INDOOR AIR POLLUTION IN CALIFORNA

A report prepared pursuant to
Health and Safety Code § 39930

Air Resources Board

March 17, 2005

California Environmental Protection Agency
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Thank you, Ms. Witherspoon, and good morning, Madam Chairman and members of the Board.

Today we are presenting the highlights of a comprehensive report on indoor air quality, developed in response to Assembly Bill 1173, authored by Assemblyman Keeley in 2002. The report has had extensive public review, and was also reviewed by a scientific peer review committee and by several other state agencies. We will discuss those reviews further near the end of our presentation.

Overview

- Many indoor sources of pollutants
- Significant health risks
- Substantial economic consequences

- Some easily implemented mitigation options
- Lack of regulatory authority and need for emission limitations in other areas

The key conclusions of our report are shown here.

There are many indoor sources of both criteria pollutants and toxic air contaminants. Consequently, indoor sources cause significant health effects, and have substantial economic consequences.

There are a variety of ways to address indoor pollution. Some solutions to indoor air quality problems are relatively easy to implement. However, for some problems, there is little or no authority within either state or federal government to address the problem on a comprehensive basis.

Many Indoor Pollutant Sources

- Air cleaners (ozone generators)
- Biological contaminants
- Building materials and furnishings
- Combustion appliances
- Environmental tobacco smoke
- Soil, water (radon, chlorinated solvents)
- Architectural coatings
- Consumer products
- Household and office equipment
- Pesticide products

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Some of the more important categories of indoor sources are highlighted here.

Ozone-generating air cleaners are important sources that we discussed in January.

Biological contaminants such as mold, pollen, house dust mites, and other allergens and asthma triggers are sometimes found in greater abundance in some indoor environments.

Building materials and furnishings are important sources, because new materials such as plywood and particleboard often off-gas formaldehyde and other chemicals for several years.

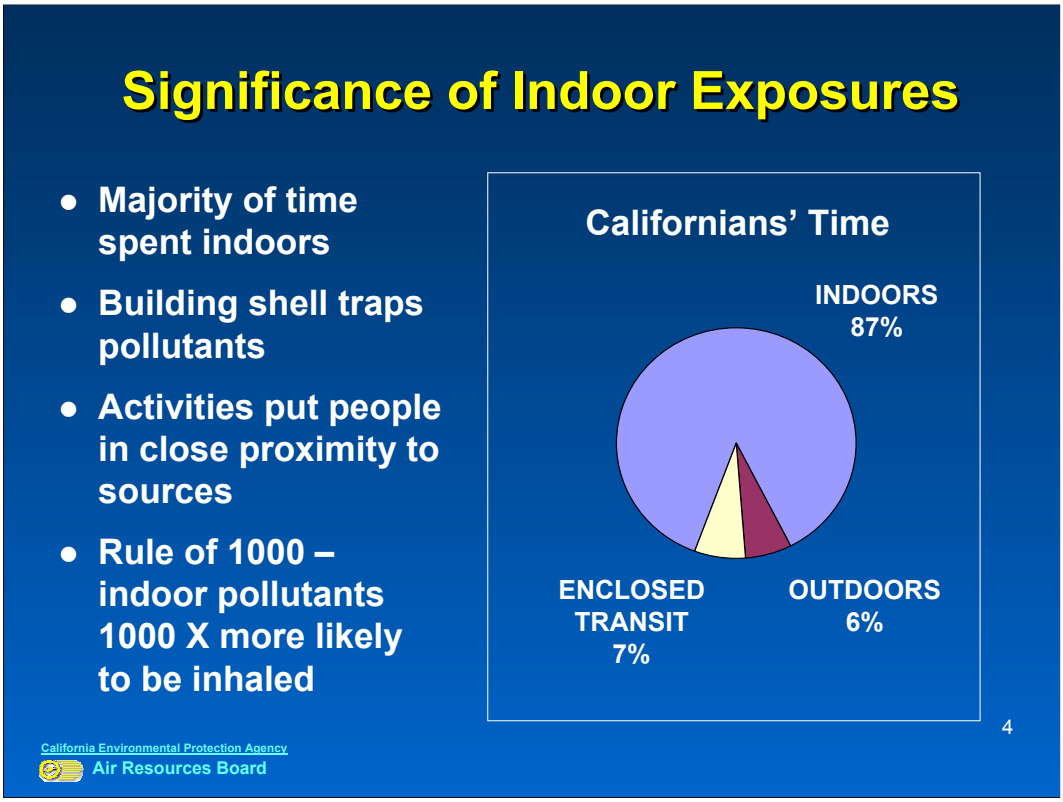
Combustion appliances that are unvented, such as most gas stoves, emit carbon monoxide and nitrogen oxides directly into the living space. Fireplaces and woodstoves can be a major source of particles.

Tobacco smoke from cigarettes and cigars has a major, well-documented impact on indoor air quality.

Uranium-containing soil and rock are the source of radon gas, which seeps into buildings through cracks and openings. Treated municipal water, chlorinated to keep it sanitary, can result in exposure to chloroform, especially during showers, dishwashing, and clothes washing.

Architectural coatings and consumer products can be a source of certain harmful volatile organic chemicals, or VOCs. Office equipment such as laser printers and copiers have been shown to emit VOCs, fine particles, and ozone.

Finally, pesticides are used frequently in homes. Recent studies indicate that pesticides may be more persistent indoors, due to the lack of weathering.



Indoor exposures are a major determinant of people's total exposure and risk, for several reasons.

Californians, like others from industrialized nations, spend most of their time indoors. As the pie chart on the right shows, we spend an average of 87% of our time indoors across the 24-hour day.

Additionally, buildings partially trap pollutants emitted from indoor sources. This leads to an extended time that the pollutants are present indoors, and thus a longer possible duration of exposure.

People's personal activities, such as cooking or the use of aerosols, puts them in very close proximity to indoor sources and the pollutants they emit, further increasing the likelihood of inhaling pollutants emitted indoors.

Based on these factors, several investigators have calculated the "Rule of 1000", which generally states that a molecule of a pollutant emitted indoors is about 1000 times more likely to be inhaled than a molecule of the same pollutant emitted outdoors by an outdoor source.

Health Effects Are Significant

- Asthma, allergies
- Cancer
- Premature death
- Increased respiratory and heart disease
- Irritant and other effects

Asthmatic child testing lung function

Scientific studies indicates that indoor air pollution poses significant health risks in many indoor environments.

Studies have repeatedly measured some indoor pollutants at levels above benchmarks established to protect health.

Indoor pollutants can exacerbate asthma and allergies, cause cancer, contribute to premature death, increase respiratory and heart disease, and produce serious irritant effects.

Indoor Exposures and Asthma

- **NAS Institute of Medicine (2000) report**
  - **confirmed known indoor triggers**
  - **new triggers: ETS, high levels of NO_2**
  - **possible triggers: formaldehyde, fragrances**

- **Recent studies – VOCs, formaldehyde, workplace cleaning products may be associated**

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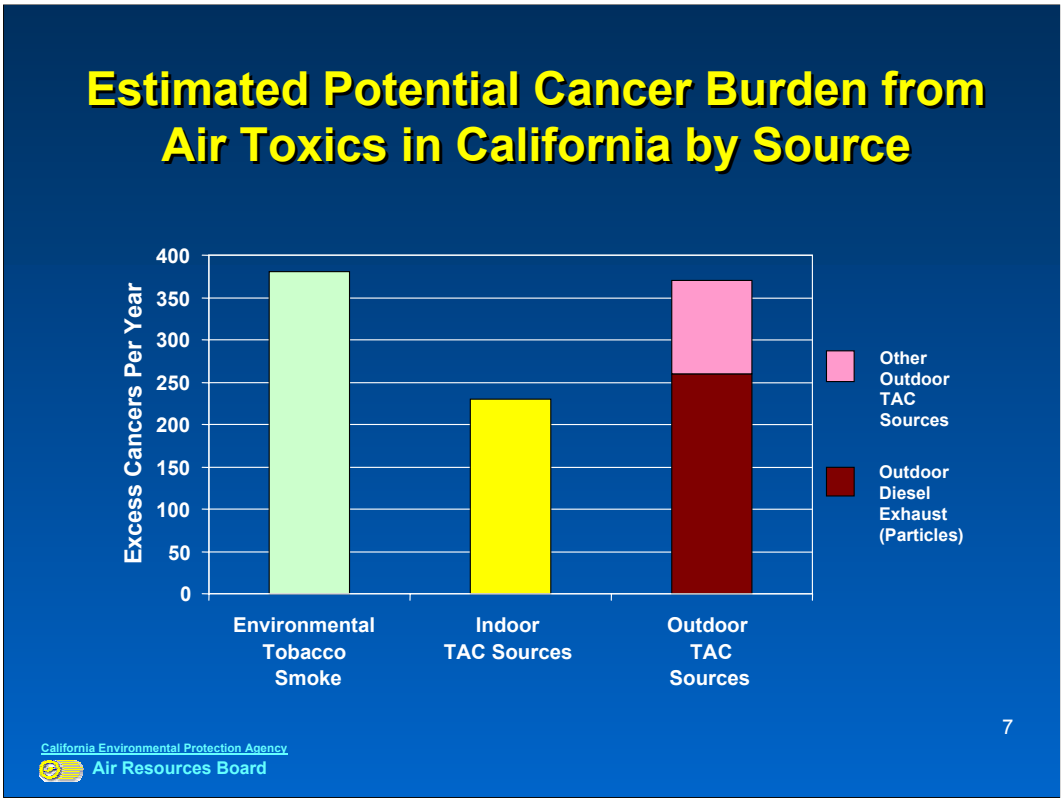
Asthma is a major public health concern, and indoor air contains a large number of substances that can trigger asthma attacks.

The Institute of Medicine, within the National Academy of Sciences, released a report on the link between indoor air quality and asthma. The report confirmed the association of traditionally known indoor triggers such as mold, pollen, animal dander, and house dust mites, with the exacerbation of asthma. More importantly, the Institute found sufficient evidence for exacerbation of asthma by ETS (for preschoolers) and by high levels of indoor nitrogen dioxide.

The Institute also found limited evidence that formaldehyde, fragrances, and ETS in other age groups also exacerbate asthma.

Studies published since the Institute's report have found further associations of asthma with formaldehyde, other VOCs, and workplace cleaning products, although the findings of these studies are largely preliminary.



A substantial number of common indoor pollutants have been classified as carcinogens.

This figure shows the estimated cancer burden from indoor and outdoor air toxics per year in California, on a year 2000 basis. OEHHA's current cancer estimates for environmental tobacco smoke, shown in the first bar, are comparable to the total cancer burden from outdoor toxics, shown in the last bar. The middle bar shows that indoor sources are estimated to cause 230 excess cancer cases per year from selected air toxics, including aldehydes, chlorinated solvents, polycyclic aromatic hydrocarbons, and others. This estimate is comparable to the total cancer burden estimated for diesel exhaust particles. The greatest contributor to the indoor estimate is formaldehyde, estimated to cause about 62 excess cancer cases per year.

Radon is not included in this graph. The Department of Health Services has developed a preliminary estimate extrapolated from national data that shows that radon may contribute to about 1500 excess lung cancer deaths per year in California. However, we do not believe the risk from radon should be pooled with other air pollutants. As noted by the National Research Council, the risk from radon cannot be fully separated from the risk associated with exposure to tobacco smoke–most cancers induced by radon will be among smokers. Additionally, California has very low average radon levels, and the potency of radon at such low levels is not known.

Death, Disease, Irritant Effects

- PM - respiratory and cardiovascular effects
- Carbon monoxide - death, flu-like symptoms
- NO_2, ozone - lung damage, respiratory disease
- Communicable diseases
- Irritant effects
- Sick Building Syndrome

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Indoor pollutants also cause premature death and increased disease other than that from asthma and cancer. Indoor sources of PM are a major health concern. Outdoor PM has been associated with thousands of premature deaths and illnesses from lung and heart disease. Studies of the impact of indoor-generated PM on health have not yet been conducted. However, indoor PM has many similarities to outdoor PM, and indoor PM emissions are likely to contribute to similar severe adverse health impacts.

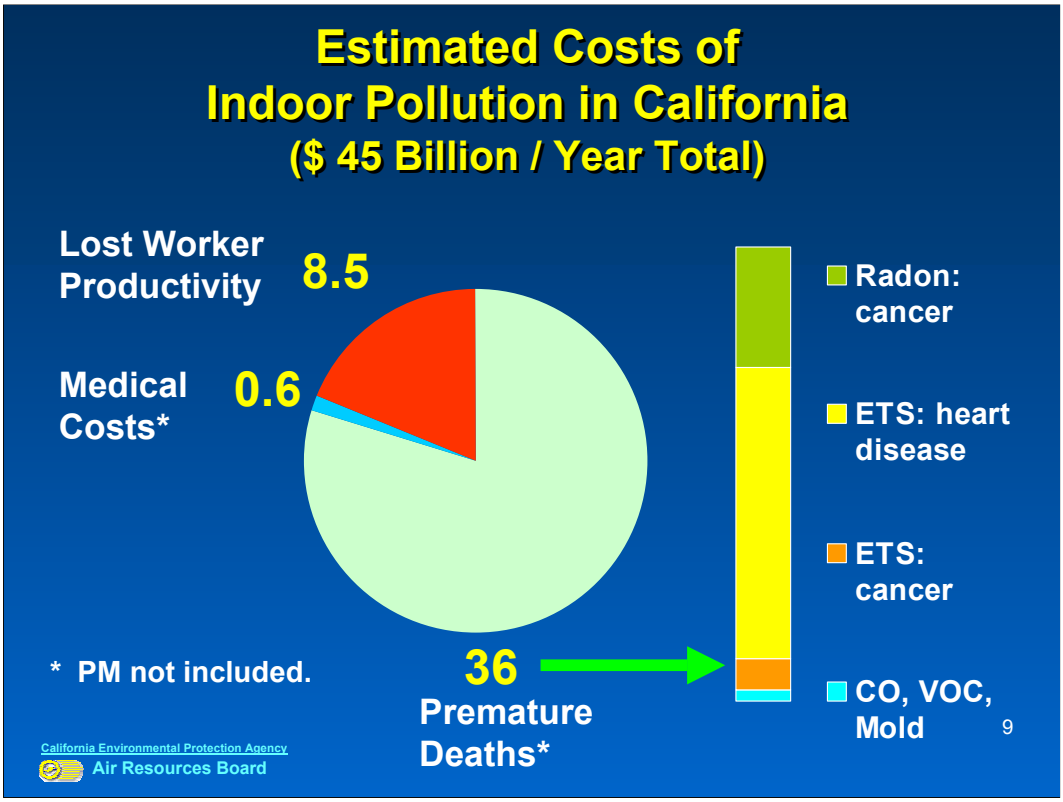
Deaths from carbon monoxide are well documented. About 2/3 of the accidental deaths that occur each year in California due to carbon monoxide poisoning result from indoor sources, such as gas furnaces and stoves and the indoor use of charcoal grills. Hundreds to thousands of hospitalizations and flu-like illnesses also are estimated to occur from CO poisoning.

Nitrogen dioxide and ozone from indoor sources can cause lung damage and respiratory disease, just as they do outdoors.

Communicable diseases such as tuberculosis and Legionnaire's disease are readily transmitted in the indoor environment.

Many indoor pollutants cause serious eye, nose, throat, and respiratory tract irritation. Formaldehyde is the most common irritant, and indoor formaldehyde concentrations nearly always exceed guideline levels for preventing irritant effects, as well as the Proposition 65 one in a hundred thousand cancer risk level.

Sick building syndrome typically refers to new or remodeled buildings in which a large number of building occupants experience irritant effects, congestion, headache, fatigue, or other symptoms, with no obvious cause. The symptoms improve when the people are away from the building. Sick Building episodes have been well documented, can affect a large number of workers, and have resulted in high costs to some businesses.



These health effects can have large economic consequences. The pie chart in this slide summarizes the costs of indoor pollution in California, estimated to total 45 billion dollars per year, adjusted to a Year 2000 basis. The major portion of this estimate is the cost of premature deaths, estimated at 36 billion dollars per year. The bar chart on the right side of the slide shows the contribution of each pollutant type to the premature death total. Heart disease deaths from ETS exposure and lung cancer deaths from ETS and radon contribute the lion's share. Other costs are from carbon monoxide poisonings, cancer from certain toxic air contaminants, and premature death from mold and moisture-related asthma and other illnesses.

Returning to the pie chart, worker productivity losses due to Sick Building Syndrome in offices and school buildings are estimated to cost at least 8.5 billion dollars per year.

Finally, total medical costs are estimated at 600 million dollars per year. Medical costs include direct costs such as hospitalization, medication, and doctor visits.

These cost estimates are likely to underestimate the full cost of indoor air pollution in California, because the necessary quantitative data are not available for all known impacts or costs. For example, other pollutants such as indoor PM, lead, pesticides, and airborne infectious diseases are not included in the estimates. In addition, data for some of the indirect costs are not available; the costs of pain and suffering are not included.

The health impacts and costs we have discussed can be avoided through the methods shown on this slide. Source control is the most reliable approach to assuring good indoor air quality. Source control includes using alternative products with lower emissions, removing sources, and modifying sources at the manufacturing level through reformulation or engineering approaches.

Ventilation is essential for assuring good indoor air quality and comfort, even if the major pollutant sources have been reduced. Most commercial buildings have mechanical ventilation systems that filter and condition the air. Homes usually rely on natural ventilation through windows and doors, but it is not always sufficient.

The proper operation and maintenance of buildings is critical to maintain healthy air quality.

Professional training and public education programs are useful tools that can lead to better choices that minimize adverse health impacts.

Air cleaning devices include both central air systems and portable devices. They are effective in some situations, but portable devices generally have only limited effectiveness in removing pollutants, especially gases.

Existing Regulations and Guidelines

Regulations

- Workplace standards (Cal/OSHA)
- Ventilation requirements (CEC)
- Smoke-free workplace law (AB 13)
- Consumer Products (CPSC and ARB)
- *No limitations on most indoor sources*

Voluntary guidelines

- Government agencies
- Industry and professional groups

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Although several agencies are involved in activities affecting indoor air quality, the authority for most is limited and actions are uncoordinated. Cal/OSHA's workplace standards and regulations apply to nearly all workplaces in the state, and include personal exposure limits for air contaminants, and regulations for ventilation, mold and moisture. The personal exposure limits are designed to protect only healthy adults during an 8-hour exposure period.

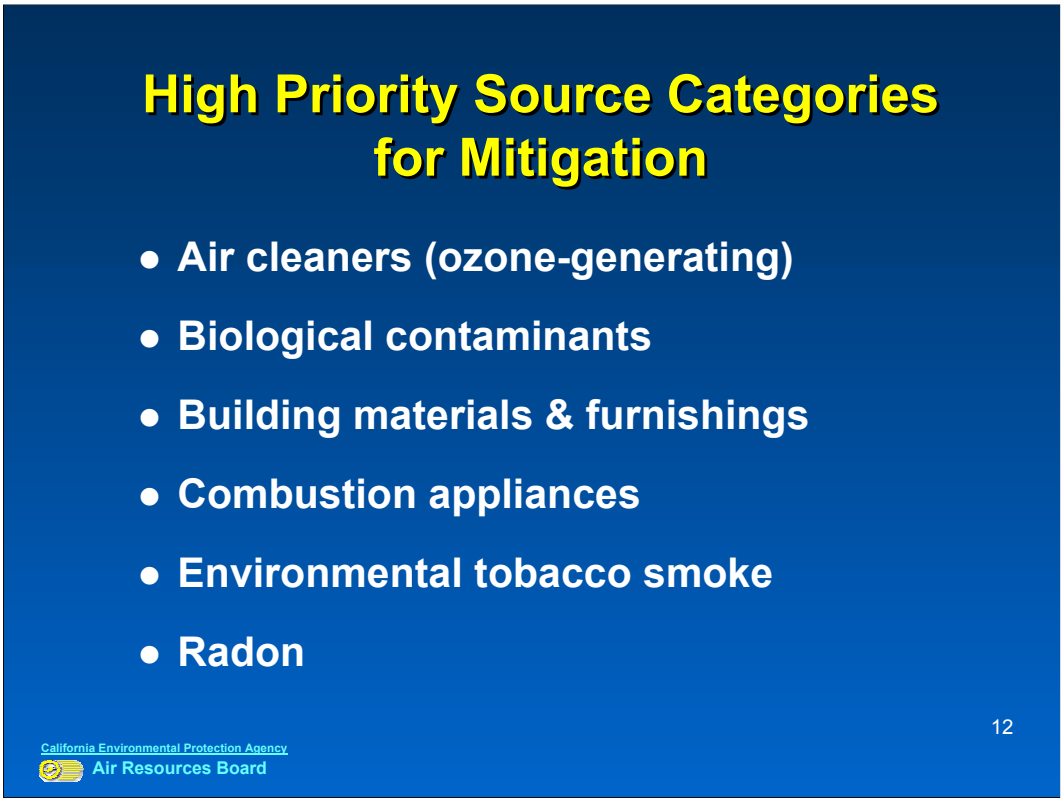
The California Energy Commission sets design standards for minimum levels of ventilation in new offices and public buildings, and sets energy efficiency standards for residences, which has reduced the outdoor air exchange in new homes.

AB13, passed in 1995, has essentially eliminated smoking in virtually all indoor workplaces in California, with just a few exceptions.

The federal Consumer Product Safety Commission is the only agency with authority to regulate indoor products for their impacts on health and safety. However, the CPSC has regulated only a few indoor products, focuses on safety more than health, and relies heavily on labeling requirements. ARB regulates consumer products for the purpose of reducing smog in California.

There is a notable gap: source emission limits and other source-related measures for most types of indoor sources are lacking.

And finally, voluntary guidelines have been developed by a number of government agencies and other organizations that address many aspects of indoor air quality. Industry groups such as the Carpet and Rug Institute, and the Composite Panel Association have developed various emission testing and labeling programs for their products.



In preparing this report, the legislation directed that we prioritize pollutants for control strategies. Because sources typically emit multiple pollutants, and because mitigation actions are best implemented by source, we prioritized by source categories. This slide shows the 6 source categories that we believe are a high priority for mitigation, in alphabetical order.

Air cleaners are a high priority because those that intentionally generate ozone can contribute to indoor ozone levels greater than Stage 1 smog alert levels, and safe alternatives are available.

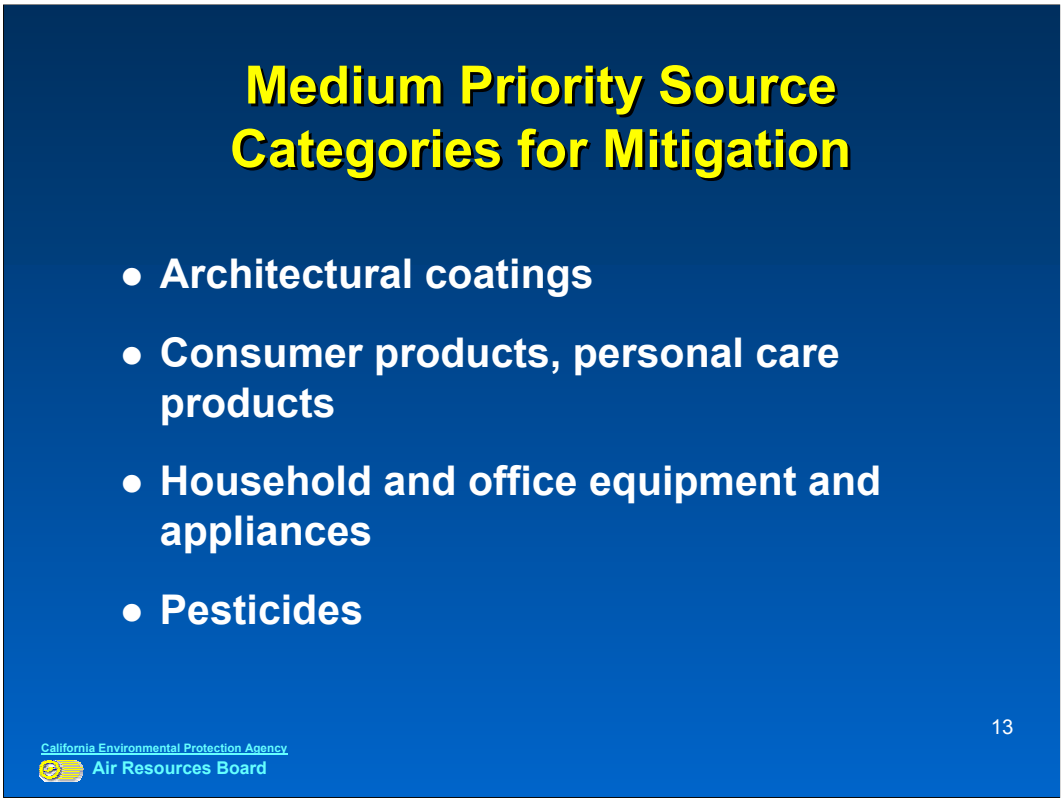
Biological contaminants are listed here because of their ubiquitous presence and their widespread health effects.

Building materials and furnishings are a high priority for mitigation because they often emit multiple toxic air pollutants, especially when new, and have a high loading level in indoor environments, resulting in high exposures for occupants. Again, low-emitting alternatives are available for these products.

Combustion appliances, primarily unvented ones, are a concern because they release pollutants directly into the living space, and they are used by most of the population. Automatic exhaust fans and direct vent models of gas appliances are two readily-available mitigation options.

Despite California's great progress in reducing cigarette smoking, environmental tobacco smoke causes thousands of deaths from heart and respiratory disease each year. Children's exposure remains a special concern in homes and vehicles where smokers are present.

Radon is estimated to pose a very high lung cancer risk, and thus is ranked high priority. However, due to its linkage to smoking and the very low levels measured in most California homes, mitigation is best achieved through increased outreach and education.



This slide shows the source categories we ranked as medium priority. These sources have been placed in medium priority primarily because, for all but the household and office equipment category, indoor emissions are partially addressed through existing regulatory programs, even though those programs are not explicitly focused on indoor air quality. Further emission reductions are needed to address those products within these categories that are not yet regulated, and to explicitly focus on indoor emissions.

Household appliances and office equipment are a concern because they can emit multiple pollutants, and are used by nearly all households. However, they require additional study to identify emissions from current models of appliances, and the best mitigation approaches.

Finally, pesticides are regulated by the Department of Pesticide Regulation. By their nature they pose a risk when used indoors, especially to children who spend time on the floor and can be exposed through dermal absorption and ingestion, as well as through inhalation. Increased public education, especially regarding integrated pest management, is needed. Children are again a top priority here.

Ozone Generator Mitigation Plan

- Request submitted to Attorney General
- Develop public and professional guidance materials, and outreach program.
- Work with air cleaner manufacturers
- Develop test protocols for air cleaners
- Emission limits needed

Returning to our highest priority category for a moment, as you requested in January, we have developed a mitigation plan for air cleaners that purposely generate ozone.

First, our Legal Office has submitted a request to the Attorney General's Office to take action to address ozone generators.

Next, we will develop public and professional guidance materials and a strong outreach program, with a special focus on doctors, building managers, and other professional groups.

We also plan to initiate conversation with manufacturers of ozone generators and manufacturers organizations.

Additionally, there is a need to develop standardized test protocols to measure ozone emissions from air cleaners.

And finally, ozone emission limits are needed; they would provide the greatest assurance of risk reduction.

As required by the legislation, we have developed a list of mitigation options for improving indoor air quality in California. Most notably, a comprehensive management program is needed to assess indoor air problems, identify the best solutions, and develop guidelines, emission limits, or other requirements to address those problems. Many agencies have a role to play in improving indoor air quality, but efforts to date have been piecemeal.

Emission limits for some sources are needed to assure risk reduction, but, unlike ventilation and workplace issues, no agency has such authority. Additionally, with or without the development of emission limits, requirements for emissions tests of building materials, furnishings, combustion appliances, and consumer products would provide information needed for informed choices. Children's health should be the top priority in improving air quality in homes and schools and I'll comment further on this in the next slide. Indoor air quality guidelines should be developed for homes, schools and other non-industrial buildings to focus on protecting children's health as well as that of other sensitive groups. For some problems, amendments to the building codes could address indoor combustion sources and prevent moisture and mold problems. An education, training, and outreach program that focuses on key professionals, as well as the public, could also go far to address many of the known indoor air quality problems.

More research is needed in several areas, such as the health impacts of indoor-generated particles, indoor chemistry reaction products, and emerging pollutants of concern. Additionally, an innovative clean air technology program to foster the development and commercialization of legitimate, cost-effective technologies that improve indoor air quality could have a major impact on reducing indoor pollution while bringing jobs to California.

School Mitigation Options

Implement all 16 Recommendations from the California Portable Classrooms Study

- Direct / assist schools to comply with state regulations
- Promote "Best Practices"
- Improve funding for facilities and training for staff
- Establish guidelines and standards for schools to protect children's health

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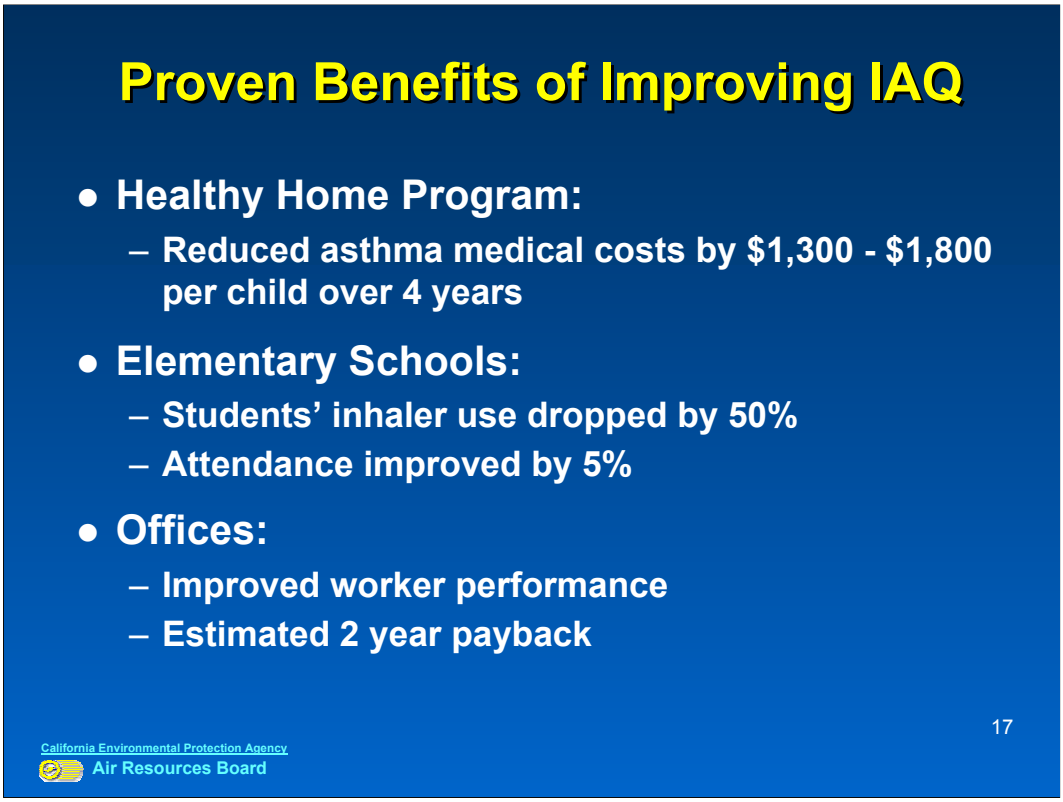
The legislation also requires us to provide mitigation options to address indoor air quality in schools. ARB and the Department of Health Services jointly developed mitigation recommendations specific to California schools, as part of the recent report to the Legislature on Environmental Health Conditions in California's Portable Classrooms. That report includes 16 specific recommendations, which you have previously reviewed and which are summarized in the four general recommendations shown on the slide.

Some steps have been taken to implement a few recommendations in the Portable Classroom report, but a more focused effort is needed.



Several studies have documented the economic benefits of improving indoor air quality. In the Seattle Healthy Home Program, intervention in low-income households with asthmatic children to identify and control indoor asthma triggers reduced asthma medical costs by $1,300 to $1,800 per child over four years.

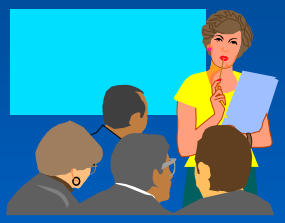
Several grade schools in California and other states have demonstrated that improving indoor air quality improves student health. For example, one San Francisco school found that, after implementing an indoor air quality management plan, student use of asthma inhalers dropped by 50 percent. A school in Illinois found that improving ventilation and reducing indoor pollutant sources improved student attendance by five percent.

In a study of office workers, task performance was significantly improved by removing indoor pollutant sources and increasing ventilation rates. Economic analyses indicate that such improvements would pay for themselves in two years, and that the benefits would be 60 times greater than the costs of the improvements.

These and other studies show that improving indoor air quality can pay for itself in terms of reduced illness, reduced medical costs, and improved student performance and worker productivity.

Stakeholder Review

- Held two public workshops
- Two previous public comment periods (received 65 and 28 sets of comments)
- Reviewed by UC scientific review panel
- Substantial input from state agencies

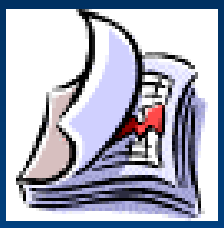


To meet the mandate of AB 1173, ARB obtained input from various groups. We held two public workshops and two public comment periods on the draft report prior to the comment period associated with this Board meeting. We received numerous comments from a broad range of interested stakeholders, but primarily from various industries.

As required under AB1173, a scientific review committee reviewed the draft report. We also solicited and received substantial input from a number of state agencies.

The current draft report reflects a substantial number of changes that were made in response to the comments we received.

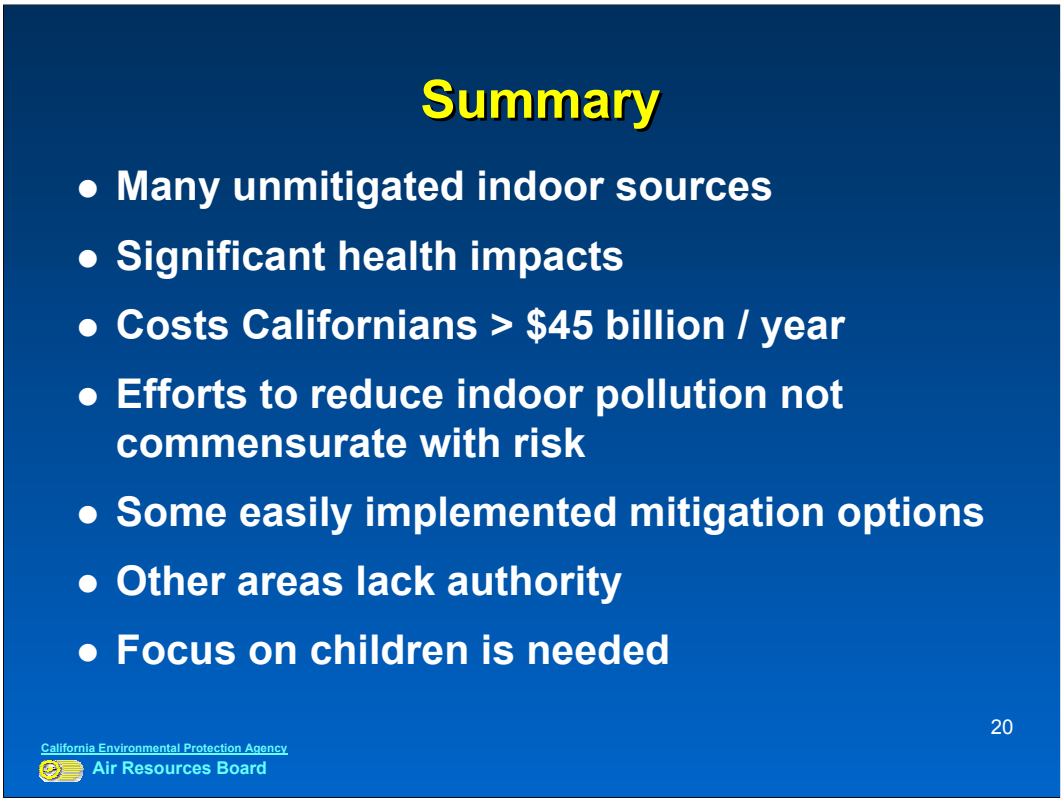
Comments



- Public comments
  - Quantitative prioritization
  - More on biologicals
  - More costs, e.g. radon, biologicals, lead
  - Corrections and additions
- Scientific review committee
  - Generally supportive
  - Tiered approach, some changes longer term
  - Improve methods section, other clean-up
  - Add non-industrial workplace information, other references, other information

This slide highlights the main comments from the public and peer review committee. To address these comments, we modified the prioritization tables, but did not undertake a quantitative assessment because we believe that is beyond the scope of the current report. More information was added to the report on biological contaminants and the cost of radon.

The scientific peer review committee was generally supportive of the report and agreed that the topic is not well addressed by government at any level. They suggested a tiered approach for addressing indoor air quality so that policies can be pursued now for pollutant issues that are well defined, while additional information is gathered on other sources and pollutants. At their suggestion, we expanded the section on methods of mitigation; added a section on non-industrial workplace exposures; incorporated some additional references; and made other technical changes suggested.



In summary, there are many unmitigated sources of indoor pollutants.

Pollutant emissions from indoor sources have significant health impacts that cost Californians a minimum of $45 billion per year.

Efforts to reduce indoor pollution are not commensurate with the risk it presents.

There are some options available for reducing indoor pollution that could be readily implemented if resources are available. However, authority is lacking for other areas, and there is no comprehensive program focused on achieving some of the known solutions.

Finally, a focus on protecting children's health from indoor pollution should be the highest priority.

This concludes my presentation. We would be happy to answer any questions you may have.