THE IMPACT OF INDOOR AIR QUALITY ON THE GAS INDUSTRY

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I. Indoor Air Quality and Gas Appliances: An Overview

A. *Introduction*

The quality of indoor air is emerging as a popular environmental issue. Gas appliances, particularly unvented stoves and space heaters, are all too often cited as sources of indoor air pollution which may endanger health. Energy conservation measures which reduce outside air infiltration have also been associated with the deterioration of indoor air quality.

In response to concerns raised about the impact of gas appliance emissions on indoor air quality, the gas industry has been involved in indoor air quality-related research since the 1970's. The industry is also making efforts to work with members of the public and private sectors to prevent the dissemination of misinformation about gas appliances. Currently, the industry is particularly interested and involved in the Consumer Product Safety Commission's investigation of fuel-fired appliances.

The purpose of this paper is to present an overview of the indoor air quality issue to gas utility legal representatives. The paper discusses the *scientific, technological, regulatory* and *legal* issues relating to the indoor air quality debate. Particular emphasis is placed on matters of interest to the gas industry.

This paper recommends that the gas industry develop an informative position on indoor air quality and the proper use of gas appliances. It is further recommended that gas utility companies consider developing customer information programs on the subject. These efforts will enhance industry credibility and fulfill companies' responsibilities to provide safe gas service and information.

B. *Description of the Indoor Air Quality Controversy*

According to the National Academy of Sciences, many people in this country spend 80-90% of each day indoors — in a house, car, factory, office, store or

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restaurant.[1] Specific groups of individuals — children, the aged and the infirm-spend virtually all of their time in enclosed environments. The composition of the indoor environment is essentially the same indoors as outdoors, but the types and quantities of contaminants indoors are often different than those outside.[2] Numerous studies conclude that indoor exposure to pollutants can be substantial, and in many cases, unhealthy. Researchers have found concentrations of certain pollutants inside buildings which exceed outside concentrations, and in some cases, exceed the environmental standards set for outdoor pollutants.[3] Moreover, there is a large group of pollutants generated indoors which have no significant concentrations in the outdoor air.[4]

Pollutants which are frequently discussed as being "hazardous" include radon, aldehydes, certain consumer products, asbestos, tobacco smoke and combustion products from fuel-fired appliances. The combustion products which have received the most attention are nitrogen dioxide and carbon monoxide. The appliances most frequently discussed include unvented gas stoves and gas and kerosene space heaters.

Prior to the energy crisis in the 1970's, most buildings allowed infiltration of outside air into the living space sufficient to remove indoor pollutants. Increases in energy prices, however, have prompted individuals and institutions to reduce outside air infiltration to reduce energy consumption. Because more than one-third of the nation's energy is consumed in buildings,[5] federal and state energy conservation programs have focused on limiting the air exchange between indoors and outdoors.

This recent trend toward reducing air infiltration to conserve energy has raised concern that harmful concentrations of particular pollutants may be built up in buildings which are too "tight." According to the National Academy of Sciences, "Efforts to conserve energy present other potential problems indoors. Effective energy conservation measures can result in an over-capacity of existing heating equipment. Operation of such equipment at low load factors may decrease its overall combustion efficiency and increase emission of the products of combustion."[6] Higher indoor pollutant concentrations have also resulted as individuals have switched from clean space-heating fuels such as electricity and gas to wood and coal burning stoves, in response to rising energy costs.[7]

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[1]Comm. on Indoor Pollutants, Board on Toxicology & Envtl. Health Hazards, Assembly of Life Sci., Nat'l Acad. Sci./Nat'l Research Council, Indoor Pollutants [hereinafter cited as NAS Report] 1, 226-231 (1981). Time budget surveys also show most people in U.S. spend 16 hours at home. J.D. Spengler, K. Sexton. *Indoor Air Pollution: A Public Health Perspective,* 221 Science No. 4605, 9 (1983) [hereinafter cited as Spengler].

[2]J. Yocum, *Indoor-Outdoor Air Quality Relationships,* 32 Journal of the Air Pollution Control Assoc. No. 5, 500 (1982).

[3]*Id.*; J. Repace, *Indoor Air Pollution,* 8 Environ. Int'l No. 1-6, 21-36 (1982) [hereinafter cited as Repace].

[4]Repace, *supra. See also* NAS Report, Table I-1, Exhibit A of this paper.

[5]Spengler 9.

[6]NAS Report 8-9.

[7]Spengler 10. According to B. Hileman, *Indoor Air Pollution,* 17 Environ. Sci. Technol. No. 10, 470A (1983), U.S. sales of wood-burning stoves increased from fewer than 200,000 in 1972 to approximately 1.5 million in 1981, while about 3 million kerosene heaters were operated in the 1981-82 winter.

C. *Reactions of Popular Press, Scientific Community and Government*

The subject of indoor air pollution has become a matter of increasing interest and concern both in the popular press and the scientific community. Over the past five years, articles have appeared in *Consumer Reports,*[8] *Reader's Digest,*[9] *The Wall Street Journal,*[10] *Science,*[11] and *Environmental Science and Technology*[12] as well as many other periodicals describing the "dangers", "hazards" and "menace" of indoor air pollution. Hundreds of technical or scientific studies have been conducted on indoor air quality, the health effects of indoor pollutants, and air infiltration.[13] Many of these papers have been presented at conferences such as the International Symposium on Indoor Air Pollution, Health and Energy Conservation, which was conducted in October, 1981 in Massachusetts. At that conference alone, 15 papers dealt specifically with pollution from fuel-fired appliances.[14] Many others referenced the problem.

At the federal government level, a significant commitment has been made to investigate indoor air quality. In 1979, an Interagency Research Group on Indoor Air Quality was established to coordinate research between federal agencies.[15] In September, 1980, the Comptroller General released GAO Report CED-80-111 entitled *Indoor Air Pollution: An Emerging Health Problem.*[16] The study recommended that the Environmental Protection Agency (EPA) be given a mandate to address indoor air quality. In late 1981, the National Academy of Sciences released an extensive study entitled *Indoor Pollutants* (NAS Report), which was performed at EPA's request under the Carter Administration.[17] These two reports have influenced the activities of various federal agencies in investigating indoor air pollution.

Although some commentators maintain that indoor air quality research has been given a low priority in federal research circles, more than $71 million was

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[8]*Kitchen Ranges,* Consumer Reports, 46-49, 58 (Jan. 1984); *The Kerosene-heater Controversy,* Consumer Reports, 20 (Jan. 1983); *Are Kerosene Heaters Safe?,* Consumer Reports, 499-507 (Oct. 1982).

[9]L. Ponte, *The Menace of Indoor Pollution,* Reader's Digest Reprint 2-6 (Feb. 1983).

[10]G. Getschow, *Indoor Air Pollution Worries Experts As Buildings Are Sealed to Save Fuel,* The Wall Street Journal, Aug. 15, 1979, at 6, col. 1, 2.

[11]Spengler 9-17.

[12]Hileman, *supra* note 7 at 469A-472A.

[13]A computer data base search conducted at NSP found over 60 scientific/technical papers published in the past 3 years.

[14]130 papers were presented at the International Symposium on Indoor Air Pollution, Health and Energy Conservation, Amherst, Mass., Oct. 1981, and 67 of these papers were published in 8 Environ. Int'l No. 1-6 (1982).

[15]The composition of this group was described in the 1983 House Subcommittee Hearings, *Indoor Air Quality Research, Hearings Before Subcom. on Energy Dev. and Applications & Subcom. on Nat'l Resources, Agric. Research and Environ. of Comm. on Sc. & Tech.,* U.S. House of Reps., 98th Cong., 1st Sess., August 2, 3, 1983, No. 54, at 36-37 [hereinafter cited as Subcom. Hearings]. The politics affecting the group are described in Hileman, *supra,* note 7 at 472A. This group sponsored a Workshop on Indoor Air Quality Research Needs in Dec., 1980. *See* Potential Health Effects of Residential Energy Conservation Measures. GRI Final Report (Feb. 1980 - Feb. 1981), July 1981 at 7-1 [hereinafter cited as GRI Report].

[16]U.S. General Accounting Office, Indoor Air Pollution: An Emerging Health Problem 1 (1980) (Pub. No. CED-80-111).

[17]NAS Report, *supra* note 1.

expended on indoor air research by federal agencies, in 1981 and 1982.[18] In 1983, Congress approved spending bills that included $2 million for EPA and $1.6 million for Department of Energy indoor air research in fiscal year 1984.[19]

Currently, there are bills pending in both houses of Congress which would require the EPA to conduct an indoor air quality research program, with a proposed appropriation of $4 million for each of the fiscal years 1984 and 1985.[20] Although the Reagan Administration has proposed a $278 million budget for EPA research, the proposal has been criticized as being too low. Critics have identified several specific research programs that merit additional funding, including indoor air pollution.[21]

In August, 1983, two House Science and Technology Subcommittees held hearings on indoor air quality. Witnesses at the two-day session testified that air quality in certain buildings is dangerous to the health of occupants and emphasized the need for a concerted federal agency effort to assess and deal with the problem.[22]

Although no federal agency has specific authority to regulate indoor air quality, a variety of federal agencies have jurisdiction over particular pollutants and/or their sources. The relevant activities of federal agencies are described in Section V of this paper. Of particular interest to the gas industry is the Consumer Product Safety Commission's recent investigations and reports relating to fuel-fired appliances, including kerosene heaters and unvented gas space heaters.

State and local governments are also becoming increasingly active in the indoor air quality area. A review of the activity of certain states in regard to indoor air quality is provided in Section VI, below.

D. Utility Industry Activities

In light of recent governmental activity and concerns raised by various non-utility groups, it is no surprise that the gas industry is also actively involved in this issue. The Gas Research Institute (GRI), for example, has an Environmental and Safety Research Program, a key element of which is indoor air quality research. As part of this program, GRI recently issued contracts to study exposure to selected emission species and health risks associated with appliances. Previously, in 1981 GRI issued a detailed report on *Potential Health Effects of Residential Energy Conservation Measures* (GRI Report) which focused on the residential indoor air quality environment.[23]

The American Gas Association (AGA) has also been active in the area of indoor air quality.[24] The AGA has sponsored a number of studies, including an

[18]J. Everett and T. Dreher, *Institutional Aspects of Indoor Air Pollution in Energy Efficient Residences,* 8 Environ. Int'l No. 1-6, 525-526 (1982).

[19]The politics relating to the EPA appropriation are interesting. The current EPA administration has reversed a previous EPA request for zero funding for indoor air quality research in 1984. *See* Subcom. Hearings, 406.

[20]S. 768, sec. 305; H.R. 2899, sec. 8. In another bill to be considered in the House in June, 1984, EPA would be provided $3.5 million for indoor air quality research. H.R. 5713.

[21]R. Sangeorge, UPI wire service, April 10, 1984.

[22]Subcom. Hearings, *supra* note 15.

[23]GRI Report, *supra* note 15.

[24]*See* Erickson, *Overview of Indoor Air Quality,* AGA Technical Note-Operating Section, presented at the Indoor Air Quality Workshop, Dallas, Texas, Sept., 1983, sponsored by AGA Task Committee on Environmental Matters; DeWerth, *Emissions from Gas Appliances,* AGA Labs, Sept., 1983.

epidemiology[25] study which examined the association between respiratory disease and lung function with the use of gas or electric stoves. Recently, AGA Laboratories also opened a Gas Appliance Research and Demonstration House, supported by a GRI grant. This house will be used to test new gas appliances and to provide better data on emissions from such appliances.

In addition to the individual efforts of the GRI and the AGA, these groups are working with the Gas Appliance Manufacturers Association and the National LP-Gas Association as a technical task force to address concerns raised by the CPSC staff in their investigation and study of unvented gas space heaters. Other organizations such as the Southern California Gas Company have also maintained active indoor air quality research programs.

While the gas industry has been involved in the indoor air quality debate, it is also significant that the Electric Power Research Institute (EPRI) recently sponsored a 2-year, $700,000 study to examine the role pollutant sources and weatherization practices play in determining indoor pollutant concentrations. The results of this research were discussed in two recent EPRI Seminars on Indoor Air Quality.[26] EPRI also issued a useful report in February, 1984, entitled *Manual on Indoor Air Quality* (EPRI Manual) which was prepared "to assist electric utilities in helping homeowners, builders and new home buyers to understand a broad range of issues related to indoor air quality."[27] Previously, EPRI sponsored an indoor/outdoor air quality study consisting of a literature search and 20-month monitoring program comparing the air quality of residences with gas or electric stoves and smoking or non-smoking occupants.[28]

II. Sources, Characterization and Reported Health Effects of Frequently Studied Indoor Pollutants, With Particular Emphasis on Combustion Products

A. An Overview of Indoor Pollutants

The National Academy of Sciences Report extensively reviewed available data on radioactivity,[29] aldehydes,[30] certain consumer products,[31] asbestos and other fibers, tobacco smoke, fibrous glass, odors, combustion products and other

[25]Epidemiology is defined as the science that deals with the incidence, distribution and control of diseases in a population. Manual on Indoor Air Quality, EM-3469, Research Project 2034-3, Final Report, Feb. 1984 [hereinafter cited as EPRI Manual].

[26]EPRI Seminars on Indoor Air Quality, March 6-7, May 1-2, 1984.

[27]EPRI Manual iii.

[28]Yocum, *supra* note 2 at 505-518; R. Whitaker, *Air Quality in the Home,* EPRI Journal 7-14, March, 1982.

[29]Radioactivity includes radon and its alpha-emitting decay products. NAS Report 58-82, 307-322.

[30]The NAS Report focuses on formaldehyde, NAS Report 82-100, 322-339.

[31]Consumer products include aerosols, solvents, insecticides and pesticides. NAS Report 100-111.

pollutants.[32] Ultimately, the NAS Report concluded, upon review of indoor air pollutants, that "the present quality of the indoor environment and how this quality may change are matters of immediate and great concern."[33]

The following two subsections discuss the findings of the 1981 NAS Report, and the 1981 GRI Report, in regard to combustion products in general. The third subsection discusses a 1984 report of findings from the Harvard Six Cities Study, an important epidemiological study of the health effects associated with emissions from gas stoves and tobacco smoke.

B. Combustion Products

1. NAS Report

Representatives of the gas industry should be particularly interested in the NAS Report's discussion of fuel combustion products from space heaters, gas stoves and gas water heaters. According to that Report,

> The major pollutants associated with indoor combustion are carbon monoxide, nitric oxide, nitrogen dioxide, aldehydes and other organic compounds and find particles. These combustion products usually occur in low concentrations compared with the major combustion products — carbon dioxide and water vapor. Inefficient combustion from unvented or poorly vented space heaters, fireplaces and lamps can also emit carcinogenic hydrocarbon particles. Carbon dioxide and water vapor are also produced as a result of normal metabolic processes of building occupants and add to the burden associated with gas appliances[34] . . . . The extent to which products of combustion contaminate indoor air depends on the composition of the fuel, the temperature of combustion, the efficiency of combustion, the efficiency of the venting of the combustion products to the outdoor air, and the isolation of discharged air from makeup air that enters the occupied space[35] . . . . The products of indoor combustion that are most often of *health concern* are *carbon monoxide* and *nitrogen dioxide.* Airborne concentrations of these pollutants have been measured in a number of epidemiologic studies; but other air pollutants were also present, and these concentrations were usually not measured. *At best, epidemiology can demonstrate an association, but it cannot establish causality.*[36] (Emphasis added.)

The Report goes on to describe in detail the hazards of exposure to carbon monoxide and then states,

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[32]The NAS Report describes the nature and source of each pollutant and reported health effects. The Report also discusses the effect of indoor pollution on human welfare including human discomfort, decreased productivity, soiling, corrosion, maintenance and housekeeping. NAS Report 419-450. Table I-1 of the NAS Report depicts the source of certain pollutants and is attached here as Exhibit A. NAS Report 23. The table indicates that the sources of some pollutants like radon and formaldehyde are primarily indoor, while others like nitrogen dioxide and carbon monoxide have both indoor and outdoor sources.

[33]NAS Report 2.

[34]NAS Report 134.

[35]NAS Report 351.

[36]*Id.*

> Moderately severe exposures to carbon monoxide . . . can occur in kitchens as a result of ordinary use of a gas range, especially when the cooking utensils divert or quench the flame . . . [However, because] carbon monoxide is, of course, a pollutant common to cigarette-smoke and fossil-fuel combustion effluents . . . [the] effects of carbon monoxide from indoor combustion cannot be adequately assessed without considering the influence of exposure to cigarette smoke.[37]

In its discussion of the health effects of nitrogen oxides (NO_x) the NAS summarizes a number of epidemiologic studies wherein the occupants of homes with gas stoves were compared with those who used electric stoves. Ironically, most of these studies were primarily conducted to evaluate exposure to NO_x in the outdoor (not indoor) environment. The NAS Report notes that several British studies suggested a relationship between respiratory illness and/or lung (pulmonary) function and the use of a gas stove. In contrast, more recent studies in the United States failed to establish any such relationship.[38]

In its final analysis of combustion products the NAS Report concludes,

> Although confirmation is necessary, the available evidence suggests that important exposures to nitrogen dioxide and carbon monoxide can occur indoors and may constitute a sufficient threat to the general public health to justify remedial action.[39]

While this conclusion is troublesome for the gas industry, the NAS Report is reasonably evenhanded in its analysis of combustion products based upon the research information available in 1981. Although new research information since 1981 (see subsection B.3. below) could likely alter the NAS conclusion, at least with respect to gas stove emissions, the NAS Report and the studies it describes, are frequently referenced in discussions of the health risks associated with gas appliances.

Indeed, *Consumer Reports* stated in 1982 that studies indicate, "Children from gas-stove homes have a greater incidence of respiratory illness and impaired lung function than those from homes with electric stoves."[40] In a 1984 article, *Consumer Reports* further stated that,

> the evidence so far suggests that emissions from a gas range do pose a risk — though probably not a major one — of impairing the health of some people in some homes. If you are buying a new range and can choose between electric and gas, that fact, added to other advantages of electric ranges may make you choose an electric one.[41]

Similar discussions of the "gas stove" studies are found in the *Reader's Digest*,[42] *The Harvard Environmental Law Review*[43] and *Environment International*,[44] and in material

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[37]NAS Report 353.

[38]NAS Report 361.

[39]NAS Report 15.

[40]*Are Kerosene Heaters Safe?*, Consumer Reports 506 (Oct. 1982).

[41]*Kitchen Ranges*, Consumer Reports 49 (Jan. 1984).

[42]L. Ponte, *The Menace of Indoor Pollution*, Reader's Digest Reprint 2-6 (Feb. 1983).

[43]L. Kirsch, *Behind Closed Doors: Indoor Air Pollution and Government Policy* 6 Harv. Environ. L.R. No. 2, 48-352 (1982) [hereinafter cited as Kirsch].

[44]Repace 26-27.

submitted to the House Subcommittees.[45]

2. GRI Report

In order to get a thorough perspective on the current state of knowledge about sources of combustion products, the indoor concentrations of these products, and their health effects, representatives of gas companies should also consult the GRI Report. That Report characterizes pollutants identified in the residential environment, particularly those associated with the use of unvented heating and cooking appliances, and critiques the results of published indoor air sampling studies. A discussion of the health effects of pollutants associated with gas combustion, particularly nitrogen dioxide and carbon monoxide, is also included.

According to the Report, the association between nitrogen dioxide (NO_2) exposure and health effects is a controversial subject,

> because NO_2 is frequently associated with other pollutants such as ozone, sulfates and particulates and it is difficult to assess their relative effects. Furthermore, much of the monitoring data in NO_2 epidemiological studies is frequently of poor quality because it was collected using inaccurate sampling and analytical methods. Finally, at low levels of exposure the observed effects such as increased airway resistance may indicate normal adaptive responses rather than early signs and symptoms of disease.[46]

The GRI Report assesses evidence purporting to show a relationship between exposure to pollutants in the residential environment and adverse health effects, focusing on the effects of exposure to nitrogen oxides generated by indoor combustion processes.[47] The Report concludes that there are many unanswered questions regarding the health effects of nitrogen oxide exposure, because oxides of nitrogen at sufficiently elevated concentrations can cause adverse health effects.[48] Thus epidemiologists and other public health professionals remain concerned about the potential adverse health effects of low level exposures.[49]

It is apparent from both the NAS and GRI Reports that the subject of the health effects of pollutants from gas appliances is a controversial one, particularly in view of the inconsistent conclusions reached in the scientific studies summarized in those reports.

3. Harvard Six Cities Study

The most recent definitive and comprehensive epidemiological study of the respiratory health effects of indoor and outdoor air pollutants, including pollutants from gas cooking and passive smoking, is the Harvard Six Cities Study. This ongoing longitudinal study has been assessing the respiratory health effects of air pollutants among children and adults living in six cities in the United States, over a period of

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[45]Subcom. Hearings 17-24, 199, 250-265.

[46]GRI Report 3-2.

[47]GRI Report 3-1.

[48]The GRI Report reviews the EPA-Long Island study, several British studies and the AGA Indoor Epidemiology Study. GRI Report at 3-3 through 3-6.

[49]GRI Report 3-7.

years. Both the NAS and GRI Reports referred to *preliminary* results from this study in 1980. The results indicated that children from households with gas stoves had a greater history of respiratory illness before age 2, and significantly reduced pulmonary function, than children from households with electric stoves.[50] While those findings were based on very limited data, they were frequently cited in discussions on the subject of indoor air quality.

More substantive information from this study was recently reported in a 1984 issue of the *American Review of Respiratory Disease*.[51] As part of the study, pulmonary function, respiratory illness history and symptom history were recorded at two successive annual examinations of 10,106 white children in 6 cities. Parental education, illness history and smoking habits also were recorded, along with the fuel used for cooking. The results of these examinations do *not* show increases in respiratory illness among children exposed to gas stoves, although they do suggest "that exposure to gas stoves may be associated with reduced pulmonary function." The results also "provide strong support for a causal effect of sidestream cigarette smoke on increased respiratory illness" and reduced pulmonary function. The study further suggested a need for studies quantifying individual exposure to indoor air pollutants to provide a better understanding of health effects.[52]

Based on the most recent reports from the Six City Study, it appears that the health risks of gas stoves are probably minimal and may be nonexistent. The current information on other unvented appliances such as space heaters is not as clear.

III. Factors That Influence Exposure to Indoor Pollution

There are a variety of complex factors which can influence a person's exposure to indoor air pollution including human activities, geographic variations, building design and construction, and interaction with outside air. Of course each of these factors, in turn, varies over time. These factors are described in detail in a number of reports and summarized below.

A. Human Activities

According to the NAS Report, patterns of human behavior and activity determine the time spent in specific locations and thus knowledge of such patterns is essential in estimating pollutant exposures.[53] The amount of time spent at home, at work, in transit, etc., is relevant to the issue of pollutant exposure. Furthermore, the activities of building occupants that affect indoor air quality include not only the type and intensity of activities, e.g., smoking, cleaning, cooking, painting, sleeping, but the location and frequency of the activities. Occupants also determine the extent

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[50]Speizer, *Respiratory Disease Rates and Pulmonary Function in Children Associated with NO_2 Exposure*, 121 Am. Rev. Resp. Dis. 3-10 (1980).

[51]Ware, Dockery, Spiro, Speizer and Ferris, *Passive Smoking, Gas Cooking and Respiratory Health of Children Living in Six Cities*, 129 Am. Rev. Resp. Dis. 366-374 (1984).

[52]*Id.*

[53]NAS Report 226.

to which environmental and other control systems are used. For example the patterns of opening doors, windows, and vents, all impact individuals' exposure to both indoor and outdoor air pollution.[54]

B. Geographic and Local Variations

"The types of pollutants and the concentrations of each type vary between locations within a structure, between structures within a geographic area and between areas."[55] The NAS Report discusses some of these interrelationships.

Geographic variations are inextricably related to issues such as outdoor air quality and air infiltration. Weather, which has a regional character, influences the indoor air concentration of some chemicals such as formaldehyde. Moreover, there have been studies that indicate the geographic distribution of residential indoor sources of pollutants such as combustion products,[56] formaldehyde[57] and radon.[58] The NAS Report also identifies urban, suburban and neighborhood variations in indoor air quality.[59]

C. Building Factors

The NAS Report describes a variety of building factors that may affect indoor air quality,[60] including the building site, occupancy factors and building design. Characteristics of a building site can influence indoor air quality and include air flow around buildings, proximity to major sources of outdoor pollution, and type of utility service available.

Occupancy factors include the type, intensity and spatial characteristics of activity in a particular building and the operation schedule of a building. Elements of building design that affect the indoor environment include interior-space design, envelope design and selection of materials.

D. Interaction With Outside Air

1. Infiltration, Ventilation: General Discussion

Included in most major reports on indoor air quality is a detailed discussion of the relationship between indoor and outdoor air, and/or the significance of air

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[54]EPRI Manual 3-7.

[55]NAS Report 234.

[56]NAS Report, Table V-4 shows the geographic distribution of residential energy consumption by fuel type and region. NAS Report 236, 238.

[57]NAS Report, Table V-5 contains a list of the estimated stock of mobile homes in each state. NAS Report 236, 239.

[58]The Dept. of Energy has been analyzing the geographic distribution of radon-emitting materials in the nation. NAS Report 236, 240.

[59]NAS Report 240-245.

[60]NAS Report 247-252.

infiltration and ventilation in this regard.[61-64] The GRI Report includes two chapters on air infiltration and trends in residential air infiltration. The EPRI Manual also presents a useful discussion of air exchange, infiltration and ventilation.

All buildings exchange indoor air with outdoor air. The uncontrolled leakage of air through cracks and other openings in the shell of a building is called infiltration. The air intentionally supplied by opening doors and windows and by mechanical means is called ventilation.[65]

While outside air can bring dust and other outside pollutants indoors, it can also dilute indoor pollutants. "Thus it is generally true that higher rates of air exchange or infiltration are associated with lower indoor levels of airborne contaminants, and conversely, that lower rates are associated with higher levels."[66] One of the most common sets of units used to denote a ventilation rate is in terms of cubic feet of air per minute (cfm). Another measure used to describe the total infiltration rate into a space is the air exchange rate or air changes per hour (ach).[67] Air exchange rates in houses have been measured as low as 0.1 ach and as high as 4.0 ach. Rates in the same house may vary enormously from day to day and even hour to hour, depending on wind and temperature.[68]

Air exchange results in a sizeable transfer of heat across the shell of a building, accounting for a loss of 11% of the total annual energy consumption of the nation.[69] It is estimated that perhaps ⅓ to ½ of the heating and cooling loss in residential buildings is due to the air exchange between indoors and outdoors.[70]

As noted at the outset of this paper, the energy crisis of the 1970's resulted in a national energy conservation effort. Reducing air exchange and air flow rates in existing buildings through insulation and weatherization is one of most cost effective strategies for improving the energy efficiency of buildings.[71] Special techniques for reducing air infiltration in new construction are now employed by home builders and result in high energy efficiency. Unfortunately, by "tightening" existing and new buildings and reducing the air exchange, homeowners and builders may be increasing the concentrations of indoor air pollutants and the exposure of occupants to such pollutants.[72]

Both gas and electric utilities which are currently offering energy audits and energy conservation advice to customers should be aware of the potential problems associated with reduced air exchange. According to EPRI, however, "current research seems to indicate that conservation measures — unless carried to the extremes — may have only an incremental effect on indoor air quality."[73]

[61]GRI Report 4-1 through 6-35.

[62]EPRI Manual, *passim.*

[63]Yocum, *supra* note 2.

[64]At least 10 articles included in 8 Environ. Int'l No. 1-6, 395-409, 435-505 (1982) deal with infiltration and/or ventilation issues.

[65]EPRI Manual 2-2.

[66]GRI Report 4-1.

[67]GRI Report 4-2.

[68]EPRI Manual 2-4. Measurement techniques are detailed in GRI Report 4-2 to 4-12.

[69]EPRI Manual 2-1.

[70]EPRI Manual 1-2. *See also* GRI Report 5-1.

[71]EPRI Manual 2-7; GRI Report 5-7 to 5-10.

[72]EPRI Manual 2-7; GRI Report 5-10 to 5-12.

[73]EPRI Manual v.

2. Ventilation Standards

Standards for ventilation systems become relevant to any discussion regarding the connection between energy conservation and indoor air quality. Ventilation requirements in buildings have been specified since the 18th century.[74] Currently the primary ventilation standard in the United States is the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)'s standard 62-1981, "Ventilation for Acceptable Indoor Air Quality."[75,76]

At present, the ASHRAE standard is a voluntary one, unless incorporated by reference into building codes adopted by state or local authorities. (See Section VI.B. below). This standard was developed in an attempt to resolve conflicts between a previous ventilation standard, ASHRAE 62-73,[77] and ASHRAE standard 90-75, "Energy Conservation in New Building Design."[78] The latter standard was intended to reduce energy requirements in new buildings.[79] (See Sections VI.B. and VII.G. below).

In ASHRAE 62-1981, the quality of outdoor air to be used for dilution and control of indoor air pollution is defined in terms of EPA primary standards, other guidelines, and professional judgment. The standard contains required cfm rates per person for a variety of indoor spaces, mandating higher ventilation rates for smoking areas. The standard also includes recirculation criteria.

The ASHRAE 62-1981 standard also specifies two methods to assess indoor air quality: an objective measurement procedure, and subjective criteria to be applied in the absence of the former. Acceptable indoor air quality is defined as "Air in which there are no known contaminants at harmful concentrations and with which a substantial majority (usually 80%) of the people exposed do not express dissatisfaction."[80]

This definition, however, is subject to different interpretations. In fact, ASHRAE is reviewing and reevaluating the entire standard, in light of unresolved indoor air quality issues.[81]

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[74]NAS Report 452; EPRI Manual 2-7; Subcom. Hearings 124-126.

[75]ASHRAE Standard 62-1981, Ventilation for Acceptable Indoor Air Quality, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. 1-18 (1981) [hereinafter cited as ASHRAE 62-1981].

[76]The U.S. Dept. of HUD also has a ventilation standard applicable only to housing financed through the federal housing authority. U.S. Dept. of HUD. Minimum Property Standards for One- and Two-Family Dwellings, Vol. 1 (1973); U.S. Dept. of HUD. Minimum Property Standards for Multi-Family Housing. Vol. 2 (1973); U.S. Dept. of HUD. Minimum Property Standards for Care-Type Housing. Vol. 3 (1973).

[77]ASHRAE Standard 62-73, Standards for Natural and Mechanical Ventilation, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (1973) [hereinafter cited as ASHRAE 62-73].

[78]ASHRAE Standard 90-75, Energy Conservation in New Building Design, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (1975) [hereinafter cited as ASHRAE 90-75].

[79]NAS Report 454-456.

[80]ASHRAE 62-1981 at 2.

[81]*See* Section VII.G. *infra*, in regard to problems with ASHRAE 62-1981.

IV. Indoor Pollution Control Strategies: Technological and Behavioral Adjustments

A. Introduction

A discussion of available or potential controls for the variety of indoor pollutants is included in many reports on indoor air quality.[82-88] The importance of control technology and research, however, will depend on the levels of risk identified in risk assessment analysis.[89] Until the health effects of exposure to indoor air pollutants are validly determined, it will be difficult to gauge the amount of control necessary for any or all pollutants. This section will highlight general control strategies, with particular emphasis on controls for combustion product pollution. These controls might be voluntarily adopted by the industry in the future, or serve as the basis for mandatory regulation by future policy makers.

B. Control by Source Removal or Substitution

Source removal or substitution is the most effective means of controlling overall indoor pollution.[90] The NAS Report identifies a variety of examples of source removal including the institution of no-smoking areas in public buildings, the prohibition of the use of urea-formaldehyde foam insulation, and the removal of lead from house paint.[91] Of course, if source removal strategies "modify human behavior, conflict with consumer preference, or involve an economic penalty" they are unlikely to be effective and less likely to be adopted by regulatory agencies.[92]

In view of the lack of conclusive evidence to indicate any significant health risk associated with gas-fired appliances, and in view of the popularity of such appliances,[93] the removal of all vented and unvented gas appliances from homes has been suggested, but is not widely endorsed.[94] The removal of unvented combustion

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[82]NAS Report 450-455.

[83]GRI Report 7-5 to 7-9.

[84]EPRI Manual 8-1 to 9-1.

[85]Kirsch 339 *et seq.*

[86]Spengler 13-14.

[87]Erickson *supra* note 24 at 30-37.

[88]Repace 34.

[89]For a discussion of risk assessment *see* Section X.B.2.d. *infra* and the footnotes therein.

[90]NAS Report 495.

[91]*Id., See also* EPRI Manual 8-1 to 8-3.

[92]NAS Report 495.

[93]An estimated 45% of U.S. homes use gas for cooking. J. Raloff, *Cleaner Cooking With Gas,* 125 Science News 28 (Jan. 1984). Nearly 60% of U.S. homes use gas for water heating and home heating. Clean Your Room. A Compendium on Indoor Pollution, Calif. Dept. of Consumer Affairs at III. F. 9 (1982) [hereinafter cited as California Report].

[94]Kirsch 351, note 90. While Consumer Reports does not advocate removal of gas stoves, it does not give them a strong endorsement: "If you now own a gas range, should you consider junking it? Probably not, unless someone in your family has chronic respiratory problems." *Kitchen Ranges,* Consumer Reports 49 (Jan. 1984).

appliances is more frequently recommended[95] for eliminating the emission of combustion products into the indoor air. Although most space heating in the nation is by externally vented heating systems, the use of unvented gas and kerosene space heaters for residences is prevalent in rural and warm climates such as the southern United States.[96] The CPSC staff has recommended major technological changes in unvented kerosene space heaters and is now investigating unvented gas space heaters.[97] It is anticipated that the CPSC will also investigate gas stoves in the future.[98]

C. *Source Modification*

Source modification is an alternative to source removal. Containment of emissions from radon- and formaldehyde-emitting surfaces or asbestos building materials by barriers or sealants are examples of source modification controls.[99] Modification of the design of gas-fired appliances is currently a popular topic in the indoor air quality debate. Recently adopted environmental regulations in California, which limit the allowable concentration of nitrogen oxides in flue gas for water heaters and furnaces vented to the outdoors, prompted GRI and the AGA Laboratories to develop new burners and burner modifications for these appliances.[100]

Similar concerns about potential CPSC restrictions on gas range emissions have prompted the AGA Labs to develop low nitrous-oxide range burners for GRI. A low-NO_x jet-powered infrared gas range burner is also under design at Thermo Electron Corporation in Waltham, Massachusetts. Of course these burners are more expensive than other burners, at least at the present time.[101] Another technological modification which is already available on all new ranges is an automatic ignition device, rather than a pilot light. This device reduces gas consumption and emissions.[102]

Other possible modifications to the gas stove which are under consideration include lowering NO_x emissions from ovens and broiler burners, as well as equipping stoves with interlocking devices that would coordinate the use of a stove with a range hood fan and/or with warning devices which could be activated by contaminant levels or temperature.[103]

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[95]EPRI Manual 8-3; *Indoor Air Pollution: A Serious Health Hazard* at 12, National Indoor Environmental Institute (1983).

[96]NAS Report 135.

[97]*See* Section V.C. *infra* for discussion of CPSC activities.

[98]Erickson, *supra* note 24 at 41; *see also* the discussion on ventilation controls in Section IV.D. *infra*.

[99]NAS Report 495-496; Spengler 13.

[100]*Burner Inserts for NO_x Reduction,* GRI Technology Profile, (July, 1983). According to this source, the California market represents 10-15% of total furnace and water heater sales in the U.S.

[101]Raloff, *supra* note 93 at 28-29.

[102]J. Laboon, *Indoor Air Quality and Gas Appliances,* Presentation to Communications Conference (May, 1984) AGA Critical Issues Supp.6.

[103]GRI Report 7-5 to 7-9; EPRI Manual 8-3 to 8-8; California Report III F. 1 to III. G. 1; Repace 34.

D. Ventilation

Control of all indoor contaminant concentrations by dilution with fresh outdoor air, or recirculated filtered air using mechanical or natural methods, to promote localized, zoned, or general ventilation is a major control strategy. Field studies have demonstrated the effectiveness of mechanical ventilation systems in reducing indoor pollutants.[104] The cost-effectiveness of mechanical ventilation systems, however, will be a major concern to any building owner.[105]

Both the NAS and GRI Reports describe the need for new mechanical ventilation techniques and control sensors.[106] Air-to-air heat exchangers, which recover the heat contained in the outgoing air stream and transfer it to the incoming air stream, are currently available. Reports indicate heat recovery efficiencies as low as 50%, if fan power consumption is considered, and as high as 85%, if it is not.

Spot or local ventilation is frequently cited as the most effective control stratelgy for the elimination of combustion products from indoor air, particularly with respect to gas stoves. The majority of gas stoves in homes are not equipped with a vented range hood,[107] however, the typical vented hood has "the potential to reduce contaminant emissions to the indoor environment by approximately 40 to 50% or more when activated above an operating gas stove."[108] Indeed, some studies show use of a range hood effects 60 to 87% reduction in combustion products and is more effective than increasing whole house ventilation because pollutants are removed before they can enter the living space.[109]

Because there is nearly universal agreement that the use of a vented range hood alleviates any potential "problems" associated with gas cooking, regulators may consider a mandatory venting requirement for gas stoves in the future. To induce consumers to use range fans, some commentators have suggested the development of quieter fans and an interlocking mechanism integrated with burner controls.[110] Future fan redesign, however, should also take into account the fact that hood fans use energy and may provide a source of unwanted air infiltration when not in use, depending on their design and maintenance.[111] As an alternative to vented range hoods, unvented range hoods may effectively remove pollutants with the development of inexpensive filters.[112]

Unfortunately, vented and unvented range hood fans increase the cost of gas ranges. This fact concerns gas appliance manufacturers and gas industry marketing

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[104]EPRI Manual 8-7.

[105]EPRI Manual 8-6; A. Persily, *Evaluation of An Air-to-Air Heat Exchanger*, 8 Environ. Int'l No. 1-6, 453-459 (1982).

[106]NAS Report 496; GRI Report 7-5.

[107]Raloff, *supra* note 93 at 28.

[108]GRI Report 7-6.

[109]EPRI Manual 8-5; Traynor, Apte, Dillworth, Hollowell, Sterling, *The Effects of Ventilation on Residential Air Pollution Due to Emissions From A Gas-Fired Range*. 8 Environ. Int'l. No. 1-6, 445, 452 (1982). On the other hand, some studies suggest that the use of cross ventilation (two open windows) may be "more effective than hood fans in quickly reducing existing pollutant concentrations." California Report III. F. 17.

[110]GRI Report 7-6 to 7-7.

[111]California Report III F. 17.

[112]GRI Report 7-6 to 7-7.

representatives. It has also been suggested, however, that electric stoves should be required to have sensors, hoods and vents included with their installation to control the particulates which result from cooking food.[113]

E. Air Cleaning

Purification of indoor air by gas absorbers, air filters and electrostatic precipitators is viewed as a viable control mechanism for tobacco and wood smoke. These processes are described at length in the NAS Report[114] and the EPRI Manual.[115] Air cleaning devices have been used in large indoor commercial, industrial and institutional environments. Their efficiencies for smaller, residential environments, however, have not been determined.[116] Air purification technology for recirculating exhaust hoods is still being developed, however, and may also be necessary in the redesign of mechanical heating, ventilation and air conditioning systems.[117]

F. Behavioral Adjustments

The fourth control measure for indoor air pollutants is modification of behavioral patterns to reduce human exposure. Behavioral adjustments can be facilitated by consumer education, product labeling, building design and warning devices.[118]

1. Consumer Education

The importance of the initiation of consumer information programs to educate the general public about the sources, effects and remedies for indoor air pollution was discussed at the hearings before House Subcommittees last year.[119] According to the NAS Report,

> Education provides easy and inexpensive steps that help to improve indoor air quality . . . . Public interest organizations, public utilities, professional societies, trade and manufacturing associations and government agencies all have a responsibility to ensure that the public receives factual information related to indoor contaminants.[120]

Although the controversy surrounding the existence of indoor pollution "hazards" is not resolved, the public is becoming increasingly aware of the reports of health risks from indoor air pollution.[121] One recent survey of gas customer attitudes reported that 50% of the general public believes pollution directly and

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[113]Repace 34.
[114]NAS Report 471.
[115]EPRI Manual 8-7 to 8-11, App. B.
[116]NAS Report 495.
[117]GRI Report 7-7 to 7-8.
[118]Spengler 13.
[119]Subcom. Hearings 195-200.
[120]NAS Report 498.
[121]Subcom. Hearings 195.

immediately affects their health and welfare. The survey findings indicated that smoking is believed to be the major cause (58%) of indoor pollution, followed by gas furnaces (11%), gas appliances (9%) and kerosene heaters (9%).[122]

Consumers are getting some information, and possible misinformation, about indoor pollution from articles in the popular press[123] and other sources.[124] Gas utilities are also providing some indoor air quality information to customers. Currently, Northern States Power Company in Minneapolis, Minnesota, includes information in its Energy Library (a telephone call-in service available to customers) warning that "Making Your Home Too Tight Can Be Dangerous." Similarly, Minnegasco of Minneapolis, Minnesota, includes a customer bill insert in its winter gas bills describing why "Homes Need Fresh Air During the Heating Season," and also provides a "Combustion Air" fact sheet upon request. While these materials focus on the dangers of carbon monoxide gas buildups from automobiles, wood stoves and improperly vented furnaces, they also discuss the importance of air infiltration and ventilation.

A fact sheet dealing directly with indoor air pollution was published by Pacific Gas and Electric in June, 1983 entitled, "Commonly Asked Questions and Answers Regarding Indoor Air Quality." The information provided in this sheet generally describes the potential sources, possible effects and means to minimize indoor air pollution. It also provides a reading list of ten resources on the subject, including the NAS Report.

In addition to the types of customer advice offered by the utilities considered above, gas companies may wish to consider educating customers on the proper use of unvented gas appliances, since there may be some health risks associated with their improper use. In states in which the use of unvented space heaters is not contrary to law, the importance of ventilation, as well as the proper sizing of the heaters, should be discussed. The availability, cost effectiveness and limitations of technological controls such as exhaust fans, range hoods, air-to-air heat exchangers, air cleaners, and warning sensors could also be described in customer literature. The key emphasis for utilities should be to provide factual material to counteract inaccurate or incomplete information received from other sources.

As a final matter, because energy conservation advice offered by gas utilities to customers may affect indoor air quality, companies may wish to consider incorporating education on this subject into their conservation programs. The newly issued EPRI Manual on *Indoor Air Quality* provides some assistance in making this information available. That manual was "intended for utility conservation services, energy management, consumer relations and corporate planning professionals who need a concise but authoritative introduction to the subject."[125] The recent EPRI Seminars on Indoor Air Quality also dealt with the impact of this subject on utility conservation programs.[126]

[122]Laboon, *supra* note 102 at 4, citing result of 1983 Yankelovich, Skelly and White survey of customers attitudes toward natural gas industry.

[123]*See* notes 8 and 9 *supra*.

[124]The National Indoor Environmental Institute, Plymouth Meeting, Penn. offers indoor pollution advice and premises evaluation and diagnosis, for a fee, to building owners. *See 'Sick' Buildings a Pandora's Box*, ENR, 26, 33 (Oct. 1983).

[125]EPRI Manual iii, vi.

[126]*See* note 26 *supra*.

2. Other Behavioral Adjustments

Other behavioral adjustment devices suggested as controls include providing a description of the proper use and potential hazards of products and materials which may be sources of indoor air pollution on those materials, as well as altering the architectural design of building space, to create, for example, tobacco smoke free zones. Pollution detectors, which emit warning signals if certain contaminant concentrations are exceeded, are also behavioral control mechanisms.[127]

V. Current Role of Federal Government Agencies

A. Introduction

No federal government agency has unequivocal statutory authority to regulate the quality of non-occupational indoor air, i.e., the air quality in residences, office buildings, and public places. A number of agencies, however, have exercised jurisdiction over toxic and hazardous substances and other sources of indoor air pollution.

Previous agency reluctance to act on indoor air pollution[128] or to seek greater legislative authority in this regard, seems to be giving way to an increasing interest in the subject. The heightened awareness of agency officials and the interest of members of Congress is evident from the testimony presented at the House Subcommittee hearings. At those hearings, agency representatives emphasized a need for additional federal funding and research on indoor air quality. Increased agency involvement in this subject is also evidenced by the fact that the Federal Interagency Research Group on Indoor Air Quality, comprised of members from a variety of federal agencies, is now active for the first time in several years.[129]

A variety of resources have discussed current and potential federal regulatory activities in the area of indoor air quality.[130-136] The following discussion will highlight some of the current activities.

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[127]NAS Report 488-499; Spengler 13.

[128]Kirsch 361-362 describes five reasons for reluctance of federal agencies to act on indoor air pollution.

[129]The Federal Interagency Research Group is composed of the Environmental Protection Agency, The Dept. of Energy, the Consumer Product Safety Commission, the Dept. of Housing and Urban Development and the Dept. of Health and Human Services and other agencies. Subcom. Hearings 397.

[130]Kirsch 360-394.

[131]Erickson *supra* note 24 at 37-41.

[132]Spengler 11.

[133]Yocum, *supra* note 2 at 500.

[134]B. Raffle, *Indoor Air Pollution-Regulatory Options* Presented at the 87th Nat'l Meeting of Amer. Inst. of Chem. Eng. 1-14 (August, 1979).

[135]E. Ferrand and S. Moriates, *Health Aspects of Indoor Air Pollution: Social, Legislative and Economic Considerations,* 57 Bull. N.Y. Acad. Med. No. 10, 1063-1064 (Dec., 1981).

[136]R. Nalesnik, An Analysis of Federal Legislative Jurisdictional Responsibilities for Toxic and Hazardous Materials, Final Report 1-58 (Feb., 1980).

B. Environmental Protection Agency (EPA)

The EPA co-chairs the federal Interagency Research Group on Indoor Air Quality. Although under past EPA administrators the agency lost interest in indoor air,[137] testimony by EPA representatives at the House Subcommittee hearings indicated the agency's renewed interest and active participation in research in this area.[138] The EPA's spokesman noted that,

> EPA has the statutory authority to protect public health from air pollution and other airborne contaminants, as required by the Clean Air Act (CAA); the Toxic Substances Control Act (TSCA); the Safe Drinking Water Act (SDWA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); and the Uranium Mill Tailings Act.[139]

Under the Clean Air Act (CAA),[140] the EPA has the authority to regulate air pollutants emitted into the ambient air.[141] While the Act does not define "ambient air," EPA regulations specifically limit the CAA's scope to outdoor air or air "external to buildings."[142] Thus the EPA cannot regulate indoor air quality under the CAA. The National Ambient Air Quality Standards (NAAQS), however, which are set by the EPA under the Act, and which specify maximum permissible concentrations in the outdoor air for certain criteria pollutants,[143] are inevitably cited by some commentators as reference points for evaluating indoor air quality.[144]

The CAA directs the EPA to issue "primary" NAAQS to protect public health[145] and "secondary" NAAQS to protect public welfare.[146] The primary or public health standards are to be set at "the maximum permissible ambient air level . . . which will protect the health of any (sensitive) group of the population."[147] Thus EPA standards include a margin of safety between allowable levels and the lowest level found to produce adverse effects on an exposed sensitive person. Moreover, the NAAQS are time-weighted standards. Long-term standards for some pollutants are averaged over a year, while short-term standards include averaging times of one

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[137]Hileman, *supra* note 7, at 472A; Kirsch 365, note 203.

[138]Subcom. Hearings 394. EPA has the authority to work with the Dept. of Health and Human Services, Consumer Product Safety Commission and other agencies to research indoor pollutants under the Public Health Services Act, 42 U.S.C.S. § 242b(d)(1) (Supp. 1984).

[139]Subcom. Hearings 325.

[140]42 U.S.C.S. §§ 7401-7642 (1982 & Supp. 1984).

[141]42 U.S.C.S. § 7602(g) (1982 & Supp. 1984).

[142]40 C.F.R. § 35.501-1 (1983); 40 C.F.R. § 50.1(e) (1983).

[143]42 U.S.C.S. § 7409 (1982); 40 C.F.R. pt. 50 (1983).

[144]Kirsch 343-360; Yocum, *supra* note 2, 508-510. According to John Erickson of AGA, comparison between indoor pollutant concentrations and EPA's NAAQS is inappropriate. "The point to be made is that EPA standards are the result of a long political process, are developed from incomplete scientific data, and *definitely do not represent a threshold above which health effects will result.*" (emphasis in original). Erickson, *supra* note 24, at 15.

[145]42 U.S.C.S. § 7409 (1982 & Supp. 1984).

[146]Welfare effects are defined to include effect on soils, water, crops, vegetation, man-made materials, animals, weather, visibility, hazards to transportation, economic values, personal comfort, well-being and similar factors. 42 U.S.C.S. § 7602(h) (1982 & Supp. 1984).

[147]Erickson, *supra* note 24, at 13.

to 24 hours.[148]

The CAA also requires periodic review, and, if appropriate, revision of existing outdoor air criteria and standards.[149] Currently, the gas industry is particularly interested in the EPA's proposed reaffirmation of its NAAQS for nitrogen dioxide (NO_2).[150] After reviewing health and welfare criteria, EPA has proposed to retain the existing long-term primary and secondary standards for NO_2 now set at 0.053 ppm (100 ug/m^3) as an annual arithmetic average. The agency is currently reviewing public comments on this proposal.[151]

The EPA has not proposed to set a short-term NO_2 standard, although it has stated that it "is continuing to evaluate the evidence bearing on whether a separate short-term standard is requisite to protect public health." The agency, however, has specifically requested public comment on the question of the need for such a standard.[152]

As part of its reaffirmation of its current long-term NO_2 outdoor air standard, EPA assessed health effects data contained in animal toxicology studies, controlled human exposure studies, and community epidemiology studies including studies involving homes with gas stoves. In its evaluation of these studies, the EPA cited the outdated 1980 preliminary findings from the Harvard Six Cities Study and concluded,

> While the findings from the gas stove studies are preliminary and must be qualified, in EPA's judgment they do suggest that multiple exposures to peak short-term NO_2 concentrations may pose some unquantified health risk for young children.[153]

In response to the EPA's conclusions, AGA has informed that agency that recent 1984 data from the Six Cities Study has dramatically altered the preliminary reports and indicates no correlation between gas stoves and respiratory illness.[154] The industry also noted in its comments on the EPA proposal, that EPA's reference to indoor epidemiologic studies as "gas stove studies," is a misnomer. Such a misnomer is misleading and creates a negative public image for gas ranges, the AGA told the agency.[155]

Indeed, in a press report of the EPA's proposed reaffirmation of its long-term NO_2 standard, the reporter began the story with the following lead, "Children living in homes with gas stoves may suffer more respiratory illness and heart problems than those in homes with electric ranges, the Environmental Protection Agency

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[148]Because EPA standards are time-weighted, any comparisons of indoor air pollution levels with NAAQS must insure that averaging periods are comparable. Erickson, *supra* note 24, at 14.

[149]42 U.S.C.S. § 7409(d) (1982 & Supp. 1984).

[150]49 Fed. Reg. 37, 6866 (1984).

[151]In comments filed with the EPA on May 23, 1984, the AGA did not take issue with EPA's proposal to maintain its long-term No_2 standard, although the AGA noted it did not agree that available studies provide support for that standard.

[152]In its May 23, 1984 comments, the AGA strongly supported the EPA's proposal not to establish a short-term NO_2 standard, pointing out the recent results of the Harvard Six Cities Study, and other studies.

[153]49 Fed. Reg. 37, 6873 (1984).

[154]AGA Comments to EPA, May 23, 1984, *see* Section II.B.3. *supra.*

[155]AGA Comments to EPA, May 23, 1984.

reported . . . ."[156] Apparently the reporter interpreted EPA's references in its press release to impaired pulmonary function to be synonymous with heart problems. Clearly the focus of the report was on gas stoves, not the EPA long-term NO_2 standard.

Another relevant section of the CAA, in addition to the provisions relating to NAAQS, is section 112 which authorizes the EPA to set National Emission Standards for Hazardous Air Pollutants (NESHAPS).[157] The EPA can issue NESHAPS for pollutants which "may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible or incapacitating reversible, illness."[158] "A NESHAP can prohibit or regulate release of the pollutant from stationary sources."[159]

Under the NESHAPS provision of the CAA, EPA has regulated one aspect of indoor air pollution by curtailing the spraying of asbestos insulation and decorative material inside buildings.[160] The EPA has also used section 112 to regulate asbestos emissions in outdoor air.[161] According to an article in *The Harvard Environmental Law Review,* however, the EPA has promulgated NESHAPS for only four substances, notwithstanding the requests of environmental groups for the development of NESHAPS for many more substances.[162]

Another relevant source of EPA authority is the Toxic Substances Control Act (TSCA).[163] Pursuant to this statute, EPA may regulate chemical substances[164] presenting an "unreasonable risk of injury to health or the environment."[165] EPA has extensive authority under this statute and may prescribe a variety of remedies to alleviate the dangers of a substance. In prescribing such remedies, however, the EPA must use the latest burdensome approach and must also weigh costs and benefits.[166] Finally, if the health threat could be taken care of under another law administered by the EPA, then the TSCA cannot be used unless it is in the public interest to do so.[167]

Pursuant to the TSCA, the EPA has inventoried approximately 55,000 chemical substances in commerce, but has regulated only five classes of chemicals.[168] The EPA has not regulated indoor air quality under the TSCA, other than to issue asbestos rules in conjunction with the Department of Education under the Asbestos School Hazard Detection and Control Act of 1980.[169]

In November, 1983, however, EPA requested comments as to whether it should make a threshold determination under section 4(f) of the TSCA that formaldehyde

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[156]R. Sangeorge, UPI wire service, Feb. 17, 1984.
[157]42 U.S.C.S. § 7412 (1982 & Supp. 1984).
[158]42 U.S.C.S. § 7412(a)(1) (1982 & Supp. 1984).
[159]42 U.S.C.S. § 7412(c) (1982 & Supp. 1984).
[160]Kirsch 368, note 228 citing 40 C.F.R. § 61.22(e) (1981).
[161]Kirsch 368, note 228 citing 40 C.F.R. § 61.22(a)-(e) (1981).
[162]Kirsch 369.
[163]15 U.S.C.S. §§ 2601-2629 (1982 & Supp. 1984).
[164]15 U.S.C. § 2602(2)(A) (1982 & Supp. 1984).
[165]15 U.S.C.S. § 2605(a) (1982 & Supp. 1984).
[166]15 U.S.C.S. § 2605 (1982 & Supp. 1984).
[167]15 U.S.C.S. § 2605(c)(1) (1982 & Supp. 1984).
[168]Kirsch 372.
[169]20 U.S.C.S. §§ 3601-3611 (1982); 34 C.F.R. pts. 230-31 (1983).

presents a "significant risk of serious or widespread harm" sufficient to warrant expedited agency action to reduce such risk or harm.[170] This request reflected EPA's decision to re-examine its previous determination in 1982, that formaldehyde did not meet statutory criteria for priority designation under section 4(f) of the TSCA. The 1982 decision had been widely criticized by environmental groups and prompted a lawsuit by the Natural Resources Defence Council and American Public Health Association.[171]

Other statutes under which the EPA has regulated contaminants include the Federal Insecticide, Fungicide and Rodenticide Act,[172] the Safe Drinking Water Act,[173] Federal Water Pollution Control Act Amendments,[174] and the Uranium Mill Tailings Act.[175] None of these acts, however, directly provide for the control of indoor air quality.

C. *Consumer Product Safety Commission (CPSC)*

According to the testimony of Dr. Peter Preuss, Associate Director for Health Services, CPSC, at the August, 1983 Subcommittee hearings,

> The Commission has consistently selected indoor air quality as a priority project, committing contract dollars and staff time to research . . . In F.Y. 1983 the Commission provided a million dollars in funding for indoor air quality and will provide more than $1.3 million in F.Y. 1984. Although the Commission has limited resources *we are devoting more staff and money to indoor air quality than to any other issue.* (Emphasis added.)[176]

The CPSC is involved in indoor air quality research because many sources of indoor pollutants fall under its jurisdiction.

The Federal Hazardous Substances Act[177] gives the Commission authority to regulate hazardous substances, as defined by the Act, through the imposition of labeling and packaging requirements as well as product bans. The CPSC has used the Act to ban vinyl chloride as a propellant in household products, although the focus of the CPSC's activities has been principally to eliminate hazardous toys under the Act.[178]

Pursuant to the Consumer Product Safety Act (CPSA),[179] the Commission can also regulate indoor air quality, to an extent, by regulating "consumer products."[180]

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[170]48 Fed. Reg. 224, 52507 (1983).

[171]*See* 48 Fed. Reg. 224, 52508; N. Ashford, C. Ryan, C. Caldart, *Law and Science Policy in Federal Regulation of Formaldehyde,* 222 Science 894, 896-898 (1983).

[172]7 U.S.C.S. §§ 135-135k, 136-136y (1982 & Supp. 1984). Under this Act, the EPA has regulated pesticides. Kirsch 370, note 241.

[173]42 U.S.C.S. §§ 300f-300j-1 (1982 & Supp. 1984). Under this Act, the EPA has regulated asbestos and radon.

[174]33 U.S.C.S. §§ 1251-1265, 1281-1297, 1311-1328, 1341-1345, 1361-1376 (1982 & Supp. 1984). Under this Act, the EPA has regulated PCB's. *See* Environmental Defense Fund v. E.P.A., 598 F.2d 62 (D.C. Cir. 1978).

[175]42 U.S.C.S. §§ 2014, 2021, 2022, 2111, 2113, 2114, 2201, 7901, 7911, *et seq.* (1982 & Supp. 1984).

[176]Subcom. Hearings 39.

[177]15 U.S.C.S. §§ 1261-1276 (1982 & Supp. 1984).

[178]Kirsch 375, note 285 citing 16 C.F.R. § 1500.17(a)(10) (1981).

[179]15 U.S.C.S. §§ 2051-2083 (1982 & Supp. 1984).

[180]15 U.S.C.S. § 2052(a)(1) (1982).

Such products are defined as articles "for the personal use, consumption or enjoyment of a consumer."[181] Cigarettes, pesticides, drugs and other items are explicitly excluded from the definition.[182] Moreover, houses are not "consumer products" and components of houses, such as radon-emitting bricks, may not be included in the definition.[183]

The CPSC may promulgate consumer product safety standards for the performance and/or labeling of a product under the CPSA. The Act, however, mandates that the Commission rely upon voluntary standards in lieu of rulemaking, if the voluntary standards adequately address the risk associated with a product.[184] The CPCS can ban a consumer product which represents an unreasonable risk of injury, when no standard would adequately protect the public[185] and/or order a manufacturer to give notice of a hazard to the general public or known purchasers.[186] Other remedies are also available to the Commission under the CPSA.[187]

One of the Commission's major efforts under the CPSA at this time,[188] is its priority investigation of indoor air quality and fuel-fired appliances, including kerosene heaters and unvented gas space heaters and stoves. The purpose of such an investigation is "to define the pollutants that are emitted during combustion and to determine the levels of such pollutants that can build up indoors."[189] Although the agency has not yet taken any action with respect to gas stoves, it has investigated kerosene and gas space heaters.

An eight-month investigation of kerosene heaters, which followed a *Consumer Reports* article detailing potential hazards of those heaters,[190] resulted in the CPSC staff's recommendations for voluntary standards to limit nitrogen dioxide and carbon monoxide emission rates from kerosene heaters.[191] According to a CPSC representative, the kerosene heater association has unanimously adopted the CPSC's recommendations and is now working with the Commission in developing standards[192] and heater redesign.[193]

The history of the CPSC's review of the unvented gas space heater is more complicated. In response to a petition for a mandatory standard for all space heaters, the CPSC proposed a ban of unvented gas space heaters in February, 1978,

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[181]*Id.*

[182]*Id.*

[183]Kirsch 377.

[184]15 U.S.C.S. § 2056(b) (1982).

[185]15 U.S.C.S. § 2057 (1982).

[186]15 U.S.C.S. § 2064(c) (1982).

[187]Kirsch 374-382.

[188]The CPSC is also conducting a study of airborne pollutants (including volatile organic compounds and formaldehyde) in certain residences in its Oak Ridge Study. This study was discussed in the Subcom. Hearings 51-53. In a March 16, 1984 status report on this study, the CPSC staff stated that data from 10 homes using fuel-fired appliances as supplemental heat sources was not available at the time of the status report. Status Report on Indoor Air Quality Monitoring Study in 40 Homes, March 16, 1984 at 2.

[189]Subcom. Hearings 39.

[190]*Are Kerosene Heaters Safe?*, Consumer Reports, 499-507 (Oct. 1982).

[191]Subcom. Hearings 41-45.

[192]Subcom. Hearings 41-42.

[193]Subcom. Hearings 30.

but withdrew that proposal in March, 1979. In January, 1980, the CPSC proposed a standard requiring that unvented gas space heaters be equipped with oxygen depletion sensors. The standard became effective in December, 1981, but was withdrawn in May, 1983.[194]

In August, 1983, the CPSC staff issued its "Preliminary Findings On Pollutant Emissions From Unvented Gas Space Heaters"[195] which described the results of research performed at Lawrence Berkley Laboratory in California. Citing the adverse health effects of exposure to emissions from unvented gas space heaters the staff concluded, in a preliminary report,

> that unvented gas space heaters appear to present a risk to consumers through the pollutant emissions associated with normal use and reasonably foreseeable misuse. This risk increases with increasing heater size and decreasing ventilation.[196]

The gas industry criticized a draft of this report, prior to its issuance, but the CPSC staff was not persuaded by the criticism to change its conclusions.

The CPSC staff further recommended that additional efforts be made by the Commission, in cooperation with the LP and gas industries and appliance manufacturers, to characterize appliance emission rates and consumer use patterns, to determine "whether a nitrogen dioxide emission standard is needed and what level is technologically feasible."[197] The staff also cited a need to develop consumer use information and to provide this material to current users.[198]

While a gas industry task force is attempting to work with the Commission in its further study of the unvented gas space heater,[199] it is difficult to predict what action the CPSC will take in regard to these appliances. In view of the Commission's recommendations for kerosene heaters, the CPSC may propose voluntary emission limitation standards for unvented gas space heaters as well.

In the event that the CPSC decides to impose some sort of a mandatory performance standard, e.g., an emission standard, for unvented gas space heaters, the Commission must make a number of findings pursuant to Section 9(f) of the CPSA.[200] These findings concern, among other things, the degree and nature of the risk of injury the standard is designed to reduce, and the approximate number of products subject to the rule. The agency must also determine the public need for the products, and the means to accomplish the order while minimizing adverse effects on competition or disruption of manufacturing, consistent with the public health and safety.[201] Moreover, the rule or standard must also be reasonably necessary to eliminate an unreasonable risk of injury and impose the least burdensome

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[194]Indoor Air Quality. Fuel-Fired Appliances. Unvented Gas Space Heaters: A Preliminary Report. Chemical Hazards Program, U.S. Consumer Product Safety Commission at 1 (July, 1983) [hereinafter cited as Prelim. Report].

[195]Prelim. Report 8.

[196]*Id.*

[197]*Id.*

[198]Prelim. Report 8-9.

[199]*See* Section I.D. *supra.*

[200]15 U.S.C.S. § 2058(f) (1982).

[201]15 U.S.C.S. § 2058(f)(1) (1982).

requirement to prevent or reduce this risk.[202]

Finally, the CPSC's findings must be supported by substantial evidence on the record taken as a whole, according to the Act[203] and the courts.[204] The recent decision in *Gulf South Insulation v. U.S. Consumer Products Safety Commission,* 701 F.2d 1137, (5th Cir. 1983), indicates that the substantial evidence test places a heavy burden of proof on the CPSC. The case arose from a challenge by the formaldehyde industry to the Commission's ban of the use of urea-formaldehyde foam insulation (UFFI). The ban was premised on the CPSC's conclusion that formaldehyde poses an unreasonable risk of cancer to humans.

The *Gulf South* opinion found inapplicable the Commission's argument that the reviewing court should avoid substituting its judgment for that of the CPSC, where policy judgments and the resolution of conflicting scientific evidence plays a central role in the decision-making process. Instead the Court found that the Commission's ban was not supported by substantial evidence because (1) a single animal study was insufficient as the basis for a cancer risk assessment; (2) the statistical and scientific procedures used to measure formaldehyde levels were invalid; and (3) the CPSC was required but failed to show that the risk of injury from UFFI was unreasonable. *Id.* at 1140-1148. The court also concluded that any future regulatory effort directed at UFFI should be made pursuant to the Federal Hazardous Substances Act, not the CPSA. *Id.* at 1150.

Clearly, any efforts by the CPSC to establish mandatory standards for gas-fired appliances must improve upon the methodology and analysis employed in banning UFFI, in order to survive judicial scrutiny.

D. Department of Energy (DOE)

The DOE co-chairs the Federal Interagency Research Group with the EPA. According to the testimony of a DOE assistant secretary at the House Subcommittee hearings, DOE has been involved in indoor air quality research, since its inception.[205] Current research efforts were described at those hearings, including joint projects with EPRI and GRI.[206] Congressmen in attendance at the hearings, however, criticized recent decisions by DOE to cut back on some indoor air quality research.[207]

DOE's activities in regard to indoor air quality stem from the ancillary effects of efforts to reduce energy consumption in buildings, i.e., reduced outdoor air infiltration, etc. Under the National Energy Conservation Policy Act,[208] the DOE administers the Residential Conservation Service (RCS) Program to encourage the installation of energy conservation measures in existing homes. Recently a program similar to the RCS program was also instituted by the DOE for small commercial and

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[202]15 U.S.C.S. § 2058(f)(3) (1982).

[203]15 U.S.C.S. § 2060 (1982 & Supp. 1984).

[204]*See* Gulf South Insulation v. CPSC, 701 F.2d 1137, 1142 (5th Cir. 1983); A.S.G. Industries v. CPSC, 593 F.2d 1323, 1326 (D.C. Cir. 1979) *cert denied* 44 U.S. 864 (1979); Aqua Slide 'N' Dive v. CPSC, 569 F.2d 831, 837 (5th Cir. 1978).

[205]Subcom. Hearings 360-376.

[206]*Id.*

[207]Subcom. Hearings 376-393.

[208]42 U.S.C.S. §§ 8201, *et seq.*

apartment buildings.[209]

At the time the DOE proposed its rules[210] governing the RCS program, the EPA and others commented on the subject of indoor air quality and its relationship to conservation measures and criticized the program.[211] These comments were summarized in the preamble to the final rules, but there are no specific indoor air quality provisions in the RCS program rules.[212]

E. Occupational Safety and Health Administration (OSHA)

Under the Occupational Safety and Health Act of 1970,[213] OSHA has the broad authority to promulgate mandatory occupational safety and health standards which are "reasonably necessary or appropriate to provide safe or healthful employment and places of employment."[214] The Act also authorizes OSHA to adopt emergency temporary standards in situations in which workers may be exposed to grave danger from exposure to a toxic substance.[215]

In 1971 when OSHA first established its mandatory occupational safety and health standards, it adopted, practically without exception, the American Conference of Governmental Industrial Hygienists' list of Threshold Limit Values for chemical substances in workroom air, and incorporated the American National Standards for 18 contaminants into law.[216]

Current OSHA Permissible Exposure Limits for airborne contaminants[217] do not eliminate all effects such as unpleasant smells or mild irritation, but are designed to limit workers' exposure to substances harmful to health, based on accumulated experience and animal studies.[218] OSHA has promulgated standards for carbon dioxide, carbon monoxide, formaldehyde, nitrogen oxide and dioxide, ozone, asbestos, radon and a number of other contaminants.[219]

OSHA's standards for exposure to substances in the industrial workplace environment are generally expressed as time-weighted average concentrations and based on the assumption of a 40-hour work week of 8- or 10-hour days.[220] Application of these standards by reference to non-industrial environments, including residential environments, has been criticized as inappropriate, because the standards "deal with only one chemical at once . . . [and are] set for eight hours a

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[209]48 Fed. Reg. 208, 49642 (1983) (to be codified at 10 C.F.R. pt. 458).

[210]10 C.F.R. pt. 456 (1983).

[211]Kirsch 341-342, note 21.

[212]GRI Report 5-2 to 5-5.

[213]29 U.S.C.S. § 651, *et seq.* (1982 & Supp. 1984).

[214]29 U.S.C.S. § 652(8) (1982).

[215]29 U.S.C.S. § 655(c) (1982). Controversies have arisen under this statutory provision. *See* Public Citizen Health Research Group v. Auchter, 702 F.2d 1150 (D.C. Cir., 1983). *See also* N. Ashford, C. Ryan, C. Caldart, *Law and Science Policy in Federal Regulation of Formaldlehyde,* 222 Science 894, 898-9 (1983).

[216]GRI Report 5-2 to 5-4.

[217]29 C.F.R. 1910.1000, *et seq.* subpt. Z (1983).

[218]EPRI Manual 5-2.

[219]*See* EPRI Manual 5-4, 5-10; NAS Report 508, 510-511. Litigation has resulted from implementation of these standards. *See* Industrial Union v. American Petroleum Institute, 448 U.S. 607 (1980); United Steelworkers of America Etc. v. Marshall, 647 F.2d 1189 (D.C. Cir. 1980).

[220]EPRI Manual 5-2.

day for healthy working individuals and don't consider the elderly or the sick."[221] Notwithstanding this criticism, OSHA standards, like EPA's NAAQS, are frequently used as reference points in indoor air quality discussions.[222] Indeed, ASHRAE 62-1981 on "Ventilation for Acceptable Indoor Air Quality" refers to OSHA standards for guidance on acceptable exposure levels, although it recommends a reduction in OSHA concentration limits for the general public.[223]

As a final matter, it is interesting to note that OSHA standards differ from EPA's NAAQS in some cases, due to differences in the criteria used for each standard.[224]

F. National Institute of Occupational Safety and Health (NIOSH) and Centers for Disease Control (CDC)

NIOSH and CDC are part of the Department of Health and Human Services, formerly the Department of Health, Education and Welfare.[225] NIOSH also provides research support for OSHA.[226] NIOSH was established to conduct research in occupational health and safety, among other duties. Most of NIOSH's research on indoor air quality has been done as part of the Health Hazard Evaluation and Technical Assistance Program mandated by the Occupational Safety and Health Act and the Mine Safety and Health Act. Under this program NIOSH evaluates indoor air quality investigations in the work place. Dr. James Meklius of NIOSH described the results of over 200 investigations, more than 90% of which were conducted in the last 5 years, in his testimony before the House Subcommittees.[227]

NIOSH and the CDC have also initiated research that considers non-occupational exposures to indoor pollution, including a survey of state health department programs for hazard evaluations of such pollution.[228] This survey is discussed in Section VI.A. below.

Pursuant to the Occupational Safety and Health Act, NIOSH has also developed criteria for dealing with toxic materials and harmful agents, including safe levels of exposure. NIOSH may also recommend revisions to OSHA standards where changes appear warranted. Up to 1978, NIOSH published criteria for almost 100 individual substances or chemical families.[229] Consequently, NIOSH has a recommended standard for certain contaminants, e.g., formaldehyde and asbestos, which differ from OSHA's regulations.

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[221]*'Sick' Buildings a Pandora's Box*, ENR 32 (Oct. 1983).

[222]Kirsch 340; NAS Report *passim.*

[223]EPRI Manual 5-2; Subcom. Hearings 174; ASHRAE 62-1981 at 5.

[224]J. McFadden, J.H. Beard, D. Moschandreas, Survey of Indoor Air Quality Health Criteria and Standards, EPA-600/7-78-027 at 19 (March, 1978).

[225]20 U.S.C.S. § 3508 (1982).

[226]*See* Erickson, *supra* note 24, at 37-38; Public Citizen Health Research Grp. v. Auchter, 702 F.2d 1150, 1154, note 14 (D.C. Cir. 1983).

[227]Subcom. Hearings 324-339; Spengler 221.

[228]Subcom. Hearings 337.

[229]GRI Report 8-2 to 8-4; J. McFadden, J.H. Beard, D. Moschandreas, *supra* note 224, at 18-19.

G. Department of Housing and Urban Development (HUD)

HUD is involved in regulating certain aspects of the indoor environment. Under the National Manufactured Housing Construction and Safety Standards Act of 1974,[230] HUD has established federal manufactured home construction and safety standards.[231] These mobile home regulations include general provisions regarding air infiltration and ventilation,[232] but do not currently prescribe any mandatory indoor air quality standards. Mobile homes account for 5.1% of housing nationwide and make up 10% of the housing in each of 10 states.[233] Mobile homes are frequently cited as a source of indoor air pollution problems, particularly with regard to formaldehyde emissions.[234] According to testimony at the House Subcommittee hearings, HUD has initiated action to develop a mandatory standard to limit formaldehyde emissions in mobile homes.[235]

HUD has also promulgated Minimum Property Standards[236] applicable to housing built under HUD mortgage insurance and low-rent housing insurance. The Veteran's Administration, the Farmers Home Administration, and the Government Mortgage Corporation utilize HUD's Minimum Property Standards to a large extent in setting conditions on housing assistance grants.[237] In 1977 and 1979, HUD revised these standards to include a ventilation standard and infiltration rate limit, in an effort to comply with federal energy conservation efforts.[238]

H. Other Federal Agencies

A number of other agencies have some jurisdiction over indoor pollutants[239] or some aspect of indoor environments. The Food and Drug Administration (FDA) of the Department of Health and Human Services (DHHS), for example, has promulgated an allowable indoor air quality and emission standard for ozone in houses, apartments, hospitals, and offices.[240] This standard is the *only* mandatory indoor air non-workplace standard in the United States.[241] The FDA standard is lower than OSHA's 8-hour workplace standard and EPA's outdoor NAAQS 1-hour

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[230]42 U.S.C.S. § 5401, *et seq.* (1982 & Supp. 1984).

[231]24 C.F.R. pt. 3280 (1983).

[232]24 C.F.R. §§ 3280.505, 3280.710 (1983).

[233]U.S. Census Report for 1980, reported in Mpls. Star & Tribune, May 5, 1984 at 2S, col. 3.

[234]Spengler 10; Yocum *supra* note 2, at 516; NAS Report 86, 93; Repace 27-28.

[235]Subcom. Hearings 50.

[236]U.S. Dept. of HUD, Min. Prop. Stnds., *supra,* note 76.

[237]GRI Report 8-14.

[238]GRI Report 5-2; EPRI Manual 2-8.

[239]A general (although somewhat outdated) summary of federal agency jurisdictional responsibilities for toxic and hazardous substances is contained in Nalesnik *supra,* note 136. Additional agencies involved in indoor air quality include: the Mine Safety and Health Administration which has issued standards for mining operations, including radon exposure standards, 30 C.F.R. §§ 57.5-38 to 57.5-39 (1981); the Nat'l Aeronautics & Space Admin. which prescribes exposure limits in space craft, Bioastronautics Data Book, NASA-SP3006 (1973); the U.S. Navy which has developed air quality criteria for the air in nuclear submarines, U.S. Navy Pub. NAVSEA 0938-011-4010.

[240]21 C.F.R. § 801.415 (1983).

[241]J. McFadden, J.H. Beard, D. Moschandreas, *supra* note 224, at 34.

average for ozone,[242] and includes a margin of safety to protect sensitive individuals exposed to ozone over extensive time periods.[243]

Another agency which has regulated the indoor environment is the DHHS' Health Resource Administration. That office publishes standards for construction and equipment in hospitals and medical facilities, including ventilation requirements.[244]

VI. Current State and Local Activities Relating to Indoor Air Quality

A. Smoking Restrictions; General Indoor Air Quality Oversight

As evidenced by the increasing number of state "clean indoor air" laws and local ordinances regulating smoking in public places, state and local governments have responded to widespread public concern about tobacco smoke pollutants in the indoor air. According to the Department of Health and Human Services' July, 1983 Report on State Legislation on Smoking and Health, 61 state legislative bills were passed from 1975 through 1982 pertaining to regulating smoking in public areas,[245] including the workplace.[246]

Aside from the well publicized state and local interest in the tobacco smoke aspect of the indoor air quality controversy, a 1983 survey of state and Washington, D.C. health departments, by the DHHS' Center for Environmental Health, Centers for Disease Control, indicates that 63% (32 states) of these departments have a program for hazard evaluations of non-occupational indoor air pollution. Sixteen percent (8 states) of the health departments have a consultant available, but no program *per se*. Only 2% (1 state) has no program or consultant for indoor air evaluations.[247]

The fact that the vast majority of state health departments, and an unquantified number of other state administrative agencies, are currently interested in indoor air quality suggests that states may become more aggressive in regulating indoor air quality in the future. Regulation of certain aspects of indoor pollution could be accomplished through the adoption of state or local building code provisions.

B. Building Codes

According to one commentator there are approximately 8,000 building codes and regultions in state and local jurisdictions throughout the United States.[248] Only

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[242]J. McFadden, J.H. Beard, D. Moschandreas, *supra* note 224, at 3; NAS Report 506, 508, 512.

[243]J. McFadden, J.H. Beard, D. Moschandreas, *supra* note 224, at 3-4.

[244]Minimum Requirements of Construction & Equipment for Hospital & Medical Facilities. U.S. Dept. of HEW Pub. No. (HRA) 79-14500 (1979).

[245]State Legislation on Smoking and Health, 1982. U.S. Dept. of HHS, Public Health Service 90 (July 1983). *See e.g.* The Minn. Clean Indoor Air Act, M.S. §§ 144.411, *et seq.* (1982).

[246]The states of Minn., Mont., Neb., Utah and Conn. have all passed laws limiting smoking at work. San Francisco voters recently voted to enact a local ordinance to limit smoking in the work place. Mpls. Star & Trib., March 2, 1984, at 12A, col. 1-3.

[247]State Legislation on Smoking and Health, 1982, *supra* note 245.

[248]J. McFadden, J.H. Beard, and D. Moschandreas, *supra* note 224, at 46.

about 20 states, however, have state-promulgated building codes.[249] Existing building code provisions generally include design and construction standards relating to indoor air quality, including specifications for building materials and ventilation and infiltration requirements.[250]

Enforcement of building codes is left to the governing body of the particular state or local jurisdiction adopting the code. However, according to a 1978 EPA report prepared for HUD, while code enforcement is easily handled at the design stage or onset of new consturction or renovation, "experience with state codes has shown that, because of resource limitations, enforcement of state codes is weak."[251] Enforcement difficulties may preclude state regulators from utilizing building codes to apply strict indoor air quality standards.

At least 45 states have also adopted energy conservation codes[252] based on ASHRAE 90-75, "Energy Conservation in New Building Design.[253] While ASHRAE 90-75 does not contain indoor air pollutant emission standards, it does incorporate by reference ASHRAE Standard 62-73 on natural and mechanical ventilation which establishes allowable limits for indoor air.[254,255]

C. *Specific State Legislative and Regulatory Efforts*

As indicated above, a majority of state health departments are currently involved in some type of indoor air quality program. The following paragraphs will briefly highlight some specific state activities relating to indoor air quality. This is not intended to be an exhaustive description of all state legislative or regulatory efforts in this regard.[256]

1. California

The outdoor air pollution problem in Southern California has been widely

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[249]J. McFadden, J.H. Beard, and D. Moschandreas, *supra* note 224, at 47-48; Kirsch 392.

Sixty percent of all jurisdictions with building codes have adopted all or part of one of the three main model building codes: The Uniform Building Code, the Basic Building Code or the Southern Building Code. Kirsch 392. There is also a National Building Code which is used primarily as a fire code. J. McFadden, J.H. Beard, D. Moschandreas, *supra,* note 224 at 47. A 1971 survey showed 73.5% of municipalities with populations greater than 10,000 used one of four model codes. An additional 13% used state promulgated codes. J. Everett, T. Dreher, *Institutional Aspects of Indoor Air Pollution in Energy Efficient Residences,* 8 Environ. Int'l. No. 1-6, 525, 527 (1982).

[250]Kirsch 392; NAS Report 451-465.

[251]J. McFadden, J.H. Beard, D. Moschandreas, *supra* note 224, at 49.

[252]J. Everett, T. Dreher, *supra* note 249, at 527; J. McFadden, J.H. Beard, D. Moschandreas, *supra,* 37-42.

[253]ASHRAE 90-75, *supra* note 78.

[254]ASHRAE 62-73, *supra* note 77.

[255]As discussed in Section VII.G. *infra,* ASHRAE 90-75 has been citicized for failing to properly account for indoor air quality.

[256]Some additional state activities which are not described in the text of this paper include: Connecticut's ban on the installation of UFFI, Conn. Gen. Stat. tit. 29, § 29-277 (1983); Wisconsin's indoor ambient air quality standards for formaldehyde in new mobile homes, Wis. Adm. Code Sec. 14.03; Florida's radon regulations for homes near phosphate lands, *see* Subcom. Hearings 293-322, 479-503; and research in Maine on radon, *see* Subcom. Hearings 409; NAS Report 510-515.

publicized.[257] Indeed, problems associated with NO_x emissions resulted in the South Coast Air Quality Management District's[258] promulgation of limitations for NO_x emissions into the outdoor air from all new gas furnaces sold after January 1, 1984, and all new gas water heaters sold after January 1, 1983.[259] These regulations prompted the development of more efficient burners by GRI and AGA Labs to meet the new emission requirements.[260]

There has also been a great deal of interest in indoor air quality in California. In 1980 the State of California held a series of hearings on "Buildings That Make You Sick."[261] Subsequently, in February, 1982 the Department of Consumer Affairs issued an extensive report entitled "Clean Your Room." The Report explains that it is a compendium written for the consumer, "Describing a Wide Variety of Indoor Pollutants and Their Health Effects, and Containing Sage Advice to Both Householders and Statespersons in the Matter of Cleaning Up." The publication also includes "A List of Experts Who Know What They're Talking About as Well as a Consumer Clean Up Kit."[262] This Report is referenced in the reading list provided by Pacific Gas and Electric Company to its customers, as part of its customer information on indoor air quality.[263]

Among the numerous recommendations in the Report are the following: 1) a formal Interdepartmental Task Force should be convened to draft appropriate laws specifically directed at protecting indoor environmental quality, and to consider the appropriateness of a single agency to deal with indoor pollution; 2) the state should disseminate information on indoor pollution through property tax and utility billings; 3) gas utilities should undertake voluntary campaigns to increase customer awareness of hazards associated with gas appliances, and trained energy auditors employed by public utilities should advise consumers on indoor pollution implications of energy conservation measures; and 4) additional research should be funded, including exploration of the use of warning devices and of the viability of an interlock mechanmism between combustion appliances and monitoring equipment.[264]

Currently, a California state indoor pollution program is the focus of the Indoor Air Quality Group, Air and Industrial Hygiene Laboratory, Department of Health Services in Berkeley. Under that program, state agency activity is

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[257]A CPSC spokesman at the Subcommittee hearings noted that the exposure of Southern California's Coastal Basin to "unhealthful levels" of nitrogen dioxide in 1981 was 228 million person days, out of a total national exposure of 241 million person days. Subcom. Hearings 40-41.

[258]The South Coast Air Quality Management District includes portions of Los Angeles, Orange, Riverside and San Bernadino Counties. 50 Cal. Jlur. 3d. (1980), p. 39.

[259]According to GRI, the California regulations limit the allowable concentrations of nitrogen oxides in flue gas emissions to 40 nanograms per Joule of heat output, approximately equal to one-tenth of an ounce per 10 hours of operation for a typical Btu/hr furnace. *Burner Inserts for NO_x Reduction,* GRI Technology Profile, July, 1983.

[260]*See* J. Raloff, *Cleaner Cooking With Gas,* 125 Science News 28, 29 (Jan. 1984); *Burner Inserts for NO_x Reduction,* GRI Technology Profile, July, 1983. *See also* Section IV.C. *supra.*

[261]Repace 29.

[262]California Report, *supra* note 93.

[263]*See* Section IV.F.1. *supra.*

[264]California Report Ch. VI.

coordinated and research is conducted.[265] A statewide agency task force on indoor environmental quality is also operative.

In March, 1983, a bill was introduced in the California State Assembly which would have required the State Building Standards Commission to adopt rules, based on recommendations of the Department of Health Services and other interested persons, prescribing "standards for minimum levels of indoor air quality for a residential dwelling, including a house or apartment, or inside a school, office, public building, or other facility to which the general public has access."[266] The bill was not passed by the Assembly. The Assembly Committee on Consumer Protection and Toxic Materials did hold hearings, however, in November, 1983 on indoor air quality.

2. Massachusetts

The primary indoor air quality issue of interest in Massachusetts is the State Department of Public Health's controversial ban on the sale, distribution and all uses of urea-formaldehyde foam insulation (UFFI).[267] After nearly four years of litigation the Massachusetts Supreme Court reversed a lower court and upheld that ban in *Borden, Inc. v. Comm'r. of Public Health,* 388 Mass. 707, 448 N.E.2d. 367 (1983), *appeal dismissed sub nom. C.P. Chemical Co. v. Comm'r of Public Health,* 104 S.Ct. 323 (1983); *cert. denied sub nom. Formaldehyde Institute v. Frechette,* 104 S.Ct. 345 (1983).

Berkshire Gas Company was one of the parties challenging portions of the Massachusetts regulations, along with members of the formaldehyde industry. Berkshire did not manufacture or install UFFI, but it did promote the use of UFFI for its residential customers. Berkshire challenged the provision of the UFFI regulations which required the repurchase of UFFI by the supplier, in certain circumstances.[268]

Experts employed by the federal Consumer Product Safety Commission testified at the trial on the Massachusetts rule, in their private capacity and not as representatives of the CPSC. The Massachusetts court also referred to the 1982 CPSC ban on UFFI, although that ban was later reversed by the Fifth Circuit Court of Appeals.[269]

3. Minnesota

In contrast to the Massachusetts court ruling on the Massachusetts UFFI regulation, the Minnesota Department of Health's formaldehyde rule[270] was remanded to the Department for further reconsideration in *Manufactured Housing Institute v. Petterson,* 347 N.W.2d. 238 (Minn. 1984).

The Minnesota rule set a maximum indoor air level of formaldehyde in newly

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[265]This is the first general state research program on indoor air quality in the country. Subcom. Hearings 409.

[266]Assembly Bill No. 2107, introduced March 8, 1983.

[267]105 Code Mass. Regs. 650.000-650.990 (1979).

[268]105 Code Mass. Regs. 650.220(3), 650.222 (1980).

[269]*See* Section V.C. *supra.*

[270]7 MCAR 1.448, recodified as Minn. Rule 4620.1800 (1984).

constructed housing units. The state Supreme Court found that the agency's maximum ambient formaldehyde level determination was not explained by the Commissioner of Health and was therefore arbitrary and capricious and violated substantive due process. In remanding the case, the court directed the Department to reconsider its determination on the administrative record already made.

Several portions of the Minnesota Supreme Court's opinion in that case are worth highlighting. First, the Court discussed the nature of the Department's determination that formaldehyde in building materials posed a significant health problem. This determination preceded the issuance of the formaldehyde rule.[271] While the Court found that it was "perhaps unfortunate" that this determination was made in the form of a "press release," the Court also held that this determination was "duly made." *Id.* at 242.

Second, in discussing the difficult task of devising a rule for the maximum level of ambient formaldehyde, the court noted that it is possible that formaldehyde emanates from sources other than building materials "such as carpets, household furnishings, cooking exhausts, and cigarete smoke." *Id.* at 243. The Massachusetts court also referred to formaldehyde produced by the use of gas stoves in its opinion.

Third, the court agreed with the Department's contention,

> that in fulfilling [its] obligation to protect the public health, it may be necessary, as here, to make judgments and draw conclusions from "suspected, but not completely substantiated, relationships between facts, from trends among facts, from theoretical projections from imperfect data, from probative preliminary data not yet certifiable as 'fact,' and the like." (Citations omitted.) *Id.* at 244.

Notwithstanding its concurrence with the state on the latter point, the court did not uphold the agency's formaldehyde standard, based on the record before it. To date, the Health Department has not taken any final action regarding the formaldehyde ambient standard upon remand.

Minnesota law also prohibits manufacturers from selling any building materials, and builders from selling or leasing a housing unit, containing UFFI unless a written disclosure is provided. The disclosure must inform such purchasers of the formaldehyde content and warn them of possible health problems associated with formaldehyde.[272]

In addition to activities relating to formaldehyde, an Indoor Air Interagency Work Group composed of individuals representing 11 Minnesota state agencies[273] has convened several times since the beginning of 1984. In a March 15, 1984 Report to the Minnesota Environmental Quality Board the work group identified the responsibilties of various agencies for dealing with different types of indoor air quality issues.

The group recommended that, due to disparity in agency responsibilities, a formalized and coordinated complaint referral system, including a standardized

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[271]Minn. Stat. § 144.495 (1982) required that such a determination be made prior to the issuance of any formaldehyde limitation rules.

[272]Minn. Stat. § 325F.18 (1982).

[273]The group includes representatives from the Departments of Administration, Agriculture, Attorney General, Education, Energy and Economic Development, Environmental Quality Board, Health, Housing and Finance, Labor and Industry, Pollution Control Agency and Public Safety.

complaint documentation form, should be developed. The group also proposed to undertake a work program including: a preliminary literature review as a first step in defining the existence and nature of indoor air quality problems, and a comparison of the results of this review with information obtained in the complaint documentation program. Furthermore, the group recommended assessing the need for future legislative action.

4. New York City and State

In New York City, the Bureau of Science and Technology, New York City Department of Environmental Protection, investigates residential and workplace complaints regarding indoor environmental quality.[274] That agency, along with the City Health Department, are the departments with the major involvement in the control of indoor air pollution;[275] The city's Occupational and Health Agency also oversees the indoor working environment.

On the state level, a bill was introduced in both the 1981-82 and 1983-84 sessions of the State Assembly, to amend the public health law to establish a center for indoor air studies within the Department of Health. That center would investigate the causes, levels and impacts of indoor air pollution. The bill was not passed in either session.[276] Currently a small group within the State Health Department has indoor air quality responsibilities.[277]

VII. Involvement of Miscellaneous Groups in the Indoor Air Quality Controversy

While government and gas industry representatives are investigating indoor air quality issues, a number of private organizations are also actively involved in matters relevant to the indoor environment. Several of these organizations and their activities are discussed in the following section.

A. Air Pollution Control Association (APCA)

According to material provided to the House Subcommittees at the 1983 hearings, APCA is "the only technical society that exclusively represents air pollution control professionals in the United States."[278] APCA, through its Technical Committee on Indoor Air Quality,[279] issued a "Position Statement on Indoor Air Quality" in March, 1982.[280] In that statement, APCA recommended amending the Clean Air Act to authorize funds for indoor air quality research, to undertake a health effects assessment program and to establish a national data base and

[274]E. Ferrand, S. Moriates, *supra* note 135, at 1061-1063.

[275]E. Ferrand, S. Moriates, *supra* note 135, at 1065.

[276]E. Ferrand, S. Moriates, *supra* note 135, at 1064-1065; Bill No. A7556 (1981-1982), Bill No. A7066 (1983-1984).

[277]E. Ferrand, S. Moriates, *supra* note 135, at 1065.

[278]Subcom. Hearings 246.

[279]Yocum, *supra* note 2, at 920.

[280]Subcom. Hearings 247-249.

information clearing house with appropriate scientific staff.[281]

B. American Conference of Governmental Industrial Hygienists (ACGIH)

"Although not a governmental body *per se,* ACGIH has had widespread impact on occupational exposure standards in the United States and elsewhere, through its process of promulgating Threshold Limit Values (TLV's) for substances in the workroom air."[282] As noted earlier,[283] when OSHA first developed its own standards in 1970, it adopted ACGIH's list of TLV's almost without exception. Today ACGIH's standards may differ from those of OSHA and/or NIOSH for a particular airborne pollutant, e.g., formaldehyde.[284]

C. American Industrial Hygiene Association (AIHA)

AIHA has assembled a committee to establish criteria and standards for indoor air quality in all buildings, including residences.[285] AIHA publishes an extensive list of chemicals in its *Hygiene Guide Series.* "Information provided for occupational exposures includes 8-hour time-weighted limits, short exposure tolerance and atmospheric concentrations immediately hazardous to life."[286] AIHA's *Community Air Quality Guides* are also referenced in ASHRAE's ventilation standard for indoor air quality, 62-1981.[287]

D. American National Standards Institute (ANSI)

ANSI publishes workplace air quality standards. Eight-hour time-weighted average limits are virtually identical to ACGIH's standards. Also provided are "acceptable ceiling concentrations" and "maximum acceptable peak concentrations."[288] ANSI, formerly the American Standard Association, was one of the first groups to attempt to develop a national ventilation standard in 1946.[289] ANSI has now adopted ASHRAE's ventilation standard 62-73 and redesignated that standard ANSI Standard B194.1.[290]

E. American Council for an Energy Efficient Economy (ACEEE)

ACEEE is a private, non-profit research group, offering consultation to utilities and other companies on topics relating to energy efficiency. Currently ACEEE is

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[281]Subcom. Hearings 247-249; 438-439.

[282]GRI Report 8-2.

[283]*See* Section V.E. *supra.*

[284]EPRI Manual 5-10 to 5-11.

[285]A. Caruba, *An Air Quality Time Bomb Is Ticking,* Modern Office Technology 87 (April, 1984). The Wall Street Journal recently described the job of an industrial hygienist. S. Jacobs, *Industrial Hygienists Increase Firms' Output and Efficiency,* Wall St. Jour., Mar. 5, 1984, at 27, col. 1-2.

[286]GRI Report 8-8.

[287]ASHRAE 62-1981 at 14; Subcom. Hearings 183.

[288]GRI Report 8-8.

[289]J. McFadden, J.H. Beard, D. Moschandreas, *supra* note 224, at 36-37.

[290]NAS Report 454.

developing a report on indoor air quality control strategies.

F. *American Institute of Architects (AIA)*

AIA provided a written statement to the House Subcommittee expressing its concern about indoor air quality "because of its implications for energy efficiency and the health and productivity of building occupants."[291] AIA recommended further federal research in the area and asked that research results be more widely disseminated, "to be of more benefit to the design community."[292]

G. *American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)*

ASHRAE and its standards have been referenced frequently in this paper. In testimony before the House Subcommittees, a spokesman described ASHRAE as

> a non-profit organization whose objective is to advance the arts and sciences of heating, refrigeration, air conditioning and ventilation, the allied arts and sciences and related human factors for the benefit of the general public. Founded in 1894, it consists of some 50,000 members from around the world.[293]

Further testimony identified needs regarding energy conservation and acceptable indoor air quality which "must be addressed by both governmental and private organizations such as ASHRAE." These needs included, among other things, the characterization of building stock, the education of professionals and the general public regarding safe and comfortable energy conservation methods, and the development of new methods of measuring contaminants, new controls, and new standards.

As discussed in earlier Sections, ASHRAE has had a considerable impact on building codes in recent years, particularly ventilation standards. In 1975, in response to the national energy conservation trend, ASHRAE developed its Standard 90-75, "Energy Conservation in New Buildings"[294] which specified *maximum* infiltration rates. According to the GRI Report, however, ASHRAE did not fully consider the impact of this standard on indoor air quality in 1975, as evidenced by the incorporation by reference of ASHRAE's earlier ventilation standard 62-73[295] which was somewhat inconsistent with 90-75.[296] In fact, an ASHRAE spokesman has acknowledged that the requirement of Standard 90-75 "is the cause of serious concern in new buildings."[297] Moreover, there is concern that the 45 states which have adopted this standard[298] now have conservation codes which are

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[291]Subcom. Hearings 504-507.

[292]Subcom. Hearings 504.

[293]Subcom. Hearings 110, 118.

[294]ASHRAE 90-75, *supra* note 78.

[295]ASHRAE 62-73, *supra* note 77.

[296]*See* NAS Report 455-456.

[297]GRI Report 5-5, 5-13; *see also* J. McFadden, J.H. Beard, D. Moschandreas, *supra* note 224, at 31-34, 37.

[298]*See* previous discussion of building codes in Section VI.B. of this paper.

"deficient in their treatment of potential indoor air quality problems."[299]

As discussed in Section III.D.2., *supra,* ASHRAE attempted to resolve some of the problems with Standard 90-75 and "the apparent conflict between operating ventilation control systems for energy savings and operating them for protection of the health and comfort of the occupants,"[300] by adopting Standard 62-1981, "Ventilation for Acceptable Indoor Air Quality," in 1981.[301] Even this modified standard, however, has been misunderstood and misinterpreted.[302] According to a written statement by the National Institute of Building Sciences provided last year to House Subcommittees,

> Recent attempts to adopt portions of [Standard 62-1981] by two of the three major model building code organizations have been defeated because the majority of voting members considered them unenforceable due to lack of available or affordable equipment and expertise, and lack of ability to control the exterior environment (i.e., the level of pollutants in the outdoor air).[303]

Consequently, as noted earlier in this paper, ASHRAE is now revising its standard on ventilation for acceptable indoor air quality.[304]

VIII. Standards of Foreign Countries Relating to Indoor Air Quality

The indoor air quality issue has attracted the attention of environmental officials around the world. One EPA survey of indoor air quality health criteria and standards conducted in 1978, included a fairly extensive discussion of maximum allowable and design-level indoor air quality standards abroad, as well as indoor air emission standards.[305] Moreover, several papers presented at the International Symposium on Indoor Air Pollution in 1981 were based on research in foreign countries.[306]

Because particle board has been used extensively in Northern European countries,[307] there have been extensive studies done on formaldehyde in those countries. Both the NAS Report[308] and the EPRI Manual[309] refer to formaldehyde standards recommended in the Federal Republic of Germany and the Netherlands, as well as proposed standards in Denmark and Norway. Sweden also has a proposed standard for radon, while the Canadian Atomic Energy Control Board has issued a

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[299]GRI Report 5-7.

[300]NAS Report 456.

[301]According to ASHRAE 62-1981's subjective evaluation provision, indoor air "can be considered acceptably free of annoying contaminants if 80% of a panel of at least 20 untrained observers deems the air to be not objectionable under representative conditions of use and occupancy." ASHRAE 62-1981 at 13. *See also* Section III.D.2. of this paper which discusses standard 62-1981.

[302]Subcom. Hearings 111, 120-121; *'Sick' Buildings a Pandora's Box,* ENR 32-33 (Oct. 1983).

[303]Subcom. Hearings, Appendix, 417.

[304]Subcom. Hearings 111, 120-121; *'Sick' Buildings a Pandora's Box,* ENR 32-33 (Oct. 1983); *see* Section III.D.2. *supra.*

[305]J. McFadden, J.H. Beard, D. Moschandreas, *supra* note 224, at 51-59.

[306]8 Environ. Int'l. No. 1-6, 17-21, 67-71 193-197 (1982).

[307]Yocum, *supra* note 2, at 3.

[308]NAS Report 511.

[309]EPRI Manual 5-10.

policy statement specifying limits on radon concentrations.[310] ASHRAE's Standard 62-1981 incorporates ambient air quality guidelines for several pollutants from foreign standards.[311]

One of the most significant efforts to control indoor air quality has been taken by the Subcommittee on Indoor Climate of the Nordic Committee for Building Codes. That group adopted guidelines in 1981 for building regulations regarding indoor air quality and thermal climate, especially concerning ventilation. These guidelines will be included in the national building codes of the five Nordic countries.[312] The purpose of the guidelines is to form a "basis for designing energy efficient buildings while maintaining an indoor air quality which provides acceptable comfort and does not impair health."[313]

IX. Theories of Legal Liability Regarding the Effects of Indoor Air Contaminants

A. Introduction

It should come as o surprise that some persons allegedly injured by indoor air pollutants have taken legal action against parties associated with pollutant sources. The most widely publicized lawsuits include those relating to urea-formaldehyde foamed-in insulation (UFFI) and asbestos exposure.[314] There has also been some interest in non-smokers' actions against smokers.[315] To-date, however, there has not been significant discussion on the issue of legal liability for injuries associated with indoor air pollution.

Because there is no conclusive evidence of any health hazards associated with the proper use of gas appliances, gas utilities have faced few legal challenges relating to gas appliances. Legal counsel for gas utilities, however, would be well advised to familiarize themselves with those few documents,[316] particularly the California Department of Consumer Affairs' Report on Indoor Pollution (California Report),[317] which discuss some of the relevant cases dealing with indoor air quality-type disputes and homeowners' claims. Indeed, "[p]recedents established through private lawsuits in the civil courts may determine what minimum indoor air quality controls must be included in residential structures."[318]

The traditional liability theories of strict liability in tort, breach of warranty or

[310]EPRI Manual 5-6; NAS Report 510.

[311]ASHRAE 62-1981, *supra,* at 5, 13.

[312]J. Sundell, *Guidelines for Nordic Building Regulations Regarding Indoor Air Quality,* 8 Environ. Int'l. No. 1-6, 17-20 (1982); *see also* EPRI Manual 2-8, 209.

[313]J. Sundell, *supra,* at 17.

[314]*See* Kirsch 352, note 97, 356, note 143. Repace 27 reports that there may be as many as 700 UFFI-related suits, not counting a large N.Y. state class action.

[315]*See* D.M. Shimp, *How to Protect Your Health at Work: Sue Against Smoke and Other Occupational Hazards* (1976), cited in Repace 36.

[316]The two sources from which much of the discussion in Sections IX.B. C. and D. is derived are: J. Everett, T. Dreher, *Institutional Aspects of Indoor Air Pollution in Energy Efficient Residences,* 8 Environ. Int'l. No. 1-6, 525-531 (1982) and the California Report.

[317]The California Report was described in Section V1.C.1. *supra.* Much of the legal discussion in this Report is based on California case law.

[318]J. Everett, T. Dreher, *supra* note 316, at 530.

contract and negligence may apply to injuries arising from indoor pollution. Potential defendants include builders, building design professionals, contractors, manufacturers and suppliers of building materials and, perhaps, utility companies. The following paragraphs include a discussion of each of these three liability theories and a description of some recent decisions involving urea-formaldehyde insulation.

B. Strict Liability in Tort

Strict liability in tort is a popular legal liability theory in cases involving allegations of defective product manufacture and/or design. Generally, strict liability does not extend to services.[319] Once the basic elements of the doctrine are established, defenses are extremely limited.[320] Personal injury is compensable under this theory, but commercial or economic losses are not recoverable in every jurisdiction.[321] Some courts, however, have differentiated between property losses and economic losses, finding the former to be recoverable in certain cases.[322]

This theory has been frequently raised against manufacturers of formaldehyde[323] and asbestos products. A manufacturer is strictly liable in tort,

> when a product he places on the market knowing that it is to be used without inspection for defects, proves to have a defect that causes injury to person or property. Liability extends to any person or entity that is an "integral part of the business enterprise of marketing a product" even though that person or entity did not know of or create the injury-producing defect. (Citation and footnotes omitted.)[324]

According to the California Report, one of the most challenging issues in regard to the application of a strict liability theory in indoor air quality cases, is to determine that a particular product actually caused the indoor pollution damage in question. This is a challenge because a number of pollutants, associated with different products, can cause similar injuries. Furthermore, the same pollutant can be released from several different products. The Report concludes that, "Thoughtful common sense testing of the indoor environment is required to narrow the source of the injury to the appropriate pollutant and defendant."[325]

Another aspect of strict liability theory which may become significant in indoo air pollution cases is the defendant's duty to instruct or warn the consumer. Cour have found a manufacturer's failure to provide adequate use or installatic instructions or product warnings to be a design defect.[326] Even if use or installatic requirements are provided, liability can result from inadequate instructions.

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[319]Mass-produced houses, however, have been considered to be products for product liabili purposes. California Report IV.A.2.

[320]California Report IV.A.5. In some jurisdictions, once the plaintiff has demonstrated that tl defendant's product caused injury, the burden of proof shifts to the defendant to prove that tl product was not defective. California Report IV.A.2., IV.A.3.

[321]California Report IV.A.2.

[322]*See* Shooshanian v. Wagner, 672, P.2d 455, 464 (Alaska, 1983).

[323]*See* discussion in Section IX.E. *infra.*

[324]California Report IV.A.1, IV.A.2.

[325]California Report IV.A.2.

[326]California Report IV.A.3.

In the case of *Wallinger v. Martin Stamping and Stove Co.,* 93 Ill. App.2d. 437, 236 N.E.2d. 755 (1968), for example, the defendant gas heater manufacturer provided detailed installation instructions which were followed by the victim. Unfortunately, the instructions did not detail the proper chimney height. The victim installed a short chimney which resulted in his death by carbon monoxide poisoning. The court found the defendant strictly liable for failure to provide more specific instructions.

C. *Negligence*

In conjunction with or as an alternative to a strict liability claim, plaintiffs can sue product manufacturers for negligent manufacture, design, and provision of product warnings. Because the negligence theory is applicable to the provision of services, lawsuits may also involve allegations of negligent installation, maintenance and inspection.[327]

There are several negligence cases against manufacturers which are relevant in this discussion of indoor air quality legal liabilities. In *Olgers v. Sika Chemical,* 437 F.2d. 90 (4th Cir. 1971), the court found a chemical manufacturer liable for the negligent failure to warn of potential dangers of exposure to its product, a patching compound, which resulted in the death of a construction worker. In a similar case, *Dover Corp. and J.R. Preis d/b/a/ Coastal Bend Sales v. Perez,* 587 S.W.2d. 761 (Tex. Civ. App., 1979), a gas heater manufacturer was found negligent for placing an unreasonably dangerous product in commerce because of its failure to preclude mismatching of compounds, resulting in improper venting and a carbon monoxide poisoning death. The court found the manufacturer negligent, even though the manufacturer included a warning of the consequences of mismatch with the heater.

While the negligence theory is common in lawsuits against product manufacturers, it has also been applied in cases against builders, contractors, engineers and architects. Courts have found such defendants liable for injury or damage caused by negligent performance of their work, notwithstanding its completion or lack of privity with the plaintiff.[328]

The California Report suggests that building professionals may be negligent if they create indoor pollution by specifying polluting products or designing a building with a limited ventilation system or both.[329] The key issue is the foreseeability of any injury that results from either or both of these actions. Furthermore, that Report also proposes that a presumption of negligence may be applicable in indoor pollution injury cases. This presumption would be based upon the doctrine of *res ipsa loquitor* and the argument that "buildings don't make people sick absent someone's negligence."[330]

In at least two cases involving building professionals, courts have considered liability for indoor pollution. The first of these cases involved a death and injuries by carbon monoxide poisoning on a boat. The court found a boat designer-builder negligent and liable for placement of an air conditioner intake in proximity to an

[327]California Report IV.A.5.

[328]California Report IV.A.6.

[329]*Id.*

[330]California Report IV.A.5, IV.A.6.

engine compartment, that could be expected to accumulate excessive amounts of carbon monoxide at some time. The court also found an air conditioner manufacturer liable for negligent failure to warn of the consequences of improperly locating the intake.[331]

In a second case against a heating and air conditioning contractor, the placement of a humidifier reservoir above a furnace resulted in growth of a thermophilic fungus in the reservoir, and the distribution of the organism through the hot air heating system caused one resident to develop hypersensitivity interstitial pneumonitis. The disease and organism were unknown at the time of installation and the injured party was not a resident at that time. The appeals court reversed the trial court, however, and held that once the defendant was found negligent, he may be held responsible for injurious consequences which occur naturally and directly from that negligence, without reference to whether he anticipated or reasonably might have foreseen such consequences. The case was then remanded to the lower court for trial on that issue.[332]

One final consideration for utility companies is the California Report's suggestion that negligence may also be an issue in the provision of energy audit services by utilities, if utility employees "do not take into account potential indoor air pollution problems from energy retrofit recommendations." The Report notes that "Federal law specifically does not exempt utilities from civil liability for the energy conservation services they supply the public" (citing 42 U.S.C.A. §§ 8201 et seq., particularly 42 U.S.C.A. § 8235(f)).[333] In addition, the California commentators argue that if a utility endorses a product which causes indoor pollution it may be liable if that product results in injury.[334]

Although no judgments have been rendered against utilities as a result of energy conservation programs and the advice given to customers under these programs, there is growing concern within the utility industry about exposure to such lawsuits. Indeed, this was one of the eight major concerns raised by attendees at one of the recent EPRI Seminars on Indoor Air Quality.[335]

D. Breach of Warranty or Contract

Express and implied warranty-based causes of action are potentially significant in indoor pollution situations for two reasons. "First, a product or building may not be defective, in the sense of strict liability, or negligently designed or constructed and yet still breach an express or implied warranty. Second, commercial losses may be recovered in warranty actions."[336]

Express warranties for goods can be found in sales contract language, brochures, advertising, label descriptions, samples or other sources. Express

[331]Heiman v. Boatel Company, Inc., Marine Development Corporation, Kohler Co. and Medlin Marine, Inc. Slip. op. (8th Cir., 1976), *withdrawn* April 14, 1976 (available on LEXIS, Genfed Library, Cases file).

[332]Koski v. Automatic Heating Service a/k/a Automatic Heating and Air-Conditioning Sales and Service, Inc. and Herrmidifer Company, Inc. 75 Mich. App. 180, 254 N.W. 2d 836 (Mich. 1978).

[333]California Report IV.A.7.

[334]*Id.*

[335]EPRI Seminars on Indoor Air Quality, *supra* note 26.

[336]California Report IV.A.7.

warranties in building sales can be in the sale contract or, perhaps, in the model home.[337] Obligations imposed by express warranties are absolute, whether or not the defendant-seller knew of the falsity of his or her representations.

Thus, in *Alfieri v. Cabot Corporation,* 17 A.D.2d. 455, 235 N.Y.S.2d. 753 (N.Y., 1962), *aff'd,* 13 N.Y.2d. 1027, 245 N.Y.S.2d. 600, 195 N.E.2d. 310 (N.Y., 1963), the court held defendant charcoal manufacturer liable for breach of warranty and negligence, as a result of death and injury from carbon monoxide poisoning caused by using a charcoal-burning burner as a heat source in a poorly ventilated cabin. The label on the bag of charcoal read, "Safe use for cooking, indoors and outdoors, while producing an even reliable heat."[338]

There are generally two kinds of implied warranties pertaining to goods: warranties of merchantability and fitness for a particular purpose. Merchantability means, among other things, that a product is "fit for the ordinary purposes for which such goods are used."[339] In the case of *Shirley v. Drackett Products Company,* 26 Mich.App. 644, 182 N.W.2d. 726 (Mich., 1970), the plaintiff used the cleaner "Vanish" to clean a toilet. The plaintiff used the product as directed, but suffered respiratory damage when the cleanser reacted with rust deposits in the bowl. The defendant was held liable for a breach of implied warranty.

Courts are currently split on the applicability of implied warranties to consumers with an unusual sensitivity to a product. In fact, some courts have restricted recoveries under implied warranties to those injuries which would only affect normal consumers. Other courts have required only that an appreciable class of consumers be subject to injury.[340]

In evaluating a claim of an implied warranty of fitness for a particular purpose, two elements are required. First, the seller must have reason to know of the particular purpose for which goods are intended to be used. Second, the buyer must rely on the seller's expertise or judgment to select the goods. If such a warranty exists, the seller is liable if the product is unfit for buyer's purpose. An example of the application of this theory, is found in a case involving a home builder-seller who, after being informed of a buyer's pulmonary illness, expressly implied and warranted that the basement would be dry. When water appeared in the basement within four months of purchase and the condition became permanent, the seller was found to have breached his warranties.[341]

Implied warranties of habitability are also being imputed in sales of buildings in a number of jurisdictions in the United States.[342] In one recent case this theory was extended to protect the third buyers of a house who purchased it within nine months of construction.[343] The California Report speculates that the implied warranty of habitability "may be a substantial basis of liability for indoor pollution injuries" against builders and design professionals, particularly for non-mass

[337]California Report IV.A.8.

[338]The California Report at IV.A.8. also notes that false representations can result in tort liability.

[339]*Id.*

[340]California Report IV.A.9.

[341]Bradley v. Brucker, (Penn. 1952), reported in 69 *Mont. Co. L.R.* 38. *See* 25 Am. Law, Rep. 3rd., 383-441; J. Everett, T. Dreher, *supra* note 316, at 529.

[342]California Report IV.A.9, IV.A.10. *See* Waggoner v. Midwestern Development Inc. 154 N.W. 2d 803, 809 (S.D. 1967).

[343]Blagg v. Fred Hunt Co. Inc., 272 Ark. 185, 612 S.W.2d, 321 (Ark. 1981).

produced structures, and may apply to structures such as office buildings.[344]

E. Recently Reported Cases Involving Formaldehyde Emissions

Several recent opinions involving formaldehyde exposure and related injuries contain holdings which could be relevant in future indoor air pollution cases. In *Heritage v. Pioneer Brokerage and Sales, Inc.,* 604 P.2d 1059 (Alaska, 1979), for example, buyers of a mobile home sued the retailer and manufacturer of that unit, for "painful, disabling, and incapacitating personal injuries" and economic loss resulting from exposure to formaldehyde fumes present in the home. The action was based solely on the theory of strict liability in tort. Because the Alaska Supreme Court found that the trial court erred in injecting negligence terminology in its instruction defining design defect, a new trial was ordered.

The appellate court, however, discussed and approved a "scientific knowability" instruction given by the trial court. The plaintiffs argued that the trial court erred in admitting evidence of the "scientific unknowability" of the risk of injury involved with exposure to formaldehyde fumes. That evidence included expert testimony to the effect that exposure to formaldehyde concentrations measured in the plaintiffs' mobile home, for the length of time in which they resided there, was "not known scientifically to cause permanent deep lung damage of the type suffered by [one of the plaintiffs.]" *Id.* at 1063.

The *Heritage* court approved an instruction allowing the jury to consider whether "the amount of the scientifically knowable danger inherent in the product at the time it was sold to plaintiffs" outweighed the utility of the product. The Court, however, limited the appropriateness of the instruction to cases "where the 'knowability' of the dangerous character of the product is an issue." *Id.* at 1064.[345]

In another Alaskan Supreme Court case, purchasers of urea-formaldehyde foam insulation for their retail business building brought action against the installer and manufacturer of the insulation, for breach of express and implied warranties, strict products liability, negligence and violation of the Alaska Unfair Trade Practices and Consumer Protection Act. *Shooshanian v. Wagner,* 672 P.2d 455 (Alaska, 1983). The plaintiffs alleged that the fumes from the insulation caused allergic reactions, created a health hazard and had driven away customers. Furthermore, the plaintiffs argued that the value of the building itself had been reduced to almost nothing. The court reversed the lower court's dismissal of the purchasers' suit, for failure to state a claim upon which relief can be granted, and remanded the matter for trial.

Two relevant federal district court cases also reviewed claims of injury from exposure to formaldehyde. In *Alley v. Gubser Development,* 569 F. Supp. 36 (D. Colo., 1983) a husband and wife sued a variety of defendants, for injuries and losses allegedly caused by the manufacture and sale of a mobile home in which the plaintiffs lived for six months after purchasing it in 1978. The suit was based upon

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[344]California Report IV.A.10.

[345]In a later case involving an accident with a Caterpillar-manufactured front-end loader, the Alaskan Supreme Court specifically rejected the "scientific knowability" instruction as inapplicable stating, "that a person can be injured in a front-end loader that overturns is too apparent to reasonably raise a 'scientific knowability' issue." Caterpillar Tractor Company v. Beck, 624 P.2d 790, 792-793 (Alaska, 1981).

breach of implied warranty of merchantability, negligent failure to warn and products liability. A jury awarded the couple $50,000 in compensatory damages and $510,000 in punitive damages. Defendants appealed both awards.

The defendants argued that there was insufficient evidence to support the compensatory damage award. They pointed out that,

> the elements of permanent injury, loss of credit, loss of reputation and impairment of earning capacity were all removed from the case . . . . [and] that because the evidence indicated the plaintiffs' bankruptcy and anxiety were caused by facts other than the presence of urea formaldehyde in the mobile home and because the evidence relating to the liver attack of Mr. Alley was supported only by testimony of [one doctor] the resulting verdicts were both unsupported by the evidence and excessive. *Id.* at 38.

The district court, however, upheld the jury's compensatory damage award, finding that,

> Although plaintiffs' presentation on liability issues was based primarily on circumstantial evidence and inference, there was sufficient evidence to support a finding that there was urea formaldehyde in plaintiffs' home and that it did cause injury to the plaintiffs. *Id.* at 39.

In reviewing the punitive damage award the court noted that, under Colorado law, "before a corporation can be held liable for punitive damages, it must be shown that the corporate management authorized or approved the culpable conduct or participated in the wrong." *Id.* at 39. The court concluded, as a matter of law, that "there was sufficient evidence to create an inference that management personnel of each defendant corporation knew of the potential problems caused by exposure to urea formaldehyde." *Id.* at 40. The court also found, however, that the award, which was greater than ten times the compensatory damage award, was "so excessive . . . as to shock the judicial conscience and to raise an irresistible inference that passion, prejudice . . . or other improper cause invaded the trial." *Id.* at 40. Consequently, the Court reduced the punitive damages to $150,000.

A final case in which liability for formaldehyde exposure was considered, is *Pearl v. Allied Corp.*, 566 F. Supp. 400 (E.D. Penn., 1983). In that case two classes of plaintiffs brought an action against defendant-manufacturers of urea-formaldehyde insulation. One class alleged that installation of the insulation in their residences resulted in property damages and a diminution of fair market value. A second class alleged it suffered or will suffer physical harms and unspecified injuries as a result of exposure to urea-formaldehyde insulation. The District Court rejected the defendants' motion to dismiss and held: 1) that the class one plaintiffs' complaint which sought recovery for alleged property damage stated "a colorable tort claim;" and 2) that the allegation of unspecified physical injuries was sufficient to state a claim under the Federal Rules. *Id.* at 401-404. The plaintiffs were also granted the opportunity to amend their complaint "to moot out any perceived defect which may exist in the first amended complaint." *Id.* at 401-404.

X. Need for Additional Research and Development to Assess Indoor Pollution Sources, Concentrations, Health Effects

A. General Statement of Need

Although a variety of scientific and technical studies have been conducted in regard to indoor air pollutants, the results of the studies have been provocative, *not* conclusive. Indeed there is a real need for more extensive and comprehensive research on the characterization, sources, concentration and health effects of indoor air pollutants. The necessity for more research and development was identified in the NAS and GRI Reports.

This need was discussed in the 1983 House Subcommittee hearings by a variety of witnesses, including Dr. John D. Spengler of the Harvard School of Public Health who has done extensive work in the field of indoor air quality. Dr. Spengler stated that while there are 80 million residential units and 20 million other types of indoor environment in the United States, "we have probably measured in 3,000 of them. And these are sporadic measurements. They are not long term, they don't really characterize what is going on . . . ."[346]

B. Suggestions for Further Research and Development

1. NAS Report

The NAS Report states that,

> Definitive conclusions on the character of indoor air are prevented by the lack of systematic studies. The available data base has been generated by a series of pilot studies and does not fully characterize the variety of pollutants, indoor environments, and occupancy conditions . . . . Studies explicitly addressing both long-term and episodic events have not been undertaken . . . . Current knowledge would permit the establishment of defensible indoor-air quality standards for only a few, if any, contaminants . . . .[347]

The Report also discusses the imprecision in air-pollution health effects data and the potential bias which can result.[348] In addition to eight other recommendations, the NAS Report concludes that the federal government should conduct a staged assessment of the exposure of the general population to indoor pollutants and of the effects of such exposures on health and welfare in both residential and office buildings.[349]

3. GRI Report

The recommendations for future research and development, which are most relevant to the gas industry, are contained in Chapter 7 of the GRI Report. Borrowing the outline of research elements developed by the federal Interagency

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[346]Subcom. Hearings 196.

[347]NAS Report 10-12.

[348]NAS Report 26-29.

[349]NAS Report 13.

Research Group on Indoor Air Quality,[350] GRI addresses five areas and identifies research needs consistent with GRI's interests:

a. Monitoring and Pollutant Characterization

The GRI Report identifies a need to develop improved sample collection and analysis methods, as well as models of personal activity patterns to be used to improve exposure profiles. It also suggests that there is an immediate need to evaluate existing personal monitoring devices and a long-term need for studies to quantify personal exposure both indoors and outdoors.[351]

b. Instrumentation

The GRI Report identifies specific research needs for instrumentation for sampling, monitoring, analyzing and controlling indoor air pollutants.[352]

c. Health and Welfare Effects

Noting the limitations of currently available health and welfare effects data, GRI states that there is a need to conduct "a comprehensive review of experimental human exposure studies to determine the statistical validity and physiological or epidemiological relevance of the results."[353] The Report also finds that the "most essential research need is a long-term prospective epidemiological study which should include monitoring of actual personal exposures and investigation of any related adverse health effects."[354] The Harvard Six Cities Study is referenced as the best example of such a large scale study to-date.

d. Risk Assessment

The GRI Report itself has been identified as one of the few examples of indoor air quality risk assessment,[355] and both the federal Interagency Research Group and GRI recognized the importance of and need for risk assessment in indoor air quality research. Risk assessment involves the evaluation of pollutant exposure data and health effects data to estimate the risk of indoor air pollutants to human health. Because all of the steps in such an analysis are subject to error and uncertainty,

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[350]These elements were discussed at a Workshop on Indoor Air Quality sponsored by the federal Interagency Research Group on Indoor Air Quality in December, 1980. GRI Report 7-1.

[351]GRI Report 7-1 through 7-4. Descriptions of current techniques and devices for monitoring, sampling, and modeling are contained in EPRI Manual 6-1 through 7-11; NAS Report 259-301.

[352]GRI Report 7-4.

[353]GRI Report 3-7.

[354]*Id.*

[355]GRI Report 7-5.

however, risk assessment is not an exact science.[356] It is necessary to develop research techniques and data to provide better indoor air quality risk assessment. The GRI Report concludes that such research should include studies of the cost-effectiveness of alternative controls and the relative costs and benefits to society of various levels of control.[357]

e. Control Technology

The GRI Report describes a variety of approaches for control technology which can be applied to indoor combustion processes and then discusses needed research relating to such controls. Technological controls were previously discussed in Section IV.

XI. The Future of the Indoor Air Quality Controversy: Where Do We Go From Here?

A. Introduction

The following paragraphs discuss some public policy considerations with respect to indoor air quality. The responsibilities of the gas industry in this regard are also identified.

B. The Future Role of Government: Some Public Policy Considerations

Environmental concerns are a potent political force in the United States.[358] The

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[356]John Erickson of AGA described risk assessment in detail. Erickson *supra,* note 24. According to Erickson, "Risk assessment is an analytical tool used to compare the probable results of a number of possible courses of action. In the case of indoor air quality, the purpose of risk assessment is to estimate the probability that a change in a factor, such as ventilation, that affects indoor air quality will improve or worsen the health of the occupants of a home . . . almost all of the research current planned, underway, or completed is intended to provide one or more of the pieces of information needed to perform a risk assessment. In other words, risk assessment is the final step in the process of investigating the potential health effects of indoor air quality." *Id.* at 2-3.

Erickson describes the performance of a health risk assessment as involving 1) the collection of environmental quality data for all environments (both indoor and outdoor) for a study population; 2) the collection of behavior pattern data; 3) the integration of data from steps 1) and 2) to develop an exposure profile to estimate the dose of pollutants received by a person over an average time period. Parallel with the estimation of pollutant dosage is the collection of data on the health effects of various doses of pollutants. Such data is obtained from three types of studies: animal toxicologicl (animal laboratory experiments), human clinical experiments and epidemiological studies (which are of particular concern to the gas industry since these studies are often of interest to the general public). Each of these studies has its particular limitations. *Id.* at 3-8.

[357]The Report goes on to state, "A particularly important question is the costs and benefits of environmental health programs which seek to protect the most sensitive members of the population . . . contrasted with a program which seeks to protect the majority of the population while encouraging sensitive persons to initiate additional protective measures . . . ." GRI Report 7-5.

[358]As described in J. Laboon, *Indoor Air Quality and Gas Appliances,* Presentation to Communications Conference, (May, 1984) AGA Critical Issues Supplement at 2, a recent article by pollster Lou Harris in *Advertising Age* magazine discussed the pivotal role environmental issues will play in the 1984 elections.

increasing interest of the scientific and health communities, the press, and the general public in indoor air quality will likely give government officials strong incentive to take further action on the subject. Assuming some official intervention will occur in the future, consideration should be given to the available public policy alternatives.

Many professionals involved with the indoor air quality issue have advocated a more structured, regulatory approach by the federal government to the issue, compared to the somewhat piecemeal efforts described in Section V above. In addition to suggestions for more coordinated interagency research and consolidation of federal responsibilities within one agency,[359] commentators have recommended amending standards for all federally sponsored or assisted housing,[360] to impose indoor air quality requirements. Other suggestions include more extensive use of the Toxic Substances Control Act, the Consumer Product Safety Act[361] and the Federal Hazardous Substances Act[362] to regulate indoor pollution sources.

Another proposal has been to amend the Clean Air Act to control indoor air pollution, as well as outdoor air pollution. Proposed amendments to the Clean Air Act include, granting states the primary authority to regulate indoor air quality, applying the current national ambient air quality standards to the indoor environment, or requiring the federal government to develop a new set of indoor ambient air quality standards which could be directly enforced by federal officials or which states or localities might incorporate into their building codes.[363]

Several experts, however, rightly point out that any decision to regulate the indoor environment, must take into account the differences between indoor and outdoor air quality.[364] "Ambient outdoor air quality is a 'public good' in the sense that enjoyment by one individual in no way detracts from use or enjoyment by others"[365] and "members of a community breathe basically the same ambient air."[366] Because no private individual or group has the incentive or means to reduce outdoor air pollution "since the personal share of the benefits would be much smaller than the costs,"[367] governmental regulatory intervention is appropriate and effective.

"This situation is quite different for some indoor environments, especially residences. Both the costs and benefits of pollution control are internalized within households."[368] Indoor air is not a public good. Complex regulations for indoor air quality, similar to those enforced under the Clean Air Act,

> would almost certainly be expensive because of the costs associated with monitoring and regulating approximately 100 million buildings in the United States. Perhaps the most

[359]Spengler 14.

[360]J. Everett, T. Dreher, *supra* note 316, at 527-528.

[361]Kirsch 370-380, B. Raffle, *supra* note 134, at 8-9.

[362]B. Raffle *supra* note 134, at 9-10.

[363]Repace 33-34; Kirsch 390-394; B. Raffle *supra*, note 134 at 10-14; J. Yocum, *supra* note 2, at 519.

[364]Spengler 14; K. Sexton, R. Repetto, *Indoor Air Pollution and Public Policy*, 8 Environ. Int'l No. 1-6, 5-10 (1982) [hereinafter cited as Sexton].

[365]Sexton 6.

[366]Spengler 14.

[367]Sexton 6.

[368]Spengler 14.

> serious impediments to the regulatory approach are public antipathy toward this form of intervention and problems associated with enforcement.[369]

Clearly, a complex regulatory framework for indoor air quality is "not necessarily optimal or even desirable."[370]

Because of the unique nature of indoor air quality, policy makers should consider certain key issues, prior to developing public responses to indoor air pollution. First, policy makers must address the issue of proper government functions in public vs. private buildings and "the correct balance between privacy and government responsibility to protect public health."[371] The rationale for government intervention may be stronger in hospitals and convention halls than in private dwellings. Furthermore, government responsibility "may be different for occupational and non-occupational settings and for existing and planned buildings."[372]

Second, the dissimilarities among indoor emissions sources is significant. Many indoor contaminants result from human activities, e.g., tobacco smoke, combustion products, while others are not as dependent on occupants' activity patterns, e.g., radon, formaldehyde. Behavioral adjustments could be "the most effective and inexpensive way to control pollutants arising from discretionary actions" while for other pollutants "stricter building codes, simple air-cleaning devices or sealants might be required."[373]

Third, "consideration of voluntary and non-voluntary risks is important for policy decisions."[374] Some indoor pollutants, e.g., tobacco smoke, are perceptible to most people, while other pollutants are below perception thresholds, e.g., radon, asbestos, NO_x. The development and voluntary use of sensors in the latter case "could reduce the need for government intervention to mitigate public health risks."[375]

Fourth, policy makers should consider energy conservation tradeoffs. Because energy conservation programs reduce air exchange rates, they may result in the deterioration of indoor air quality. Higher energy costs may result from decisions to maintain some minimum air exchange rate to ensure adequate air quality. Furthermore, increased energy use could lead to increases in outdoor pollution from fossil fuel combustion. "Balancing the need to conserve energy against possible health effects from indoor air pollution is a major problem facing policy makers."[376]

Fifth, "the level of government at which regulatory action, if any, should be taken, is also a critical issue."[377] While the issue of uniform national ambient air standards for outdoor air is still controversial, there is even more disagreement about the desirability of such standards for indoor air. Thus, policy makers should

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[369]*Id.*
[370]*Id.*
[371]Sexton 8.
[372]Spengler 15.
[373]*Id.*
[374]Spengler 16.
[375]*Id.*
[376]Sexton 8-9.
[377]Sexton 9.

carefully assess the need for federal, as opposed to state or local, intervention.[378]

In view of the complex issues relating to indoor air quality, a rigid regulatory approach should not automatically be adopted. Government intervention may be most effective if it focuses on improving the private choices of each individual through economic incentives and public information programs.

C. *The Role and Responsibilities of the Gas Industry*[379]

Indoor air quality has become an issue of significant national focus. Although the emission of combustion products from gas appliances is only one of many factors contributing to the indoor air environmnent, unvented gas appliances have been the focus of much attention in recent years, in the political as well as the scientific arena.

The gas industry should continue its commitment to support indoor air quality research in the future, in order to provide accurate and factual answers to questions raised about gas appliances and their impact on the indoor environment. Collaborative research efforts by members of the gas industry and representatives of other groups, in both the private and public sector, will be particularly persuasive in the current debate.

Furthermore, the gas industry should continue its efforts to work with governmental agencies, such as the Consumer Product Safety Commission, in an attempt to assist the government in developing objective and factual data about gas appliance emissions. These efforts should also help to prevent the dissemination of misinformation about gas appliances by public agencies.

Ultimately, however, the gas industry's biggest concern is, as it should be, for the health, safety and security of its customers. In light of the fact that some natural gas customers have expressed concern about gas appliances and indoor air pollution[380] these concerns must be acknowledged and addressed. The industry should also continue to monitor public perceptions in this regard in the future. Gas utilities also face the dilemma posed by the administration of energy conservation programs and the effect of such programs on indoor air quality.

In order to effectively and responsibly deal with these issues, the gas industry and each local gas company should give serious consideration to developing an indoor air quality policy. To assist in the development of such a policy, gas utility representatives should become informed about the complexities of the indoor air quality issue in general and in relationship to gas appliance emissions.

Consideration should also be given to developing customer information on indoor air quality, including the best available information on issues relating to gas appliances and energy conservation measures. Review and reconsideration of currently available customer materials on related issues may also be appropriate. The legal ramifications of existent or proposed customer information programs should also be reviewed.

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[378] *Id.*

[379] *See* J. Laboon, *Indoor Air Quality and Gas Appliances*, Presentation to Communications Conference (May, 1984) AGA Critical Issues Supplement.

[380] *See* Section IV.F.1., *supra*, describing a recent survey of gas customers' attitudes toward the gas industry.

The formulation of an informed and responsible position on indoor air quality by gas utilities will enhance the gas industry's credibility on the subject and is consistent with the industry's commitment to provide quality, dependable and safe gas service and advice to customers.

TABLE I-1
Typical Sources of Some Pollutants Grouped by Origin

Pollutants	Sources
Group I – Sources predominantly indoor:	
Sulfur oxides (gases, particles)	Fuel combustion, smelters
Ozone	Photochemical reactions
Pollens	Trees, grass, weeds, plants
Lead, manganese	Automobiles
Calcium, chlorine, silicon, cadmium	Suspension of soils or industrial emission
Organic substances	Petrochemical solvents, natural sources, vaporization of unburned fuels
Group II – Sources both indoor and outdoor:	
Nitric oxide, nitrogen dioxide	Fuel-burning
Carbon monoxide	Fuel-burning
Carbon dioxide	Metabolic activity, combustion
Particles	Resuspension, condensation of vapors and combustion products
Water vapor	Biologic activity, combustion, evaporation
Organic substances	Volatilization, combustion, paint, metabolic action, pesticides, insecticides, fungicides
Spores	Fungi, molds
Group III – Sources predominantly indoor:	
Radon	Building construction materials (concrete, stone), water
Formaldehyde	Particleboard, insulation, furnishings, tobacco smoke
Asbestos, mineral and synthetic fibers	Fire-retardant, acoustic, thermal, or electric insulation
Organic substances	Adhesives, solvents, cooking, cosmetics, solvents
Ammonia	Metabolic activity, cleaning products
Polycyclic hydrocarbons, arsenic, nicotine, acrolein, etc.	Tobacco smoke
Mercury	Fungicides, in paints, spills in dental-care facilities or laboratories, thermometer breakage
Aerosols	Consumer products
Viable organisms	Infections
Allergens	House dust, animal dander