

## *Day 2: First Morning Session*

# Review of Federal Research and Development and Outreach Activities: A Federal Agency Panel

RADM Robert Williams began with a summation of the first day's activities and introduced the Federal Agency Panel assembled to review and discuss federal research and development and outreach activities, summarizing goals, scope, and efforts.

Mr. William Fisk introduced the session, acknowledging that it was not possible to include representatives from every federal agency with stakeholder interest in the indoor environment at this workshop (such as the U.S. Department of Education, for example), but that the involvement and coordination of all agencies is still valued and encouraged. The session was structured in two parts: (1) presentations by each panel member on indoor environment issues addressed by his or her agency; and (2) individual responses to a series of questions presented on slides that Mr. Fisk wanted panel members to address from the perspective of the agency they represented.

*Henry Falk, M.D., M.P.H.  
Centers for Disease Control and Prevention*

Dr. Henry Falk suggested that indoor environment problems are likely be solved by many small steps, rather than with a single sweeping action like removing lead from gasoline. Indoor environment issues tend to occur in all areas of the neighborhood/community environment, from the home to related problems in schools, workplaces, health care facilities (such as hospitals and nursing homes), and recreational and travel facilities. Indoor environment issues encompass factors that impact on asthma (such as mold, dust, pollen, animal and insect allergens, cigarette smoke, and volatile organic chemicals), pesticides and toxicants, lead and mercury (in paint, dust, and vapor), radon, vapor intrusion (from landfills or Superfund sites), carbon monoxide injuries and poisonings, and infectious diseases. There are more than 6 million substandard housing units nationwide and a critical need to address the public health problems that stem from these units; the Healthy People 2010 program goals call for a 52% improvement in reducing the number of occupied substandard housing units. CDC's Healthy Homes Initiative includes development of guidance documents for housing inspection and risk evaluation, integrated pest management and field surveys for rodent control, and the National Healthy Homes Training Center and Network. Asthma prevalence shows minority group disparities related to housing conditions.

CDC takes a traditional public health approach, linked to NIH medical information and EPA environmental surveillance activities. Science-based CDC-funded intervention programs, such as the Inner City Asthma Intervention (based on research funded by the National Institute of Allergy and Infectious Diseases [NIAID]), are complemented by additional activities based on cooperative agreements with many state agencies. Dr. Falk discussed the evaluations reported in the *Damp Indoor Spaces and Health* report and the

*Second National Report on Human Exposure to Environmental Chemicals* (released January 2003). CDC has been monitoring exposure of the United States population to ETS and has documented the effects of decreased exposure to second-hand smoke by a decrease in 50<sup>th</sup> percentile serum cotinine levels from 0.20 ng/ml to 0.05 ng/ml, comparing population samples taken in 1999–2000 to a comparable group evaluated in 1988–1991. The next *National Report* will look at an expanded list of chemicals, including volatiles from water use and groundwater. NIOSH HHEs assess potential health concerns in the workplace; about 30% of the 12,378 requests received through fiscal 2003 were related to indoor air quality issues. Common problems related to heating and air conditioning system maintenance and operation occur often.

Dr. Falk concluded by discussing CDC's international outreach program, which includes indoor environment issues in developing countries. There is an "energy ladder," moving from the least expensive fuels (animal dung, crop by-products, wood) to more expensive and complex fuel sources (natural gas and electricity) that provide increasing cleanliness and convenience in parallel with increasing cost. Low-quality fuels introduce more particulates into the air; but even without fuel changes, dramatic reductions in indoor air particulates can be achieved by introducing simple and inexpensive technology, such as replacing a traditional open fireplace with a wood stove and chimney.

*Samuel H. Wilson, M.D.*  
*National Institutes of Health*

Dr. Samuel Wilson said his agency's focus since around 1998 has been on health effects of the built environment. In the view of NIH, the built environment essentially defines "indoor" exposures that not only contribute directly to human disease but also interact indirectly with social and lifestyle factors that can result in health problems. For example, in looking at the increased incidence of asthma, the built environment may increase human exposure to indoor allergens and other agents through poor air quality, and may also increase time spent indoors and decrease physical activity, possibly contributing to the health risk. A poorly designed built environment also contributes to resource waste and environmental degradation. The National Institute of Environmental Health Sciences (NIEHS) has a strong interest in the possible contribution of biological factors to health problems.

Asthma is not only a serious health concern but also represents a \$13 billion annual cost for the United States health care system. NIH supports research on asthma in three focus areas: genetic predisposition (susceptibility), environmental factors (e.g., indoor allergens, endotoxin, ETS, viral infections, outdoor pollution), and allergy and asthma responses. The agency supports both observational and interventional studies. Dr. Wilson described the complex sequence of epithelial and immune system cellular and biochemical responses involved in asthma. Various steps in these reactive pathways suggest potential molecular targets for medical intervention. Studies of environmental factors offer other opportunities for intervention. However, because most previous indoor allergen and endotoxin exposure studies have been small and geographically localized, they have limited application to other regions or different socioeconomic groups. In collaboration with the Department of Housing and Urban Development (HUD), NIH has

added allergen exposure levels to a nationwide study of lead exposure in housing (National Survey of Lead and Allergens in Housing [NSLAH]) to identify prevalence, to establish correlates for identifying problem homes, and to begin to examine the relationship between indoor allergen exposure and disease (allergy and asthma).

Another collaborative effort is the allergy and asthma component of the National Health and Nutrition Examination Survey (NHANES). In this study, funded by NIEHS and conducted in collaboration with investigators from NIAID and CDC, data from 5,000–6,000 subjects per year will be collected from 2005 to 2008. The allergy assessment will involve analysis of blood samples for serum total IgE, and for specific IgE (antibodies) to 19 indoor, outdoor, and food allergens. In parallel environmental sampling, vacuumed dust samples from two home locations will be collected and tested for markers of specific allergens (endotoxin and markers of cat and dog, cockroach, dust mite, two genera of fungi, and rodents). Information will be collected by questionnaire on housing characteristics, pet ownership, diagnosed allergy and related diseases, exposure to tobacco smoke, diet and nutrition, and occupational exposures. In conclusion, Dr. Wilson indicated that a series of conferences on the built environment played a key role in stimulating interest in indoor environment issues and developing objectives for each institution involved in these studies. The resulting cooperative studies indicated what can be done by taking a broad holistic approach.

*Elizabeth Cotsworth, B.A., M.A.*  
*U.S. Environmental Protection Agency*

Ms. Elizabeth Cotsworth described her agency's indoor environment activities, emphasizing that EPA's current program is the cumulative response to limited statutory authority. EPA co-chairs and is a major participant in the CIAQ, along with the CPSC, DOE, OSHA, and NIOSH.

EPA works with other agencies to identify unique, high-impact niches that it can fill related to overall agency mission and strategic priority decisions. In addition to well-established regulatory programs on lead and asbestos, Ms. Cotsworth indicated that EPA's indoor environment program largely provides sound science and technology-based information related to any and all indoor issues, including carbon monoxide poisoning in homes, mold in schools, product use in commercial office buildings, and reducing indoor cooking smoke in developing countries. EPA has sponsored reviews assessing the effects of low-level ionizing radiation, such as the NAS Biological Effects of Ionizing Radiation BEIR VI Committee review (1999).

EPA currently focuses its major investments on a high-priority set of issues in which behavioral changes to reduce public health risks in indoor environments are promoted. These priority investment areas are: indoor radon, environmental management of indoor asthma triggers, childhood exposure to ETS, and indoor air quality in schools. EPA has established quantitative national goals in these four areas and tracks progress against these goals. For example, EPA set an objective of reducing ETS exposure levels by 12% for children less than 6 years of age, and has now achieved a level of 11%. EPA's model for addressing each of these areas involves defining a sound scientific rationale, raising public and stakeholder awareness of the issue, recommending (in some cases developing)

mitigation measures, leveraging resources with the use of cooperative partners and “train the trainer” approaches, and seeking institutionalization of the issues through non-federal means (local building codes, mortgage company requirements, etc.). For example, EPA played a key role in the development of standards for radon-resistant new homes and practices in the radon mitigation industry. For environmental management of indoor asthma triggers, EPA’s primary objective is to motivate people to take essential actions to reduce their exposures by providing culturally appropriate information. An example of this type of audience-focused information is the *Tools for Schools* material such as *Managing Asthma in the School Environment* (<http://www.epa.gov/iaq/schools/asthma/>). Approximately 30% of schools have adopted an EPA indoor air plan. EPA also supported a University of Michigan School of Public Health study of best intervention practices. EPA has classified secondhand smoke as a Group A carcinogen, and has established voluntary programs to encourage smoke-free homes and day care centers (e.g., <http://www.epa.gov/smokefree/index.html>).

Ms. Cotsworth also described EPA’s development of a strategic vision (EPA’s *Healthy Buildings, Healthy People: A Vision for the 21st Century*, published in 2001) for the future of healthy indoor environments in consultation with a broad set of stakeholders. This document serves as the basis for an informed discussion on public policy, health, building sciences, product manufacturing, and environmental research. The *Healthy Buildings, Healthy People* initiative is based on six strategies for producing improvements:

1. Partnership,
2. Technologies,
3. Market incentives,
4. Research and development,
5. Legislation/standards, and
6. Public information.

EPA is involved in identifying knowledge gaps related to indoor air quality, particularly in the areas of pollution sources, building design, and homeland security needs. To help achieve its vision, EPA recently completed a more than year-long effort to codify its indoor environmental research and development needs. The draft *Program Needs for Indoor Environment Research* (PNIER) document will be released soon and posted on the EPA Web site. Ms. Cotsworth indicated that EPA has already started to market those needs inside and outside the agency through various channels.

*Jerome Dion, M.S.*  
*Department of Energy*

Mr. Jerome Dion, substituting for Richard Moorer, summarized the impact of his agency’s activities on indoor environment issues. DOE has a \$1.3 billion research and development budget with components that include energy-efficiency programs and low-income home weatherization. Research targeted toward the achievement of Zero Net Energy buildings (buildings that produce on average as much energy as they use) has a

goal of reducing energy use by 50% by 2015. Three strategies have been developed for addressing indoor air quality issues in this energy conservation program:

1. Reducing the need for dilution air in buildings;
2. Source control (reducing pollutants from building materials); and
3. Cleaning recirculated air.

These strategies recognize the need to address health and safety concerns while promoting reduced and more economic energy use. Activities are closely coordinated with HUD's Healthy Homes and EPA's Energy Star programs. There are research and development programs (budgeted at about \$3.5 million per year) involving Lawrence Berkeley National Laboratory, the National Institute of Standards and Technology (NIST), and the National Center for Energy Management and Building Technology.

Some of the technical pathways being investigated include:

- Developing new methods for determining the amount of outdoor air needed in buildings;
- Improving controls and equipment to supply outdoor air;
- Improving techniques for measuring and monitoring the quality of air supplied to buildings;
- Finding ways to reduce pollutant emissions from building materials; and
- Finding ways to clean recirculated building air.

The technological challenge in maintaining environmental quality in tight buildings is to ensure that energy-efficient buildings are healthy buildings by good design and operation. To this end, DOE is developing a "best practices" guide for energy efficiency in hot/humid climates, to be followed by similar material for conditions applicable to other regions of the country. DOE's current unmet research and development needs include getting better information on building performance and its impact on health, and defining better minimum ventilation requirements. The agency is currently using American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards as guidance. Mr. Dion explained that DOE depends on other agencies to identify potential health problems and counts on other agencies concerned primarily with health issues to promote solutions that are as energy-efficient as possible.

*Kevin Kampschroer*  
*General Services Administration*

Mr. Kevin Kampschroer described General Services Administration (GSA) workplace initiatives designed to provide the "best value" for customer agencies and taxpayers. His perspective on indoor environment issues was primarily economic, particularly with respect to justifying improvements and motivating changes. Responsible asset management at GSA ("the nation's landlord") requires research to know how the built environment can affect work, and to define and deliver what is really best while taking into account all factors, including the health and productivity of employees.

Workplace quality is a major factor in attracting and retaining good employees; this will be a particular problem for the federal government as up to 70% of the federal workforce

becomes eligible for retirement by 2005. Factors such as providing an opportunity for contact with nature or aesthetic and sensory variability should be considered from an economic as well as a humanistic perspective in the effort to attract new workers. GSA places 60,000 government workers per year into new office space (mainly due to lease turnover). A healthy indoor environment is usually assumed to be a feature of rented office space, but is often not addressed beyond making sure that the work environment is comfortable. Factors that promote psychological well-being and cognitive functioning are important for a workforce composed primarily of “knowledge workers,” and need to be included in a workplace evaluation. Mr. Kampschroer indicated that he would like GSA to develop a way to rate the environmental quality of a building, such as the Hong Kong building certification system discussed the previous day. The acoustic environment is often most troubling to people, but air flow and temperature are most often the subject of worker complaints, perhaps because most people do not think noise problems can be solved. GSA developed the Workplace 20•20 program to address issues of economic pressures, demographic shifts, and technological opportunities, and to evaluate their consequences on workers’ performance, resource constraints, and human capital challenges. The program uses a scorecard to evaluate four domains important to knowledge workers. They have limited experimental work underway (11 projects for 2005) to measure changes in performance factors after changes are made in the workplace.

Mr. Kampschroer discussed potential improvements to the office environment as analogous to improvements in modern zoo design. He showed a four-panel slide that depicted the old system of small barred cages compared to the newer design of large naturalistic environmental enclosures, and a typical windowless office with cubicle work stations compared to a blank space with a question mark. The point made was that just as zoos are trying to look beyond simple survival to an animal’s well-being by giving the animal more control over its behaviors and environment, we should try to give offices more aesthetic and sensory variety, provide places to be alone or work together as appropriate, and allow more control over our environment.

There are many emerging challenges for GSA in accommodating changing technology and work patterns, but the economic leverage of GSA real estate management activities provides an opportunity to advocate for and promote workplaces with good environmental quality. Economic concerns and productivity outcomes (evaluated with behavioral research methods) form a substantial portion of GSA’s concerns, but workplace environment (including issues like levels of carbon dioxide, particulates, volatiles, formaldehyde, and mold and mildew) is part of that evaluation.

*David Jacobs, Ph.D., CIH*  
*Department of Housing and Urban Development*

Dr. David Jacobs described HUD’s efforts to address indoor environment issues in the context of providing quality affordable housing in the United States. He discussed the history of public health interest in housing, starting from the late 19<sup>th</sup> century, when substantial improvements in tuberculosis and typhoid morbidity were achieved by

successful efforts to reduce crowding, improve sanitation, and bring more light and fresh air to urban housing. Physical characteristics of housing have an impact on the social and psychological characteristics of the home's occupants, and, at a broader level, the neighborhoods. In the United States, half of the lowest-income households spend 50% or more of their incomes on housing, nearly 2 million live in severely inadequate housing, and 2.5–3.5 million people are homeless at some time during any given year. These factors result in a segment of the population that is at much higher risk for asthma and infectious diseases.

Lead toxicity has been recognized for over a century, as illustrated by a paint advertisement from 1897, which claims it is “not made with lead and is non-poisonous.” Lead abatement programs have reduced the percentage of 1- to 5-year old children with blood lead levels at or above 10 µg/dL from 88.2% in 1976–1980 to 2.2% in 1999–2000. However, as of 2000, there were still an estimated 38 million houses containing lead paint and 434,000 children with elevated blood lead levels. Lessons learned from dealing with lead paint might be applied to other housing-related diseases and injuries, specifically diseases caused by mold and allergens in indoor air, exposure to neurotoxicants, carbon monoxide fatalities, and fall and trip hazards. Progress on residential lead hazard control was made by (1) assessing the magnitude of the problem in existing housing, with studies like the NHANES dust lead survey and the National Survey of Lead and Allergens in Housing; and (2) establishing mandated standards and guidelines for hazard assessment and abatement. Exposure assessment is feasible, but hazard levels are not currently well established for mold and allergens.

HUD's primary focus is on low-income homes and community development. In this context, improvements made for one purpose can produce other unrecognized health benefits. For example, moving people to more stable, mixed-income neighborhoods results in significant improvements in the physical condition of housing, as well as in mental health and reduced obesity, according to HUD's *Moving to Opportunity for Fair Housing* experiment. Window replacement programs remove a major source of lead paint and lead-contaminated dust in low-income housing and also address energy conservation and moisture infiltration. New windows can impact indoor air quality by improving ventilation because they can be opened and closed more easily. While it is recognized that energy conservation offsets the cost of windows over a 5- to 10-year period, the health benefits are generally not recognized in the market value of housing, although they may be even more substantial in terms of reduced medical and other health care costs.

Dr. Jacobs pointed to the need to make the economic benefits of improved indoor environment more evident so as to use market pressures to favor interventions. At present, many home improvements that would address health issues are not carried out because they would be economically irrational from a homeowner's point of view. When we improve our homes with a new furnace or roof, we anticipate at least a partial return on investment in the form of increased market value when that home is sold, but measures taken to produce health benefits like radon or lead abatement generally are not reflected in the market value of the home. In dollar terms, health benefits may greatly outweigh the value of improvements in other areas, but most improvements that affect

health generally do not affect the market value of homes. Dr. Jacobs suggested that we need to find a way to articulate the cost of not making health-based housing improvements and to document the cost-shifting to the medical sector that results from allowing substandard housing, and the illnesses associated with it, to persist.

Dr. Jacobs concluded by mentioning the HUD publication *Basic Healthy Housing Reference Manual*, which is being reissued in collaboration with CDC. He discussed a list of specific research needs and national and international policy objectives with respect to healthy housing and other indoor environments that have been formulated at recent international conferences. He recommended that the Surgeon General and others work with WHO to advance these objectives. Several of these recommendations are focused on developing a specific way of assessing policy effectiveness (e.g., research to develop better housing-hazard measurement technologies, to determine the interactions of specific housing conditions and physical and mental health, and to measure interactions with confounding variables). He stressed the importance of not focusing on hazards individually, but rather taking an integrated approach to establishing healthy conditions by looking at housing systems and integrated housing and community intervention. It is important to assess how variables interact, and how social conditions impact on health issues (e.g., obesity). There is a need to partner with the private sector in marketing healthy home improvements. Window and door manufacturers market primarily on aesthetics and energy conservation and typically do not consider advertising the health aspects of their products. He suggested a program, analogous to EPA's Energy Star program, for labeling new and existing homes and products that contribute to improved indoor environment design. Looking at marketing techniques would be a key research need. There is a need to formulate policy and develop technology for developing healthy housing on contaminated sites that often provide low-cost real estate in urban areas. Finally, he noted that unique ethical issues arise in intervention research on substandard housing, which must be taken into account when planning studies. We should not be using our children as detectors of substandard housing; we have technologies and techniques we can use to provide America's families with decent, safe, and affordable housing.

*James E. Hill, Ph.D.*

*National Institute of Standards and Technology*

Dr. James Hill discussed NIST's engineering and technology perspective on indoor environment issues. The agency's primary mandate is to strengthen the technological innovation infrastructure in the United States for the occupational sector, but to do so with attention to public safety and security while maintaining quality of life and jobs. NIST conducts and supports extramural air quality and ventilation research to improve indoor environmental conditions in a cost-effective manner, which is done through development of measurement and design procedures and simulation programs for air and contaminant transport in buildings. Ventilation research is a \$2 million-per-year program carried out with 10 permanent staff members plus students and guest researchers and supported by the Air Conditioning and Refrigeration Technology Institute, California Energy Commission, DOE, EPA, HUD, and the U.S. Navy. As with DOE's program,

NIST is looking for technology that improves indoor air quality without substantially increasing energy costs. Addressing indoor environment issues should be a routine aspect of engineering and should be included in computerized design tools. There is a need to understand health-effects studies at a level where useful information is provided that can be used by engineers (“what to do and what not to do”). Also, standards cannot be too complicated if firms are expected to implement them.

NIST works on many issues that impact on the indoor environment, such as developing test methods and standards for contaminant emissions (e.g., sulfur in fossil fuels), gaseous air cleaner performance, alternative refrigerants, volatile organic compound emission rates into indoor air, and residential and office building ventilation technology. NIST activities have expanded recently to include security issues, and the CONTAM modeling program is being used in research supported by the Defense Advanced Research Projects Agency (DARPA) on enhancing the software to analyze the impact of protective measures and analyze chemical/biological agent transport in buildings. Dr. Hill stressed the need to develop practices that can be implemented quickly and easily, because otherwise there is a tendency to “keep building new buildings like the last building.”

## Questions and Comments

In audience comments following these presentations, one participant indicated disappointment at the lack of progress made in determining adequate ventilation rates for homes to ensure indoor air quality, noting that the ASHRAE standard used in the United States is about one third or one half the rate used in the rest of the industrialized world. Fundamental research to understand the health implications of this has not been carried out. Day care centers and schools may require even higher ventilation rates than common workplace settings to reduce infection rates. There is also a lack of research information on the basic spread of infectivity and ventilation. Several people from the audience commented on points made in the presentations from the perspective of their particular public health interests. One participant commented that HUD housing should be able to accommodate those with MCS; another suggested a need for better environmental health education for health professionals, particularly with regard to mental health problems. Several audience members reinforced points made by the speakers regarding health care costs associated with inadequate indoor environment practices. Ms. Cotsworth responded that EPA works with the health insurance industry and providers to try to understand management of environmental triggers, and Dr. Falk indicated that CDC is also promoting these programs.

### **Highlights from Federal Research and Development and Outreach Activities Session**

Many federal agencies conduct research and operate health intervention programs that involve agents in the indoor environment.

Federal agencies work collaboratively to identify and address common problems in the indoor environment. These collaborative efforts include sharing expertise for research design and evaluation, co-funding basic research and needs assessment studies, and cooperative programs to inform the public and promote behavioral changes that reduce public health risks associated with poor indoor environment conditions. HUD's Healthy Homes and EPA's Energy Star programs are examples of programs that have promoted public behavioral changes.

There is lack of research on certain basic scientific questions, such as understanding how infective agents are spread in the indoor environment.

Federal agencies work together to develop building technology solutions that meet multiple objectives, such as producing a healthier indoor environment without compromising energy efficiency or substantially increasing costs of managing government facilities.

There is a need to understand health effects research at a level that can be applied by engineers.