**Seal air leaks and save energy!**

**WHAT IS AIR LEAKAGE?**
Ventilation is fresh air that enters a house in a controlled manner to exhaust excess moisture and reduce odors and stuffiness. Air leakage, or infiltration, is outside air that enters a house uncontrollably through cracks and openings. It is unwise to rely on air leakage for ventilation. During cold or windy weather, too much air may enter the house and, during warm or calm weather, too little. Also, a leaky house that allows moldy, dusty crawlspace or attic air to enter is not healthy.

The recommended strategy in both new and old homes is to reduce air leakage as much as possible and to provide controlled ventilation as needed. For simple house designs, effective spot ventilation, such as kitchen and bath fans that exhaust to the outside, may be adequate. For more complex houses or ones in colder climates, whole house ventilation systems may be appropriate. Such systems may incorporate heat recovery, moisture control, or air filtering.

**WHAT IS AN AIR BARRIER?**
The ceilings, walls, and floor/foundation that separate the inside conditioned space from the outside or unconditioned space form the air barrier and the insulation barrier for a house. These two barriers differ by the materials used.

For most homes, the sheet goods that form the ceilings, walls, and floor (such as drywall, sheathing, and decking) are effective at stopping air leakage. It is critical to seal all holes and seams between these sheet goods with durable caulks, gaskets, and foam sealants to create a continuous air barrier. The insulation barrier is usually made up of standard insulating materials, such as batt or loose-fill products, that do not seal against air leakage.

**WHAT ARE THE BENEFITS OF AIR SEALING?**
Air infiltration can account for 30 percent or more of a home’s heating and cooling costs and contribute to problems with moisture, noise, dust, and the entry of pollutants, insects, and rodents. Reducing infiltration can significantly cut annual heating and cooling costs, improve building durability, and create a healthier indoor environment. The size of heating and cooling equipment can also be decreased, which saves additional dollars. Reducing air leakage in new homes, as required by the 1995 Model Energy Code (see page 4), typically costs less than $200 for the average home and does not require specialized labor.

**Annual Energy Costs for 1300 sq. ft. House**

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* Estimated 12 air changes per hour at 50 Pascal pressure difference

**AIR SEALING CHECKLIST**

1. **BEFORE DRYWALL**
   - Seal around the metal flue of combustion penetrations through drywall with caulk or foam.
   - Seal between a masonry chimney and the air tight using latch bolts and weatherstripping. Add an insulated cover.
   - Seal the cans in recessed light fixtures (that meet ASTM E283 requirements); seal between fixture and drywall with caulk.
   - Seal wiring and knockouts in electrical boxes with caulk. Also seal outdoor-mounted boxes to the exterior sheathing.
   - Seal between door thresholds and the sheathing during installation.

2. **DURING DRYWALL**
   - Seal the framing and drywall during installation to interrupt air pathways.
   - Seal electrical switch, outlet, and circuit breaker boxes to drywall with caulk or foam.
   - Seal light fixture boxes, medicine cabinet boxes, and appliance (such as kitchen and bath fans that exhaust to the outside, may be adequate. For more complex houses or ones in colder climates, whole house ventilation systems may be appropriate. Such systems may incorporate heat recovery, moisture control, or air filtering.

3. **AFTER DRYWALL**
   - Seal drywall to top and bottom plates.
   - Seal all electrical wire, plumbing, and gas piping penetrations between any conditioned and unconditioned spaces with caulk or spray foam.
   - Seal drywall in vents and with backer rod and caulk, or use non-expanding latex-based spray foams that will not pinch jambs or void window warranties.
   - Seal between door thresholds and the sheathing during installation.
   - Seal wiring and knockouts in electrical boxes with caulk. Also seal outdoor-mounted boxes to the exterior sheathing.
   - Seal around the metal flue of combustion penetrations through drywall with caulk or foam.

**Buildings for the 21st Century**

Buildings that are more energy-efficient, comfortable, and affordable—that’s the goal of DOE’s Office of Building Technology, State and Community Programs (BTSC). To accelerate the development and wide application of energy efficiency measures, BTSC:

- Conducts R&D on technologies and concepts for energy efficiency, working closely with the building industry and with manufacturers of materials, equipment, and appliances.
- Promotes energy/money saving opportunities to both builders and buyers of homes and commercial buildings.
- Works with State and local regulatory groups to improve building codes, appliance standards, and guidelines for efficient energy use.
- Provides support and grants to States and communities for deployment of energy-efficient technologies and practices.

For more information, contact:

- The Model Energy Code (see page 4), typically costs less than $200 for the average home and does not require specialized labor.

**Atlanta**
- MECcheck, a companion to States and communities
- Infiltration rate Savings
- Annual Energy Costs for 1300 sq. ft. house
- Building Technology Center
- Oak Ridge National Laboratory
- Southface Energy Institute
- Builder’s Guide
- Office of Building Technology, State and Community Programs
- Energy Efficiency and Renewable Energy
- U.S. Department of Energy

**High**
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**Low**
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For most homes, the sheet goods that form the ceilings, walls, and floor (such as drywall, sheathing, and decking) are effective at stopping air leakage. It is critical to seal all holes and seams between these sheet goods with durable caulks, gaskets, and foam sealants to create a continuous air barrier. The insulation barrier is usually made up of standard insulating materials, such as batt or loose-fill products, that do not seal against air leakage.

**WHAT ARE THE BENEFITS OF AIR SEALING?**
Air infiltration can account for 30 percent or more of a home’s heating and cooling costs and contribute to problems with moisture, noise, dust, and the entry of pollutants, insects, and rodents. Reducing infiltration can significantly cut annual heating and cooling costs, improve building durability, and create a healthier indoor environment. The size of heating and cooling equipment can also be decreased, which saves additional dollars. Reducing air leakage in new homes, as required by the 1995 Model Energy Code (see page 4), typically costs less than $200 for the average home and does not require specialized labor.
**What are the Priorities for Air Sealing?**

Although windows, doors, and outside walls contribute to air leakage, the biggest holes are usually hidden from view and connect the house to the attic, crawlspace, or basement. The key is to identify these areas during the design process, assign responsibility for sealing holes, and check to ensure that the air sealing was done effectively. Usually, seal all the big holes first, then the large cracks and penetrations, and finally the smaller cracks and seams.

**Where are these leakage sites?**

Dropped ceilings and kitchen soffits, ductwork and plumbing chases, attic accesses and pull-down stairs, recessed light fixtures, holes in mechanical room closets, and wiring penetrations through the top plates of walls represent major connections between the attic and conditioned space. Many times unseen holes or pathways, called bypasses, occur at key junctures in the framing (such as at attic-to-knee wall transitions) and permit large quantities of air to leak in and out of the home.

Major leakage sites in the floor can be found around the tub drain and the numerous plumbing, HVAC, and wiring penetrations through the floor decking and bottom plates of walls. In walls, the band joist (for two-story homes), window and door rough openings, and penetrations through the drywall and exterior sheathing are primary leakage sites.

- **Exterior wall:** Closed-cell foam or rope caulk. Press into crack or gap with screwdriver or putty knife. Often used with caulk around window and door rough openings.
- **Seal plumbing penetrations:** Seal plumbing penetrations. Must be sealed with housewrap tape or caulk plumbing chases, attic accesses and pull-down stairs, attic space and electrical penetrations through the top plates of walls represent major connections between the attic and conditioned space. Many times unseen holes or pathways, called bypasses, occur at key junctures in the framing (such as at attic-to-knee wall transitions) and permit large quantities of air to leak in and out of the home.

**Diagnostic Tools**

Testing the air tightness of a home using a special fan called a blower door can help to ensure that air sealing work is effective. Often, energy efficiency incentive programs, such as the DOE-EPAs or NSW Program, require a blower door test (usually performed in less than an hour) to confirm the tightness of the house.

**Air Sealing Materials**

Use a combination of these different air sealing materials.

- **Caulk:** Seals gaps of less than ½”. Select grade (interior, exterior, high temperature) based on application.
- **Weatherstripping:** Used to seal moveable components, such as doors, windows, and attic accesses.
- **Mastic:** Seals air handlers and all duct connections and joints.
- **UL181 or foil-faced tape:** Temporarily seals the air handler.

**Don’t Relly on the Insulation:**

The most common insulation, fiberglass, does not stop air leakage. In older homes, dirty fiberglass is a telltale sign of air movement (it simply collects dirt like a filter). Certain types of insulation, such as loose-packed cellulose and certain foams, can be effective at reducing air flow as well as heat flow.
DIAGNOSTIC TOOLS

Fan chases.

Air pressure gauge

Seal dropped soffit ceilings, plumbing and electrical penetrations, and utility seal exterior sheathing joints, and top and bottom plates.

The most common insulation, fiberglass, does not rely on the insulation handler. Certain types of insulation, such as dense-packed cellulose and certain foams, can be effective at reducing air flow as well as heat flow.

Unwanted air leakage only at unsealed seams or penetrations. DON'T RELY ON THE INSULATION Mastic and plastic or sheet material: Seals gaps of less than ½". Select grade (interior, exterior, high temperature) based on application.

DON'T RELY ON THE INSULATION Polyethylene plastic: This inexpensive material for air sealing also stops vapor diffusion. All edges and penetrations must be completely sealed for an effective air barrier. Poly is fragile, and proper placement is climate specific.

WHERE ARE THESE LEAKAGE SITES?

Major leakage sites in the floor can be found around window and door rough openings, and penetrations through the drywall and exterior sheathing are primary leakage sites.

HIGH PRESSURE<br />
Exterior wall: Closed-cell foam or rope caulk. Press into crack and plastic or sheet material: Temporarily seals the air leak on only at unsealed seams or penetrations.

WHAT ARE THE PRIORITIES FOR AIR SEALING?

Although windows, doors, and outside walls contribute to air leakage, the biggest holes are usually hidden from view. Usually, seal all the big holes first, then the large cracks and penetrations, and finally the smaller cracks and seams.

USE A COMBINATION OF THESE DIFFERENT AIR SEALING MATERIALS.
**Air Sealing**

For more information, contact:

Energy Efficiency and Renewable Energy Clearinghouse (EREC)
1-800-DOE-3732
www.eren.doe.gov

Or visit the BTS Web site at www.eren.doe.gov/buildings

Or refer to the Builder’s Guide Energy Efficient Building Association, Inc.
651-268-7585
www.eebaa.org

Written and prepared for the U.S. Department of Energy by:

Southface Energy Institute
404-872-3549
www.southface.org

Oak Ridge National Laboratory
Buildings Technology Center
423-574-5178
www.opt.gov/oml/btc

The Model Energy Code can be obtained from the International Code Council by calling 703-931-4533

MECCheck, a companion compliance software package, can be ordered from DOE by calling 1-800-270-CODE or downloaded directly from the Web at www.energycodes.org/resid/resid.htm.

**AIR SEALING CHECKLIST**

**BEFORE DRYWALL**

- Seal bottom plate of exterior walls with caulk or gasket; seal inside edge with caulk after walls are up.
- Seal band joist with caulk, spray foam, or gasketing between top plate and band joist, and between band joist and subfloor.
- For bath tubs on outside walls, insulate the exterior wall and air seal behind tub with sheet goods or plastic before tub is installed. After the drain is installed, seal the tub drain penetration with sheet goods and caulk or spray foam.
- For dropped ceilings or soffits, duct and flue chases, and open partition walls, use sheet goods and sealant to stop air leakage from attic into soffit and then insulate. Alternate: install framing and drywall for the soffits after the taped ceiling drywall is installed.
- Caulk the backside of window flanges to the sheathing during installation.
- Seal between door thresholds and subflooring with caulk.
- Seal window and exterior door rough openings with backer rod and caulk, or use non-expanding latex-based spray foams that will not pinch jams or void window warranties.
- Seal all electrical wire, plumbing, and HVAC penetrations between any conditioned and unconditioned spaces with caulk or spray foam.
- Seal wiring and knockouts in electrical boxes with caulk. Also seal outdoor-mounted boxes to the exterior sheathing.

**DURING DRYWALL**

- Seal drywall to top and bottom plates using gaskets, adhesive, or caulk.

**AFTER DRYWALL**

- Seal electrical switch, outlet, and circuit breaker boxes to drywall with caulk or foam.
- Seal light fixture boxes, medicine cabinets, and bath and kitchen ventilation fans to drywall with caulk or foam.
- Seal all duct boots to floor or drywall with caulk, foam, or mastic.
- Seal any plumbing or electrical wire penetration through drywall with caulk or foam.
- Seal gaps at whole house fan with spray foam or housewrap tape (ensure louvers function properly).
- For attic hatches and kneewall access doors, weatherstrip and include a tight latch. Add rigid insulation.
- For attic pull-down stairs, make stairs airtight using latch bolts and weatherstripping. Add an insulated cover.
- Seal between a masonry chimney and the attic framing using sheet metal or other noncombustible sheet goods and high-temperature (450°F), fire-rated caulk.
- Seal around the metal flue of combustion equipment using a UL-approved metal collar and high-temperature (450°F), fire-rated caulk.
- Use only UL-approved airtight, IC-rated recessed light fixtures (that meet ASTM E283 requirements); seal between fixture and drywall with caulk.
- Repair any damaged sheathing pieces.
- Seal all exterior penetrations, such as porch light fixtures, phone, security, cable and electric service holes, with caulk or spray foam.
- If not using housewrap, seal all sheathing seams with housewrap tape or caulk.