Implications

VOL. 03 ISSUE 7 www.informedesign.umn.edu

A Newsletter by InformeDesign. A Web site for design and human behavior research.

Construction barrier with manometer.

IN THIS ISSUE

Construction and Indoor Airborne Contaminants

Architects, interior designers, building owners, facility managers, and contractors need to be aware that construction can generate and disperse airborne contaminants that may adversely affect occupant health, comfort, and productivity. In schools, for example, construction-related activities are the fourth largest cause of indoor air quality (IAQ) problems. In healthcare facilities, construction-related pollutants increase risk of patient infections that may cause death. Construction is also an important source of pollution in the build-out of commercial spaces and the renovation of residential and other types of buildings. The most susceptible occupants include those who are immune compromised, those who have pre-existing respiratory (e.g., asthma, allergies) and cardiac conditions, the aged, and fetuses and infants.

Construction-Related Contaminant Sources

Indoor air pollutants can be from sources either inside or outside the occupied space. Outdoor pollutant sources include:

- volatile organic compounds (VOCs) from asphalt roofing and particles,
- microbial aerosols,
- particles generated by demolition of adjacent structures, excavation, and diesel equipment.

These pollutants can enter the occupied space through penetrations (e.g., doors, windows) in the building envelope and outdoor air intakes due to lower indoor air pressure in the occupied space compared to the outdoors.

Much of the early research literature on indoor pollutant sources has focused on VOCs released from building components, finishes, and furnishings. Increasingly, the importance of construction processes and activities as sources has been recognized. The pollutants generated by indoor construction sources including inorganic and viable particles from activities such as:

- grinding concrete and metal,
- removal of wallboard, carpeting, and ceiling tile,
- applying adhesives, paints, and finishes, and
- transportation of materials, equipment, debris, and workers in and out of the building.

Viable (e.g., alive mold) and nonviable (i.e., non-living) particles come from mold that is disturbed during the construction process.

Implications

Health Effects of Construction-Generated Pollutants

Much of our understanding about the health effects of construction-generated pollutants initially came from studies of construction workers and their exposures. More recently, the health effects of construction pollutants on occupants have come from two sources: studies in healthcare environments and National Institute of Occupational Health and Safety (NIOSH) Health Hazard Evaluation Reports from investigations in commercial, educational, and institutional buildings. Health effects from indoor air contaminants, including those from construction, are most commonly those that involve:

- respiratory symptoms and diseases,
- allergies and other immune system diseases,
- cancer,
- skin and mucous membrane effects,
- sensory and central nervous effects, including Sick Building Syndrome (SBS).

Strategies to Control Construction Pollutants

There are a number of tools to manage the risks of construction pollutants in occupied spaces. These tools include: pre-design programming, planning and bid documents; control measures during construction; and environmental monitoring and surveillance. In healthcare facilities, especially hospitals, Infection Control Risk Assessment (ICRA) strategies are another very important tool. ICRA programs focus on protecting patients according to patients' levels of susceptibility. The most susceptible to airborne contaminants are bone marrow transplant patients, AIDS patients, those with leukemia, solid organ transplant patients, those with cancer, and those undergoing chemotherapy.

Demolition of adjacent structure.

IRCA team reviews plans.

Pre-design Programming. Early in the construction planning process, identify occupants that may be affected by construction activities and assess their relative vulnerability. The occupants that may be affected are commonly those in adjacent spaces including those on floors above and below the construction area and those in the same heating, ventilation, and air conditioning (HVAC) zone. ICRA is a very useful tool from healthcare settings that is applicable to other types of building infection, as are American Institute of Architects (AIA) and Center for Disease Control (CDC) design and construction guidelines. ICRA includes:

- consideration of high risk occupants,
- understanding of air handling and ventilation systems and their operation,
- understanding of water management issues associated with construction,

Implications

- identification of potential contaminants,
- strategies to protect occupants from construction pollutants, and
- strategies for air quality monitoring.

Planning and Bid Documents. It is very important to include construction pollutant strategies in bid documents as well as in specifications and plan documents. These strategies include:

- dustproof enclosures and negative air pressure to isolate the contaminated construction zone from the protected occupant zone,
- construction site zone access,
- demolition and construction phasing,
- construction and material delivery hours,
- remote construction activities, and
- exterior construction activities.

Carpet removal behind protective enclosure.

Control Measures During Construction. Control measures during construction build off those identified in the planning and bid documents and include:

- how negative pressure will be maintained in the construction zone as interfaced with fire alarm smoke control systems and the integrity of the affected mechanical systems,
- occupant relocation plan,
- material delivery schedule,
- debris and material access routes,
- housekeeping,
- contractor/owner representative coordination plan, and
- collaboration with the architect and engineer.

Environmental Monitoring and Surveillance. Environmental monitoring may include a wide variety of equipment including:

- air pressure indicators, such as micromanometers, and alarms, and
- particle counters.

Control of construction-related pollutants in occupied environments is increasingly important as the proportion of susceptible populations increases and as we gain better understanding of the impact of poor IAQ on productivity. The reputation of interior designers, architects, contractors, and building owners is at risk if construction pollutant control is ignored. Liability associated with injury of occupants is also an important concern.

To learn more about control of construction-related pollutants, go to www.cce.umn.edu/healthcarefacilities. At this site, you will learn about a September 15-16, 2005 workshop held at the University of Minnesota in Minneapolis. The workshop focuses on hands-on, small-workgroup problem solving that is immediately applicable to interior designers, architects, contractors, and building owners' representatives in construction projects. While the workshop focuses on healthcare settings, the information is applicable to all building types.

Additional Resources

—EPA: www.epa.gov/iaq
—Healthcare: www.dehs.umn.edu/iaqconf.html
—Mold: www.dehs.umn.edu/iaq/fungus
—Radon: www.cce.umn.edu/radon
—Residential: www.dehs.umn.edu/homeiaq
—School: www.dehs.umn.edu/iaq/school

About the Author

William J. Angell is a University of Minnesota professor and director of a US Environmental Protection Agency (EPA) Regional Indoor Air Quality (IAQ) Training Center, the IAQ Project. In 2004, he completed a critical review of scientific peer-reviewed literature on residential IAQ for the US EPA's Radiation and Indoor Environments (R&IE) National Laboratory. In 2003, he completed development of a US EPA-supported national pilot IAQ course for Tribes. Angell has developed and taught many IAQ courses including those dealing with biocontaminants, carbon monoxide, construction pollutants, and radon in schools, healthcare facilities, and residences. He has been principal investigator on more than 90 EPA, state, tribal, association, industry, and other sponsored projects. Angell has been a visiting scientist with the EPA's R&IE National Laboratory and the Lawrence Berkeley Laboratory's Indoor Environments Program. In the 1980s, he led a multistate investigation of mold contamination and other IAQ problems in 5,000 homes. Angell has also been a lead expert witness for the US Department of Justice.

Related Research Summaries

InformeDesign has many Research Summaries about construction-related indoor air quality and other, pertinent topics. This knowledge will be valuable to you as you consider your next design solution and is worth sharing with your clients and collaborators.

"Keeping Patients Safe During Hospital Construction"
—*American Journal of Infection Control*

"Air Quality in Damp Residences" —*Indoor Air*

"Improving Unhealthy Hospitality Work Environments" —*Cornell Hotel and Restaurant Administration Quarterly*

"Indoor Air Quality and Sick Leave" —*Indoor Air*

"Particulate Exposure Among the Elderly"
—*Journal of Exposure Analysis and Environmental Epidemiology*

"Residential Building Materials and Children's Health" —*American Journal of Public Health*

"Building Renovations for Improved Health"
—*Indoor Air*

Photos Courtesy of:

William Angell, University of Minnesota

InformeDesign®
Where Research Informs Design

The Mission

The Mission of InformeDesign is to facilitate designers' use of current, research-based information as a decision-making tool in the design process, thereby integrating research and practice.

Created by:
UNIVERSITY OF MINNESOTA

Sponsored by:
ASID