

Combustion products of heating and cooking appliances: Burning of oil, natural gas, kerosene, and wood for heating or cooking purposes can release a variety of combustion products of health concern. Depending upon the fuel, these may include carbon monoxide (a chemical asphyxiant), oxides of nitrogen (respiratory irritants), polycyclic aromatic hydrocarbons (e.g., the carcinogen benzo[a]pyrene), and airborne particulate matter (respiratory irritants). Carbon monoxide, an odorless gas, can be fatal. Nitrogen dioxide can damage the respiratory tract, and sulfur dioxide can irritate the eyes, nose and respiratory tract. Smoke and other particulates irritate the eyes, nose and throat, and can cause lung cancer.

Improper venting and poor maintenance of heating systems and cooking appliances can dramatically increase exposure to combustion products. Experts recommend having combustion heating systems inspected by a trained professional every year to identify blocked openings to flues and chimneys, cracked or disconnected flue pipes, dirty filters, rust or cracks in the heat exchanger, soot or creosote build-up, and exhaust or gas odors. Installing a carbon monoxide detector is also recommended; however, such a detector will not detect other combustion by-products.

Insect and Rodent pests: The observed association between exposure to cockroach antigen and asthma severity has already been noted above. In addition, cockroaches may act as vehicles to contaminate environmental surfaces with certain pathogenic organisms. Rodents can transmit a number of communicable diseases to humans, either through bites, arthropod vectors, or exposure to aerosolized excreta. In addition, humans can become sensitized to proteins in rodent urine, dander and saliva. Such sensitization may contribute to asthma severity among children. Insect and rodent infestation is frequently associated with substandard housing that makes it difficult to eliminate. Treatment of rodent and insect infestations often includes the use of toxic pesticides that may present hazards to occupants (see below). Integrated pest management (IPM) for rodents and cockroaches, which reduces the use of pesticides, is estimated to cost approximately \$150 per unit. IPM control measures include sealing holes and cracks, removing food sources and use of traps.

Lead: Exposure to lead, especially from deteriorating lead-based paint, remains one of the most important and best-studied of the household environmental hazards to children. Although blood lead levels have fallen nationally, a large reservoir of lead remains in housing. The most recent national survey, conducted from 1991–94, showed that nearly one million U.S. preschoolers still have elevated blood lead levels. Overall, the prevalence rate among all children under six years of age is 4.4 percent. Among low-income children living in older housing where lead-based paint is most prevalent, the rate climbs to 16 percent; and for African-American children living in such housing, it reaches 21 percent.

HUD estimates that 38 million dwellings have some lead-based paint, and that 26

million have significant lead-based paint hazards. Of those, about 5.7 million have young children and of those, about 1.6 million have household incomes under \$30,000 per year. LHC costs can range anywhere from \$500 to \$15,000 per unit. Corrective measures include paint stabilization, enclosure and removal of certain building components coated with lead paint, and cleanup and “clearance testing,” which ensures the unit is safe for young children.

Mold and moisture: An analysis of several pulmonary disease studies estimates that 25 percent of airways disease, and 60 percent of interstitial lung disease may be associated with moisture in the home or work environment. Moisture is a precursor to the growth of mold and other biological agents, which is also associated with respiratory symptoms. An investigation of a cluster of pulmonary hemosiderosis (PH) cases in infants showed PH was associated with a history of recent water damage to homes and with levels of the mold *Stachybotrys atra* (SA) in air and cultured surface samples. Associations between exposure to SA and “sick building” symptoms in adults have also been observed. Other related toxigenic fungi have been found in association with SA-associated illness and could play a role. For sensitive individuals, exposure to a wide variety of common molds may also aggravate asthma. Addressing mold problems in housing requires coordination among the medical, public health, microbiological, housing, and building science communities.

The cost of mold/moisture-related intervention work (e.g., IPM, clean and tune furnace, remove debris, vent clothes dryer, cover dirt floor with impermeable vapor barrier) is a few hundred dollars, unless major modification of the ventilation system is needed. For example, in Cleveland, mold interventions, including repairs to ventilation systems and basement flooring, in the most heavily contaminated homes range from \$500–\$5,000, with some costs also being dedicated to LHC simultaneously through its lead and asthma program.

Pesticide residues: According to the EPA, 75 percent of U.S. households used at least one pesticide product indoors during the past year. Products used most often are insecticides and disinfectants. Another study suggests that 80 percent of most people’s exposure to pesticides occurs indoors and that measurable levels of up to a dozen pesticides have been found in the air inside homes. The amount of pesticides found in homes appears to be greater than can be explained by recent pesticide use in those households; other possible sources include contaminated soil or dust that migrates in from outside, stored pesticide containers, and household surfaces that collect and then release the pesticides. Pesticides used in and around the home include products to control insects (insecticides), termites (termiteicides), rodents (rodenticides), molds and fungi (fungicides), and microbes (disinfectants). In 1990, the American Association of Poison Control Centers reported that some 79,000 children were involved in common household pesticide poisonings or exposures. In households with children under five years

of age, almost half stored at least one pesticide product within the reach of children. Exposure to chlorpyrifos (CP), a commonly used organophosphate insecticide, in the prenatal and early postnatal period may impair neurological development. While CP is a biodegradable pesticide, substantial persistence of CP in house dust has been demonstrated. Exposure to high levels of cyclodien pesticides, commonly associated with misapplication, has produced various symptoms, including headaches, dizziness, muscle twitching, weakness, tingling sensations, and nausea. In addition, the EPA is concerned that cyclodienes might cause long-term damage to the liver and the central nervous system, as well as an increased risk of cancer.

There are available data on hazard evaluation methods and remediation effectiveness regarding pesticide residues in the home environment.

Radon progeny: The National Academy of Sciences estimates that approximately 15,000 cases of lung cancer per year are related to radon exposure. Epidemiologic studies of miners exposed to high levels of radon in inhaled air have defined the dose response relation for radon-induced lung cancer at high exposure levels. Extrapolation of these data has been used to estimate the excess risk of lung cancer attributable to exposure to radon gas at the lower levels found in homes. These estimates indicate that radon gas is an important cause of lung cancer deaths in the U.S. Excessive exposures are typically related to home ventilation, structural integrity and location.

Radon measurement and remediation methods are well developed, and the Environmental Protection Agency (EPA) recommends that every home be measured for radon. EPA estimates that materials and labor costs for radon reduction in an existing home are \$800–\$2,500. Including radon resistant techniques in new home construction costs \$350–\$500, and can save up to \$65 annually in energy costs, according to the EPA.

Take-home hazards from work/hobbies and work at home: When the clothing, hair, skin, or shoes of workers become contaminated with hazardous materials in the workplace, such contaminants may inadvertently be carried to the home environment and/or an automobile. Such “take-home” exposures have been demonstrated, for example, in homes of lead-exposed workers. In addition, certain hobbies or workplaces located in the home may provide an especially great risk of household contamination.

Control methods include storing and laundering work clothes separately, and showering and changing clothes before leaving work or immediately after arriving home. Once a home becomes contaminated, cleaning floors and contact surfaces and replacing furnishings may be necessary to reduce exposures.

Unintentional injuries/fire: Unintentional injury is now the leading cause of death and disability among children younger than 15 years of age. In 1997, nearly 7 million persons in the U.S. were disabled for at least one full day by unintentional injuries