Chapter 7
Indoor Air Quality

Learning Objectives

1. Describe issues and considerations that impact indoor environmental quality.
2. Identify the primary steps builders and remodelers can take to create and maintain a healthy indoor environment.
3. Explain ways to eliminate pollutants in a building.
4. Describe ways that occupant separation from pollutant sources may be accomplished.
5. Describe filtration methods used to remove pollutants from the air that enter a home.

Indoor Air Quality Goals

- Planning and design to promote healthy IAQ
- Design for proper ventilation and filtration
- Reduce indoor pollutants
- Separate indoor air from hazardous materials
- Prevent mold
Behavior Patterns Affect IAQ

Common Pollutants
- Carbon monoxide
- Carbon dioxide
- Tobacco Smoke
- Volatile Organic Compounds (VOC’s)
- Formaldehyde
- Inhalable Particles
- Mold
- Radon

Common Pollutant Sources
Combustion Gasses

Carbon Monoxide
- Colorless, odorless and tasteless gas
- Result of incomplete combustion
- Health effects = fatigue, headaches, dizziness… DEATH

Volatile Organic Compounds

V – Volatile
O – Organic
C – Compounds
Most are carcinogens
- Organic compounds that evaporate at room temperature
- Common in building products
- Health effects = respiratory problems, eye irritation

Common VOC Sources
- Paints/sealants
- Adhesives
- Glues
- Solvents
- Carpets
- Furniture
- Aerosols
- Insulation
- Dry Cleaning
- Upholstery
Mold is everywhere
Mold needs 4 criteria to grow
- Time (24-48 hrs)
- Moisture
- Organic Food source
- Proper temperature

Food sources for mold
- Drywall
- Wood
- Paints
- Wall Coverings
- Carpet & Pad
Radon Gas

- Radon is a naturally occurring gas found in the earth’s crust
- Concentrations vary depending on location
- Believed to be leading cause of lung cancer in non-smokers

Air Quality Improvement Strategies

- Eliminate
- Separate
- Ventilate
- Filtrate
- Radon Reduction

Eliminate

- Most effective of all strategies
- Simplest of all strategies
- Hardest to police
- Requires communication between contractor and subcontractors and installers

Three ways:
- Construction methods
- Material selection
- Owner education
**Construction Contaminant Controls**

- Protect stored materials from moisture
- Seal and protect ductwork during construction

**Construction Contaminant Controls**

- Protect building interior from outdoor contaminants
- Prohibit smoking inside the building

**HRVs and ERVs**

- Incoming and outgoing airflows pass through different sides of the cube.
- ERVs also allow the exchange of moisture.
Healthy Materials

- Low-VOC or No-VOC paints and sealers
- Low VOC Adhesives
- Formaldehyde free products
- Healthy flooring
- Healthy Insulation

VOC Limits

<table>
<thead>
<tr>
<th>Paints &amp; Coatings</th>
<th>VOC Limits</th>
<th>Green Seal GS-11 r3 Interior Paints, Coatings, &amp; Primers</th>
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</thead>
<tbody>
<tr>
<td>VOC weight (g/L minus water)</td>
<td>Flats 50</td>
<td>Non-Flats 100</td>
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Healthy Flooring

<table>
<thead>
<tr>
<th>Flooring System</th>
<th>Certification</th>
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<tbody>
<tr>
<td>Carpet</td>
<td>Carpet and Rug Institute’s Green Label Plus Program</td>
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<tr>
<td>Carpet Cushion</td>
<td>Carpet and Rug Institute’s Green Label Program</td>
</tr>
<tr>
<td>Hard Surface Flooring</td>
<td>FloorScore Certification</td>
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Adhesive VOC Limits

<table>
<thead>
<tr>
<th>Adhesive Applications</th>
<th>VOC Limit (g/L minus water)</th>
<th>Adhesive Applications</th>
<th>VOC Limit (g/L minus water)</th>
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</thead>
<tbody>
<tr>
<td>Indoor carpet adhesives</td>
<td>50</td>
<td>PVC welding</td>
<td>510</td>
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<tr>
<td>Carpet pad adhesives</td>
<td>50</td>
<td>CPVC welding</td>
<td>490</td>
</tr>
<tr>
<td>Wood flooring adhesives</td>
<td>100</td>
<td>ABS welding</td>
<td>325</td>
</tr>
<tr>
<td>Rubber floor adhesives</td>
<td>60</td>
<td>Plastic cement welding</td>
<td>250</td>
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<tr>
<td>Subfloor adhesives</td>
<td>50</td>
<td>Adhesive primer for plastic</td>
<td>550</td>
</tr>
<tr>
<td>Ceramic tile adhesives</td>
<td>65</td>
<td>Contact adhesive</td>
<td>80</td>
</tr>
<tr>
<td>VCT and asphalt adhesives</td>
<td>50</td>
<td>Special purpose contact adhesive</td>
<td>250</td>
</tr>
<tr>
<td>Drywall and panel adhesives</td>
<td>50</td>
<td>Structural wood member adhesive</td>
<td>140</td>
</tr>
<tr>
<td>Cove base adhesives</td>
<td>50</td>
<td>Sheet applied rubber lining operations</td>
<td>850</td>
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<tr>
<td>Multipurpose construction adhesives</td>
<td>70</td>
<td>Top and trim adhesive</td>
<td>250</td>
</tr>
<tr>
<td>Structural glazing adhesives</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Substrate Specific Applications</td>
<td>Sealants</td>
<td>VOC Limit (g/L minus water)</td>
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<tr>
<td>Metal to metal</td>
<td>30</td>
<td>Architectural 250</td>
<td></td>
</tr>
<tr>
<td>Plastic foams</td>
<td>50</td>
<td>Roadway 250</td>
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<tr>
<td>Porous material (except wood)</td>
<td>50</td>
<td>Other 420</td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td>30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fiberglass</td>
<td>80</td>
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</table>
Healthy Insulation

- Insulation should be VOC and Formaldehyde free
- Insulation should be permeable to prevent mold growth

Separate

- Keep hazardous substances separate from living areas
- Create barriers between hazardous substances and living areas

Garages

- Dirtiest room of a home
  - Car Exhaust
  - Gasoline
  - Pesticides
  - Paints
  - Solvents
  - Cleaners
Detached Garage

- Most effective way to separate
- Not always an option
  - Design limitations
  - Site restrictions

Air Sealed Garage

Create an air barrier between garage and living area
- Seal bottom plate to floor
- Seal all penetrations
- Use exterior door with gasket
- Use automatic closer on door
- Gasket attic access
- Keep air handlers out of garage

Air Handler Placement

- Keep air handler separate from garage
- Air sealed garage closet
  - Sealed bottom plate
  - Sealed exterior door
  - Insulated walls
- Interior closet
Ventilate

- Homes are being built tighter with fewer envelope leaks
- Helps to control moisture in the air
- For indoor air to remain healthy, outdoor air should be utilized

Why Ventilate

**To Remove pollutants**
- People and pets
  - Carbon Dioxide, Water Vapor, Body Odor
- Building Pollutants
  - VOC’s, combustion gasses, radon, water vapor
- Activity pollutants
  - VOC’s, water vapor, odors

Exhaust Ventilation

- Located near pollutant
- Remove moisture and odors
- Bath fans
  - Timer/humidistat controls
  - > 50 CFM < 1 sone
  - Energy Star
- Kitchen range hood
  - Vented to outdoors
- Dryer vents
- All of these create negative pressure in home
Supply Ventilation

- Outside air intake into the HVAC return duct
- Mechanical damper closes when air handler isn’t running
- Damper can be closed if outside air is polluted
- Keep intake 10’ from exhaust vents, 2’ from roof or ground

Balanced Ventilation

Energy Recovery Ventilators
- Condition Air for both temperature and humidity
- Suitable for hot humid locations

Heat Recovery Ventilators
- Same as ERV but only condition for temperature
- Most suitable for dry cold locations

Ventilation Rate

- ASHRAE 62.2 Minimum ventilation rates
- Depend on home size and number of occupants

<table>
<thead>
<tr>
<th>Minimum Ventilation Requirements</th>
<th>CPM</th>
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</thead>
<tbody>
<tr>
<td><strong>Conditional Floor Area</strong></td>
<td><strong>0–1</strong></td>
</tr>
<tr>
<td>1500</td>
<td>30</td>
</tr>
<tr>
<td>1501–3000</td>
<td>45</td>
</tr>
<tr>
<td>3001–4500</td>
<td>60</td>
</tr>
<tr>
<td>4501–6000</td>
<td>75</td>
</tr>
<tr>
<td>6001–7500</td>
<td>90</td>
</tr>
<tr>
<td>&gt;7500</td>
<td>105</td>
</tr>
</tbody>
</table>
Filtrate

• Filters remove contaminants from the air
• The higher the MERV rating the smaller the particles it can filter

Particle Sizes

• MERV 4
  - 3-10 micron < 20%
• MERV 8
  - 3-10 micron 85%
• MERV 10
  - 1-3 micron 65%
• MERV 12
  - 1-3 microns 90%
HEPA Filters

- HEPA - High Efficiency Particulate Air filters
- Removes micron-sized particles
- Real world installations do not always achieve performance limits measured in laboratories.

HEPA Filters

- Consist of fine fibers
- Alter the airflow streamlines
  - Airflow slips around the fiber.
  - Particulate matter cannot change direction so rapidly so they impact the fiber.
  - Most particulates will not re-enter in the airstream.

Electrostatic Air Cleaners

**Electrostatic Precipitators**

- Use electrostatic attraction to trap charged particles:
  - They draw air through an ionization section.
  - Particles obtain an electrical charge.
  - The charged particles then accumulate on a series of flat plates, called a collector, that is oppositely charged.

**Ion Generators**

- Also called ionizers:
  - They disperse charged ions into the air
  - Ions attach to airborne particles
  - Charged particles attach and settle faster.
Ultraviolet

- Use UV light technology to destroy pollutants
- Air must be exposed for a minimum amount of time.
  - If too quickly, then the effectiveness is reduced.
- Three types:
  - Ultraviolet germicidal irradiation (UVGI) cleaners
  - Photo catalytic oxidation (PCO) cleaners
  - Ozone generators

Radon Reduction Techniques

- Radon is a colorless odorless radioactive gas
- Present in almost all soils and rocks
- Concentrations vary greatly
- Lung cancer can result from long term exposure at low to medium concentrations

Radon Resistant Construction

- Gas permeable layer under slab
  - 4”-6” gravel
  - “T” in gas permeable layer
- Vapor barrier
  - 6 mil lapped and taped
  - Taped to penetrations
Indoor Air Quality Review

1. What are some of the issues and considerations that impact indoor environmental quality?
2. What are the principle concepts for improving IAQ?
3. Name one mitigation approach for each of the principle concepts of IAQ.
4. The _______ the MERV filter rating the _______ the particle it can filter.
## Resources

- **EPA Indoor Air Plus**  
  - [www.epa.gov/iaplus01](http://www.epa.gov/iaplus01)
- **EPA Indoor Air Quality**  
  - [www.epa.gov/iaq/](http://www.epa.gov/iaq/)
- **GreenGuard**  
  - [www.greenguard.org](http://www.greenguard.org)
- **Green Seal**  
  - [www.greenseal.org](http://www.greenseal.org)
- **Carpet & Rug Institute**  
  - [www.carpet-rug.org](http://www.carpet-rug.org)
- **EPA Radon**  
  - [www.epa.gov/radon](http://www.epa.gov/radon)
- **EPA Build Radon Out**  
  - [www.epa.gov/radon/pdfs/buildradonout.pdf](http://www.epa.gov/radon/pdfs/buildradonout.pdf)