BUILDER'S GUIDE TO ENERGY EFFICIENT HOMES IN LOUISIANA: THE HOUSE AS A SYSTEM

by
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The *Builder's Guide to Energy Efficient Homes in Louisiana* (henceforth known as "*Builder's Guide*") is being updated to reflect new code requirements. This is the third in a series of articles that will summarize the information in the guide and highlight updates.

Residential problems of unhealthy homes generally occur because of the failure of the home to properly react to the outdoor or indoor environment. Some common residential problems of unhealthy homes are as follows:

- Mold on walls, ceilings and furnishings
- Mysterious or unusual odors
- Excessive heating/cooling bills
- High humidity
- Rooms that are never comfortable
- Decayed structural wood and other materials
- Termite and other pest infestations
- Fireplaces that do not draft properly
- High levels of radon, formaldehyde or carbon monoxide

The house should be designed to properly function in spite of fluctuating temperatures, moisture levels and air pressures. If the following factors are kept at desirable levels, the house will provide comfort and a healthy air quality:

- **Moisture Levels** - Measured as relative humidity (RH), high humidity causes discomfort and generally promotes growth of mold and dust mites.
- **Temperature** - Both dry bulb (measured by a regular thermometer) and wet bulb, which indicates the amount of moisture in the air. The dry bulb and wet bulb temperatures can be used to find the relative humidity of the air.
- **Air Quality** - The level of pollutants in the air such as formaldehyde, radon, carbon monoxide, and other detrimental chemicals, as well as organisms such as mold and dust mites. The key determinant of air quality problems is the strength of the source of the pollutant.
- **Air Movement** - The velocity at which air flows in certain areas of the home. Higher velocities make the occupants more comfortable in the summer, but less comfortable in the winter.
- **Structural Integrity** - The ability of the materials that make up the home to create a long term barrier between the exterior and the interior space.

Heat loss and heat gain between a home and its exterior envelope have a major impact on health and comfort. Figure 1 explains the primary modes of heat transfer. The architect or licensed designer focuses on reducing conduction heat gain and loss by specifying more insulation.

Figure 1. How Heat Moves

How Heat Moves

Conduction

- The transfer of heat through solid objects, such as the ceiling, walls, and floor of the home.
- Insulation (and multiple layers of glass in windows) reduce conduction losses.

Convection

- The flow of heat by currents of air.
- As air becomes heated, it rises; as it cools, it becomes heavier and sinks.

- The convective flow of air into a home is known as *infiltration*; the outward flow is called *exfiltration*. In this publication, infiltration and exfiltration are known together as *air leakage*.

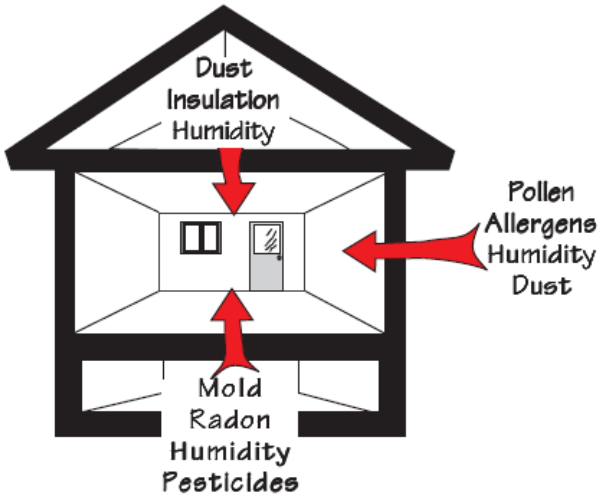
Radiation

- The movement of energy in electromagnetic waves from warm to cooler objects across empty spaces.
- Examples include radiant heat traveling from:
  - inner panes of glass to outer panes in double-glazed windows in winter.
  - roof deck to attic insulation during hot, sunny days.
- Can be minimized by installing reflective barriers; examples include radiant heat barriers in attics and low-emissivity coatings for windows.

The best solution for indoor air quality (IAQ) problems is to build a residence as tightly as possible and install an efficient ventilation system that can bring in fresh, filtered outside air. The major factor affecting IAQ is the level of pollutant causing the problem. The solution to poor IAQ is removing the problem source. Air leaks often bring in air quality problems:

- Mold from crawlspaces and from outdoors
- Radon from crawl spaces and under slab areas
- Humidity from crawl spaces and outdoor air
- Pollen and other allergens from outdoor air
- Dust and other particles from crawlspaces and attics.

Figure 2. Air Quality Problems from "Fresh" Air

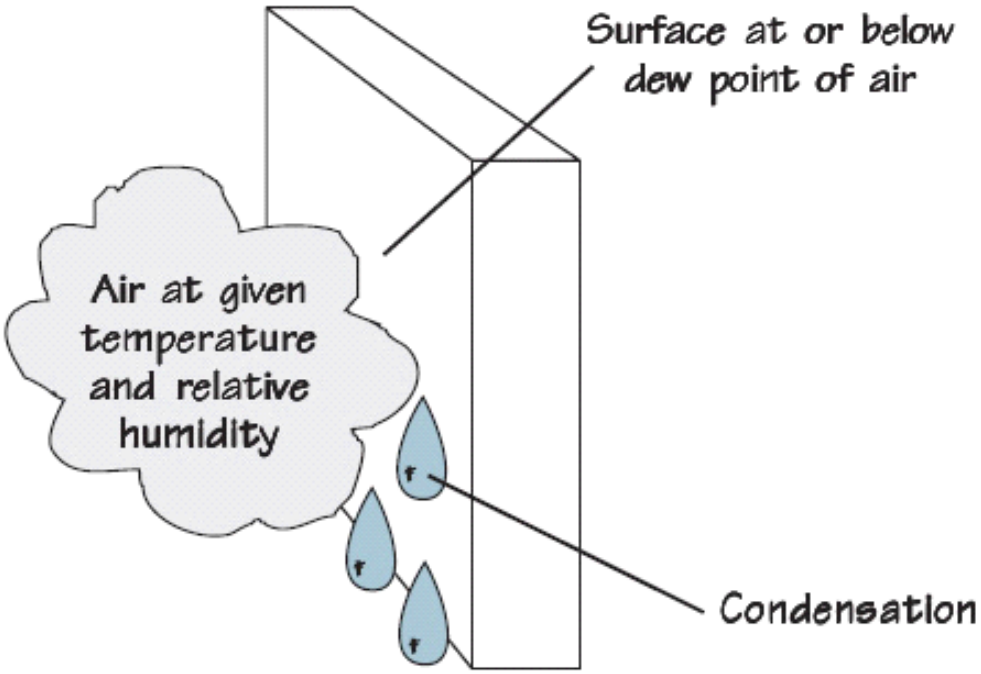


Preventing condensation involves reducing the relative humidity[1] of the air, increasing the temperatures of surfaces exposed to moist air, and blocking the flow of moisture using air barriers and vapor barriers. However, builders, architects, and designers should also allow spaces that might

[1] Air is made up of gases such as oxygen, nitrogen, and water vapor. The amount of water vapor that air can hold is determined by its temperature. Warm air can hold more vapor than cold air. The amount of water vapor in the air is measured by its relative humidity. At 100% relative humidity, water vapor condenses into a liquid. The temperature at which water vapor condenses is its dew point.

trap moisture to have drying potential – the ability to shed or reject moisture.

Figure 3. Conditions for Condensation



The heating, ventilating and air conditioning system (HVAC) is designed to provide comfort and improved air quality year round. Energy efficient homes, especially passive solar designs[2], can reduce the number of hours that the HVAC system is needed. Poor HVAC design causes higher heating bills than necessary as well as discomfort. Poor HVAC design can also lead to moisture and air quality problems.

In the field of building science, the term boundary has been applied to an external barrier created to control moisture, air leakage, and thermal conduction losses and gains. Every successful energy efficient home should have a moisture boundary, air leakage (pressure) boundary, and thermal boundary that separates unconditioned areas of the home from areas with heating or cooling.

In Figure 4, two different boundaries are shown for homes identical in shape and size. The boundary in example A, which depicts standard construction, is smaller than the boundary in example B. However, it is also more complicated. The boundary in example B is simpler because it incorporates virtually the entire exterior. One advantage of the boundary in example B is that the ductwork is all located within the sealed insulated envelope of the home. In example A's boundary, the ducts must be sealed and insulated as they are part of the boundary. The air quality and durability of a home depend on how well these boundaries are installed and maintained.

More information on energy saving features, and the full text of the *Builder's Guide*, can be found on the DNR Technology Assessment Division website at URL: http://www.dnr.louisiana.gov/tad.

[2]Passive solar energy means that mechanical means are not employed to utilize solar energy. Solar energy is a radiant heat source. When sunlight strikes a building, the building materials can reflect, transmit, or absorb the solar radiation. Additionally, the heat produced by the sun causes air movement that can be predictable in designed spaces. These basic responses to solar heat lead to design elements, material choices and placements that can provide heating and cooling effects in a home.

Figure 4. Residential Boundaries