Indoor Air Quality: Risk Reduction in the 21st Century

May 3-4, 2000

Sacramento, California

Symposium Proceedings

***Sponsor*:**
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Acknowledgements

The Symposium organizers at the Air Resources Board and the Department of Health Services want to express their gratitude to each of the individuals, agencies, and organizations that participated in the Symposium. We are especially indebted to the session chairpersons and the speakers for the time and effort they contributed to produce such excellent sessions and presentations. We also wish to thank Dorothy Shimer of ARB's Indoor Exposure Assessment Section and Priscilla Gandy of the California State University at Sacramento Business Services Group for handling the organizational details of the Symposium. Finally, we appreciate the work by Dorothy Shimer, Peggy Jenkins, Susan Lum, Scott Fruin, and Jed Waldman in preparing this proceedings document.

We extend a special acknowledgement to former Assemblywoman Sally Tanner. This Symposium is a legacy to her foresight and leadership in protecting public health and the environment during her years in the California Legislature, particularly her leadership in initiating the State indoor air quality programs. Her achievements include legislation that established the Air Resources Board's Toxic Air Contaminants Program and part of ARB's Indoor Air Quality and Personal Exposure Assessment Program; the Indoor Air Quality Program at the Department of Health Services; and the Carpenter-Presley-Tanner State Superfund Law to address toxic wastes. We were very pleased that Mrs. Tanner could join us for the symposium. We also thank Winston Hickox, Secretary of the California Environmental Protection Agency, for his support and for joining us to honor Mrs. Tanner.

DISCLAIMER

The statements and opinions mentioned in this summary are those of the speakers, panel members, and audience members who participated in the Symposium, and are not necessarily those of the Air Resources Board or the Department of Health Services. The mention of commercial products, their source, or their use in connection with the material herein is not to be construed as either actual or implied endorsement of such products.

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PROGRAM SYNOPSIS

The California Air Resources Board (ARB) sponsored a symposium on May 3-4, 2000 in Sacramento entitled *Indoor Air Quality: Risk Reduction in the 21st Century*. The California Department of Health Services (DHS) co-sponsored the event. The objective of the symposium was to highlight new findings in the fields of indoor air quality and exposure assessment, and to promote actions to prevent and reduce indoor air pollution. About 170 people from government, school districts, private consulting firms, environmental groups, the media, and others attended the symposium. This document summarizes the two days of presentations and panel discussions held during the Symposium.

ARB Chairman Alan Lloyd opened the Symposium with welcoming remarks and a reflection on the growing importance of indoor air issues. Topics on the first day included scientific updates on the risks posed by indoor air pollution, the costs of indoor pollution, and approaches to reducing indoor exposures. Several sessions focused on children's exposures and measures needed to reduce risk in California schools.

On the second day, a roundtable of State agency leaders and others discussed policy changes and actions needed to reduce the risk posed by indoor air pollution. While many State agencies, boards and departments are engaged in activities that promote more healthful indoor environments, participants clearly stated that a comprehensive and coordinated approach is needed to reduce risks from indoor air pollution, and many suggestions were given on how this might be accomplished.

As a highlight of the Symposium, Winston Hickox, the Secretary of the California Environmental Protection Agency, presented a special plaque of appreciation to former Assemblywoman Sally Tanner. Mrs. Tanner was recognized for her legislative achievements in the fields of public health and the environment, including legislation that initiated the indoor air quality programs in both the ARB and DHS. Through her foresight and leadership, several programs were established that enable State agencies to more effectively protect Californians from the harmful effects of pollution.

EXECUTIVE SUMMARY

On May 3-4, 2000, the Air Resources Board (ARB) sponsored a symposium entitled *Indoor Air Quality: Risk Reduction in the 21st Century*. The Department of Health Services (DHS) co-sponsored the event. The objective of the symposium was to highlight new findings in the fields of indoor air quality and exposure assessment, and to promote actions to reduce the risk posed by indoor pollution.

Indoor pollution poses a high risk, relative to other environmental problems. One scientist (see p. 10) has estimated that a given quantity of pollutant released indoors is 1000 times more likely to result in human exposure than the same quantity released to the outdoors. However, indoor pollutants and their sources are largely unregulated. These pollutants can be as diverse as toxic chemicals emitted from building materials and furnishings, combustion pollutants like carbon monoxide and toxic particles, and biological contaminants such as molds and bacteria. The adverse health effects they cause range from immediate harm, such as asthma and heart pain, to longer-term effects such as cancer and chronic lung disease. The toll they take in health costs and lost productivity is estimated to range to tens of billions of dollars per year.

Indoor Exposure and Risk in California

In the first session, speakers concluded that future policies for protecting public health should focus on reducing people's exposure to indoor air pollutants, as an addition to existing programs that reduce sources of outdoor air pollutants. Several speakers reviewed the many studies that have shown that, for most volatile organic chemicals (VOCs), pollutant concentrations in an individual's breathing zone (the air near their nose and mouth) are usually higher than average indoor air concentrations, which in turn are usually much higher than outdoor air concentrations. Speakers illustrated the much higher impacts of indoor sources of pollutants on exposure compared to emissions from outdoor sources.

> ***A typical pollutant release indoors is 1000 times as effective in causing human exposure as the same release to urban outdoor air.***

Californians spend about 87% of their time indoors, most of it in their homes, so elevated indoor concentrations translate into very high exposures. Members of the population who are especially vulnerable to the impacts of air pollutants, such as children and the elderly, spend even more time indoors at home. Thus, the home is a particularly critical environment for children and seniors.

Because regulatory strategies have almost exclusively focused on outdoor sources, indoor air quality (IAQ) holds great promise for cost-effective measures to reduce

health risks. The potential benefits of reduced illness and improved productivity are estimated at tens of billions of dollars annually (see p. 12). For example, actions to reduce emissions of formaldehyde, a carcinogen and toxic air contaminant, from the many building materials and consumer products in which it is used, could achieve a substantial reduction of risk to the general population, for a small increase in product cost.

> ***Increased effort could achieve large reductions in risk.***

Children's Health and Indoor Air Quality

Children are more susceptible to health effects from air pollutants than the general population. They are still developing physically and they have higher breathing rates than adults have, resulting in higher relative doses of pollutants than adults experience when exposed to the same air concentrations.

Child-related concerns include the rising rates of asthma and frequent problems with poor air quality in schools. The three most frequently reported environmental quality problems in schools are inadequate ventilation, water damage with subsequent mold growth, and elevated levels of formaldehyde and other VOCs. An action as simple as enforcement of Cal/OSHA's Minimum Building Ventilation Standard (California Code of Regulations, Title 8, Sec. 5142, see http://www.dir.ca.gov/title8/5142.html) in schools would greatly improve indoor environmental quality in classrooms.

School districts typically do not have a dedicated staff position that can receive and review information on safety, health, and environmental issues and implement best management practices for schools. There are many competing priorities for scarce school-budget dollars, and school administrators are focused on educational issues other than indoor air quality. Therefore, indoor air quality awareness and training are key requirements for schools to improve their air quality.

Reducing Indoor Exposures – Key Principles

Fortunately there are many methods and tools available to improve indoor air quality. Reduction of indoor emissions and removal of indoor sources are the most effective strategies for improving indoor air quality in many situations. Speakers provided examples for reducing emissions from formaldehyde-emitting building materials and consumer products, such as through product substitution. For example, manufactured wood products made with phenol-formaldehyde resins have lower emission rates than products made with urea-formaldehyde resins. An alternate way of reducing formaldehyde emissions from building materials is to coat the emitting

product. Vinyl, laminate, and paper coatings can reduce emissions from sheet wood products by up to 90%.

Minimizing indoor emissions is generally more effective than removing them after emission has occurred.

Another key strategy is ensuring proper building ventilation. Proper building ventilation is an essential tool for maintaining contaminant control and thermal comfort. Contrary to popular belief, air cleaners have limited application as a supplement to source reduction and proper ventilation.

A third key strategy is providing sufficient information to the public and to professional building managers so that appropriate actions can be taken. Education and training can be used to influence people to change their choices and activities that contribute to indoor pollution.

Moisture and mold problems present special IAQ concerns and are currently very prevalent. Molds can exacerbate asthma and cause allergic responses. Some produce toxins that can cause inflammation and suppress the immune system. Mold problems in landlord/tenant situations are particularly frustrating in the absence of enforcement tools for proper remediation. Mitigation of these problems includes identifying and correcting the source of the moisture and properly removing the mold. Other biological contaminants, including house dust mites and cockroaches, are also significant contributors to indoor environmental problems and health impacts.

Current Activities by Agency

Many state agencies, boards and departments are engaged in activities that promote more healthful indoor environments. However, none has authority to regulate indoor air quality or pollutant sources. Some environmental health organizations, utilities, and members of the private sector are also engaged in activities to address indoor air quality concerns.

Major program activities of the Air Resources Board include sponsoring research on all aspects of indoor air quality, assessing indoor exposures to toxic air contaminants, and taking actions to prevent indoor air pollution. Prevention has focused on public education with the publication of guidelines, fact sheets, and brochures, as well as participation on interagency committees and panels that have addressed specific indoor air quality issues.

The Department of Health Services includes several units that deal with indoor air quality, including a general Indoor Air Quality Program and units specifically focused on reducing lead, radon, and occupational exposures. DHS has published numerous fact sheets and advisories, and conducted a wide range of scientific studies on indoor air quality. The Department of Health Services also chairs the California Interagency Working Group on Indoor Air Quality. This group meets quarterly to

communicate and coordinate the various state efforts and programs dealing with indoor air quality.

The California Energy Commission promulgates building energy efficiency standards. Title 24, the energy efficiency standards for non-residential buildings, currently sets the minimum outdoor air ventilation requirement at 20 cubic feet per minute per person in most non-residential buildings. (A revision of energy efficiency standards is expected in 2005. The revision will include standards for commissioning of buildings to assure that the HVAC system works properly and that related building systems work effectively and compatibly.)

The Department of General Services (DGS) has several units involved in indoor air quality. The Office of Public School Construction determines the allocation of state resources for construction, modernization, and maintenance of K-12 public school facilities. (School building design is approved at the local level.) The Division of the State Architect in DGS reviews state building plans for fire, life, and safety concerns, and enforces mechanical and electrical codes. However, they do not have authority to require measures to specifically reduce or prevent indoor pollution.

Current activities for the Department of Education include working with the Department of Toxic Substances Control to implement a requirement that they review and approve proposed school sites. The Department of Education also responds to school districts and members of the public that are having problems and need guidance on indoor environmental problems.

The U.S. EPA is working on several major projects for improvement of IAQ. One is developing guidelines for new school construction to complement their existing “Tools for Schools” program which addresses existing schools. Another is developing a guide for medical practitioners to recognize and manage health effects related to indoor mold. Other projects include compiling data on current indoor environmental conditions and pollution levels in public and office buildings (BASE study) and working with the American Lung Association to train children to manage their asthma.

Several private sector organizations were represented as well. CASH, the Coalition for Adequate School Housing, is an affiliation of school districts, county offices of education, architects, relocatable building manufacturers, attorneys, financial institutions, and other business interests. Geary Pacific, an HVAC company, has been serving the factory-built classroom industry for many years, and works closely with the Modular Building Institute. The School Facilities Manufacturing Association represents a majority of the modular manufacturers constructing educational facilities in California.

Strategies for Action

During the panel discussion and roundtable discussion on the second day, many of the panel members and members of the audience offered recommendations and solutions to prevent and address indoor air quality problems. Designation of a lead regulatory agency for indoor air quality and promulgation of indoor air quality standards and regulations were widely recommended as the bases of a unified, effective, statewide program. However, because no agency has explicit authority to regulate indoor sources of pollutants, or to set standards for healthful indoor air quality, such authority must be provided before many of the recommended actions can be accomplished.

Develop Standards and Regulations. Representatives from State and local government, industry, and the public identified the need for a variety of standards and regulations. A clearly defined, tangible standard has the potential to protect public health, and provides a level playing field and an enforceable benchmark that is awaited by many sectors. (Many schools do not want to be tested for environmental contaminants, even if there is no cost, because the lack of standards means they cannot interpret the results and there is not an accepted remediation method.) The types of standards and regulations recommended include:

- Health-based standards for pollutant concentrations in indoor air.
- Emission limits for consumer products, appliances, and building materials.
- Standards for building design, and for HVAC specifications, operation, commissioning, and maintenance, especially for schools.
- Regulations for procedures on mold remediation.
- Specifications for school renovation projects.
- Product labeling requirements.

Solutions for Schools. A critical requirement for schools should be installation, maintenance, and operation of adequate ventilation systems. (Schools are currently exempt from Title 24 ventilation requirements.) Requirements should be more comprehensive than just ventilation levels for classrooms; they should include a mechanical system commissioning report, an annual audit of each mechanical system, standards for mechanical system noise in the classroom, and guidelines for draftless register operation.

Additionally, emission limits should be set for school building materials, and specifications should be set for a minimum level of custodial and maintenance staff, improved classroom design (to improve energy usage and IAQ), mold remediation protocols, and audit procedures. Funding for improved materials and training for school officials and maintenance personnel and funds for new construction and maintenance were also recommended as part of the solution.

Develop Technical Assistance. The development of technical assistance for local agency personnel and practitioners is needed and would be widely accepted. Recommended assistance measures include:

- "Best practices" manuals, including those for integrated pest management.
- Training classes and videos to implement new practices.
- Checklists for homeowners and schools.

The State should offer more outreach and training to local government so that health officers, housing authorities, air pollution control officers, and school districts can assist their local clientele.

Coordination among agencies. The many agencies that hold a stake in indoor environmental policy need to better communicate with each other and coordinate their efforts. The role of each agency should be clearly identified for members of the public who are seeking assistance. Government must also coordinate with affected industries.

Public outreach. Members of the public and school districts who have questions regarding indoor air quality often find it difficult to find answers and assistance. A one-stop-shopping approach for assistance (central information clearinghouse) would eliminate this problem. This could be as simple as a listing of specific problems, local contacts who can help Internet would also be an important resource. Data could include information on indoor sources, pollutant emissions, health effects, and standards or guideline levels for each pollutant where those exist.

Build a public constituency. The public must be made aware of issues related to poor indoor air quality in schools, homes, and public buildings. As public awareness is raised, the public will lobby legislators and demand improved indoor air quality. An effective approach might be to highlight the cost of not prioritizing indoor air quality. Quantifying and publicizing lost days of production, school attendance, etc. due to building related illnesses could help build a constituency.

SESSION I: INDOOR EXPOSURE AND RISK IN CALIFORNIA

Chair: Steven D. Colome, Sc.D.
Adjunct Professor, and Deputy Director,
Southern California Particle Center and Supersite
University of California, Los Angeles

Speakers provided an overview of indoor exposures and risk, particularly in California. They identified common indoor air pollutants, defined the magnitude of the indoor air quality problem, and the potential benefits of reducing indoor exposures. A summary of the speakers' presentations follows.

Indoor Pollutants in California Homes

Lance Wallace, Ph.D.
U.S. Environmental Protection Agency, and
Recipient, Intl. Society of Exposure Analysis Jerome J. Wesolowski Award

Because no agency has authority to regulate them, indoor sources are largely unregulated. Many independent task forces have recognized indoor air pollution as one of the top environmental problems, but the Federal government's response has been fractionated and inadequate. Major emissions come from manufacturing plants, hazardous waste sites, and urban industrial areas; however, in terms of actual human exposure, these sources are relatively minor when compared to indoor sources.

The Total Exposure Assessment Methodology (TEAM) studies conducted in the 1980's provide extensive data on air pollutant concentrations indoors and outdoors. The studies were designed so that a small sample of people could represent the entire population at large in a given city. Concentrations of 25 to 32 target volatile organic chemicals (VOCs) in personal, indoor and outdoor air, exhaled breath, and water were measured. Participants kept diaries of their activities so that investigators could identify possible links between activities and exposure to certain chemicals.

CONCLUSIONS

- Indoor sources account for 75 - 98% of exposures to many VOCs
- Major Sources of VOC Exposures
  - Consumer products
  - Personal activities
  - Building materials

A primary finding of the TEAM studies was that VOCs were found at higher concentrations indoors than outdoors. This was true for para-dichlorobenzene (found in air fresheners and mothballs), tetrachloroethylene (wearing and storing dry-cleaned clothes), benzene (smoking cigarettes or living with a smoker), methylene chloride (removing/stripping paint), and some pesticides. Exposure to VOCs from common everyday activities can be greater than the exposure from ambient levels. Regulators have focused on the large company down the street, but people's use of, and proximity to, specific sources have the potential to create more harmful exposures than the ambient air.

Indoor Chemistry and Physics: Implications for Exposure and Risk

William W. Nazaroff, Ph.D.
Roy W. Carlson Distinguished Professor
University of California, Berkeley

The impact of releasing a given quantity of a pollutant indoors has a much greater potential health impact than releasing the same amount of pollutant outdoors. The "rule of a thousand" states that there is a thousand-fold increase in potential human exposure to a typical pollutant released indoors versus the same release to outdoor air. Modeling exercises indicate that there is about one chance in a hundred that a molecule of pollutant released indoors will be inhaled. In contrast, there is about one chance in a hundred thousand that a molecule of pollutant released to ambient, urban air will be inhaled. To illustrate this example, based on total emissions, it is estimated that Californians inhale about a kilogram per day of diesel particles and four kilograms of particles from cigarettes smoked indoors.

*The Rule of 1000**

A typical pollutant release indoors is 1000 times as effective in causing human exposure as the same release to urban outdoor air.

*KR Smith. See e.g., Air Pollution: Assessing Total Exposure in the United States, *Environment*, **30** (8): 10, 1988.

One physical principle necessary for understanding indoor pollution is that mass is conserved. Indoor pollutant concentrations are affected by pollutant supply mechanisms and by pollutant removal mechanisms. Another physical principle is that buildings are dynamic systems. Approximately five to ten minutes after a pollutant is released indoors, it will be mixed to a uniform level within a room.

Reducing the supply rate of pollutants is the most effective way to reduce indoor pollution levels.

Californians inhale about six times as much indoor air as outdoor air. While efforts have been made to protect public health through various regulations, this large portion of human exposure and risk has not been systematically addressed. For example, paints are regulated based on their VOC content that can contribute to photochemical smog in outdoor air; they are not based on concern for the exposure to the painter and the people who will occupy the building.

Reducing the supply rate of pollutants is the most effective way to reduce indoor pollution levels.

Future policies for protecting public health need to focus on the largest contributors to exposure and risk, which would include indoor air pollution. Legislators need to develop some distinct creative approaches for improving indoor environments.

Benefits of Improved Indoor Air Quality

William J. Fisk, M.S., P.E.
Acting Head, Indoor Environment Department
Lawrence Berkeley National Laboratory

Improvements in indoor environmental quality (IEQ) can reduce adverse health effects and bring about substantial (up to $50 billion nationally) economic benefits from reduced health care costs, fewer absences from work, and fewer periods when work performance is degraded by health effects. Salaries dominate the costs of operating an office building, so implementing measures that enhance worker health and productivity will generally be very cost effective. At present, the health and productivity benefits of improved IEQ can only be roughly estimated. Better information is needed to convince designers, fabricators, owners, operators, and occupants of the benefits of improved indoor air quality.

Special attention is needed on three categories of health effects influenced by IEQ that affect very large populations: communicable respiratory illnesses, allergies and asthma, and sick building syndrome symptoms.

Ten studies provide evidence that communicable respiratory illnesses, such as influenza and common colds, can be significantly decreased through changes to buildings, such as providing higher ventilation rates. Annual health care costs for these illnesses are about $36 billion per year. If absences from work are included, annual costs are about $70 billion per year. The estimated potential reduction in these illnesses by 9 to 20% would eliminate 16 million to 37 million illnesses and save $6 billion to $14 billion annually.

Approximately 53 million people in the U.S. have allergies and 16 million have asthma. Annual costs for allergies and asthma total approximately $15 billion. Indoor environmental factors that affect allergies and asthma include dust mites, animal dander, cockroaches, fungi and moisture problems, tobacco smoke, and pollens. The literature indicates that many of these building-related risk factors could be eliminated or reduced, resulting in a ten to 30 percent reduction in the symptoms of allergy and asthma, and annual economic benefits of about one to four billion dollars.

Sick Building Syndrome (SBS)

- Acute symptoms (e.g., headache, irritation of eyes and nose) linked to occupancy in building
- Experienced in all office buildings, but to a highly variable degree
- Selected building and environmental characteristics increase the risk of symptoms
- Source of distraction while at work, associated with absence from work, and linked to poorer performance on computerized tests

Sick Building Syndrome (SBS) health effects include acute symptoms like headache and eye and nose irritation associated with occupancy in a building. A large EPA study found that 23 % of office workers, or 15 million workers, report two or more SBS symptoms frequently. There is evidence that symptoms can be reduced by 20% to 50% with increased ventilation, cleaned indoor surfaces, decreased temperature, reduced indoor pollutant sources, and other measures that improve IEQ. Based on objective and subjective data, the productivity decrement due to these symptoms is roughly 2%, which translates to a loss of $60 billion annually. A 20% to 50% reduction in symptoms would save $15 to $38 billion annually.

Two example cost-benefit analyses have been performed. In a large office building, the savings resulting from increasing ventilation rates and, thus, improved health, were estimated to be a factor of 14 times larger than the energy and equipment costs. For improving air filtration in a large office building, the estimated benefit-cost ratio was nine.

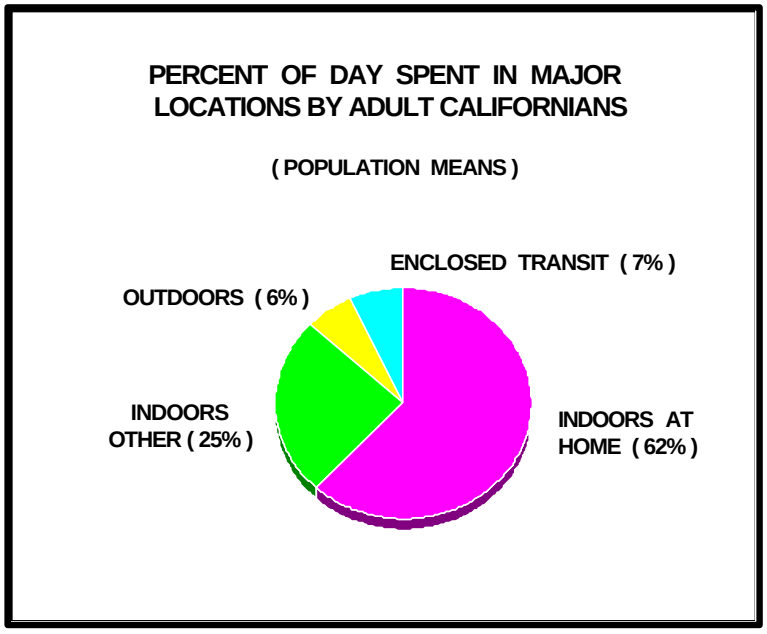
In conclusion, data suggest that an opportunity exists to improve the health of millions of people in the U.S., with annual financial benefits of tens of billions of dollars.

Overview: California Indoor Exposures and Risk

Peggy L. Jenkins, M.S.
Manager, Indoor Exposure Assessment Program
California Air Resources Board

Federal and state comparative risk projects have identified indoor air pollution as a high risk category relative to other environmental issues. The health risks associated with indoor air quality stem from the many indoor sources of pollutants and the large amount of time people spend indoors. Elevated pollutant concentrations and longer exposure times result in high exposures. Indoor pollutant sources include building materials and furnishings, consumer products, combustion appliances, office equipment and supplies, chlorinated domestic water, activities such as smoking and cooking, and excess moisture.

As a population, the majority of our time is spent indoors. Adults and teens spend on average 62 % of their time indoors at home, and 25 % indoors at other locations. Children under 12 spend 76 % of their time at home, while infants and toddlers, spend 85 % of their time in the home, on average. Thus, the presence of pollutants in the home can be a major factor for children's health.



Numerous pollutants have been measured indoors, most at higher levels than common outdoor levels. These include many VOCs, formaldehyde, phthalates (plasticizers), particles, carbon monoxide, and biologicals such as mold spores. Formaldehyde occurs at especially high levels indoors, which is a concern because it

is a carcinogen and can cause acute irritant effects at high levels. There are many indoor sources of formaldehyde, including pressed wood products, such as particleboard and plywood, which are used in construction of buildings and furniture. Indoor levels typically are above current levels of health concern for long term effects.

Increased action by regulators and educators to reduce sources of indoor air pollution could result in a large reduction of exposure and risk. Substantial risk reduction could be achieved with formaldehyde (mentioned above). Attention should also be directed to reducing personal exposures to particulate matter (PM); these levels can exceed the California Ambient Air Quality Standard for PM. Carbon monoxide continues to cause roughly 40 deaths per year due to accidental poisonings. Biological pollutants such as house-dust mites and others contribute to allergy effects.

Risk from indoor pollution is high relative to other environmental problems.

Increased effort could achieve large reductions in risk.

SESSION II: CHILDREN'S HEALTH AND INDOOR EXPOSURE AND RISK

Chair: Raymond Richard Neutra, M.D., Dr.P.H.
Chief, Division of Environmental and Occupational Disease Control
California Department of Health Services

Speakers in Session II focused on the heightened susceptibility of children to indoor pollutant exposure and risk. Topics included children's toxicologic sensitivity, increased incidence of asthma, environmental conditions in California schools, and challenges that must be overcome for improved environmental school conditions.

Children's Health - Toxicologic Sensitivity

George V. Alexeeff, Ph.D.
Deputy Director for Scientific Affairs
California Office of Environmental Health Hazard Assessment

The incidence rates in children of asthma, cancer and birth defects raise questions about the adequacy of protection for children from environmental hazards. Risk assessors are developing a new framework for risk assessment, which requires considering child-specific data.

Children are subject to greater risk than adults from environmental pollutants for several reasons. They are often closer to the floor and dust, and spend more time on the floor or ground than do adults. This increases their inhalation exposures to particles and associated pollutants on the ground, as well as subjects them to possible dermal and ingestion exposures. Based on body weight, children have a greater exposure to chemicals via inhalation than adults do. At a one-hour acute exposure level set for an adult, a child could receive a seven-fold higher dose than would be intended for the adult. Based on metabolic needs, children have increased absorption for certain chemicals. For example, children absorb a substantially higher proportion of lead than adults do, presumably due to their increased need for calcium for bone growth. Adolescents in puberty may have particular susceptibilities due to rapidly changing hormones. Research on DNA damage from exposure to tobacco smoke also indicates that children may have unique genetic sensitivities.

Further evaluation of these factors is required so that children's exposures to environmental hazards can be reduced to levels that are truly safe.

Childhood Asthma

Michael Lipsett, M.D., J.D.
Public Health Physician
California Office of Environmental Health Hazard Assessment, and
Associate Clinical Professor
University of California, San Francisco

Asthma is a chronic inflammatory disorder of the pulmonary airways, which is characterized by recurrent episodes of wheezing, breathlessness, chest tightness and cough. It is particularly important in children because they have narrow airways that can become more easily obstructed than those of adults. The increase in childhood asthma has been greater than the increases observed in the overall population. Between 1980 and 1994 children up to age four had about a two and one-half-fold increase in reported asthma prevalence. Morbidity and mortality rates for African-Americans are several-fold higher than for whites.

The strongest risk factor for asthma in children is atopy, a genetic predisposition to produce immunoglobulin E or to develop allergies. There is an important window of susceptibility from birth to age two that affects whether or not an individual develops asthma. Thus, most asthma in children involves the combination of exposure to allergens during a critical period of development superimposed on the innate tendency towards allergy. Cockroaches, certain molds, and dust mites in particular appear to be important sources of allergens in childhood asthma in different parts of the United States.

For one who has asthma, the asthmatic reaction can be exacerbated by, among other things, respiratory infection, as well as exposure to specific aeroallergens, respiratory irritants, cold air, exercise and hyperventilation, hormonal factors, foods and drugs.

Exposures to both biological and chemical agents during the first two years of life seem to be important factors for the development of asthma. Understanding the critical exposures related to asthma development are key to devising an environmental intervention program for primary prevention of this disease.

Air Quality and Asthma

- Indoor exposures linked primarily with induction of childhood asthma, and possibly with specific exacerbations
- Outdoor exposures associated with asthma exacerbations; relationship with induction of asthma not extensively examined

Air Quality in California Schools

Jed M. Waldman, Ph.D.
Manager, Indoor Air Quality Program
California Department of Health Services

The indoor environment of schools presents a set of unique indoor air quality challenges. Schools have far more people per square foot than most other indoor environments. They also house individuals with a wide variety of sensitivities, such as asthmatics and allergic persons. Activities in schools can generate a wide variety of pollutants. Schools are often designed incrementally, so space is often used for purposes other than originally intended. Additionally, funds are often lacking for proper school maintenance.

Environmental problems in schools are varied. Inadequate ventilation is the most common complaint associated with classrooms. This complaint was documented as early as 1871. More recently, the California Energy Commission reviewed ventilation in statewide classrooms and found that one out of three classrooms had less than half of the code-required ventilation rate. The second most common problem reported is water damage and promotion of mold growth.

IAQ IN CALIFORNIA SCHOOLS

- School classrooms have often been found to have lower ventilation rates than required.
- Widespread use of pesticides in public schools has been reported.
- Nearly all schools have some lead-containing paint (much less post-1979).
- A range of VOCs is often found indoors; e.g., formaldehyde levels can exceed 100 parts per billion when ventilation is insufficient.

There are several approaches to improving school indoor air quality that could be enforced or implemented on a statewide basis. These include enforcement of the minimum ventilation standard in the Labor Code, minimizing products emitting higher amounts of volatile organic compounds (e.g., from pressed-wood furniture), restricted use of certain products in the classroom (such as solvents and pesticides), and design review of the classroom mechanical system for new construction by the State Architect. Many school districts are implementing best management practices to improve indoor air quality. A number of schools have addressed their pesticide practices and are moving toward integrated pest management practices. Recently, the Legislature passed a bill requiring notification to parents when pesticides are used in schools. Finally, the U.S. EPA's *Indoor Air Quality Tools for Schools* is an important resource on best management approaches and training for school staff.

School Administrative Perspective on Indoor Air Quality Issues in Schools

Andy Yasenovsky, ARM, CPSA
Safety/Loss Control Manger, Risk Assessment
San Bernardino County Superintendent of Schools

Typically, school districts do not have a dedicated staff position (i.e., safety and health officer or risk manager) that can receive and review information on safety, health and environmental issues and implement best management practices for schools. With such a position, time and effort could be dedicated to implementing the *EPA Tools for Schools Kit* and positive strides could undoubtedly be made to improve the school indoor air quality environment. Small to medium size school districts could share such a staff position amongst themselves. Many school districts are not aware of the myriad of existing safety, health and environmental regulations, nor do they have the personnel or funding to implement them. Districts are not afforded the "in-service" time to train teachers and support staff on these regulatory requirements (i.e., Cal-OSHA, EPA, AQMD, Ed. Code, etc.).

Lack of adequate ventilation is also a challenge for schools. Many do not meet the ASHRAE 62-1989 minimum standard for outdoor levels of ventilation. Inadequate ventilation can lead to stale air, high concentrations of carbon dioxide, increased potential for spread of airborne diseases and decreased learning efficiency for students. Schools need to identify deficient ventilation systems and retrofit them, but funding is not currently available. Additional opportunities for improving the indoor environment include proper commissioning of portable classrooms to address off-gassing of volatile organic compounds, use of high-efficiency pleated filters, and prevention and prompt repair of roof leaks to eliminate mold growth. Other special use classrooms need to be properly designed (i.e., properly designed local exhaust ventilation, vacuum systems and floor sump systems for washdown) to address health hazards associated with activities such as ceramics, wood technology, welding, science and reprographics.

Efforts must continue to reduce risk from identified environmental health hazards such as lead-containing paint, friable asbestos, and pesticide use. The bottom line is that without a staffing requirement and funding to address these issues, they will continue to take a "back seat" to other important education issues such as improving test scores and preventing school violence.

SESSION III: REDUCING INDOOR EXPOSURE AND RISKS—PRINCIPLES

Chair: Charlene W. Bayer, Ph.D.
Principal Research Scientist
Georgia Tech Research Institute

Session III speakers presented methods and tools that are currently available for reducing exposure and risk to indoor air pollutants. Methods include emission reduction from indoor sources, substitution to less polluting sources, moisture reduction, proper ventilation, education and training, and limited use of air cleaners.

Preventing and Reducing Emissions from Indoor Sources

Thomas J. Kelly, Ph.D.
Senior Research Scientist
Battelle, Columbus

Minimizing indoor emissions is generally more effective than removing them after emission has occurred.

To avoid exposure to volatile chemicals, minimizing indoor emissions is generally more effective than removing emissions after they have occurred. Building materials such as particle board, hardwood plywood, and paneling made with urea-formaldehyde (UF) resins tend to have high emissions of formaldehyde. Other materials such as softwood plywood, countertop laminates, and hard board made with phenol-formaldehyde resins (PF) have lower emissions. Formaldehyde emissions may originate from residual formaldehyde in the product, or from damage to the polymer due to moisture. Information on emissions can often be obtained from manufacturers, though it can be a difficult process. Manufacturers of some products have voluntary standards for formaldehyde emissions.

Minimizing Formaldehyde from Building Materials

- Substitute low-emitting alternatives–e.g., PF vs. UF products
- Cover the emitting product
- Keep temperature and humidity low

Formaldehyde emissions from building materials can be reduced by covering the emitting product. Vinyl, laminate, and paper coatings can reduce emissions by up to 90 percent. A waterproof treatment for particleboard flooring can result in an 80 percent reduction of emissions. One product tested, an acid-catalyzed finish used on cabinets and furniture, actually increased

emissions because it was a source of formaldehyde itself.

Consumer products, particularly wet ones such as nail polish and latex paint emit formaldehyde during the drying process. Ventilation must be used with these products. When possible, substitute with formaldehyde-free products, such as formaldehyde-free cosmetics.

Indoor combustion sources are a concern because they release toxins into an enclosed space. Sources include gas cooking appliances, unvented space heaters, smoking, candles, and oil lamps. Combustion emits nitrogen dioxide, carbon monoxide and formaldehyde. Cigarettes are unique in that they are specifically designed to deliver toxic substances to the user. Stoves and heaters can be designed for reduced emissions, however the reduction of less toxic chemicals may not achieve a great reduction in health risks. An electrostatic air cleaner removed nitrogen oxide, but produced nitrogen dioxide, which is more toxic. Care must be taken to make sure the overall health risks are reduced when emissions of individual toxic compounds are considered.

Moisture, Molds and Bacteria

Sandra McNeel, DVM
Research Scientist
Environmental Health Investigations Branch
California Department of Health Services

Over 40 studies have demonstrated an association between building dampness and increased risk for respiratory symptoms in both children and adults. Symptoms include eye, nose, throat or skin irritation and cough or wheeze. Headache, fever, dizziness and fatigue have also been reported. The causative agent for these health problems may be mold, other microorganisms such as bacteria (or their metabolites) or dust mites, as all prefer damp environments.

Water intrusion or moisture problems stem from improper maintenance, construction defects or inadequate ventilation that fails to remove water vapor generated by occupant activities. There are currently no federal, state, or local regulations governing the remediation of indoor molds; however, two voluntary guidelines are available:

1. American Conference of Governmental Industrial Hygienists. Chapter 15 - ”Remediation of Microbial Contamination” in Bioaerosols: Assessment and Control, edited by J Macher. ACGIH, Cincinnati, OH. 1999. Order copies at http://www.acgih.org or (513) 742-6163.

2. New York City Department of Health. “Guidelines on Assessment and Remediation of Fungi in Indoor Environments”. 2000. Full text available at http://www.ci.nyc.ny.us/health or call (212) 788-4290.

The California Department of Health Services recommends the following general actions. The full text of the information sheet "Mold in my home: What do I do?" is available at http://www.cal-iaq.org.

1. Visible mold growth should be physically removed either by wiping it off or by removal of material if mold and water damage has altered the structure of the substance it is growing on. Decontamination methods depend on the porosity of the contaminated material. Hard surfaces can be wiped clean with a 10 % bleach solution, clothing can be washed or dry cleaned, but large upholstered items with visible mold or a moldy odor should be discarded. Painting over mold is not recommended because excessive numbers of spores remain in place and may still be released into the air.
2. The underlying water intrusion or moisture accumulation problem should be identified and corrected promptly.
3. Removal or cleanup of molds should include the control of mold spore dispersal. See references 1 or 2 for specific recommendations for containing spores during cleanup based on amount of surface area affected.
4. Biocides alone are not recommended. The ability of spores and other mold components to cause allergies and other health problems is **not** eliminated when molds are killed by biocides such as bleach or quaternary ammonium.
5. After mold removal or cleanup, physically remove any excess mold spores by damp wiping adjacent solid surfaces and using a HEPA (high-efficiency particulate air) filtered vacuum to clean carpet and upholstery.

Indoor mold growth should be prevented through routine building inspections that check for water leaks and ventilation problems, prompt response to water intrusions (flooded areas should be dried within 48-72 hours), adequate preventive maintenance and good routine cleaning and housekeeping.

Indoor Molds: Regulatory Status

- No federal, state or local regulations
- Guidelines for mold remediation are recommendations
- No authority to require compliance with remediation guidelines
- No license or certification required for private sector remediation companies

Ventilation

Francis (Bud) J. Offermann III, CIH, P.E.
President, Indoor Environmental Engineering
San Francisco, CA

Building ventilation is critical for maintaining thermal comfort and contaminant control. ASHRAE set it's first ventilation standard in1973 which has evolved to the present day standard of 20 cubic feet per minute (cfm) per person in office buildings. This is supported by the International Building Code which requires equipment capable of providing a set level of ventilation. California law improved the Building Code in 1987 by requiring that the system be operated when people are present.

It is estimated that ventilation costs one to two dollars for a whole year of operation at one cubic foot per minute of outside air. As a rule of thumb, this would translate to $20 to $40 annually for an office occupant that is receiving 20 cfm.

Ventilation does have limitations. While appropriate for removing diffuse contaminants such as human bio-effluents and emissions from furnishings, it is not appropriate for controlling gross contaminant sources such as fungal contamination or tobacco smoking, As Pettenkoffer noted in 1858 "If there is a pile of manure in a space, do not try to remove the odor by ventilation. Remove the pile of manure."

Positive pressure in a building is necessary to maintain a healthy building and prevent air entry through undesirable pathways. Sick Buildings Suck (SBS) while Healthy Buildings Blow (HBB). HVAC systems need better commissioning and need to be quieter, particularly in schools. High efficiency filtration has improved in recent years and can be implemented without problems such as a pressure drop.

What is needed to improve ventilation in California buildings?

- Better commissioning and annual operational checks
- Quieter systems, especially for schools
- Control of building space pressures
- Use of higher efficiency air filters
- Better control of thermal comfort parameters (temperature and humidity)

Education and Training

Barbara Spark
Indoor Air Coordinator, Region IX
U.S. Environmental Protection Agency

U.S. EPA's indoor air program is non-regulatory, so education and training are central to the program. Education and training on indoor air quality (IAQ) aren't just about teaching new skills - they're also about convincing people to adopt behavioral changes. Often, to be effective, people's life-long habits must be overcome. Many of the most potent and frequent IAQ messages people receive - for example, advertising for services or products - may run counter to, or at least confuse efforts to reduce risk. To help everyone better interpret such messages, education about indoor air quality needs to be incorporated into school science/health/environmental curricula beginning in the early grades.

"Keep it simple" as a communications principle can be hard to achieve with a complex subject like indoor air. Until IAQ becomes part of the culture, we need to identify and analyze the core IAQ misunderstandings, and consistently respond to them with scientifically valid, plain English messages which cut to the heart of the matter.

There has been much talk of IAQ in schools at this conference. There is a need for educated communicators to reach out to schools to explain how to address IAQ problems.

In California, where school funding is among the lowest in the nation, significant improvements in school IAQ can be achieved by adopting the common sense no-cost/low-cost practices contained in EPA's voluntary program, "IAQ Tools for Schools." Yet fear of even mentioning indoor air to parents and has prevented widespread adoption of the program.

"Learning by doing" is central to effective learning. U.S. EPA encourages knowledgeable individuals who truly want to understand what "education and training" on IAQ is about, to "learn by doing" themselves, by volunteering to "adopt" a school or school district, and guide it through implementation of the "Indoor Air Quality Tools for Schools Action Kit" program. (See web site: http://www.epa.gov/iaq)

In the current information environment, public policy decisions may appear to be "media-driven" and based on a simplistic understanding of IAQ. The flip side is that real problems might not be taken seriously because decision-makers may conclude that the media have just "blown it out of proportion." In either case, improved education is needed.

Air Cleaners

Thomas J. Phillips, M.S.
Air Pollution Research Specialist
California Air Resources Board

The large number of public inquiries about air cleaners has led the ARB to recently publish a fact sheet on air cleaning devices for the home. Increases in regional fires, traffic density, air conditioning, allergies, and asthma have contributed to the rapid growth in the demand for air cleaners. However, air cleaners should be viewed as a supplement to source reduction and proper ventilation.

Air cleaners can be portable stand-alone models or central units used with forced air systems. The principle of operation is based on particle removal with filters or electronic charges, or gas removal by adsorbents.

There are many common myths regarding air-cleaning devices. One myth is that ozone generators are effective air cleaners. In fact, they are not. They can also easily generate enough ozone to exceed the health-based air quality standards for California and U.S. OSHA. The California Department of Health Services issued a warning and fact sheet on this type of air cleaner. Ductless range hoods are also ineffective air cleaners. They quickly reach saturation and have no effect on air cleaning. Houseplants have been touted as air cleaners, but are ineffective indoors due to the extremely large number that would be required. Moreover, they contribute to moisture problems and biological pollutants.

The effectiveness of air cleaners for the reduction of allergy symptoms is unclear. This is due to several reasons: people do not normally stay near the air cleaner; many allergens are relatively large particles that settle out of the air before they can be filtered; and gases and very small particles are not usually removed by air cleaners.

If any air cleaner is used, it needs to be properly installed and maintained. Therefore, in order to improve the design and performance of air cleaners we need ozone emission standards, and improved installation and maintenance standards.

Air Cleaners

- Source control and ventilation are more effective approaches.
- Ozone emission standards are needed for air cleaners.
- Improved installation and maintenance of air cleaners are needed.

PANEL I: REDUCING INDOOR EXPOSURE AND RISKS: CURRENT ACTIVITIES AND NEEDS

Chair: Kathleen Tschogl
Ombudsman, California Air Resources Board

Many state agencies, boards and departments are engaged in activities that promote healthful indoor environments. However, no agency has explicit authority to regulate indoor sources of pollutants. Representatives from state and federal government, and private sector organizations summarized what their agency or industry is doing to improve indoor air quality, and suggested further steps that need to be implemented.

Jed Waldman, Ph.D.
Manager, Indoor Air Quality Program
California Department of Health Services

The Department of Health Services includes several units that deal with Indoor Air Quality. These include the Indoor Air Quality Program, the Environmental Health Investigations Branch, the Occupational Health Branch, and the Childhood Lead Poisoning Prevention Program.

The Department of Health Services chairs the California Inter-Agency Working Group (IWG) on Indoor Air Quality. This group meets so that State agencies can coordinate and communicate with each other on the various state efforts and programs dealing with indoor air quality. This group represents a large knowledge base on IAQ issues; however, greater effort must be made to get this knowledge to the public. The many questions from the public received by members of the IWG indicate the need to develop more opportunities and resources for outreach activities.

Local health agencies, local housing agencies, and local Air Pollution Control Officers (APCOs) are not getting the IAQ message as clearly as they should be. There is a need to systematize the best practices that are associated with good indoor air quality and get that information to local agencies so they have tools to help the public. Of particular urgency is the lack of health and safety regulations regarding housing and mold problems.

Audrey Edwards
Manager, Program Services
Department of General Services
Office of Public School Construction

The Office of Public School Construction determines the allocation of state resources for construction, modernization, and maintenance of K-12 public school facilities. However, the school building design is determined at local levels. Local districts need assistance with decisions that will lead to improved indoor air quality.

Resources for building and maintenance are in short supply. Proposition 1A passed in November 1998 provided $6.7 million for K-12 public school facilities' needs. At the current time, demand exceeds availability of funds by $285 million.

Laura O'Leary
Coalition for Adequate School Housing (CASH)

CASH believes that school facilities are a critical component of effective schools. Indoor air quality problems exist in both relocatable and permanent buildings. Lack of adequate funding for maintenance is one of the biggest contributing factors to poor indoor air quality. In 1997-98 a Department of Finance report entitled *School Facilities Utilization and Maintenance* indicated that the backlog of maintenance repairs exceeded $800 million. The number is now estimated to exceed $2 billion.

Schools do not know whom to turn to for help with IAQ. CASH would like to see a one-stop-shop to assist school districts, including specific phone numbers and local contacts for assistance on IAQ problems. This shop would offer procedures for addressing the problem and guidance on how to deal with parents, staff and media. Small districts and rural districts need extra assistance because they can not hire their own hygienist or risk manager.

Donald Kazama
Senior Program Supervisor
Non-residential Building/Office
California Energy Commission

The California Energy Commission promulgates the building energy efficiency standards. Title 24, the energy efficiency standards for non-residential buildings, currently states that the minimum outdoor air requirement is 20 cubic feet per minute (CFM) per person in most non-residential buildings. A revision of energy efficiency standards will be available in 2005. The revision will include standards for commissioning of buildings to assure that the HVAC system works properly.

Inadequate ventilation can lead to odor, moisture, and mold problems. However, schools are exempt from complying with Title 24. As a result, schools have no requirement for mechanical systems and generally have much too low of a ventilation rate. Government's best role is to raise awareness regarding indoor air quality, especially among policy makers, the State Legislature, school boards, and other organizations.

Barbara Spark
Indoor Air Coordinator, Region IX
U.S. Environmental Protection Agency

Agencies need to work cooperatively to make improvements in indoor air quality. Decision-makers must truly understand that the goals for improved indoor air quality are worthwhile. Substantial leadership is needed at the state level. Tools for Schools is used in thousands of schools throughout the country, but is only slowly being implemented in California.

Actions needed in California to move toward better indoor air quality include:

- Release of the Interagency Working Group (IWG) report on environmental quality in California schools.
- More guidance to the public from state agencies.
- State promotion of work with partners to achieve voluntary goals.

Forthcoming EPA projects include:

- A guide for medical practitioners on recognizing and managing health effects related to mold indoors.
- Guidance on new school construction.
- Data on current indoor environmental parameters and pollutant levels in public and office buildings (BASE study).
- Work with American Lung Association (ALA) on training children to manage their own asthma.

Goals for the U.S. EPA Indoor Program are:

- Fifteen percent of schools will implement practices similar to Tools for Schools by 2005.
- Five percent of commercial buildings will be managed for indoor air quality.

Peggy Jenkins, M.S.
Manager, Indoor Exposure Assessment Program
California Air Resources Board

The goal of ARB's Indoor Air Quality and Personal Exposure Assessment Program is to identify and reduce risk from indoor air pollution. Major program activities at the ARB include sponsoring research, assessing indoor exposures to toxic air contaminants, and undertaking a variety of efforts to reduce and prevent indoor air pollution. Prevention is accomplished through public education with the publication of guidelines (formaldehyde and combustion pollutants), fact sheets (residential air cleaners), and brochures. Prevention efforts also include participation on numerous interagency committees and panels.

Many opportunities exist for further reduction of indoor air pollution risk. High priority needs include:

- Emission limits for consumer products, appliances, and building materials.
- Development of additional guidelines.
- Labeling programs.
- State training and oversight of practitioners who inspect and clean HVAC systems.

Duwayne Brooks
Assistant Superintendent of Public Instruction, and
Director, School Facilities Planning
California Department of Education

Current activities for the Department of Education include working with the Department of Toxic Substances Control to implement a requirement that they review and approve proposed school sites. The Department of Education is attempting to complete the review in a timely and least costly manner. The Department also responds to school districts and members of the public that are experiencing problems and need guidance regarding who can assist them in indoor air quality problems. The Department tries to be a resource that directs school districts to the right agency for assistance with problems, which can be a challenge.

The Department of Education has identified four areas of need in indoor air quality:

1. Better coordination and better state response to school districts. This could be a one-stop shop, or a list of who to contact for a certain type of problem.
2. Assess the scope of the school indoor air quality problem. If legislative support is to be obtained, the problem must first be carefully articulated.
3. Provide technical assistance. This may include a best practices manual, a training video, and answering questions over the phone.
4. Adequate funding is necessary to adequately address any problems that arise.

Dennis E. Bellet, SE
Regional Manager, Sacramento Area Office
Department of General Services
Division of the State Architect

The Division of the State Architect (DSA) has been involved in public school construction since 1933 when 70 school buildings collapsed during a Long Beach earthquake. The DSA addresses indoor air quality by enforcing mechanical and electrical codes. The DSA reviews plans for fire, life, and safety only. They do not have authority to require measures to specifically reduce indoor pollution. The DSA has about 3,000 projects to review this year, which is about twice what was anticipated in the budget. The review places emphasis on structural components, with a trend toward safer and more accessible buildings.

Maury Tiernan
Sales Manager
Geary Pacific Corp.

Education and knowledge are necessary for all parties involved in indoor air quality issues. Facts, logic and common sense are necessary to overcome fear of the unknown and scare tactics of the media.

A central indoor air quality clearing house is needed to track the many state agencies involved with aspects of indoor air quality. Additionally, people must realize that their actions greatly affect IAQ. These actions can be as varied as wearing perfume and cologne, exceeding the occupancy level of buildings, and choosing the right filters for mechanical systems.

Schools and other facilities should have a designated indoor air quality coordinator who has IAQ as their primary responsibility.

Specifications must be developed for better IAQ. Until specifications are developed, systems will operate as they currently do. Legislation may be required to change the status quo. The EPA's Tools for Schools Action Kit is a good starting point for a good IAQ program. There are potentially many practical ways to assure better ventilation and use of ventilation in a school room. These include:

- Site inspection of school mechanical plants.
- A mechanical system commissioning report.
- Annual mechanical system compliance report.
- Standards for mechanical system noise in a classroom.
- Enforce ventilation levels in a classroom.
- Standards or guidelines for draftless register operation in a classroom.

Improvement will not happen unless criteria are specified.

Don Funkhouser
Quality Control Manager
Aurora Modular Industries
representing School Facilities Manufacturing Association.

Good indoor air quality is a common concern at all educational facilities. If there is an IAQ problem at an educational facility, many levels of government, school districts, and industry must work together to address the common problem. Several agencies have different requirements for different aspects of school construction. In the requirements, modular and conventional construction are treated equally. The local school district can determine many design features of a classroom such as number of doors and window size.

In the absence of construction requirements between modular and conventional classrooms, other factors should be investigated for their contribution to IAQ. These items include school furnishings, ventilation, and maintenance.

Additional suggestions for improved IAQ include:

- Develop and implement IAQ guidelines and standards.
- Identify the IAQ roles of various state agencies.

Comment/Discussion Session

Participants from the audience asked questions and offered their own opinions on several topics. There was a general cry to put more money into existing IAQ programs. The following comments have been grouped by topic. The discussion points are not necessarily in the order they were raised and reflect comments from audience members as well as the panel members.

Schools. Many felt monies for funding schools should contain stipulations that would lead to improved IAQ. Others suggested implementation of legislative mandates that require schools to implement practices to improve IAQ. Some school districts are more aggressively addressing IAQ by forcing manufacturers to improve the design of relocatable classrooms through bid specifications. Schools would like quick access to IAQ information through websites. New information should be distributed through sites the schools are familiar with, such as the CASH website.

Mold. Clear guidance should be developed for landlord-tenant disputes regarding mold. It was suggested that legislation be passed that require landlords to disclose past mold problems, and that effective standards be developed for mold cleanup. The many complaints that government agencies hear need to be routed to the media, and ultimately the Legislature, so that laws are enacted to protect individuals from the adverse effects of indoor mold contamination.

Mechanical Systems. Building defects related to mechanical systems will be addressed in CEC 2005 commissioning standards. Problems can still exist with improved codes because the codes do not insure proper daily usage and maintenance. Problems arise after design and construction due to human actions such as a teacher turning off the HVAC, delayed maintenance, and filters being changed as needed.

Public Education. Homes are probably the biggest source of indoor exposure. This should be the first target for public education. Citizens need to be educated about the risk in their homes, and then they will influence their legislators, pass school bonds, and take other actions to improve indoor air quality.

Risk Assessment. Levels of VOCs in our schools and homes are unacceptable, yet the public does not have a handle on the degree and severity of the problem. The IAQ problem needs to be better defined, along with specific (numerical) definitions of a safe and healthy environment. Once standards are implemented, engineers can design a solution. Some felt that the public is not being adequately told what sort of health impacts result from concentrations of VOCs found indoors.

LUNCHEON SPEAKERS

On the second day of the Symposium, two excellent speakers provided food for thought during the luncheon. Dr. Maxwell Sherman, from the Lawrence Berkeley Laboratory, discussed the draft residential ventilation standard prepared by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, a professional society that develops industry standards. Tim Hardin, with the Department of Health in the State of Washington, presented information on activities in the State of Washington to address indoor air quality, especially in schools. Their presentations added a valuable, outside perspective to the discussions at the conference.

ROUNDTABLE DISCUSSION: STRATEGIES FOR ACTION

The final roundtable discussion included leaders of environmental, health, and education agencies and organizations. The panel's task was to identify actions that can be taken to improve IAQ in California. The panel was asked to arrive at concrete solutions and to suggest strategies for implementing actions to improve IAQ.

Designation of a lead regulatory agency for indoor air quality and promulgation of indoor air quality standards were widely recommended as the basis of a coordinated statewide program. Both of these require legislative authority. In the absence of that authority, agencies can develop guidelines or best practice manuals. Additional strategies with strong support include developing training programs for professionals and for local agency personnel, building a public constituency in support of measures to improve IAQ, educating the public more fully, addressing environmental problems in schools, and increasing coordination among state agencies.

Moderator:

Michael P. Kenny
Executive Officer
California Air Resources Board

Mr. Kenny stressed the need for the state to develop an action plan for addressing indoor air quality issues. The fact that a pollutant indoors is 1000 times as likely to result in human exposure as the same release to urban outdoor air, coupled with inadequate ventilation and children's increased susceptibility, presents a serious problem that needs attention. It is time to move beyond discussion, to specific actions to address indoor air quality.

Joan Denton, Ph.D.
Director
Office of Environmental Health Hazard Assessment

The Office of Environmental Health Hazard Assessment sets the risk-based numerical values that are the basis for the regulations of other departments. Numerical values identified by OEHHA are health-based, not product-based. Indoor air quality is an extremely complex area with many different components, yet our task is to develop a "unified theory" for addressing indoor air quality.

A first step would be implementation of a systematic method of defining the extent of the problem. Secondly we need legislation to designate a lead agency that has primary responsibility for IAQ. The third area of a comprehensive approach would be

establishing health-based standards. Also, data on chemical emissions and health effects need to be coordinated in a database that is easily accessible by the internet.

Duwayne Brooks
Assistant Superintendent of Public Instruction, and
Director, School Facilities Planning
California Department of Education

When one steps back from the topics of this symposium, one realizes that there are many entities working to address IAQ. Unfortunately these actions are not fully communicated with others. We need a better system of being informed about who is doing what.

A next step would be to develop an action plan. It would need to be a comprehensive, sequential plan with short-term, intermediate, and long-term goals. High level leaders such as Winston Hickox, Delaine Eastin, and the Director of the Department of Health Services would be the appropriate leaders to develop an action plan.

Raymond Richard Neutra, M.D., Dr. P.H.
Chief, Division of Environmental and Occupational Disease Control
California Department of Health Services

The Department of Health Services can be compared to the sentries and scouts in the war on indoor air pollution. There are two populations in the indoor environment that we have responsibility for, and that we can do something about: students in schools and workers in state office buildings. Our concern with the indoor environment extends beyond the air we inhale and includes topics such as childhood lead poisoning, exposure to pesticides, and dermal exposure. We want to take a comprehensive look at the entire indoor environment.

The magnitude of the IAQ problem is not fully known. In regard to schools, we need to look at exposures and the cost of reducing those exposures. Then we will know the cost required to meet a certain level of acceptability. Additional work is required to guide policy.

Douglas Grandy
Chief, Energy Assessments
Department of General Services

The Department of General Services' Real Estate Services Division (RESD) is responsible for building public buildings. Currently funds are available for many new buildings, which provide an opportunity for integrating sustainable building design

principles into new construction projects. The DGS policy is to plan, design, construct and operate facilities that are energy efficient, cost effective, and efficient in use of resources for construction, and that promote the health, well-being and productivity of building users, while minimizing environmental impacts that result from the construction and operation of facilities.

DGS is the lead agency for the Green Building Task Force, an *ad hoc* group of state agencies that meet to address a mutually perceived need for green and sustainable building design in state buildings. The Capitol East End Office Building Project is a successful statement of the group's collaborative efforts.

More research is needed to define the extent of the indoor air quality problem. Although quantifying health effects is difficult, standards would make it more feasible for the DGS to provide facilities that promote the health, well-being and productivity of the building users.

John MacLeod
Executive Officer
California Occupational Safety and Health Standards Board

Cal/OSHA is responsible for protecting workers in the workplace. Cal/OSHA maintains regulations that are consistent, up-to-date, and reflect current scientific findings. Emphasis on good science is key to development of regulations. Workplace problems are often related to air quality; their investigation is very labor intensive. A partnership between the building industry and employer are important in solving these problems.

We must garner strong public support for any regulations governing indoor air quality because the process for adopting new regulations in California is an open process. The adoption of the ban on tobacco smoking in the workplace is an indoor air success story for Cal/OSHA.

Bonnie Holmes-Gen
Assistant Vice President of Government Affairs
American Lung Association of California

There is a strong and immediate need for action due to poor indoor and outdoor air quality and the exacerbation of asthma. Mitigation efforts should begin with schools and children. Implementation of U.S. EPA's Tools for Schools Program has shown that school districts are often not equipped to deal with indoor air quality problems. Schools are not directing energy toward indoor air quality, in part because there is no state agency specifically charged with this priority. There is a need to implement immediate relief measures based on our current knowledge.

Non-regulatory programs such as educational and mentoring programs have been used, but regulatory programs are needed. There should be requirements for on-site audits of schools. ARB seems to be the logical agency for this, with input from the Energy Commission and OEHHA. In association with this requirement, guidelines should be developed for school audits, as well as indoor air management plans, and pesticide use. ALA would like to see new standards for construction, school renovation, material emissions, and other control measures to reduce student exposure to emissions from these materials. Finally, the building industry needs to develop safer building materials and practices.

Kip Lipper
Staff Director
Senate Committee on Environmental Quality
California Legislature

Allocating additional funds to the assessment and evaluation of indoor air pollution is a very good idea. Statutory authority to improve California's IAQ might be warranted in a couple of areas: 1) an agency needs to be given the authority to set standards, and 2) better coordination among agencies could be provided through legislative authority.

There are different approaches to solving the same problem. For example, Senator Sher is authoring a bill, SB1111, to assess multiple aspects of asthma, not just as it relates to indoor air pollution. So, other avenues can be used to address IAQ as well. Lastly, there is a need to build a public constituency for indoor pollution issues. Public support is needed to influence Legislators and agencies to undertake actions in this area.

Bill Pennington
Chief Energy Efficient Program Specialist
California Energy Commission

California was one of the first states to adopt building standards into the Building Energy Code. New ASHRAE standards are being developed that may include obligatory mechanical ventilation in the near future. The Energy Commission is considering incorporating these new standards into the building standards. Currently California lacks the infrastructure of professionals for building commissioning and diagnostic testing. However, incorporation of these items into the Building Energy Code will drive a rapid development of the infrastructure.

The CEC has been addressing IAQ for some time. It has requested funds to develop maintenance training programs for personnel at schools. It would like to see design specifications for portable classrooms that improve energy and indoor air quality. CEC is studying the correlation of pollutants in portable classrooms to the type of

HVAC in the classroom. From CEC's perspective, there is a need for state agency coordination, better information about standards related to source strengths, and a strong need for public information in this area.

COMMENT/DISCUSSION SESSION

After brief presentations by the roundtable participants, the moderator opened the discussion to members of the audience. The items identified below were repeatedly mentioned by both roundtable members and members of the audience as action items to be pursued. The following are the major discussion points, summarized by topic.

Develop Standards and Regulations. State and local government, industry, and the public requested a variety of standards and regulations. A clearly defined, tangible standard has the potential to protect public health and provide an enforceable benchmark that is awaited by many sectors. Many schools do not want to be tested, even if there is no cost, because the lack of standards means they cannot interpret the results and there is not an accepted remediation method. The Legislature would need to give statutory authority to a state agency to set standards and develop regulations. The types of standards and regulations recommended include:

- Health-based standards for pollutant concentrations in indoor air.
- Emission limits for consumer products, appliances, and building materials.
- Mechanical standards for building design, HVAC specifications, operation, commissioning and maintenance.
- Regulations for procedures on mold remediation.
- Labeling programs.
- Specifications for school renovation projects.

Solutions for Schools. Several who commented stated that the first requirement for schools should be installation, maintenance, and operation of adequate ventilation systems. Schools are currently exempt from Title 24 ventilation requirements. Requirements should be more comprehensive than just ventilation levels for classrooms; they should include a mechanical system commissioning report, an annual audit of each mechanical system, standards for mechanical system noise in the classroom, and guidelines for draftless register operation. Many speakers expressed concern that these requirements do not exist for new construction, much less renovation of older school buildings. Many school facilities are being used for purposes for which they were not designed; this often results in overcrowding and very inadequate ventilation.

Other participants made recommendations to set specifications for a minimum level of custodial and maintenance staff, emission limits for building materials, design specifications for portable classrooms to improve energy usage and IAQ, and

development of audit guidelines. Funding must be increased for training and maintenance personnel in school districts.

Develop Technical Assistance. The development of technical assistance for local agency personnel and practitioners is needed and would be widely accepted. Assistance could include:

- "Best practices" manuals, including those for integrated pest management;
- Training videos to implement new practices;
- Technical guidelines;
- Checklists for homeowners and schools; and
- Mentoring programs designed for industrial hygienists to work with individual schools.

The State should offer more outreach and training to local government so that health officers, housing authorities, air pollution control officers, and school districts can assist their local clientele. Local agency personnel would like training on how to handle many common problems and informational brochures to give parents, staff, and media.

Build a public constituency. The public must be made aware of issues related to poor indoor air quality in schools, homes, and public buildings. As public awareness is raised, the public will lobby legislators and demand improved indoor air quality. An effective approach would be to highlight the cost of not prioritizing IAQ. Quantifying lost days of production, school attendance, etc. due to building related illnesses would help build a constituency.

Coordination among agencies. There was general agreement that the many agencies that hold a stake in indoor environmental policy need to better communicate with each other and coordinate their efforts. Some audience members stated that one agency should be designated as the lead agency, indicating that they are unaware that DHS is designated the lead coordinator for indoor air quality. The role of each agency should be clearly identified for members of the public who are seeking assistance. Government must also coordinate with affected industries.

Public outreach. Members of the public and school districts who have questions regarding indoor air quality often find it difficult to find answers and assistance. Several individuals suggested a one-stop-shopping approach to assistance. This could be as simple as a listing of specific problems, local contacts who can help address them, and their phone numbers. It should include a list of each State agency that offers guidance on indoor air quality and the specific role it plays. A coordinated database available on the Internet would also be an important resource for some. Data should include information on indoor sources, pollutant emissions, health effects, and standard or reference levels for each pollutant.

Further define scope of problem. Additional research may be required to fully characterize the nature and extent of the indoor environmental problem. A few felt that the problem should be better quantified and defined before regulatory solutions can be implemented. Alternately, the problem is severe in many cases, and immediate action is needed rather than additional research.

SUMMARY AND FUTURE DIRECTIONS

Panel members and participants from the audience offered many suggestions for actions that can be taken to improve indoor air quality. Many stated that an agency must step forward to formulate a plan and guide the development of a comprehensive indoor air quality program for California. Views were expressed that the Air Resources Board, along with the Department of Health Services, has shown leadership in sponsoring this Symposium.

Some actions can be taken immediately. A directory of current agencies and their role in IAQ, with contact persons, should be developed and widely distributed, particularly to local agencies. Members of the public are routed through many agency individuals before they find the right person/agency to answer their question. Current IAQ information and regulations (though limited) also should be distributed to local practitioners. For example, many (particularly school districts) are not aware of the California Minimum Building Ventilation Standard. Proper implementation of the ventilation standard along with good maintenance practices has the potential to greatly improve IAQ in many situations at a low cost.

Symposium participants repeatedly pointed to the need for a lead agency to spearhead increased efforts to improve indoor air quality and to develop standards. An effective solution to improved indoor air quality requires increased coordination among agencies, and specific legislative authority. The Green Building Task Force is a positive example of agencies working together, each with jurisdiction over some aspect of sustainable building to provide more healthful indoor environments.

The desired standards vary from health-based air concentrations to construction standards to product emission standards. There was strong consensus that any type of standard would give practitioners a bar for comparison and a level playing field, and methodologies could be developed for achieving the standard. Most stakeholders are eager to perform above a standard level, but in the absence of standards, there are financial disincentives and little motivation to change from present practices. In the absence of regulatory authority, agencies can and should develop guidelines or “best practices” manuals.

GLOSSARY

AQMD	Air Quality Management District
ARB	California Air Resources Board
BASE	Building Assessment Survey and Evaluation (U.S. EPA study)
CAL/EPA	California Environmental Protection Agency
CAL/OSHA	California Department of Industrial Relations, Division of Occupational Safety and Health, and Standards Board
CASH	Coalition for Adequate School Housing
CEC	California Energy Commission
cfm	cubic feet per minute
DGS	California Department of General Services
DHS	California Department of Health Services
DSA	Division of the State Architect (part of DGS)
HVAC	heating, ventilating and air conditioning
IAQ	indoor air quality
IEQ	indoor environmental quality
IWG	California Interagency Working Group for Indoor Air Quality
OEHHA	Office of Environmental Health Hazard Assessment
OPSC	Office of Public School Construction (part of DGS)
PF	phenol formaldehyde
ppb	parts per billion
PM	particulate matter
REL	Reference Exposure Level
RESD	Real Estate Services Division (part of DGS)
SBS	sick building syndrome
TEAM	Total Exposure Assessment Methodology
UF	urea formaldehyde
VOC	volatile organic chemical
U.S. EPA	United States Environmental Protection Agency