

1995_02

EPA'S STRATEGY TO REDUCE RISK OF RADON

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INTRODUCTION

Since the discovery of extremely high radon levels in the Reading Prong region in 1985, there has been extensive progress in the nation's program to reduce the risks of indoor radon. EPA's Radon Program has grown from a handful of researchers in isolated problem areas to an organized partnership of government agencies and private organizations working together on numerous fronts. To accommodate this rapid growth and to keep national radon efforts on track, EPA has continually evaluated and refined its strategy by adapting to new knowledge, increased experience, Congressional direction, and changing needs.

The Indoor Radon Abatement Act of 1988 (IRAA) directed EPA to undertake a variety of activities to address the growing concern over dangers posed by exposure to indoor radon. Among other requirements, the law directed the Agency to study radon levels, evaluate mitigation methods, establish proficiency programs, assist States with Program development, develop training centers, and provide public information. EPA has developed and implemented programs to address each of the key provisions of this statute.

This paper presents EPA's broad national strategy to reduce radon risks. It combines and reinforces EPA's basic foundation, including its guiding policies and cooperative partnerships, with an overall management approach and focus for the future. The paper starts with an overview that introduces the strategy's four key elements: underlying policies and scientific principles, a decentralized system of States and other partners for targeting the public, multiple strategies for achieving radon risk reduction, and a strong focus on five key program priorities. The paper then discusses each of these elements in more detail and describes how they interact to guide future efforts and directions of the Agency.

STRATEGY OVERVIEW

As illustrated in Exhibit 1, EPA's radon strategy consists of four key elements:

1. Science and policy that provide the program foundation;
2. A decentralized system for informing the public that consists of multiple, highly respected organizations that can deliver radon messages through established channels to targeted audiences;
3. A continuum of strategies for reducing radon risks, ranging from public information efforts that let people make their own decisions about the need to test and fix their homes to regulatory approaches that may ultimately require people to take action; and
4. A strong focus on those strategies that hold the greatest promise for achieving long term institutional change.

These four key elements of EPA's strategy evolved over time in a chronological order. The initial emphasis of early efforts was scientific research on the magnitude and extent of the radon problem, mitigation research, health risk research synthesis, and development of sound policy guidelines. EPA then began development of a unique system for delivering this information and recommendations to the public, and began to explore a variety of strategies for getting the public to take action. Most recently, EPA has consulted with scientists, government officials, health organizations, and others to sharpen its focus on those strategies which have the greatest potential for reducing radon risks.

Today, EPA is continuing work in each of these four key areas. EPA is advancing and refining radon science and policy, expanding and improving the system for delivering programs, incentives, and focusing all elements of this system on those strategies which have a high potential for risk reduction.

Although some scientists were aware of the U.S. indoor radon problem, it was not until the Reading Prong discovery in 1985, that the U.S. government developed a program to address this issue. The government was unequipped to begin to advise the public on what, if anything, should be done in response to the problem and how to do it. The overriding need at the early stages of the Radon Program, therefore, was to develop guiding policies and scientific principles on which to base national risk reduction efforts. In response to this need, federal agencies, the States, and the scientific community initiated and have continued an extensive research program to establish and refine several underlying principles that serve to guide the entire radon effort and as a basis for all radon messages. These guiding scientific and policy principles are outlined in Section III of this paper.

Early on, EPA recognized the importance of working with leading national organizations. EPA thus began to develop a decentralized system in the late 1980's. In this system, EPA has worked to empower States and key national organizations that serve as additional sources of radon messages. These partners have the special expertise, credibility, and communications channels needed to reach target audiences. Such a decentralized system is more flexible, innovative, and effective than the centralized system traditionally used in government. The Agency's outreach system is explained in further detail in Section IV.

Through this network, the Agency's principal approach has been a non-regulatory public information campaign designed to accurately and effectively inform and enable people to reduce their health risk through voluntary action. However, after years of public information efforts with limited public response, States and national organizations have begun to pursue a variety of other, more direct strategies. Similar trends in approach have been observed during the evolution of other national health and safety campaigns [1]. Many initiatives are now underway to actively encourage homeowners to test and fix their homes, as are activities to provide incentives for radon action. Regulations that require people to take action are being piloted in some areas. Congress, State governments and local authorities are also considering or implementing legislation that would mandate actions to reduce radon risk [2]. The continuum of strategies being used by EPA partners is described in Section V.

Finally, the Agency is focussing its efforts in five major areas recommended in a 1992 Radon Program Review that was conducted by leaders inside and outside of EPA [3]. These five areas are: targeting efforts on the greatest risks first, promoting radon-resistant new construction, supporting testing and mitigation in connection with real estate transactions, using public information and motivation programs to promote institutional change, and developing a coordinated research plan. Program plans to focus efforts in these five key areas are summarized in Section VI. Further detail on these plans is also provided in "Implementation of OPPE Panel Recommendations," which is the Radon Program's formal response to the Radon Program's Review panel [4].

GUIDING SCIENTIFIC AND POLICY PRINCIPLES

EPA has used the best available scientific data in developing risk assessments. Over the last several years, considerable effort also has been spent to build a national consensus on the foremost scientific issues related to radon and on the translation of this scientific understanding into national policy. The most significant scientific and policy principles that have been developed through this process are summarized below.

There is No Known "Safe" Level of Radon Exposure

Although uncertainty exists, we know more about radon than most other cancer-causing environmental risks. In assessing residential radon risk, EPA assumes that the exposure-response relationship is linear at low exposures [5], [6]. This assumption is consistent with the evidence for linearity at a wide range of cumulative exposures in the radon epidemiological studies of underground miners. There is no evidence of a threshold

for lung cancer from radon exposure, that is, a level of radon exposure below which no increased risk of lung cancer would exist. It is generally recognized that even at low doses of alpha radiation, most DNA damage is not effectively repaired [5], [6]. Research further indicates that at low doses of alpha radiation the dose-response relationship for cell transformation and tumorigenesis is linear and independent of dose rate [5], [6].

Continuing scientific research has helped to improve EPA's projection of lung cancer risk to the general population due to radon exposures in the home. EPA now estimates that 7,000 to 30,000 lung cancer deaths per year in the U.S. are caused by residential radon exposure. Exhibit 2 places the estimated cancer deaths from radon in context by showing the number of annual fatalities due to common occurrences that the public tries to reduce through safety and health programs. Further scientific evaluation of radon hazards will serve to refine EPA's estimate of the annual number of radon-induced lung cancer deaths. The Agency is committed to seeking the best science to guide its program.

Homes With Indoor Radon Levels Above 4 pCi/L (148 Bq/m³) Should be Mitigated

EPA recommends that homeowners fix their homes if radon levels above 4 pCi/L (148 Bq/m³) are found and confirmed. This action level is based on a combined analysis of risk (no known "safe" level) and technological feasibility.

Because we have assumed that there is no "safe" level of radon exposure, EPA has investigated a range of action levels and found that mitigation technology available today can reduce elevated radon levels to 4 pCi/L (148 Bq/m³) more than 95 percent of the time [7]. Available technology is consistently less able to reduce radon levels down to lower levels, although an estimated 70 to 80 percent of homes with elevated radon levels would be able to achieve an action level of 2 pCi/L (74 Bq/m³) at reasonable cost [7]. The 4 pCi/L (148 Bq/m³) guideline is also supported by research showing that it is more difficult to accurately measure radon at lower levels (e.g., measurement device error is significantly greater at 2 pCi/L (74 Bq/m³) than at 4 pCi/L (148 Bq/m³) [7]. Based on these considerations, EPA recommends 4 pCi/L (148 Bq/m³) as the action level but advises homeowners that they should consider mitigating homes that have confirmed radon levels between 2 pCi/L (74 Bq/m³) and 4 pCi/L (148 Bq/m³).

People Should Use Proficient Radon Measurement and Mitigation Companies

A basic function of the Agency has been to equip the public with the information necessary to make knowledgeable radon decisions, including information on competent measurement and mitigation firms. Accordingly, the Agency has operated two voluntary proficiency programs for several years — the Radon Measurement Proficiency (RMP) Program and the Radon Contractor Proficiency (RCP) Program — to evaluate the proficiency of radon measurement and mitigation companies, respectively. In 1991, EPA added a new component to the RMP designed to evaluate the proficiency of those persons offering on-site residential measurement services. Both the RMP and RCP Programs provide a mechanism for providing the public with information on proficient companies by publishing updated lists of firms that pass all relevant criteria. If a person plans to hire a trained contractor to test or fix their home, the Agency recommends that he or she hire a qualified radon firm as determined by the RMP or RCP Programs. If a person plans to take his or her own measurement, EPA recommends the use of an EPA-listed radon measurement device.

All Homes and Schools Should Test for Radon

Elevated levels of radon have been found in all States and in all types of homes. State/EPA radon screening surveys show that individual homes in relatively low-risk areas may have high radon levels, depending on the complex interaction of soil, atmospheric, and ventilation factors [8]. Based on results from EPA's National Residential Radon Survey, nearly 1 out of every 15 homes in the United States is estimated to have annual average indoor radon levels exceeding 4 pCi/L (148 Bq/m³) [8]. The only way to know the radon level in a given home is to test it. Therefore, EPA and the Surgeon General recommend testing all homes below the third floor. EPA estimates that about nine million homes have been tested to date [8].

Similarly, based on data collected in its National School Radon Survey, the Agency estimates that 2.7

percent of ground-contact schoolrooms, or about 75,000 rooms, have short-term measurements greater than the recommended action level of 4 pCi/L (148 Bq/m³) [8]. Nearly 20 percent of the public schools nationwide, approximately 15,000 institutions, have at least one ground-contact room with a short-term measurement greater 4 pCi/L (148 Bq/m³) [9]. Based on this research, the Agency recommends testing for radon in schools. EPA estimates that about 20 percent of schools nationwide have been tested to date [9].

Recently completed and ongoing efforts to identify areas where radon problems are more common, including the Map of Radon Zones and the High-Radon Areas Project, will be instrumental in targeting resources to high-risk areas. Such targeting can provide the maximum amount of risk reduction for each dollar spent and is a major program priority.

The Health Risks Posed by Radon are Especially High if a Person is a Smoker

Tobacco smoke acts synergistically with radon to cause many of the radon-related lung cancers. That is, while exposure to elevated radon levels may pose a serious health risk by itself, exposure to radon in combination with smoking poses an even more serious risk. EPA estimates that radon risk for current smokers is 15 to 20 times the risk for never-smokers, and the risk to former smokers may be over 8 times greater than the risk to never-smokers [10]. Still, never-smokers can be at substantial risk from radon. The individual risk to a person who has never smoked and is exposed to an average of 4 pCi/L (148 Bq/m³) in their residence over their lifetime is estimated to be 2×10^{-3} . Exhibit 3 shows how these radon risks compare.

This scientific information about the synergistic relationship between radon and tobacco smoke has important implications for radon outreach programs. Beginning with the 1986 *Citizen's Guide*, EPA has consistently incorporated "stop smoking" messages into radon messages and materials. The most recent initiative in this area was the development and distribution of a public service announcement featuring the Surgeon General, Antonia Novello, on the hazards of radon and smoking. Messages and programs for smokers and former smokers will increase as the program further expands its focus on the highest risk areas and populations.

Short-Term Tests Can Be Used to Decide if a Home Needs Mitigation

Short-term radon tests are conducted over a period ranging from 2 to 90 days. Long-term tests are conducted for more than 90 days. Because radon levels tend to vary from day to day and season to season, long-term tests are more indicative of annual radon exposures. This is why EPA has always recommended use of long-term radon tests to determine whether homes should be remediated. However, due to time constraints like those encountered in real estate transactions, many consumers will not use long-term tests. Six years of program experience and extensive communications research show that people are unwilling to take long-term tests [11], [12].

Given limited consumer response to long-term radon testing, EPA conducted an extensive study on the mitigation decision-making accuracy of different testing protocols involving different combinations of short-term and long-term radon tests. Combining device accuracy data with information from numerous studies on seasonal variability, floor-to-floor radon variation within homes, and the radon distribution in homes across geographic areas, EPA developed a model for estimating the accuracy of different national testing scenarios [13].

In the 1992 *A Citizen's Guide to Radon*, EPA recommends a testing protocol that allows homeowners the flexibility of reaching a mitigation decision based on either (1) two sequential short-term tests, or (2) a short-term test followed by a long-term confirmatory test [14]. The *Citizen's Guide* discusses the trade-offs between short- and long-term testing, explaining that long-term tests are more representative of actual exposures, but enabling citizens to choose a short-term measurement process, especially for confirming initial measurements above 10 pCi/l (370 Bq/m³). Similarly, the 1993 *Home Buyer's and Seller's Guide to Radon* recommends three short-term testing options when long-term testing is not possible. Like the *Citizen's Guide*, the *Home Buyer's and Seller's Guide* recommends long-term tests, but gives people the option to choose an

accurate short-term test when time is limited in the context of real estate transactions.

Continuing Scientific Research on Radon

EPA is currently conducting, contributing, or coordinating research to address a number of key scientific issues. For example, EPA is supporting a National Academy of Sciences BEIR VI study to update the radon risk information. Additional ongoing research on radon includes: further refining estimates of the magnitude of the health risk posed by residential radon exposure, assessing the interactive effect of smoking and radon, evaluating the distribution of indoor radon levels in counties across the country, identifying geographic areas with the highest potential for radon problems, research into the variation of radon levels in new homes, and studies to determine the cost and reliability of approaches for measuring, mitigating, and preventing elevated radon levels in a variety of building types. Only with a better understanding of these and other scientific issues can the Agency continue to articulate and implement effective national policies for radon action.

Translating Principles and Policies into Radon Action

The scientific principles and policies guiding the Radon Program have been distilled into succinct, "user-friendly" information for dissemination through radon public outreach programs. For example, the 1992 version of the *Citizen's Guide* contains each of these key scientific and policy messages. Consistent and accurate information about radon are critical to the success of a non-regulatory health protection program like the Radon Program. However, the message is only one component of the overall communication process. Accordingly, EPA has developed and employs a decentralized communications system for reaching the diverse audiences potentially at risk from indoor radon.

DECENTRALIZED SYSTEM FOR REACHING A DIVERSE PUBLIC

As shown in Exhibit 4, a basic communications model has five major components. The model starts with a source (e.g., government agency) developing a message (e.g., "test for radon"). The message is then delivered through selected channels (e.g., brochures, technical background documents, TV programs, and press releases) to reach the intended audience (e.g., homeowners). Feedback and evaluation from the audience is used to refine the process until the desired effect is achieved.

EPA recognizes that it should not be the sole "source" for communicating about radon risks for a variety of reasons. First, EPA messages would have limited effect on many of the diverse audiences that must be reached with radon information. Second, informational materials produced by bureaucracies are often not timely, and because they are written for a "generic" and general audience, they will not reach many of the diverse groups that make up the U.S. public. For example, national-level messages prepared for an "average audience," consisting of people at middle income and education levels, may not spark the interest of low-income and low-education populations. These "generic" messages may not be appealing and effective in prompting action among minority audiences. Third, compared to numerous other sources, EPA has only a few effective channels available for sending out radon information to the public. Finally, other sources besides the federal government are closely associated with target audiences, and thus are in the best possible position to quickly and easily evaluate the success of their communications efforts. For all of these reasons, EPA has established an expanded communications network in which multiple, key organizations serve as sources of radon information. Multiplying sources increases the likelihood that radon information will effectively reach different segments of the public and encourage public action.

As shown in Exhibit 5, EPA works with prominent leaders in each of the key areas of State government, local government, public health protection, media contact and consumer protection. For example, EPA works with Radon Program contacts in all 50 States, the District of Columbia, and Guam. These contacts use their special affinity and geographic proximity to encourage radon action by their State constituents and other organizations.

Similarly, the American Medical Association, the National Medical Association, the American Lung Association, the National Association of Counties, the Consumer Federation of America, the National Association of Homebuilders, the Regional Radon Training Centers, National Safety Council and others have joined with EPA in cooperative programs to reduce radon health risks. These cooperative partners use their expertise to reach target audiences such as doctors, county health officials, public service directors, homebuilders and others.

Each State and respected national organization sends radon information to many target audiences through a variety of innovative and diverse communications channels. For example, the American Medical Association has its own communications channels like the Journal of American Medicine, AM News, American Medical Television, and frequent continuing education conferences. These organizations have developed a wide range of channels for delivering information to their target audiences — their members and affiliates.

In turn, each of these target audiences uses its own channels to deliver radon information to individual members of the public. This means that the ultimate consumer, the homeowner, ends up receiving a consistent message on radon from a number of key sources. The radon communications program is thus highly leveraged, as illustrated in Exhibit 5. Each target audience, like physicians and local government officials, becomes a source of information for new target audiences like their patients and local constituents. Consistent and accurate information delivered by multiple sources through multiple channels will repeat and reinforce the need for public action.

Management of the Radon Program's decentralized system is predicated on four basic operating principles. First, the Program has developed a clear mission — to reduce the public health risk of indoor radon. The Radon Program seeks to accomplish this overall mission by setting measurable goals that keep efforts focused, and allow the Program and its cooperative partners to both quantify success and eliminate waste. The Program, however, maintains flexibility so that the States and cooperative partners can achieve program goals in ways that make the most sense considering their individual capabilities and constraints, and that enable rapid program adjustments and improvements.

Finally, the Radon Program stresses evaluation to ensure that results are monitored routinely and program activities are redirected and refined as needed. For example, EPA works with the States and other partners to evaluate the effectiveness of each radon initiative according to a number of key evaluation criteria. These criteria include: the number of people contacted, number of radon tests conducted, and number of homes mitigated or built with radon-resistant construction. In addition, bottom-line environmental results are also evaluated through extensive state and national surveys by CRCPD, CDC, and others. These surveys assess public awareness, testing rates and number of homes mitigated.

Through this decentralized system, EPA has made significant progress in raising public awareness and understanding of the health risks associated with indoor radon. Surveys show that about 73 percent of the U.S. public is aware of the radon health problem [15]. In addition, the Program has fostered the development of a well-trained and competent industry for radon testing and mitigation, as well as a large and diverse group of program partners that stand ready to provide the public with necessary advice and assistance.

A CONTINUUM OF STRATEGIES FOR SOLVING THE RADON PROBLEM

In developing strategies for reducing radon risks, the Radon Program is learning from the experience of other successful national public health campaigns. As summarized in the examples below, the experience gained through these programs provides valuable lessons that have been integrated into the Agency's strategy to reduce risk from radon.

U.S. Anti-Smoking Campaign: Beginning in 1966, the Department of Health, Education, and Welfare

(later reorganized into HHS) began a public awareness campaign to inform the public and reduce cigarette consumption. While the campaign has achieved dramatic success over the past 26 years, this success has come only after concerted efforts through a variety of strategies. Namely, HHS combined forces with a number of cooperative partners (e.g., the American Lung Association, States, the private sector, and others) to disseminate public information and actively encourage people to quit smoking. The campaign also has put in place incentives to stop smoking, such as insurance premium discounts, and has sought and helped to establish anti-smoking regulations [16].

U.S. Seat Belt Program: Since its beginning in the mid-1970's, this program has increased front seat belt use from about 11 percent to 49 percent. Most of this increase followed the passage of State mandatory use laws, which were enacted through the combined efforts of States, medical and public health organizations, the automobile industry, and grassroots organizations like Mothers Against Drunk Driving. While the passage of these laws in most States has resulted in an initial, significant increase in seat belt usage, the rate of belt use has subsequently stabilized or declined moderately. This "post-law stabilization" is partly due to the fact that most States are not actively enforcing mandatory use laws, nor are they providing public information that calls attention to the laws and the penalties for not wearing seat belts [17].

Saskatchewan Seat Belt Program: To combat the same "post-law stabilization" in seat belt use rates in Canada as has been observed in the U.S., the Province of Saskatchewan initiated a combined public relations and advertising campaign. This campaign, which showed drivers being ticketed for not wearing their seat belts, increased belt usage in Saskatchewan to more than 90 percent in just a few years. Both British Columbia and Quebec have implemented similar programs and now have usage rates greater than 90 percent as well [18].

A review of these and other national programs reveals a number of important lessons for EPA. For example, success in changing human behavior takes time and only comes through strong national and local networks delivering consistent information. The experience of these programs, as well as the Radon Program experience, also shows that success requires a mixture of diverse strategies. The continuum of strategies used by these programs is shown in Exhibit 6.

Several of the strategies shown in Exhibit 6 are now being used by States and cooperating national organizations. Federal and state programs have developed and disseminated public information materials and public education materials that inform people about the risk of indoor radon and what they can do to reduce that risk. Over time, these materials have grown more specialized, as large, technical documents are being replaced with more targeted materials designed to encourage specific actions among certain groups. For example, the *Home Buyer's and Seller's Guide to Radon* is specifically designed to encourage informed decisions during real estate transactions. Radon brochures and public service announcements also encourage the public to act by linking radon to family health risks. And the *Consumer's Guide to Radon Reduction* provides guidance to consumers who have already tested for radon and are considering their mitigation options. At the same time, EPA is researching incentive programs to promote radon testing and mitigation, such as discounted or free test kits, especially for high risk populations.

Finally, States and other organizations are pursuing a variety of regulatory radon initiatives. Some States have already enacted laws that require school testing and disclosure of potential radon problems in real estate transactions. Several States and local jurisdictions are either implementing or considering radon resistant new construction requirements. Many new homebuilders are voluntarily using radon resistant new construction techniques. Some real estate associations are voluntarily incorporating the use of radon disclosure forms into their regular business practices. Congress is considering new regulatory options such as mandatory testing of schools and Federal buildings, as well as minimum radon reduction measures for new construction. In the future, all of these strategies will continue to be pursued in combination by States, national organizations, EPA, and others to combat the radon problem.

FOCUS ON KEY PRIORITIES

Given the breadth of radon scientific issues and policies, as well as the decentralized outreach system and range of strategies outlined above, the number and diversity of ongoing Radon Program activities is significant. While flexibility is in itself an important element of the Program, it is also crucial, especially in light of substantial budget constraints, that the Program set priorities to help concentrate efforts on those activities that will be most effective in achieving the overall mission of radon risk reduction.

The Radon Program is establishing these priority activities based on recent recommendations from a broad internal and external Radon Program Review which was coordinated by EPA's Office of Policy, Planning and Evaluation (OPPE). In the fall of 1990, the Radon Division requested that OPPE organize a process to evaluate the Radon Program and make recommendations on future directions to increase risk reduction. OPPE organized a panel of senior Headquarters and Regional managers from across the Agency who held a series of meetings with experts outside the Agency to include their perspectives. As part of its review, the panel discussed the relative merits of a range of radon strategies, including geographic targeting, testing and mitigation during real estate transactions, and public information strategies. Radon Program plans for focussing efforts in each of the five key areas are further detailed in the strategy entitled "Implementation of OPPE Panel Recommendations." The Radon Program Review panel issued the following recommendations in their final report:

Target the greatest risks first: The Radon Program Review panel recommended that the Radon Program focus its efforts and resources in the near-term on high radon potential areas and smoking-related risks.

Promote radon-resistant new construction: The Program should encourage and support pilot projects at the State and local levels to promote radon-resistant new construction, which have the potential to reduce risks in a very cost-effective manner.

Support testing and mitigation in connection with real estate transactions: The panel recommended that the Radon Program encourage and support pilot projects at the State and local levels to further promote testing and mitigation as part of real estate transactions.

Develop a new strategy for public information: The Radon Program should continue its nationwide public information efforts such as the *Citizen's Guide* and the Advertising Campaign, focusing on high radon potential areas and high-risk populations in the short-term. In the longer-term, the panel recommended that the Program use public information, motivation and incentives programs to build institutional support for construction of radon-resistant new homes and for regulations or polices to require testing and mitigating when existing homes are sold.

Develop a coordinated research plan: Finally, the panel recommended that the Radon Program develop a long-term research plan to prioritize and coordinate potential future research.

The Radon Program, States, and cooperating national organizations have, for several years, focused on many activities that are consistent with the recommendations and directions developed by the Radon Program Review panel. The Program is now aggressively reviewing and expanding these ongoing efforts.

Target Greatest Risks First

The Radon Program is focussing resources and initiatives aimed at targeting to the greatest risk areas and populations. Examples of recently completed and ongoing activities include: developing and releasing the Map of Radon Zones, targeting State Indoor Radon Grant (SIRG) funds to highest risk geographic areas and populations, cooperating with the U.S. Geological Survey and the Department of Energy on a special project to develop a model which could further refine the identification of high radon areas, cooperating with

the American Lung Association and others to target smokers, a new initiative in cooperation with the Consumer Federation of America to encourage mitigation among people who have tested and found high radon levels, a cooperative program with the National Association of Counties to establish "Model County Radon Programs" in high-risk areas, and others.

Promote Radon-Resistant New Construction

The Radon Program is expanding initiatives aimed at promoting radon resistant new construction especially in high-risk areas. Examples of ongoing and new activities in this area include: issuing the EPA Model Radon Building Standards and Techniques, working with the national building code organizations to encourage incorporation of these radon resistant techniques into the national and regional building codes in high-risk areas, working with builders to encourage voluntary use of radon resistant construction techniques, cooperative research to refine and improve existing techniques for reducing radon in new construction, a cooperative program with the National Association of Counties to promote adoption of radon resistant techniques into local building codes and builder practices in high-risk areas, a cooperative project with the National Conference of States on Building Codes and Standards Initiatives to identify the State and local building code authorities, and others.

Promote Radon Action During Real Estate Transactions

The Radon Program is expanding initiatives aimed at promoting radon action in the context of real estate transactions. Examples of ongoing and new activities include: releasing the 1993 *Home Buyer's and Seller's Guide to Radon*, working with national organizations and State governments to promote radon disclosure, testing and mitigation policies and mandates in connection with real estate transactions especially in high-risk areas, conducting a series of forums in partnership with the Environmental Law Institute to educate realtors on radon action, research with the Massachusetts Institute of Technology to assess the efficacy of existing State radon disclosure requirements, and others.

Sustain Public Information Campaign

The Radon Program is sustaining major national public information programs and expanding initiatives to target key populations. Examples of ongoing and new activities in this area include: continuing to update and provide basic radon public information materials such as the *Citizen's Guide to Radon*, the *Physician's Guide* and others, continuing the national radon TV, radio and print advertising campaign, continuing National Radon Action Week, and expanding advertising and cooperative minority and low-income outreach programs aimed at achieving action on radon in minority and low-income populations. The Radon Program is expanding initiatives aimed at targeting high risk areas and populations through initiatives such as a cooperative public service announcement with the U.S. Surgeon General aimed at smoking-related radon risks, increasing the proportion of grants to the American Lung Association, the Consumer Federation of America, and the American Public Health Association affiliates in high-risk areas, and working with the National Association of Counties and the International City Managers Association to develop dozens of model city and county radon programs in high-risk areas.

Develop Coordinated Research Plan

EPA and other Federal agencies have conducted extensive research and collected large amounts of data on radon-related issues. However, there are still many areas that require further research. In order to ensure that the Agency's additional radon-related research efforts are coordinated, taken advantage of by key organizations developing programs, prioritized, and do not duplicate efforts by other offices within EPA or other agencies, the Radon Division is working to develop a long-term coordinated research plan. The Radon Division plan has three objectives: (1) identify key research needs; (2) identify research gaps; and (3) encourage responsible agencies to fill research gaps. The Radon Division is initiating a plan to work with other EPA offices, the Department of Energy (DOE), the EPA Science Advisory Board and others to develop the overall coordinated research plan.

CONCLUSION

As discussed in the preceding sections, EPA's strategy to reduce radon risk consists of four key elements: guiding scientific and policy principles, a decentralized management system, a continuum of strategies, and a strong program focus. These elements are summarized together in Exhibit 7.

The States, the scientific community, the radon industry, local governments, national health and consumer organizations, EPA, and others that contribute to the national Radon Program have accomplished a great deal since 1985. In the nine years since the Reading Prong discovery, EPA has significantly increased radon awareness and understanding. A competent and well-trained industry for radon testing and mitigation has emerged. Over ten million homes have been tested for radon, and three hundred thousand homes have been mitigated [15]. Many builders now incorporate radon resistant features in new homes — about 300,000 have been built with such features — and the first State and local radon building codes have been adopted [19]. Grassroots awareness and support have produced real estate radon disclosure laws in ten States, and the real estate industry has voluntarily adopted disclosure policies in many other areas of the country. The relocation industry regularly requires a radon test and remediation, if necessary, as a condition of property transfer [19]. About one-fifth of U.S. schools also have been tested for radon [9].

EPA is committed to focussing on environmental results to assess programmatic progress (Exhibit 8). "The Radon Risk Communication and Results Study," a survey effort conducted by the Conference of Radiation Control Program Directors (CRCPD) in 1993 and again in 1994, is the first comprehensive study of all 50 states and the District of Columbia which addresses key radon program indicators of progress. The extensive survey provides statistically valid baseline information about a wide array of indicators of program progress, and indicates that national and state efforts have been successful at achieving respectable levels of radon awareness and testing throughout the country, particularly in upper-income caucasian families. Less success has been achieved with both ethnic minorities and low to moderate income groups. A summary of some of the 1994 results are included in Exhibits 9, 10, and 11. The results of the study will allow EPA and States to set program goals and targets for increased risk reduction, to share successful approaches, to assess and refine current efforts and to ensure that the radon message is directed effectively to all populations at risk. CRCPD plans to continue to conduct the study periodically to assess the ongoing efforts of each State radon program.

The Agency is also committed to continuing scientific research on health risks. EPA will continue to work closely with the National Academy of Sciences (NAS), EPA's Science Advisory Board (SAB), and other members of the scientific community to use the latest scientific research to estimate risks to the general population from indoor radon exposure.

To build on initial success, EPA will also continue to deliver consistent radon information to the public, continually reinforcing basic scientific principles and policies that guide the Program. To increase the likelihood that radon messages will result in public action, the Program also will continue to rely on its network of States and other organizations. Effective cooperating national organizations serve as multiple sources of radon messages, have special expertise and communications channels needed to reach target audiences, and leverage EPA, State, and local efforts by enlisting their members and affiliates as sources and catalysts for local radon action. The Program will continue to develop and implement activities along a continuum of strategies. Efforts to inform the public and encourage action are important and will be continued, but they will be combined with incentive programs and initiatives to build institutional support for building codes and policies to require radon testing and mitigation when existing homes are sold, especially in high-risk areas. Finally, the Radon Program will increase its focus on the priority activities recommended in the Radon Program Review to ensure that the overall mission of radon risk reduction is accomplished as rapidly and efficiently as possible.

REFERENCES

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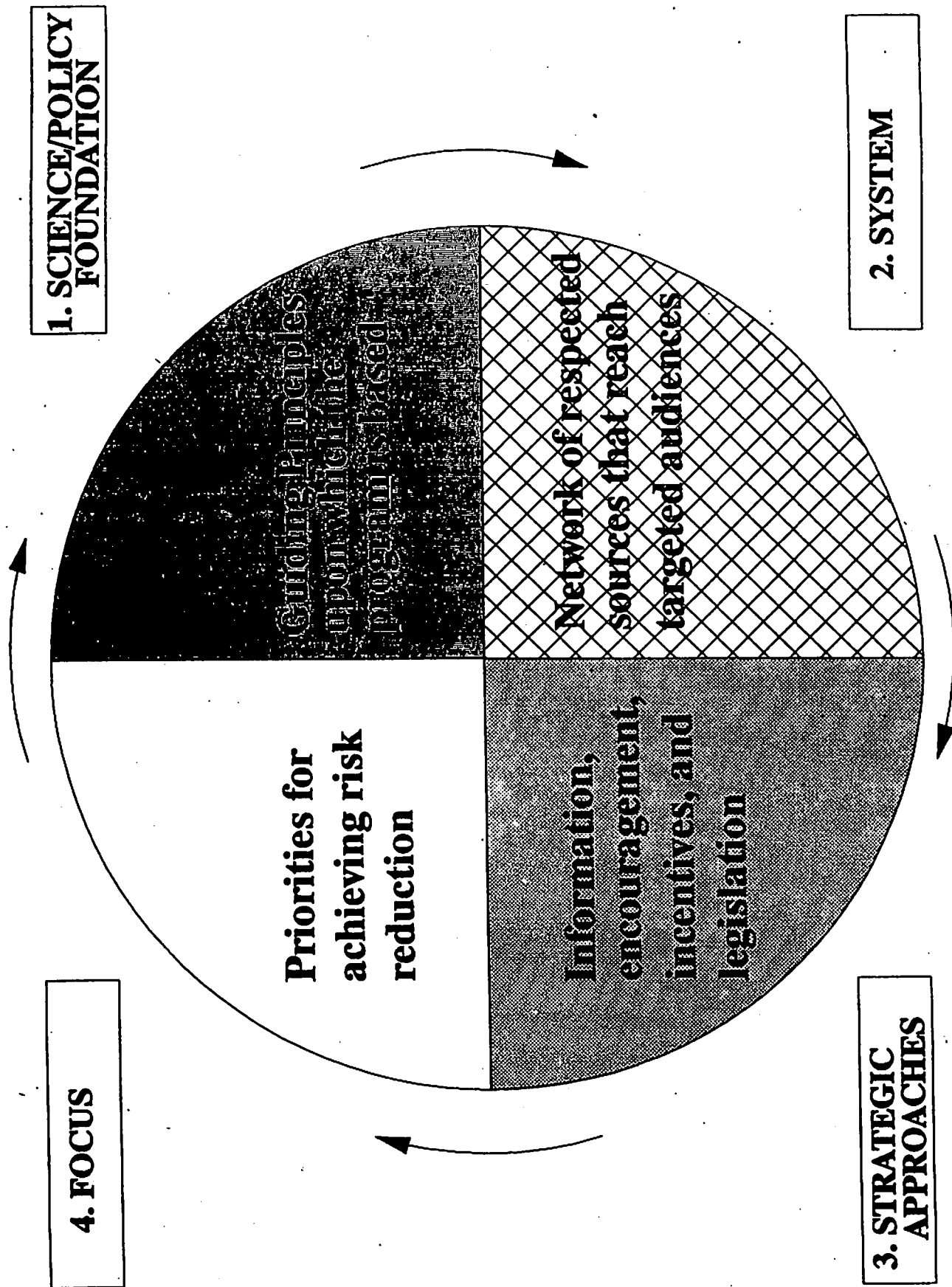
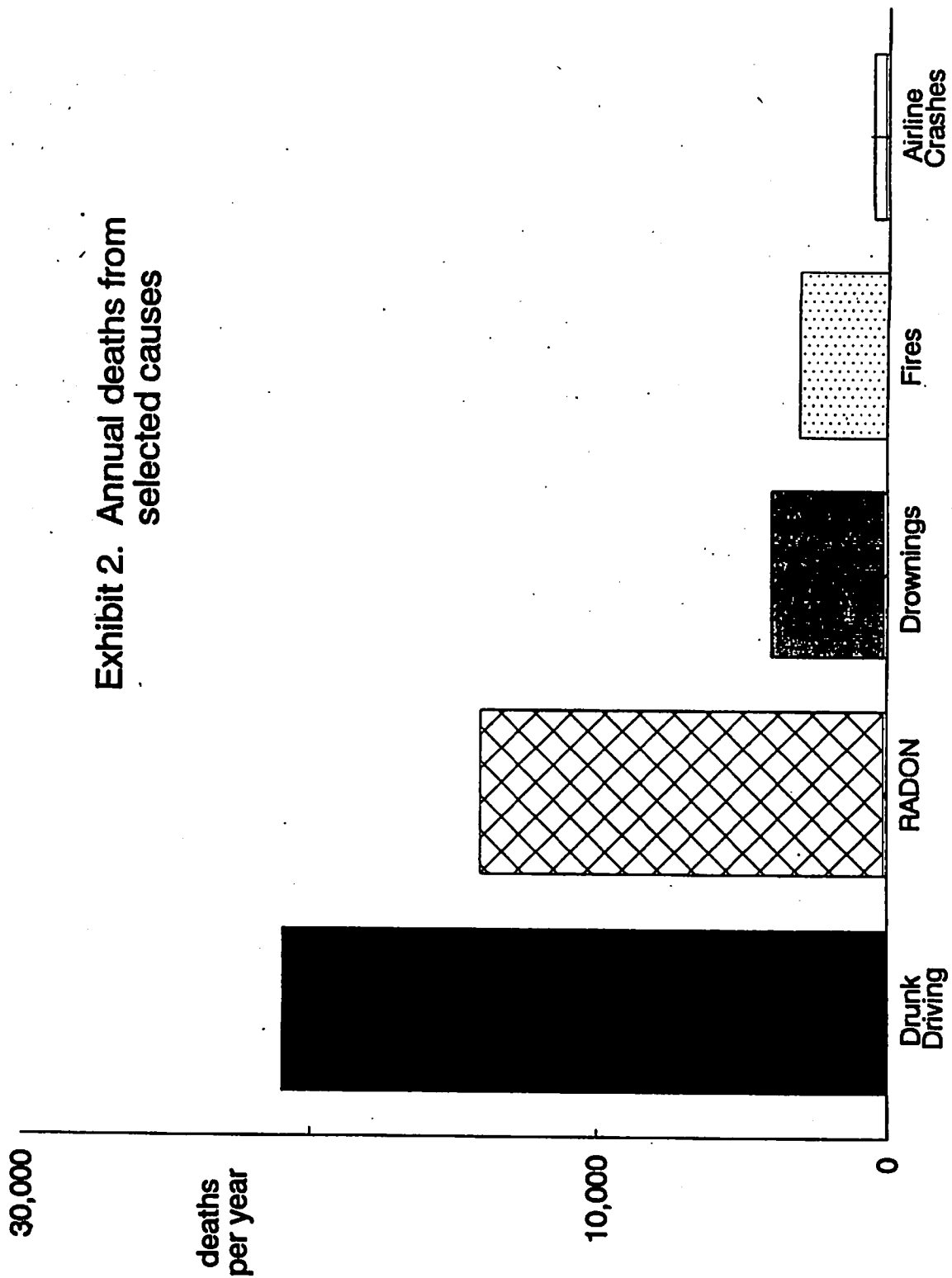


Exhibit 1. Overview of key elements of the radon program strategy

Exhibit 2. Annual deaths from selected causes



* Radon is estimated to cause about 14,000 deaths per year, however, this number could range from 7,000 to 30,000 deaths per year. The numbers of deaths from other causes are actual data taken from 1990 National Safety Council reports.

Radon Level	If 1,000 people who smoked were exposed to this level over a lifetime...	If 1,000 people who never smoked were exposed to this level over a lifetime...
20 pCi/L (740 Bq/m ³)	About 135 people could get lung cancer.	About 8 people could get lung cancer
10 pCi/L (370 Bq/m ³)	About 71 people could get lung cancer	About 4 people could get lung cancer
8 pCi/L (296 Bq/m ³)	About 57 people could get lung cancer	About 3 people could get lung cancer
4 pCi/L (148 Bq/m ³)	About 29 people could get lung cancer	About 2 people could get lung cancer
2 pCi/L (74 Bq/m ³)	About 15 people could get lung cancer	About 1 person could get lung cancer
1.3 pCi/L (48.1 Bq/m ³)	About 9 people could get lung cancer	Less than 1 person could get lung cancer
0.4 pCi/L (14.8 Bq/m ³)	About 3 people could get lung cancer	Less than 1 person could get lung cancer

Exhibit 3. Radon risk comparison for smokers and non-smokers

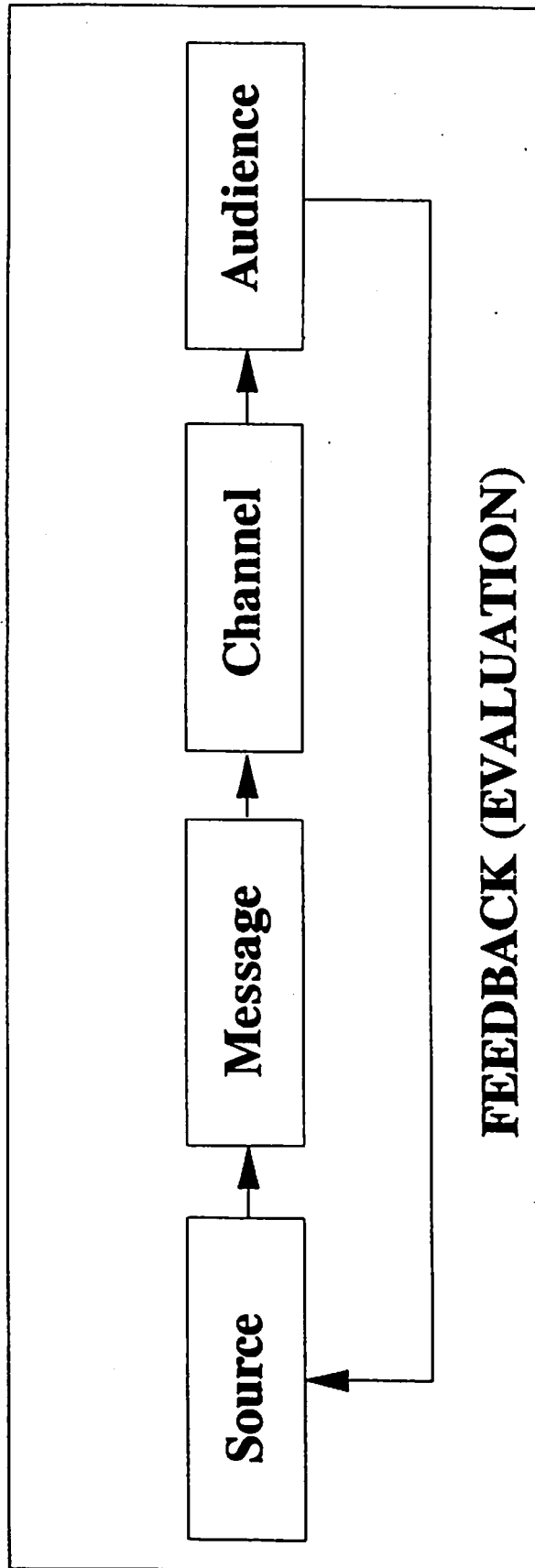


Exhibit 4. Basic communications model

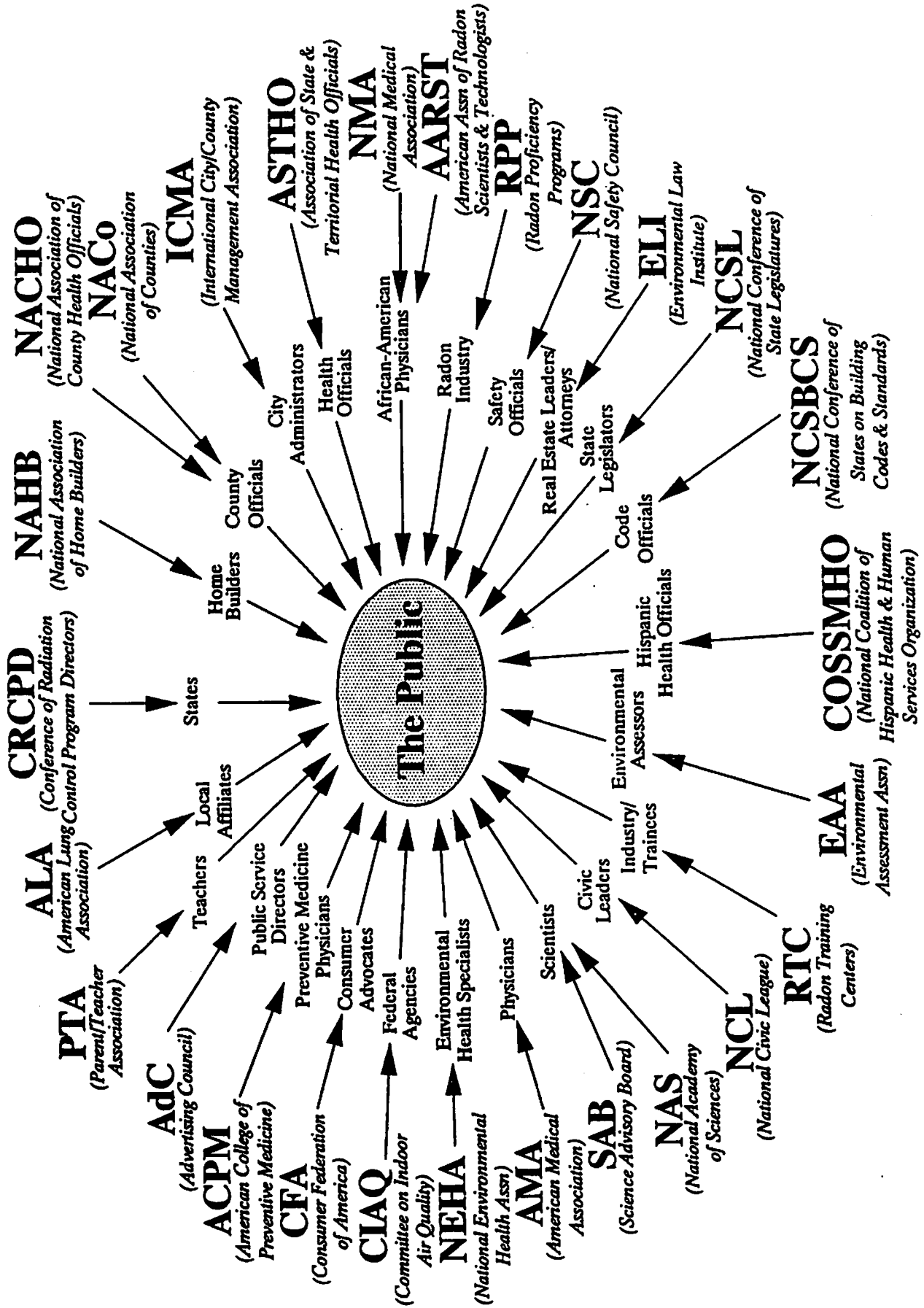


EXHIBIT 5. Repetition and reinforcement of radon messages

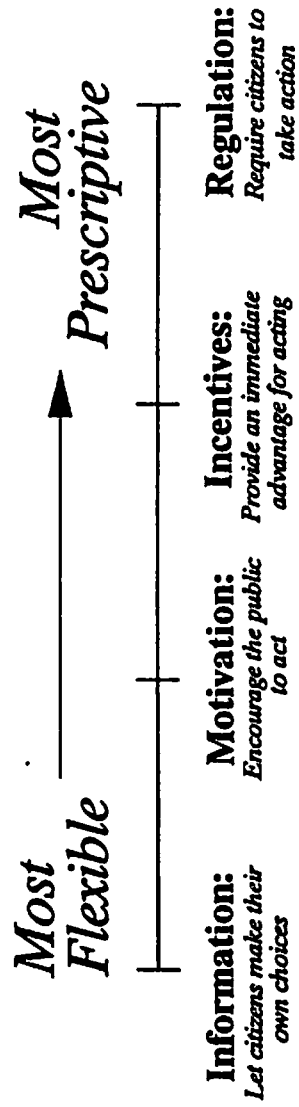


Exhibit 6. Continuum of radon risk reduction strategies

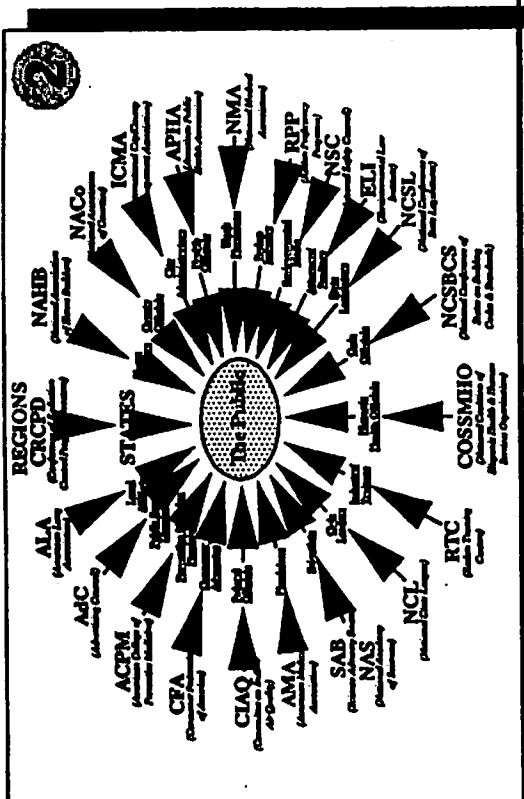
Science/Policy Foundation

System

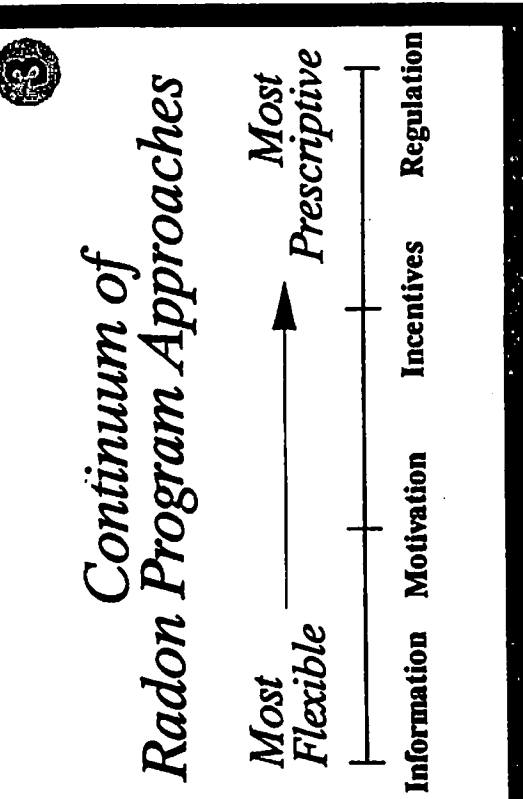
1

No Known Safe Level
 7,000 to 30,000 LCDs/Year
 Smokers At Higher Risk
 6% U.S. Homes > 4 pCi/L

Long-term Tests Are Better
 Reduce Levels Over 4 pCi/L
 Use RMP/RCP Participants
 Test All Homes/Schools
 Short-term Tests Can Be Used



- 4**
1. Target High Risk Areas
 2. Promote Codes
 3. Promote Real Estate Action
 4. Use Information, Motivation & Incentives To Push Codes & Real Estate
 5. Develop Coordinated Research Plan



Focus

Strategic Approaches

Exhibit 7. Summary of key elements of EPA's Strategy to Reduce Radon Risk

Measurable Goals for the Radon Program

Key Area	Current Estimates		1993 Targets		2000 Targets	
	National	High-Risk	National	High-Risk	National	High-Risk
Awareness	63%	NA*	65%	+ 5%	75%	90%
Testing	9%	NA*	2.3M (2.9%) ^{2,3}	1.0M (5.0%) ^{2,3}	26.1M (31%) ³	11.3M (57%) ³
Mitigation	NA*	NA*	50K (0.8%) ^{2,4}	31K (1.3%) ^{2,4}	810K (13.5%) ⁴	480K (20%) ⁴
School Testing ¹	22%	NA*	29%	62%	75%	90%
New Construction: Radon Resistant Homes Built	4%	NA*	5%	+ 10K homes ²	33% ²	50% ²
New Construction: Laws or Policies	NA*	NA*	2 States	1 State; 5 Localities	20 States; 25% of localities w/code authority	20 States; 33% of localities w/code authority
State Real Estate Laws or Policies	5 States with Laws; 2 States with Policies	NA*	6 States with proposed Laws; 5-10 States with Policies	3 States with proposed Laws; 3-7 States with Policies	45% of Zones 2 & 3 with disclosure Laws or Policies	45% of Zone 1 testing or disclosure Laws (5 States)

*NA: Data not available at this time.

¹ Figures are cumulative by years 1993 and 2000.

² Figures show incremental gain in years 1993 and 2000.

³ Percentages are of all homes covered by EPA's testing policy (83 million national; 20 million in high-risk areas). Target for 2000 assumes base of 9 million homes (10.8%) tested to date.

⁴ Percentages are of homes testing greater than 4 pCi/L [148 Bq/m³] (6 million nationally; 2.4 million in high-risk areas).

Exhibit 8. Goals for the Radon Program

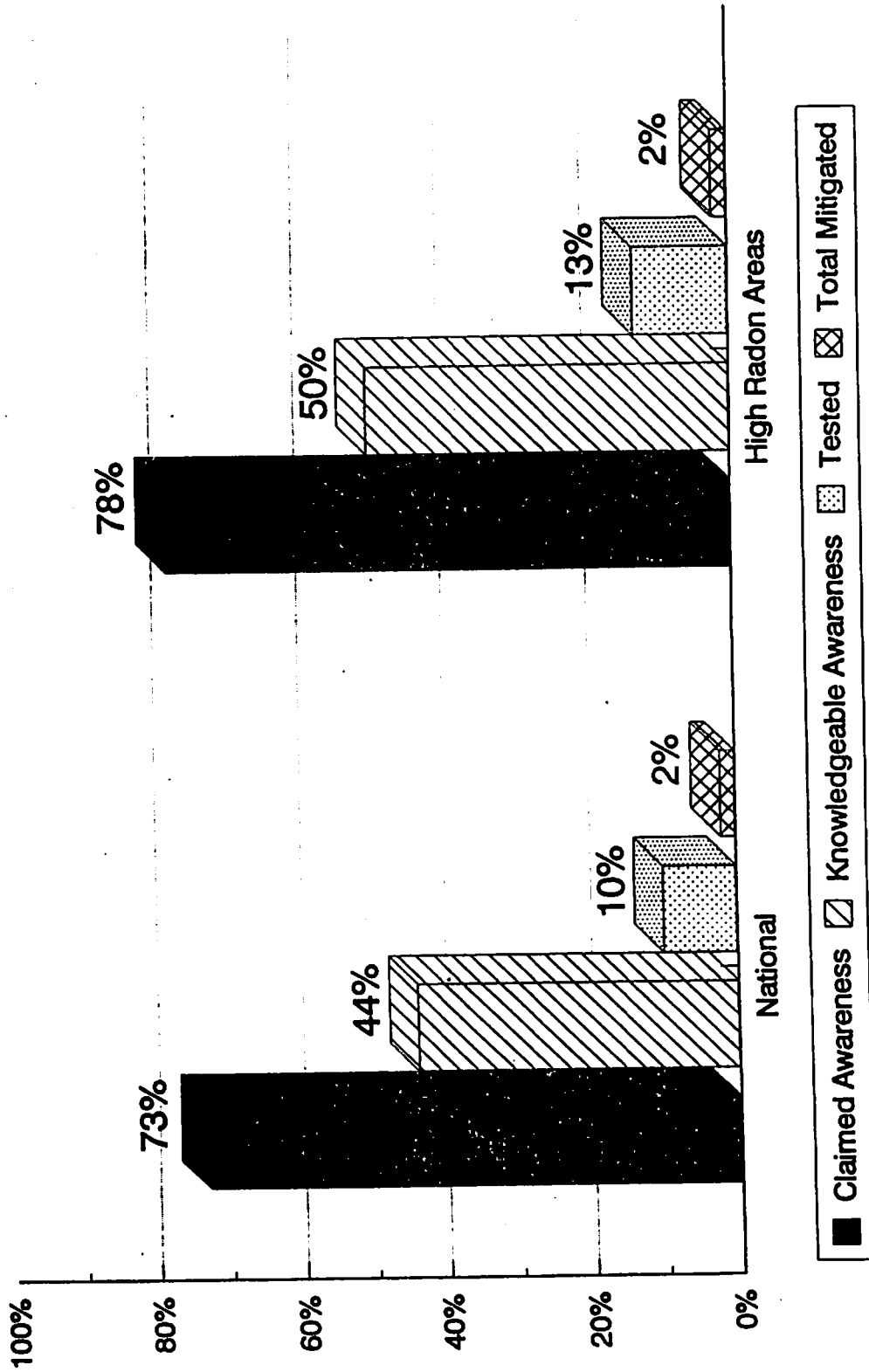


Exhibit 9. National Summary of CRCPD Results

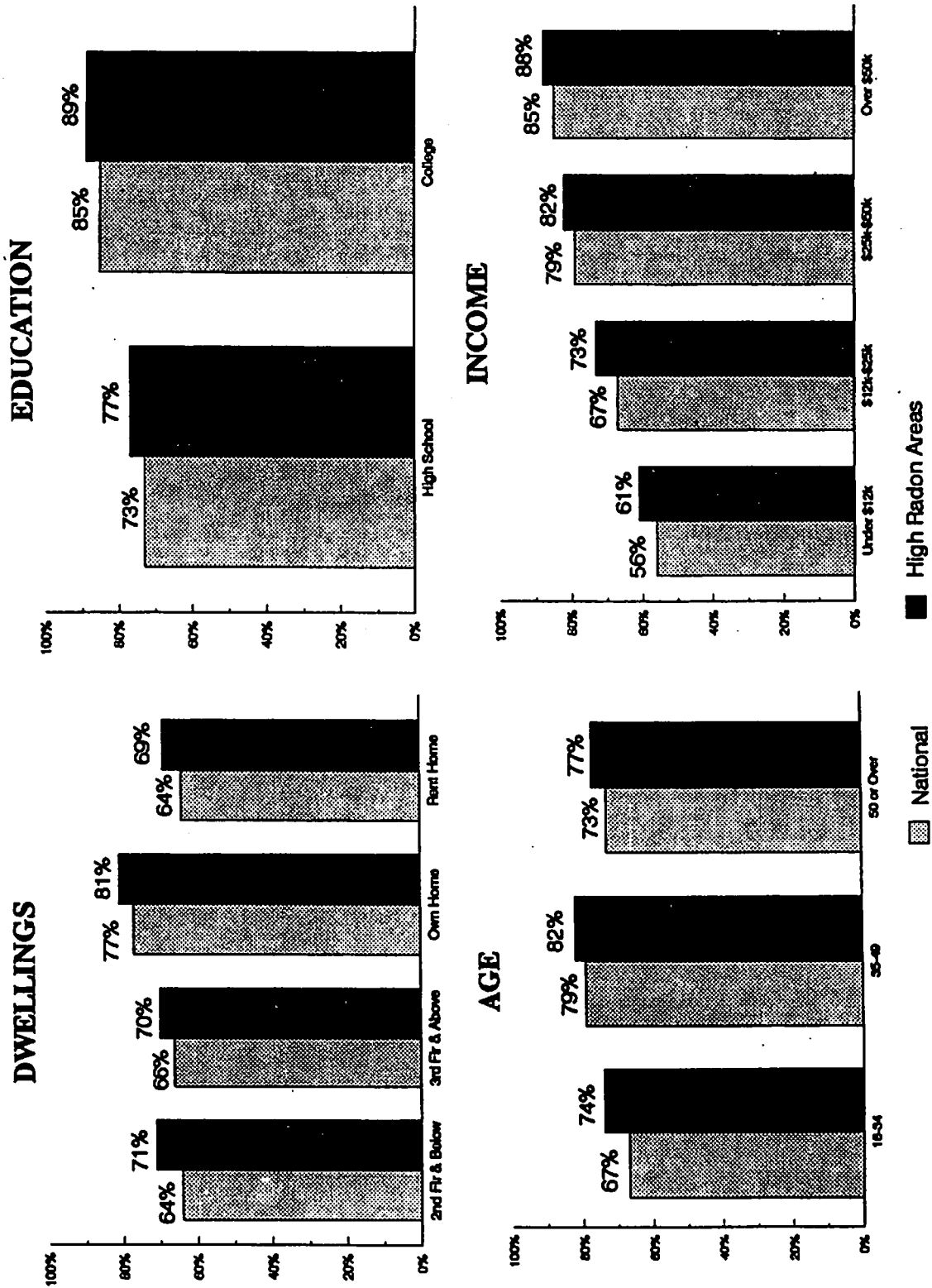
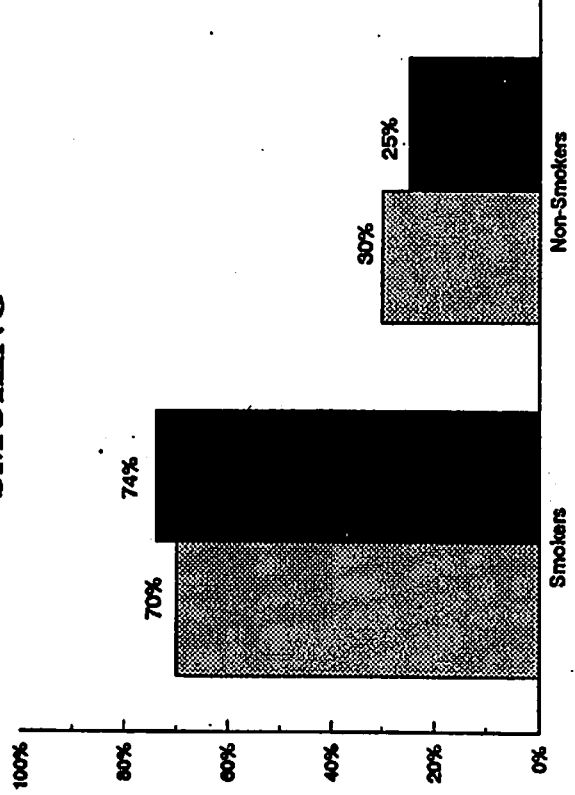
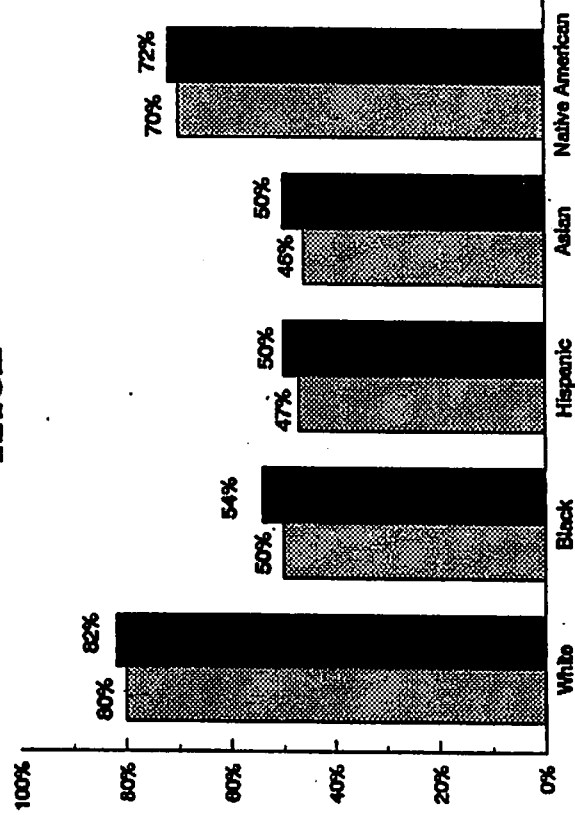


Exhibit 10. National Demographics on Radon Awareness from CRCPD Results

SMOKING



RACE



 National
  High Radon Area

Exhibit 11. National Demographics on Radon Awareness from CRCPD Results (Cont'd)