and alterations to existing buildings and as part of pre-lease surveys when leasing space from the private sector.

E. TENNESSEE VALLEY AUTHORITY

Authorization

The authorization for TVA to pursue indoor air quality activities is principally derived from its responsibilities for promoting the general welfare of Valley citizens as defined in the TVA Act, its obligations under the National Environmental Policy Act (NEPA) and related executive orders to incorporate environmental decision making into the agency's programs and operations, and the Occupational Safety and Health Act to provide a safe work environment for its employees.

Individual offices are responsible for authorizing and conducting their indoor air activities. The agency indoor air program manager coordinates and reviews these activities with the assistance of the Interoffice Indoor Air Quality advisory committee.

History of Involvement in Indoor Air

Aside from its traditional industrial hygiene activities, the agency's first indoor air quality investigations examined how building materials having elevated level of radium influenced indoor radon concentrations. A field study of 40 homes conducted in 1979 found no significant difference in structures that had radium-enhanced building materials and those that did not, primarily because the variability of background radiation was so large. This finding is consistent with later investigations that found a broad range of indoor radon levels throughout the TVA region. TVA assessments have also determined that radium-enhanced building materials result in insignificant risks because the radioactive portion of these materials is a small proportion of the totals, and because radiation releases are reduced since the radioactive portion is encapsulated.

TVA's activities in indoor air quality expanded during the early 1980's because of its need to evaluate the indoor environmental management aspects of the agency's conservation and utilization programs, and because of its responsibilities as a natural resource management agency, to protect and enhance the resource and the general welfare of the citizens of the region.

TVA'S indoor air quality program has also focused on the development of multidisciplinary cooperation studies. The agency's investigations are designed to address questions related to occupancy, building and equipment, and/or air resource effects. Virtually all of TVA's major studies have been undertaken in cooperation with local, state, or federal agencies, or private sector organizations.

Major Accomplishments

TVA has implemented an integrated air quality program to provide for public information and education; technical assistance to agencies and organizations; and research and demonstration projects supporting the evaluations of its programs and operations. The following describes major accomplishments realized for these programmatic components.

Public Outreach -- TVA provides information on indoor air quality to the public through its Citizens Action Line, the publication and distribution of booklets and brochures, and through public meetings and lectures. Since 1985 TVA's toll-free Citizen Actions Lines have been serving as a hot line for Valley residents to obtain general literature on indoor air quality. Inquiries of a highly technical nature are referred to TVA's professional staff by the Citizen Action Lines personnel. TVA has also published three consumer-oriented booklets that deal with indoor air quality concerns related to weatherization, sources, health effects and control. Also general informational sections on indoor air have been incorporated into several of its energy conservation brochures. Educational materials have also been developed by TVA for used by teachers in the Valley. Staff have made numerous presentations to civic and community groups on indoor air over the last

several years to promote awareness and understanding of potential indoor environmental risks and ways to avoid or control them.

Technical Assistance -- As part of its initial 1979 indoor air quality field study, TVA organized one of the first regional groups of state radiological health agencies specifically to address indoor radon. As a consequence of this initiative the agency provided free radon detectors in 1985 to four states in the region to conduct preliminary radon surveys. Since then the agency has also helped organize meetings of local and state officials to examine a variety of indoor air quality concerns. A good example of this control and housing agencies in Chattanooga, Tennessee to help address health complaints of residents in low income housing projects. To date two field studies have been completed with TVA assistance to examine indoor VOC concentrations and to determine the distribution of indoor nitrogen dioxide levels in five public housing projects. Currently, an intervention study is underway to evaluate the effectiveness of improved gas equipment maintenance to reduce the high indoor nitrogen dioxide levels observed in these low income housing units during the previous study. Also, technical assistance and support was provided to local minority business to develop and test radon detection and control equipment. In general, the agency's technical assistance efforts on indoor air quality are a component of its Regional Air Quality Management Program.

Research and Program Evaluation -- Most of the indoor air quality research and development activities sponsored by the agency are related to the evaluation of operational questions relate to TVA's energy conservation and utilization program, chemical development activities, and occupational health and safety program. The following field studies and test and development activities have been implemented to provide new information for environmental decision making on various aspects of the agency's operations, assess emerging regional concerns, and evaluate and develop control technology options.

Wood Heating Indoor Air Evaluations: At TVA's Energy Use Test Facility studies were conducted between 1983 and 1985 to assess the influence of woodstove design and operation on indoor emissions. These studies were co-sponsored by BPA and CPSC. Also, field studies have been undertaken in areas with high wood heating use to examine ambient and indoor pollution from woodstove use. A small computer model has been developed to evaluate control options for indoor air pollution from woodstoves.

Multi-pollutant Field Studies: To examine indoor air quality questions associated with the agency's chemical development and energy conservation activities, several multi-pollutant field studies were implemented in cooperation with CPSC, EPA, and the Electric Power Research Institute and Alabama Power Company. A 70-home study was initially developed by TVA to assess the background and seasonal variability of indoor radon levels. This was expanded by TVA and its co-sponsors to provide for the measurement of other pollutants, the evaluation of passive monitors, measurement of air infiltration rates, and an assessment of home weatherization measures. A similar expansion was developed for a study involving over 30-homes in East Tennessee which was part of the Harvard Six Cities Study. This expansion

provided new information to the researchers on pollutant exposures in these homes for their health effects evaluations as well as yielding additional information on the influence of building characteristics and energy use on indoor air quality. This study included the first characterization of microbial distributions in noncompliant residential dwellings.

Office Indoor Air Quality Assessment: TVA has developed and initiated a Building Risk Management Program which is designed to identify, evaluate, and correct conditions in the agency's facilities contributing to poor indoor environmental conditions that may affect employee health and safety. This program includes the investigations of complaints, collection of building ventilation and design criteria, evaluation of employee survey data, and monitoring of physical, chemical, and biological parameters. TVA is also in the process of quantifying the potential radiological risk from indoor radon in a number of different work environments.

Public Housing Indoor Air Studies: As previously mentioned in the Technical Assistance section, TVA in cooperation with local and state officials has conducted studies to quantify volatile and semi-volatile organic chemicals, and indoor nitrogen dioxide levels in five Chattanooga public housing developments. In FY 88 an indoor nitrogen dioxide intervention study was implemented to evaluate the effect of improved gas equipment maintenance on indoor nitrogen dioxide levels.

Indoor Environmental Control Technology Testing: TVA's Energy Use Test Facility has been conducting studies on indoor air cleaning technologies for residential housing. A room-sized test chamber is used to evaluate the performance of the systems to remove tobacco smoke and other gaseous indoor pollutants. Nine commercially available systems have been tested to-date, including heat recovery ventilators, HEPA filters, and electronic air cleaners.

Integrated Energy and Environmental Management System: In FY88 TVA started a research project to develop and test a microprocessor control system for managing energy use and indoor air quality in buildings. Development of prototype and field testing is planned for FY 89.

Radon Diagnostics and Control: In cooperation with DOE and EPA, the agency has embarked on a year long study to assess techniques for determining and controlling radon entry into residential structures. Two different building types are being evaluated in this study, at sites in Huntsville, Alabama and Oak Ridge, Tennessee.

F. Occupational Safety and Health Administration (OSHA)
U.S. Department of Labor

Authority for Indoor Air Activities

The Occupational Safety and Health Administration (OSHA) was created under the Occupational Safety and Health Act of 1970 (OSHAct). The Act

authorizes representatives of the Secretary of Labor to promulgate safety and health standards and inspect workplaces for compliance with the standards. OSHA's jurisdiction covers situations involving exposure of employees to harmful conditions in workplaces. Most public buildings, since they are workplaces, would be covered by OSHA standards.

History of Involvement in Indoor Air Quality Activities

OSHA became a member of the Interagency Committee on Indoor Air Quality in 1983. OSHA has no research program specifically designed to discover or resolve indoor air quality problems since OSHA is not a research organization. OSHA, however, is concerned with worker's exposure to pollutants regardless of the type of workplace, including public and commercial buildings.

Major Accomplishments

OSHA has promulgated occupational health standards limiting employees' occupational exposure to over 600 toxic substances and conducts health inspections in both factory and office environments to ensure compliance with the standards. OSHA has established a health Data File which contains the information found during the health inspections. This file is a part of the OSHA Integrated Management Information System (IMIS). The data are made available to the committee upon request.

OSHA has completed a draft guideline for evaluating indoor air quality in workplaces other than industrial facilities. The guidelines will be made available to OSHA compliance officers and state consultants for evaluating indoor air quality problems in commercial office buildings in light of the current OSHA standards. It will include information on major health contaminants and their sources, health effects, sampling instruments, sampling methods, evaluation procedure, and recommended actions.

FY 89 Plans

No research projects on indoor air quality are planned for FY 1989. However, OSHA will issue a guideline of evaluating indoor air quality in workplaces other than industrial facilities.

Long Term Role

OSHA will continue to participate in the CIAQ, update the Health Data File of the IMIS, and promulgate standards as necessary.

G. DEPARTMENT OF TRANSPORTATION (DOT)

Authorization

Indoor air quality responsibilities of the Department of Transportation relate largely to types of enclosed spaces such as airliner cabins, merchant ships, Coast Guard vessels, buses, and highway tunnels. With

one exception, airliner cabins, there are no statutory requirements for this Department to take specific regulatory actions. However, DOT is involved to a limited degree in air quality control of its own facilities and transportation related interiors. Following is a brief overview of these activities.

Major Accomplishments

Coast Guard

The Coast Guard has funded a variety of research projects to study overall occupational health problems in the marine industry. One project was concerned with the control of exposure of personnel to hazardous materials transported by ship. Use of asbestos in Coast Guard vessels has been banned for several years. Removal of asbestos from merchant ships is being closely monitored by the Occupational Safety and Health Administration. Removal of asbestos from Coast Guard vessels takes place at the Curtis Bay facility and is monitored by the Coast Guard. Currently, the Coast Guard is looking for alternatives for use in applications such as fire prevention where asbestos was formerly required.

Maritime Administration (MARAD)

The Maritime Administration has developed an action plan for the control of asbestos in MARAD facilities or vessels for which MARAD is responsible such as the ready Reserve Fleet, where personnel exposure to airborne asbestos fibers is a potential health hazard. MARA technical, legal and administrative personnel determined how exposure to airborne asbestos fibers may occur in MARAD programs, the level of exposures encountered, and the appropriate methods to eliminate such exposures. As a result of this three year study, in both living and working quarters and provides for careful monitoring.

Federal Highway Administration

The Federal Highway Administration has monitored and issued a series of reports on air quality related to highway facilities. These studies have included air quality in cut-and-cover tunnels, air quality in bus terminals, air quality in truck cabs, and air quality in air-rights buildings above depressed highways. An evaluation of tunnel ventilation is currently underway.

Federal Aviation Administration

The Federal Aviation Administration has issued rules to control air quality in airplane cabins. Existing Federal Airworthiness regulations (FARS) require that each passenger and crew compartment must be ventilated and must have enough fresh air (not less 10 cu.ft. per minute per crew member) so that the crew can perform its duties without undue discomfort or fatigue; crew and passengers compartment air must be free from harmful or hazardous concentrations of gases or vapors; carbon monoxide concentrations may not

exceed three percent by volume. Cabin ozone concentration is limited both for instantaneous levels and 3-hour, time-weighted average levels. The regulations further provide that hazardous contamination of cabin air systems may not result from failures of the engine lubricating systems; and that the ventilation requirements for crew members must be met after reasonably probable failures or malfunctioning of the ventilating, heating, pressurization, or other systems or equipment.

Office of the Secretary

Public Law 98-466, enacted in 1984, directed the Secretary of Transportation to commission the National Academy of Sciences to conduct an independent study which has as its objective the determination of the adequacy of current policies and standards for providing suitable air quality in the cabins of civil commercial aircraft. Among other areas, the study focused on:

- o the quality of fresh air per occupant and overall quality of air onboard;
- o the quantity and quality of humidification;
- o onboard environmental conditions and contaminating limits.

A report to Congress dated December 1986 summarizes the Academy's findings and the Departments comments and recommendations. As a follow-up of that study a contractor will soon begin monitoring the air quality within airliner cabins, assess any health risk to the cabin crew and passengers, and analyze potential mitigation strategies.

DOT Facilities

In addition to the industrial setting, DOT's internal occupational safety and health program is tasked with monitoring and controlling indoor DOT environments suspected of having a detrimental effect on the quality of life. Specific projects have included the identification, evaluation and control of:

- o airborne mold at the Coast Guard headquarters building caused by a water leak. The mold was being distributed through the building's ventilation system;
- o pesticide contamination within Coast Guard government housing caused by the inadvertent injection of to the termite control pesticide choloradane into the ventilation system;
- o diesel exhaust gases within office space of the DOT headquarters building caused by the building design and the positioning of a truck loading ramp;
- o asbestos contamination within the FAA headquarters building caused by various remodeling and renovation projects;

- o pesticide contamination within all DOT headquarters building caused by improper pesticide application and or employee hypersensitivity.

APPENDIX

INDOOR AIR AND RADON RESOURCE HISTORY

**RESOURCE CHART FOR INDOOR AIR
(in millions)**

	FY 1986 ACTUALS	FY 1987 ACTUALS	FY 1988 ACTUALS	FY 1989 OPERATING PLAN	FY 1990 PRESIDENT'S BUDGET
Office of Air and Radiation (OAR) *					
Extramural\$	\$0.05	\$0.20	\$0.35	\$0.36	\$1.36
Total\$	\$0.20	\$0.40	\$0.88	\$0.98	\$2.24
FTE	3.0	5.0	10.8	10.7	14.7
Office of Research and Development (ORD)					
Extramural\$	\$2.02	\$2.22	\$2.56	\$2.75	\$2.68
Total\$	\$2.26	\$2.85	\$3.42	\$3.71	\$4.06
FTE	4.6	10.7	17.1	15.0	15.0
Total					
Extramural\$	\$2.07	\$2.42	\$2.91	\$3.11	\$4.04
Total\$	\$2.46	\$3.25	\$4.30	\$4.69	\$6.30
FTE	7.6	15.7	27.9	25.7	29.7

* includes EPA Regional Office programs

RESOURCE CHART FOR RADON
(in millions)

	FY 1986 ACTUALS	FY 1987 ACTUALS	FY1988 ACTUALS	FY 1989 OPERATING PLAN	FY 1990 PRESIDENT'S BUDGET
Office of Air and Radiation (OAR)*					
Extramural\$	\$2.40	\$2.86	\$4.90	\$7.40	\$15.40
Total\$	\$3.96	\$5.00	\$7.13	\$10.56	\$18.66
FTE	29.5	42.0	37.9	62.0	62.0
Office of Research and Development (ORD)					
Extramural\$	\$1.50	\$1.52	\$1.51	\$2.26	\$2.56
Total\$	\$1.97	\$2.48	\$2.56	\$3.42	\$3.95
FTE	9.0	18.2	16.7	17.9	17.9
Total					
Extramural\$	\$3.90	\$4.38	\$6.41	\$9.66	\$17.96
Total\$	\$5.93	\$7.48	\$9.69	\$13.98	\$22.61
FTE	38.5	60.2	54.6	79.9	79.9

*includes EPA Regional Office programs