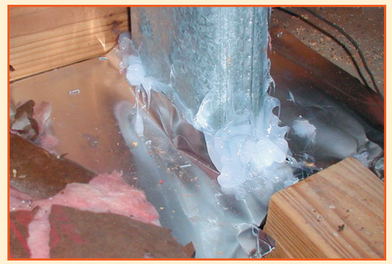
Test Effectiveness of Air Sealing

- If infiltration exceeds closure target, determine how much time can be spent on additional air sealing. See Table 1.
- For example, a house outside of Greenville (Region 1) is heated with natural gas and has air conditioning. Air sealing efforts reduce infiltration to 2900 CFM_{50}, but the closure target is 2500 CFM_{50}. From the table, the maximum air sealing cost per 100 CFM_{50} for a gas-heated house with air conditioning in Region 1 is $55. The most that can be cost-effectively spent to reduce infiltration another 400 CFM_{50} is $220 ($55/100 CFM_{50} x 400 CFM_{50}). Therefore, at a labor rate of $20 per hour, a two-person crew can spend five and a half hours sealing air leaks.



Use two-part urethane foam to air seal cracks and joints. Use high-temperature caulks (clear type is shown but red type is more widely available) around chimneys, vents, and other hot surfaces.

Table 1 – Maximum Air Sealing Cost Per 100 CFM_{50}

SPACE HEATING FUEL/EQUIPMENT	REGION 1 (**North:** Jacksonville, south to Ocala & Daytona Beach)	REGION 2 (**Central:** De Land, Orlando, south to Port Charlotte)	REGION 3 (**South:** Fort Myers, Miami, Key West)
Propane, Natural Gas, Electric Resistance	$65/$36*	$55/$18*	$64/$5*
Heat Pump	$45	$46	$65

** With air conditioning/without air conditioning.*

The Hot Climate Initiative is a partnership between DOE and hot climate states to reduce energy costs for low-income persons by improving the energy efficiency of their homes while ensuring their health and safety. Drastic funding cuts in 1995 hit hot climate states hard, forcing substantial cutbacks in weatherization staff and services. Recent funding increases have allowed DOE to reinvigorate the Hot Climate Initiative to help states adopt new weatherization practices.

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U.S. DOE Hot Climate Initiative

AIR SEALING

This technical brief reviews highlights of the blower door, pressure diagnostic, and air sealing concepts taught during the 2006 Florida whole-house weatherization training as part of the U.S. Department of Energy's Hot Climate Initiative. Materials provided during the training contain more detailed information.

Sealing air leaks improves the pressure boundary of a house—the building shell surface that limits air flow. Adding insulation improves the thermal boundary—the building shell surface that limits heat flow. For maximum energy efficiency and comfort, the pressure boundary should be aligned with the thermal boundary. The blower door exaggerates the pressure difference between the house and the outdoors—making it easier to locate and quantify air leakage. With the blower door running, use a manometer to find the pressure boundary of a house. Target air sealing and insulation efforts at

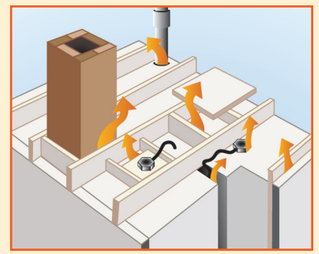
AIR SEALING CHECKLIST

The following checklist reviews the steps required to cost-effectively reduce air leakage to acceptable levels in a typical Florida low-income household. Houses with basements or finished attics require alternative air sealing strategies.

Visually Inspect to Locate Air Leaks and Thermal Boundary

- Attic

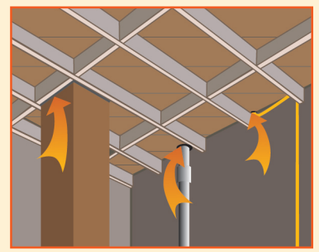
1. Check wall top plates for plumbing and wiring penetrations. Check around chimneys and furnace/water heater vents. Note any other bypasses.
2. Check location of existing attic insulation. Note whether it is on attic floor or attached to rafters.
3. Check that attic vents are adequate. One square foot (ft^2) of attic net free vent area is needed for every 300 ft^2 of attic floor area. Inadequate attic ventilation can cause misleading pressure readings.



These typical ceiling penetrations are the most important leaks to seal.

- Crawl Space

1. Check for plumbing and wiring penetrations through the floor.
2. Note any existing floor insulation.



Seal floor penetrations to reduce infiltration.

- Walls

1. Check the wall cavities for insulation. Drill test holes if necessary.
2. Locate interior walls containing plumbing and heating vents.

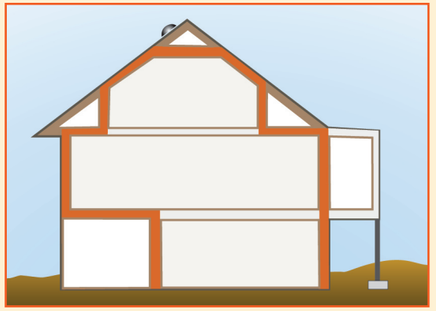
FLORIDA

Determine Air Sealing Strategy

- Use air sealing strategies that align the pressure and thermal boundaries.
- Calculate the volume of the house. Then find the *Closure Target* on table provided during training using the house volume and initial blower door reading.
- Determine the Minimum Ventilation Rate/Building Tightness Limit (MVR/BTL) to ensure air sealing efforts will not seal house too tightly.

  MVR/BTL is the highest of three calculations:

  - **((# of bedrooms + 1) x 15 CFM)**: Number of bedroom plus one multiplied by 15 gives the natural CFM of minimum ventilation needed.
  - **(# of people x 15 CFM)**: Number of people multiplied by 15 gives the natural CFM of minimum ventilation needed.
  - **(Volume x .35/60):** Volume of the house in cubic feet multiplied by 0.35 and divided by 60 gives the natural CFM of minimum ventilation needed.
  - **Use the formula that gives the highest MVR and convert $CFM_{natural}$ to CFM_{50} (multiply $CFM_{natural}$ by 20).**



Determine what kind of air sealing and added insulation will align the pressure (air) and thermal barriers. The exterior walls and ceiling do not always define conditioned and unconditioned spaces.

Seal Leaky Ducts

- Duct leakage can create positive and negative pressures on the building by delivering and taking air from the wrong places.
- Use the pressure pan test to check for duct leakage near supply and return registers. With the blower door depressurizing the house, measure the pressure at each supply and return register.
  - Pressure pan readings less than 1 Pascal (Pa) indicate no significant duct leakage near registers.
  - Pressure pan readings greater than 1 Pa indicate significant duct leakage near registers.
- See the *Pressure Pan Testing* diagram for proper hose connections and manometer settings.
- Use mastic, not duct tape, to seal ducts.
- See *Home Energy* (www.homeenergy.org) for other duct sealing strategies.

Pressure and thermal barriers are in contact as shown by the colored box. Perform zonal testing to determine which areas are inside and outside the conditioned space.

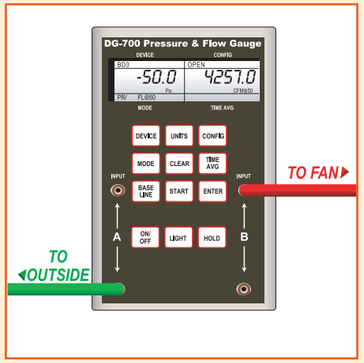
Use Blower Door to Quantify Air Leakage and Locate Pressure Boundary

Blower Door and Zonal Test Procedure

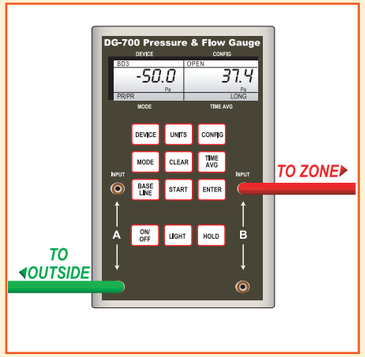
1. Prepare the house for the blower door test by closing all windows and exterior doors. Ensure that fires are out and shut fireplace dampers and wood stove flues. Turn off all combustion appliances. Turn down furnace thermostat and place water heater on pilot. Turn off all exhaust fans, attic fans, and clothes dryers.
2. Set up blower door and digital manometer. (See diagram for proper hose connections and dial settings.)
3. Measure fan flow with a pressure difference of the house with respect to the outdoors of 50 Pascals (Pa). Press the Mode button twice to read presure on Channel A and fan flow on Channel B. Turn on fan and adjust speed to maintain -50 Pa on Channel A. Read fan flow on Channel B.

   Locate and align the pressure boundary by following Step 4. The pressure difference between the house and zones outside the pressure boundary should be closer to 50 Pa. The manometer reading for zones inside the pressure boundary should be closer to 0 Pa.

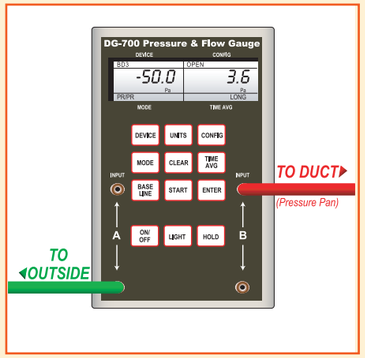
4. Keep blower door fan running to maintain the house at -50 Pa with respect to outdoors and use the digital manometer to read zonal pressure differences:
   a. Turn manometer off and on again to read pressure on both Channel A and B. Connect one end of hose to the top right-hand tap and place the other end in the attic. Close attic hatch as tight as possible without pinching hose closed. Record the pressure difference of the attic with respect to the house.
   b. Find or drill a small hole in the floor. Remove hose from attic and place in floor hole. Repeat step 4.a. to determine pressure difference of the crawl space with respect to the house.
   c. For bedrooms, bathrooms, and other rooms with interior doors, repeat step 4.a. to determine the pressure difference of the room with respect to the house. Place the hose under the closed door to take reading.
   d. Locate interior walls with plumbing and vent chases. Place a pressure pan over existing holes (e.g., electric outlets and light switches), or drill a small hole in the wall. Repeat step 4.a. to determine the pressure difference with respect to the house.



BLOWER DOOR TEST – Depressurize house to -50 Pa. Press Mode button twice to read pressure on Channel A and fan flow on Channel B.



ZONAL TESTING – Depressurize house to -50 Pa. Turn manometer off and on again to read pressure on both Channel A and B. Measure the pressure on Channel B while examining walls, ceiling, and floor to determine pressure boundary.



PRESSURE PAN TESTING – Depressurize house to -50 Pa. Reset manometer to read pressure on both Channel A and B. Measure the pressure on Channel B with pressure pan placed over each supply and return register.