PENNSYLVANIA HOUSING RESEARCH CENTER

CHALLENGES, CONSIDERATIONS, AND CONCERNS OF INDOOR AIR QUALITY

June 2015 | Bryan Heitzmann

INTRODUCTION

Indoor air quality (IAQ) is a term which refers to the quality of air within buildings, especially as it relates to the health and comfort of building occupants. Studies have actually shown that the air quality inside homes can be worse than it is outside. In fact, the air in homes can be 2 to 5 times more polluted, and in some cases up to 100 times more polluted, than outdoor air (UL 2015). This has forced industry experts to identify ways to move air in and out of homes in a managed way to minimize the factors that lead to indoor air quality problems.

IAQ can be affected by gases, such as carbon monoxide or radon; microbial contaminants, like mold or bacteria due to moisture intrusion; improper and inadequate ventilation or make-up air; or any other pollutant or condition that can cause adverse health conditions. These pollutants often result from occupant activities, household products, and building materials used in everyday construction. In many cases pollutant levels from individual sources may not pose a significant health risk by themselves, but homes can have more than one source that contributes to indoor air pollution and there can be a serious risk from the cumulative effects of these sources.

The U.S. Environmental Protection Agency (EPA) estimates that the average person receives 72 percent of their chemical exposure at home, which means the very places most people consider safest actually exposes them to the greatest amounts of potentially hazardous pollutants (UL 2015). Additionally, people who may be exposed to indoor air pollutants for the longest periods of time are often those most susceptible to the effects of indoor air pollution. Such groups include the young, the elderly, and the chronically ill. General health symptoms potentially related to poor indoor air quality include cough or respiratory related illness, headache, chronic fatigue, dry eyes/throat, and nausea.

Improving the quality of indoor air is vital for human health. Fortunately, there are steps that residential occupants can take both to reduce the risk from existing sources and to prevent new problems from occurring.

PURPOSE

This document provides some guidance on the topic of IAQ in Pennsylvania to help recognize common pollutants, understand the potential health impacts of poor indoor air quality, identify sources of indoor pollutants, and recognize methods of improving the air quality within a home.

Recommendations are provided through a list and associated house cross-section explaining ways that good indoor air quality can be maintained within a home (see Figure 2). The diagram and tips are the result of recommendations made by the ASHRAE Standard 62.2 (ASHRAE 2013).

COMMON POLLUTANTS

The pollutants contributing to IAQ issues come from a range of sources that include not only the building materials and construction practices, but also occupant behavior.

- **Combustion Sources**
  - Oil
  - Gas
  - Wood
  - Candles
  - Tobacco
  - Coal
- **Building Materials**
  - Wallpaper
  - Carpet
  - Pressed wood products
  - Insulation
  - Asbestos
- **HVAC Systems**
  - Boilers
  - Heating equipment
  - Fireplaces
  - Chimneys
  - Gas stoves
- **Outdoor Sources**
  - Radon
  - Pesticides
  - Carbon monoxide
  - Mold

IMPACTS OF POOR IAQ

Poor IAQ should be addressed because it can lead to both short- and long-term health problems.

- **Short term:**
  - Irritations (Eyes, nose, throat)
  - Headaches
  - Dizziness
  - Fatigue
  - Nausea

- **Long term:**
  - Respiratory diseases
  - Cancer
  - Heart disease

SOURCES OF AIR EXCHANGE

The rate at which outdoor air replaces indoor air is described as the air exchange rate. When there is little infiltration, natural ventilation, or mechanical ventilation, the air exchange rate is low and pollutant levels can increase.

ASHRAE Standard 62.2 provides guidance on the appropriate Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings.

Air can enter and leave a house in three main ways: infiltration, natural ventilation, and mechanical ventilation.

Infiltration

Infiltration is the unintentional or accidental introduction of outside air into a building, typically through cracks in the building envelope and through the use of doors for passage. Outdoor air flows into the house through openings, joints, and cracks in walls, floors, and ceilings, and around windows and doors.

Natural Ventilation

Natural ventilation refers to the process of supplying air to, and removing air from, an indoor space without the use of mechanical systems, or simply air movement through opened windows and doors. Air movement associated with infiltration and natural ventilation is caused by differences in air temperature and pressure.

Mechanical Ventilation

Mechanical ventilation is the process of supplying or removing air that may or may not have been conditioned by mechanical means to or from any space. This includes air handling systems that use fans and duct work to continuously remove indoor air and distribute filtered and conditioned outdoor air to strategic points throughout the house. Examples include outdoor-vented fans that intermittently remove air from a single room, such as bathrooms and kitchens, and heat recovery ventilators (HRVs), which allow for heat exchange between incoming and outgoing air to increase energy efficiency.

HOW TO MONITOR IAQ

Identify

In many cases, health effects can be useful indicators of an indoor air quality problem. If an occupant feels that adverse health symptoms exist that may be related to their home environment, discussions with a doctor or the local health department should take place to see if indoor air pollution could be the cause.

Also, occupants should look for signs of problems with the ventilation in their home. Signs that can indicate the home may not have adequate ventilation include moisture condensing on windows or walls, stuffy air, dirty central heating and air cooling equipment, or the presence of mold.

Measure

Measurements are most appropriate when there are either health symptoms or signs of poor ventilation and specific sources or pollutants have been identified as possible causes of indoor air quality problems. In many cases, such as with radon, without measurements there is no way to tell whether contaminates are present because they can be a colorless, odorless, or radioactive gas. In this case monitors or sensors for testing indoor air quality are required.

HOW TO MANAGE IAQ

The most common ways to manage IAQ problems are through proper ventilation, air cleaners, source control, and weatherization.

Proper Ventilation

One tactic to successfully lower the concentrations of indoor air pollutants in a residential building is to increase the amount of outdoor air coming indoors through ventilation. Most home heating and cooling systems, including forced air heating systems, do not mechanically bring fresh air into the house. Opening windows and doors, operating window or attic fans, or running a window air conditioner with the vent control open increases the outdoor ventilation rate. Local bathroom or kitchen exhaust fans can remove contaminants directly from the room where the fan is located and can provide air exchange by increasing infiltration through the building envelope.

Advanced designs of new homes and updated building codes are starting to feature mechanical systems that bring outdoor air into the home in a controlled or managed way. Some of these designs include energy-efficient heat recovery ventilators (HRV's - see Figure 1) and energy recovery ventilators (ERV's).

Figure 1: Heat Recovery Ventilator (HRV) used to provide mechanical ventilation in a residential application.

The 2013 version of ANSI/ASHRAE Standard 62.2, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings, is a nationally recognized standard on indoor air quality developed solely for residences. Its main purpose is to define the roles of, and minimum requirements for, mechanical and natural ventilation systems for providing acceptable indoor air quality in low-rise residential buildings. This standard states that mechanical ventilation rates shall be 7.5 cfm per person plus 3 cfm per 100 square feet. This standard is based on indoor air quality of homes being built with an envelope tightness required by current code.

Air Cleaners

Some air cleaners are highly effective at particle removal, while others are not as reliable. The overall effectiveness of an air cleaner depends on how well it collects pollutants from indoor air (expressed as a percentage efficiency rate) and how much air it draws through the cleaning or filtering element (expressed in cubic feet per minute). A very efficient collector with a low air-circulation rate will not be effective, nor will a cleaner with a high air-circulation rate but a less efficient collector. Air cleaners are generally not designed to remove gaseous pollutants. The long-term performance of any air cleaner depends on maintaining and replacing it according to the manufacturer's directions.

Source Control

The most effective way to improve indoor air quality is to eliminate individual sources of pollution or to reduce their emissions. Some sources, such as household chemicals or cleaners, can be sealed or enclosed, while others, such as fireplaces, can be adjusted to decrease the amount of emissions. Some, such as paints or stains, can simply be moved to an alternative location outside of the living environment. In many cases, source control is also a more cost-effective approach to protecting indoor air quality than increasing ventilation because increasing ventilation will in turn increase energy costs.

Weatherization

Weatherization is the practice of protecting a building and its interior from the exterior elements, particularly from air and moisture infiltration, and thus modifying the building to reduce energy consumption and optimize energy efficiency. Measures such as installing storm windows, weather stripping, air sealing, caulking, and insulating can reduce the amount of outdoor air infiltrating into a home. This will help in keeping outdoor pollutants from entering the home, however, after weatherization, concentrations of indoor air pollutants from sources inside the home can increase. It is possible for weatherization to have a negative impact on indoor air quality because of a decrease in air exchange in the home, and resulting increase in moisture and higher concentrations of pollutants in the air. This is why proper ventilation is also vital to maintaining good indoor air quality.

CONCLUSION

In conclusion, indoor air quality is an emerging topic of importance in the residential construction field that is vital to the overall health of occupants. The quality of indoor air in residential structures is determined by many contributing factors, but if proper precautions are taken and warning signs are not ignored, detrimental effects to the health of inhabitants can potentially be avoided.

REFERENCES

UL Environment (2015). *GREENGUARD Certification*, <www.greenguard.org> (June 2015).

ASHRAE (2013). *Standard 62.2-2013 - Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*. ASHRAE, Atlanta, Georgia.

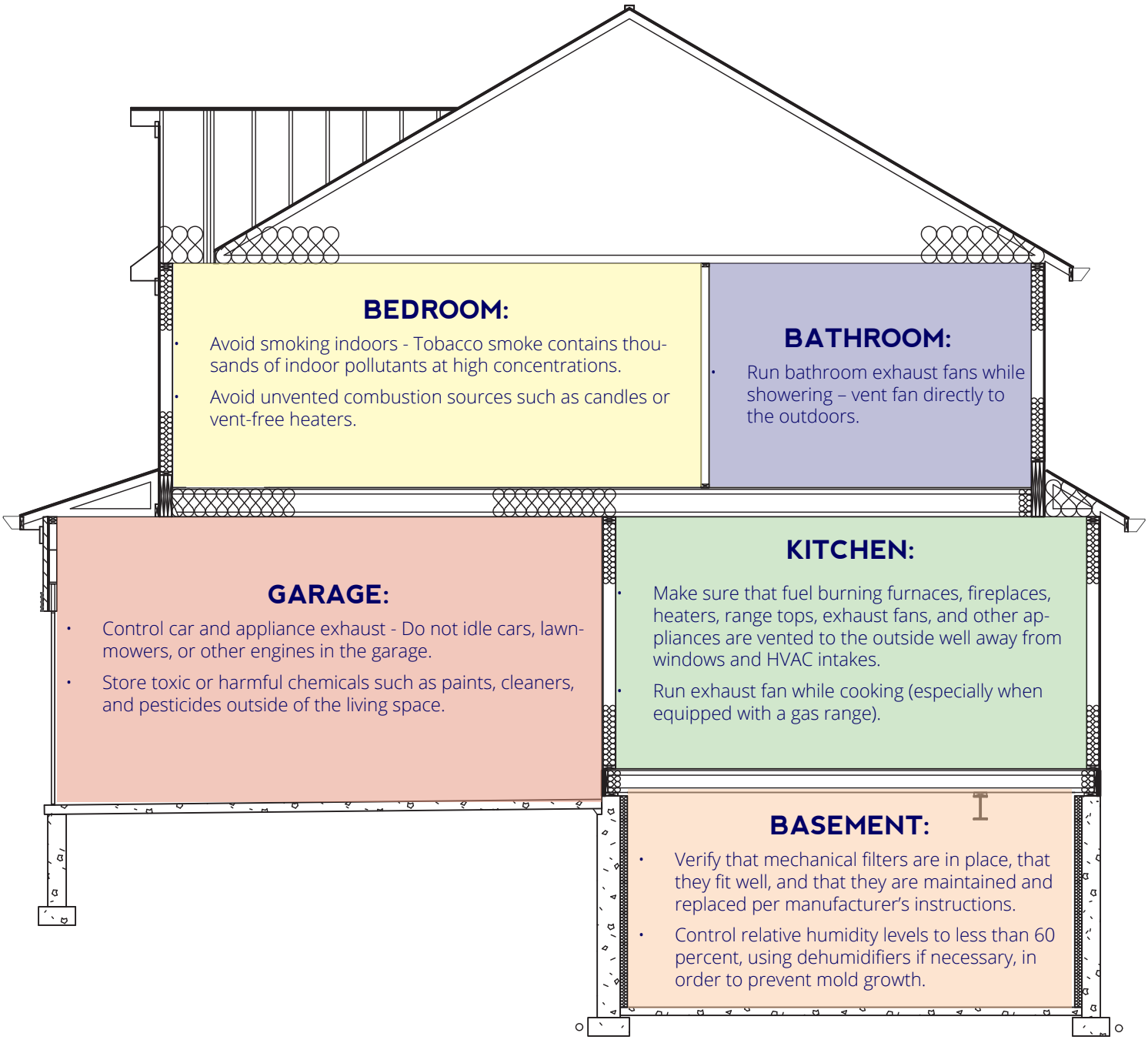

Figure 2: Recommendations for improving indoor air quality in homes.