PHRC Webinar Series / Tuesday, September 8th, 2015 @ 1pm

Indoor Air Quality

CHALLENGES, CONSIDERATIONS, AND CONCERNS

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Description

- **Recently, in an effort to build higher performing homes, more stringent guidelines have resulted in the building envelope on residential homes becoming increasingly tighter. Despite having advantages regarding air leakage and overall energy consumption, maintaining good indoor air quality has become increasingly complicated. This webinar will educate participants on the topic of indoor air quality by explaining the key considerations for health and safety issues related to indoor air quality, strategies for controlling pollutants, as well as product selection and installation.**

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Learning Objectives

- **Following the completion of this webinar, participants will be able to:**
  - Identify common pollutants in homes which may pose a threat to occupants' health
  - Understand the impacts of poor indoor air quality on the health and safety of homeowners and occupants
  - Discuss simple methods for identifying and measuring the presence and concentration of pollutants which may be affecting indoor air quality
  - Analyze various strategies for maintaining proper indoor air quality or improving poor indoor air quality in order to provide a safe and healthy living environment for occupants

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Agenda

- **Overview**
  - Background
- **Common Pollutants**
  - Impacts of Poor IAQ
- **Sources of Air Exchange**
- **Monitoring IAQ**
- **Managing IAQ**
  - ERV's vs HRV's
- **Summary & Questions**

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Overview

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Background

- **Indoor air quality (IAQ)**
  - A term which refers to the quality of air within buildings
    - Specifically as it relates to the health and comfort of building occupants
- **IAQ problems result from interactions between building materials, furnishing, occupants, activities within the home, and climate**
- **Studies have actually shown that the air quality inside homes can be worse than it is outside**
  - The air in homes can be 2 to 5 times more polluted, and in some cases can be up to 100 times more polluted, than outdoor air - UL Environment (2015)

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Why is IAQ Important?

- **Appropriate ventilation can reduce levels of indoor air pollutants**
  - Industry has identified ways to move air in and out of homes in a managed way
  - Assists in minimizing factors that lead to indoor air quality problems
    - Can improve occupant health
      - Provides fresh air
      - Removes moisture
- **Air cleaning devices are not a substitute for preventing contaminates in the air**

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Why is IAQ Important?

- **Indoor air quality is a significant concern**
  - Hours spent sleeping, working, living at home
  - People on average spend the majority of their time indoors
- **Average person receives 72 percent of their chemical exposure at home** - The US Environmental Protection Agency (USEPA)
  - Place most people consider safest might actually expose them to the greatest amounts of potentially hazardous pollutants
  - 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
    - Young
    - Elderly
    - Chronically ill

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Impacts of Poor IAQ

- **The effects of indoor air pollutants range from short-term effects to long-term effects**
  - Exposure to high levels of some pollutants result in immediate death
    - Carbon Monoxide 
- **Some indoor pollutants can magnify the effects of other indoor pollutants or contaminate building systems**
  - Cumulative effects of sources pose risks
  - Legionnaires Disease
    - Caused by a bacteria contaminating a building's air conditioning system

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Impacts of Poor IAQ

- **Short Term Impacts**
  - Dryness & irritation of the eyes, nose, throat, skin
  - Headache
  - Fatigue
  - Shortness of breath
  - Hypersensitivity and allergies
  - Sinus congestion
  - Coughing and sneezing
  - Dizziness
  - Nausea

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Impacts of Poor IAQ

- **Long Term Impacts**
  - Respiratory diseases
    - Asthma

  - Cancer
  - Heart disease
  - Cardiovascular health problems
    - High blood pressure
    - Atherosclerosis
    - Abnormal heart rhythms
  - Premature death

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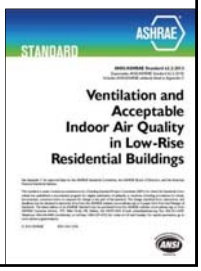
ASHRAE Standard 62.2

Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings

- The national ventilation standard of design for all homes and up to three-story multifamily buildings
- Considers chemical, physical, and biological contaminants that can affect air quality



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Common Pollutants

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Sources of Pollutants

- **IAQ problems result from interactions between:**
  - Building materials
  - Furnishing
  - Activities within the building
  - Climate
  - Systems
  - Occupants
- **IAQ problems may arise from one or more of the following causes:**
  - Indoor environment - inadequate temperature, humidity, lighting,
  - Indoor air contaminants - chemicals, dusts, molds or fungi, bacteria, gases, vapors, odors
  - Insufficient outdoor air intake

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Building Materials

- **Volatile organic compounds (VOC's)**
  - Contained in chemicals used to manufacture & maintain building materials, interior furnishing, cleaning products
  - These chemicals evaporate at or can easily get into the air at room temperature
  - Include Formaldehyde, Isopentane, Styrene, Methylene, Chloride, Vinyl chloride

- Wallpaper
- Insulation
- Carpet
- Asbestos
- Pressed wood products
- Cleaning supplies

} Contain VOC's

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Combustion Sources

- **Combustion by-products are gases and small particles created by the incomplete burning of fuels**
- **Combustion sources include:**
  - Candles
    - Most candles on the market today are made from paraffin wax, a derivative of petroleum
    - Release carcinogenic toxins such as, formaldehyde, acetaldehyde, and soot into the air
    - Emissions from paraffin candles contain many of the same toxins produced by burning diesel fuel
  - Secondhand Tobacco Smoke
    - A complex mixture of over 4,000 compounds - 40 of which are known to cause cancer in humans or animals and many of which are strong irritant
    - If smoking indoors cannot be avoided - increase ventilation where smoking takes place
  - Wood
  - Coal
  - Gas
  - Oil

} Often the result of combustion for indoor heating purposes

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HVAC Systems

- **Harmful combustion gases & particles also originate from heating systems:**
  - Release colorless & odorless gases carbon monoxide (CO) & nitrogen dioxide (NO2)
  - Often result of improperly installed or maintained chimneys and flues
  - Cracked furnace heat exchangers
  - No dedicated outdoor air supply
    - Can be "back-drafted" from the chimney into the living space
    - Particularly in weatherized homes
- **Contaminated IAQ can result from poorly kept:**
  - Boilers
  - Chimneys
  - Portable heating equipment
  - Gas stoves
  - Fireplaces
  - Woodstoves

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Outdoor Sources

- **Radon**
  - Earth and rock beneath home
  - No immediate symptoms
    - Estimated to contribute to between 7,000 and 30,000 lung cancer deaths each year – EPA
- **Carbon monoxide**
  - Automobile exhaust from attached garages
  - Can cause flu-like symptoms that clear up after leaving home
  - Fatal at very high concentrations
- **Pesticides**
  - Products to control insects, termites, rodents, fungi and microbes
  - 75% of U.S. households used at least one pesticide indoors during the past year – EPA
- **Mold**
  - Result of excessive moisture that accumulates in buildings or on building materials
  - Can grow on wood, paper, carpet, foods, and insulation

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Biological Contaminants

- **Biological contaminants are, or are produced by, living things**
  - Often found in areas that provide food and moisture
    - Humidifiers
    - Condensate pans
    - Unvented bathrooms
    - Bedding
    - Carpet
- **Biological contaminants are usually transmitted through the air**
  - Can cause:
    - Infectious illnesses
    - Influenza
    - Measles
    - Chicken pox
  - Can trigger allergic reactions
    - Asthma
    - Hives

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Biological Contaminants

- **Biological contaminants include:**
  - Bacteria
  - Molds
  - Mildew
  - Viruses
  - Animal dander
  - House dust
  - Mites
  - Cockroaches
  - Pollen

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Monitoring IAQ

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Identify

- **Health effects**
  - Indicators of an indoor air quality problem
  - Adverse health symptoms may exist related to the home environment
    - Discussions with a doctor or the local health department should take place to see if indoor air pollution could be the cause
- **Look for signs of problems with ventilation**
  - Moisture condensing on windows or walls
  - Stuffy or stale air
  - The presence of mold
  - Dirty central heating and air cooling equipment

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Diagnosing Poor Indoor Air Quality

Indoor Air Pollution: Introduction for Health Professionals

***Questions to consider asking if you suspect an indoor air quality problem in the home:**

- **When did the symptom(s) begin?**
- **Does the symptom(s) exist all the time, or does it come and go?**
  - Are you usually in a particular place at those times?
  - Does the problem abate or cease, either immediately or gradually, when you leave there?
  - Does it recur when you return?
- **Have you recently changed your place of residence?**
- **Have you made any recent changes in, or additions to, your home?**
  - Have you redecorated or refurnished recently?
- **Does anyone else in the home have a similar problem?**

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Measure

- **Measurements are most appropriate when there are either health symptoms or signs of poor ventilation**
  - Specific sources
  - Pollutants have been identified
- **Measurements may be necessary to determine if contaminates are present**
  - Colorless
  - Odorless
  - Gases
- **Monitors or sensors for testing indoor air quality may be required**

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IAQ Testing

- **Indoor Air Quality Test Kits**
  - Used to test for a variety of common threats to indoor air quality
  - Capable of testing for all possible contaminants or the contaminant with which you are remediating
    - When purchasing, be sure that the test kit will detect the allergen or contaminant to be specifically tested for
      - Radon vs Mold

- **Professional Indoor Air Quality Testing**
  - Verify that the consultant has the appropriate training and credentials
  - Determine what services, testing, and turnaround time is needed
  - Depending on the project, an IAQ professional may require:
    - An initial walkthrough
    - A visual inspection,
    - Testing may be needed for measurements

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Sources of Air Exchange

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Air Exchange

- **Exchange Rate**
  - The rate at which outdoor air replaces indoor air
    - Low infiltration
    - Low natural ventilation
    - Low mechanical ventilation

    } The air exchange rate is low & pollutant levels can increase
  - **ASHRAE Standard 62.2** provides guidance
- **Air can enter and leave a house in three main ways:**
  - Infiltration
  - Natural ventilation
  - Mechanical ventilation

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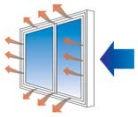
Infiltration

- **Infiltration**
  - 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
      - Walls
      - Floors
      - Ceilings
      - Around windows and doors



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Natural Ventilation

- **Natural ventilation**
  - The process of supplying air to, and removing air from, an indoor space without the use of mechanical systems
    - Air movement through opened windows and doors
  - Air movement associated with infiltration and natural ventilation is caused by differences in both air temperature and air pressure through openings in the building envelope

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Mechanical Ventilation

- **Mechanical ventilation**
  - The process of supplying or removing air that may or may not be conditioned by mechanical means to or from any space
    - Air handling systems that use fans and duct work
    - Remove indoor air & distribute filtered & conditioned outdoor air to strategic points throughout the house
- **Reasons for mechanical ventilation**
  - Indoor Air Quality
    - Fresh air, carbon monoxide, radon, cigarette smoke, pet dander, etc.
    - Moisture control
    - Insufficiency of natural ventilation
      - Only provides adequate airflow under certain conditions
- **Mechanical ventilation cannot remove the source of pollutants**
  - Lessen the presence of pollutants.

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Managing IAQ

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Source Control

- **What is "source control?"**
  - The process of eliminating individual sources of pollution or manually reducing their emissions
  - The most effective way of improving indoor air quality
- **Source control is a more cost-effective approach to protecting indoor air quality than increasing ventilation**
  - Increase energy costs
  - Increase installation costs

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Source Control

- **Certain sources can be sealed or enclosed**
  - Household chemicals or cleaners

- **Some sources can be adjusted to decrease the amount of emissions**
  - Fireplaces

- **Other sources can be moved to an alternative location outside of the living environment**
  - Paints or stains

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Proper Ventilation

- **Drops concentrations of indoor air pollutants by increasing the amount of outdoor air coming indoors**
  - Opening windows & doors
  - Operating window or attic fans
  - Running a window air conditioner with vent control open
- **Bathroom & kitchen exhaust fans remove pollutants directly from the room where the fan is located**
  - 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**

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Mechanical Ventilation – IRC Code Requirements

- **R303.3 Bathrooms**
  - The glazed areas shall not be required where artificial light and a mechanical ventilation system are provided
    - Minimum 50 CFM for intermittent ventilation
    - 20 CFM for continuous ventilation
      - Ventilation air from the space shall be exhausted directly to the outside
- **M1503.4 Makeup air required.**
  - Exhaust hood systems capable of exhausting in excess of 400 CFM shall be provided with makeup air at a rate approximately equal to the exhaust air rate
    - Shall be equipped with a means of closure
    - Shall be automatically controlled to start and operate simultaneously with the exhaust system

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Proper Ventilation - IRC Code Requirements

- **R303.1 Habitable rooms**
  - All habitable rooms shall have an aggregate glazing area of not less than 8 percent of the floor area of such rooms
  - Natural ventilation shall be through windows, doors, louvers or other approved openings to the outdoor air
  - Such openings shall be provided with ready access or shall otherwise be readily controllable by the building occupants.
  - The minimum openable area to the outdoors shall be 4 percent of the floor area being ventilated
    - **Exception**: The glazed areas need not be openable where the opening is not required by Section R310 and an approved mechanical ventilation system capable of producing 0.35 air change per hour in the room is installed or a whole-house mechanical ventilation system is installed capable of supplying outdoor ventilation air of 15 cubic feet per minute (cfm) (78 L/s) per occupant computed on the basis of two occupants for the first bedroom and one occupant for each additional bedroom.

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ASHRAE Standard 62.2

The 2013 version of ASHRAE Standard 62.2 is a nationally recognized standard on indoor air quality developed solely for residential buildings

- **What is ASHRAE 62.2?**
- **Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings**
  - The national ventilation standard of design for all homes and up to three-story multifamily buildings
  - Allows exhaust, supply or balanced ventilation, meaning that a simple exhaust fan or supply fan can be used, or these flows can be balanced with both a supply fan and an exhaust fan, with or without heat recovery
  - Up to the designer or builder to decide if filtration, tempering or dehumidification is required, based on where the house or building is built

www.ASHRAE.org

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ASHRAE Standard 62.2

- **Defines the roles of and minimum requirements for:**
  - Mechanical and natural ventilation systems
- **Intended to provide acceptable indoor air quality (IAQ) in low-rise residential buildings**
- **Applies to spaces intended for human occupancy within single-family houses and multifamily structures of three stories or fewer above grade**
  - Includes manufactured and modular houses
- **Considers chemical, physical, and biological contaminants that can affect air quality**
  - Thermal comfort requirements are not included

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ASHRAE Standard 62.2

- **ASHRAE 62.2 is designed to avoid relying on the sole use of passive ventilation to meet a home's indoor air quality needs**
- **The intent of ASHRAE 62.2 is provide the necessary continuous CFM requirement for a house based on numerous factors**
- **Also incorporates:**
  - Local Exhaust:
    - Exhausting high levels of contaminates and moisture typically associated with cooking, bathrooms, etc.
  - Source Control:
    - Preventing outside contaminates from entering the home - storing paint, gasoline, etc. inside the home

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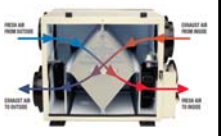
HRVs & ERVs – Improved air quality through ventilation

- **The purpose of an HRV or an ERV is to deliver fresh air to a home's interior**
  - Use fans to pull fresh air into a home while simultaneously exhausting stale air from the home
  - The fresh air stream and the stale air stream flow through the HRV/ERV
  - The core of the appliance allows some of the heat from the warmer air stream to be transferred to the cooler (Winter vs Summer) air stream
  - In some installations, the fresh air is delivered to the living room and bedrooms, while the stale air is removed from bathrooms, laundry rooms, or kitchens



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Heat Recovery Ventilators (HRV's)

- **Heat Recovery Ventilators (HRV) reclaim energy from exhausted stale indoor air to temper incoming fresh air**
  - Heat is retained during cooler seasons
  - Heat is removed during warmer seasons
- **HRV's provide fresh air and improved climate control**
  - Can save energy by reducing heating and cooling requirements
- **These systems capture about 70 percent of the energy already expended to temper incoming air**
  - Lowers energy costs
- **HRV's will meet ventilation needs based on square footage of the structure to maintain recommended ACH**

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Energy Recovery Ventilators (ERV's)

- **Similar to HRVs**
  - Heat is retained during cooler seasons
  - Heat is removed during warmer seasons
- **Provide fresh air and improved climate control**
- **An ERV allows some of the moisture in the more humid air stream (usually the stale air in winter and the fresh air in summer) to be transferred to the air stream which is dryer**
- **Typically recommended for use in warmer climates where it is desired to remove humidity from incoming fresh air**
  - Better for hot & humid climate
  - Southern states

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Air Cleaners

- **The overall effectiveness of an air cleaner depend on:**
  - how well it collects pollutants from indoor air (expressed as a percentage efficiency rate)
  - How much air it draws through the filtering element (expressed in cubic feet per minute)
- **MERV (Minimum Efficiency Reporting Value) is the industry-standard ratings system used to measure the effectiveness of air conditioner filters**
  - Ratings for residential AC filters typically fall between MERV 5 and MERV 12
    - Filters with higher MERV ratings remove more particles and allergens than lower-rated filters
- **The long-term performance of any air cleaner relies on maintaining and replacing according to the manufacturer's directions**

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Air Cleaners

- **Numerous types and sizes**
  - Relatively inexpensive table-top models
  - Sophisticated & expensive whole-house systems
- **Some air cleaners are highly effective at particle removal**
  - Are generally not designed to remove gaseous pollutants

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Weatherization

- **Weatherization**
  - The practice of protecting a building and its interior from the exterior elements
    - Particularly from air and moisture infiltration
    - Modifying the building to reduce energy consumption and optimize energy efficiency
      - Installing storm windows
      - Weather stripping
      - Air sealing
      - Caulking
      - Insulating
  - Reducing the amount of outdoor air infiltrating into a home

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Weatherization

- **After weatherization of a home is effectively completed:**
  - Concentrations of indoor air pollutants from sources inside the home can increase
  - Possible for weatherization to have a negative impact on indoor air quality
    - Results in a decrease in air exchange in the home
    - 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 in a home**

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Weatherization – IRC Code Requirements

- **N1102.4.1 Building thermal envelope**
  - The building thermal envelope shall be durably sealed to limit infiltration. The sealing methods between dissimilar materials shall allow for differential expansion and contraction. The following shall be caulked, gasketed, weatherstripped or otherwise sealed with an air barrier material, suitable film or solid material
    1. All joints, seams and penetrations
    2. Site-built windows, doors and skylights
    3. Openings between window and door assemblies and their respective jambs and framing
    4. Utility penetrations
    5. Dropped ceilings or chases adjacent to the thermal envelope.
    6. Knee walls
    7. Walls and ceilings separating the garage from conditioned spaces
    8. Behind tubs and showers on exterior walls
    9. Common walls between dwelling units
    10. Attic access openings
    11. Rim joists junction
    12. Other sources of infiltration

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Weatherization – IRC Code Requirements

- **N1102.4.2.1 Testing option.**
  - Tested air leakage is less than 7 ACH when tested with a blower door at a pressure of 50 pascals (0.007 psi). Testing shall occur after rough in and after installation of penetrations of the building envelope, including penetrations for utilities, plumbing, electrical, ventilation and combustion appliances.
- **N1102.4.2.2 Visual inspection option.**
  - The items listed in Table N1102.4.2, applicable to the method of construction, are field verified. Where required by the code official, an approved party independent from the installer of the insulation, shall inspect the air barrier and insulation

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Combination Approach

- **In most cases a combination of control techniques are used to control pollutants**
  - Periodic professional inspection and maintenance of installed equipment
  - Provide adequate outdoor air ventilation
  - Change air filters per manufacturer recommendation
  - Seal crack & voids in the exterior envelope
  - Provide adequate ventilation

Air Quality

All methods will lead to healthier IAQ in the home

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Summary

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Summary

- **Indoor air quality (IAQ)**
  - A term which refers to the quality of air within buildings
    - Especially as it relates to the health and comfort of building occupants
- **The effects of indoor air pollutants range from short-term effects to long-term effects**
- **IAQ problems may arise from one or more of the following causes:**
  - Indoor environment - inadequate temperature, humidity,
  - Indoor air contaminants - chemicals, dusts, molds or fungi, bacteria, gases, vapors, odors
  - Insufficient outdoor air intake
- **IAQ problems result from interactions between sources**
  - Not always a single source

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Summary

- **Common pollutants**
  - Volatile organic compounds (VOC's)
    - Contain chemicals used to manufacture & maintain building materials, interior furnishing, cleaning products
  - Combustion by-products are gases and small particles created by the incomplete burning of fuels
  - Poorly kept HVAC systems
  - Outdoor contaminants
    - Pesticides, Mold, Radon
  - Biological contaminants
    - Bacteria, Mildew, Viruses, Animal dander, Mites, Pollen
- **Monitoring IAQ**
  - Identify
  - Diagnose
  - Measure
  - Test

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Summary

- **Managing IAQ includes:**
  - Source control
    - Manual elimination
  - Proper ventilation
    - Natural vs Mechanical
  - Air cleaners
  - Weatherization
    - Separation of interior and exterior environments
  - Effective use of combination of practices
- **ERVs & HRVs**
  - The purpose of an HRV or an ERV is to deliver fresh air to a home's interior
  - The core of the appliance allows some of the heat from the warmer air stream to be transferred to the cooler (Winter vs Summer) air stream
  - An ERV allows some of the moisture in the more humid air stream (usually the stale air in winter and the fresh air in summer) to be transferred to the air stream which is dryer

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Summary – ASHRAE 62.2

- **The 2013 version of ASHRAE Standard 62.2 is a nationally recognized standard on indoor air quality developed solely for residential buildings**
  - Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings
- **Intended to provide acceptable indoor air quality (IAQ) in low-rise residential buildings**
  - provide the necessary continuous CFM requirement for a house based on numerous factors
- **Applies to spaces intended for human occupancy within single-family houses and multifamily structures of three stories or fewer above grade**
  - Includes manufactured and modular houses
- **Considers chemical, physical, and biological contaminants that can affect air quality**

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