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ROCIS Initiative Reducing Outdoor Contaminants in Indoor Spaces
ROCIS.org

Executive Summary

This paper provides a broad framework for understanding sources, pathways, and mitigation approaches in protecting commercial buildings from outdoor pollutants. It complements the ROCIS white paper on homes, "Protecting Homes from Outdoor Pollutants". The outdoor pollutants to be considered include outdoor pollutants that enter buildings via air, water, and/or soil media, for both the U.S. and Canada. The paper focuses on three types of commercial buildings: schools, large office buildings, and mid- and high-rise multifamily buildings.

Both indoor and outdoor environments are important in determining the type, amount, and duration of pollutant exposures we experience. People spend about 90% of their time indoors, where they are exposed to a mix of indoor and outdoor pollutants. Much, if not most, of our cumulative pollutant exposure, our body's dose, and our health risk for some outdoor pollutants occurs in indoor environments. Indoor environmental quality (IEQ), which includes the quality of air, acoustics, thermal conditions, and lighting, can have a very large impact on human health, performance, and economic productivity.

The poor quality of outdoor air, water, and soil is a growing public health concern. Existing health risks from emission sources, such as motor vehicles, freight transport, and industrial activities, continue to persist. New environmental pollution stressors, such as fracking and climate change, are growing dramatically. The types of outdoor pollutants that pose health concerns in indoor spaces span a wide variety—particles, gases, semivolatile organic compounds (SVOCs), and biological pollutants. Their sources also vary widely—industrial activities, motor vehicles, regional air pollution, agriculture, and nearby commercial, construction, and maintenance activities.

Monitoring outdoor pollutants of concern in buildings is not usually warranted due to the cost, time, and effort required and the difficulty in interpreting the results. Exceptions would be when there is a need to evaluate a mitigation measure, meet a regulatory requirement, or track indoor levels of extremely hazardous pollutants. Some pollutant sources can be identified by visually inspecting a building and its neighborhood, contacting state and local governments, and consulting maps and databases on the Internet. Some indoor pollutants can be monitored easily, at low cost (about $200 or less), and at least a semi-quantitative level. Monitoring of air pressures can also be measured easily in order to assess potential IEQ problems and monitor the

performance of air filters and air pressure control of pollutant infiltration. Liability concerns from disclosing monitoring results have been raised, but the evidence to date indicates that exposure to liability is minimized by monitoring IEQ proactively, especially if best practices for managing IEQ are followed as well.

Some community groups have employed more expensive monitoring methods to test the outdoor and indoor air, water, and soil in their neighborhoods. Numerous low cost, small, portable sensors for real-time monitoring of indoor and outdoor air pollutants are being developed, and some should be available in the near-term for public use.

Several basic strategies can be used to mitigate pollutant entry in commercial buildings, each strategy with its own limitations, advantages, and disadvantages. The appropriate strategies will depend on the pollutants, their pathways into the building, the occupants, and cost considerations. Some strategies involve avoiding nearby sources by increasing setbacks of buildings from nearby pollutant sources, locating air intakes away from nearby sources, sealing air leaks, and keeping air intakes and air filters clean. Other strategies use active removal of pollutants by filtering or cleaning air, treating potable water, reducing soil track-in, and cleaning indoor surfaces. Air pressure is used to control intrusion of soil gases and air pollutants from adjoining spaces and below-grade foundations. Water treatment is used to remove radon and VOCs from drinking water.

When considering mitigation strategies, the interactions of building systems and the durability of the strategies must be considered. Systems interactions can cause moisture condensation, depressurization of sewage vents, and inadequate air flow to air filters and building spaces. The effectiveness of a strategy may decline over time, e.g., the rapid drop in the use of portable air cleaners reported in an asthma intervention study. A mix of strategies may often be the optimal solution, e.g., improved air sealing of the building enclosure along with improved air filtration enhances pollutant removal while also saving substantial amounts of energy and reducing cleaning costs.

In terms of IEQ improvements, data on the effectiveness of many of these mitigation strategies are limited or absent for commercial buildings. Control of soil gas (vapor) intrusion by subslab depressurization and air sealing is well documented and widely used in commercial and residential applications. The effectiveness of air filters in central air systems and portable air cleaners in reducing indoor PM is fairly well documented, but the data on the health impacts are limited and the results mixed. The effectiveness of houseplants and living walls in removing indoor air pollutants has not been well demonstrated. Other strategies such as building setback, air intake location, and reducing ventilation during high pollution periods are widely used and considered best practice, but documentation of their effectiveness is limited.

In conclusion, ample opportunities are available for reducing the infiltration and intrusion of outdoor pollutants into buildings and thereby reducing the health impacts, especially for vulnerable populations. Several mitigation strategies are well characterized and commonly used, while other strategies have little or no test data on their effectiveness in commercial buildings.

Some of these strategies, such as air sealing and commissioning of buildings to reduce infiltration and duct leakage, can be cost effective based on energy savings alone. Affordable monitoring methods are available for some outdoor pollutants, and low-cost portable sensor technology should be available soon for widespread use by the public.

Several research, development, and demonstration needs are identified. In addition, the following generic, interrelated actions are recommended:

- Build the evidence base for mitigation measure effectiveness and co-benefits.
- Build a better toolbox for the monitoring of exposure, health, and biomarkers.
- Implement and improve best practices for IEQ by addressing outdoor air pollution.
- Stress awareness and training of the public, building operators, and decision-makers at all levels.
- Take a seat at the table in all forums related to buildings and their occupants.

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