



FLORIDA SOLAR ENERGY CENTER

Creating Energy Independence Since 1975

Air Distribution Systems in Conditioned Spaces – i.e. “Ducts in Unvented Attics”

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The Norm: Ducts in Unconditioned Spaces



- ❖ Losses and Risks?
 - IAQ Issues
 - Durability Losses
 - Conductive gains/losses
 - Duct Leakage
- ❖ Consequences
 - Increased machine run time
 - Durability & Cost
 - Unplanned air exchange
 - Extreme thermal conditions
 - Mold, Condensation, & Rot
 - Allergens & Irritants





Duct Leakage



- Supply Side Leaks
 - Conditioned air lost
 - Bldg. depressurization
- Return Side Leaks
 - Air pulled in
 - Bldg. pressurization

Supply leak



Supply leak



Return leak



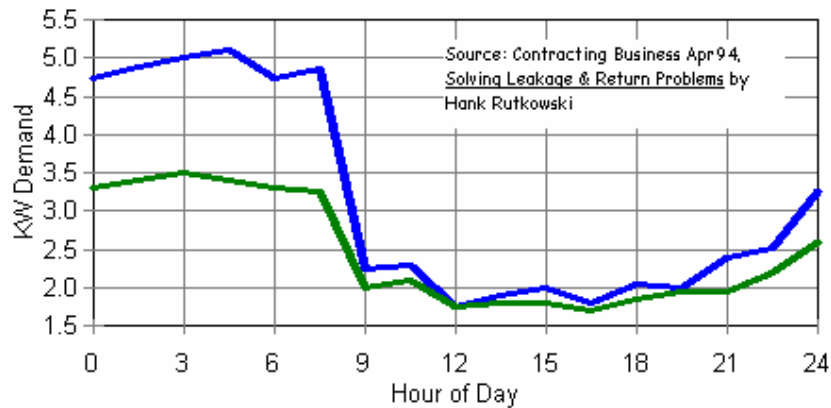
Supply leak



Leakage & KW Demand

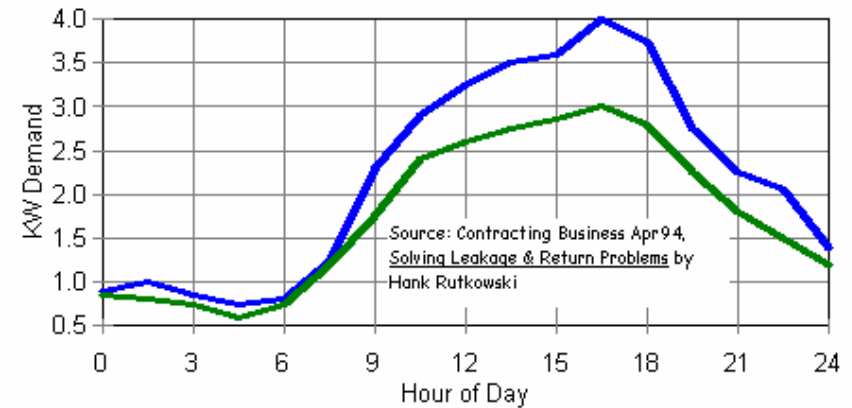


KW Demand
Heating (house in Northern Florida)



— Performance w/ leaks — w/ 70% leaks repaired

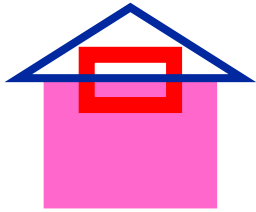
KW Demand
Cooling (house in Northern Florida)



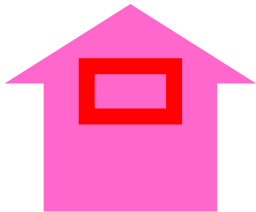
— Performance w/ leaks — w/ 70% leaks repaired



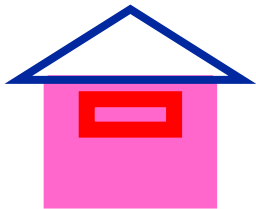
Reducing Impact of Ducts in Unconditioned Spaces



- ❖ Sealed and Insulated Ducts: continuous thermal barrier and sealed with mastic and mesh *including the return plenum.*



- ❖ Unvented Attics and Crawlspaces – move the air and thermal barriers to the other side of the air distribution system



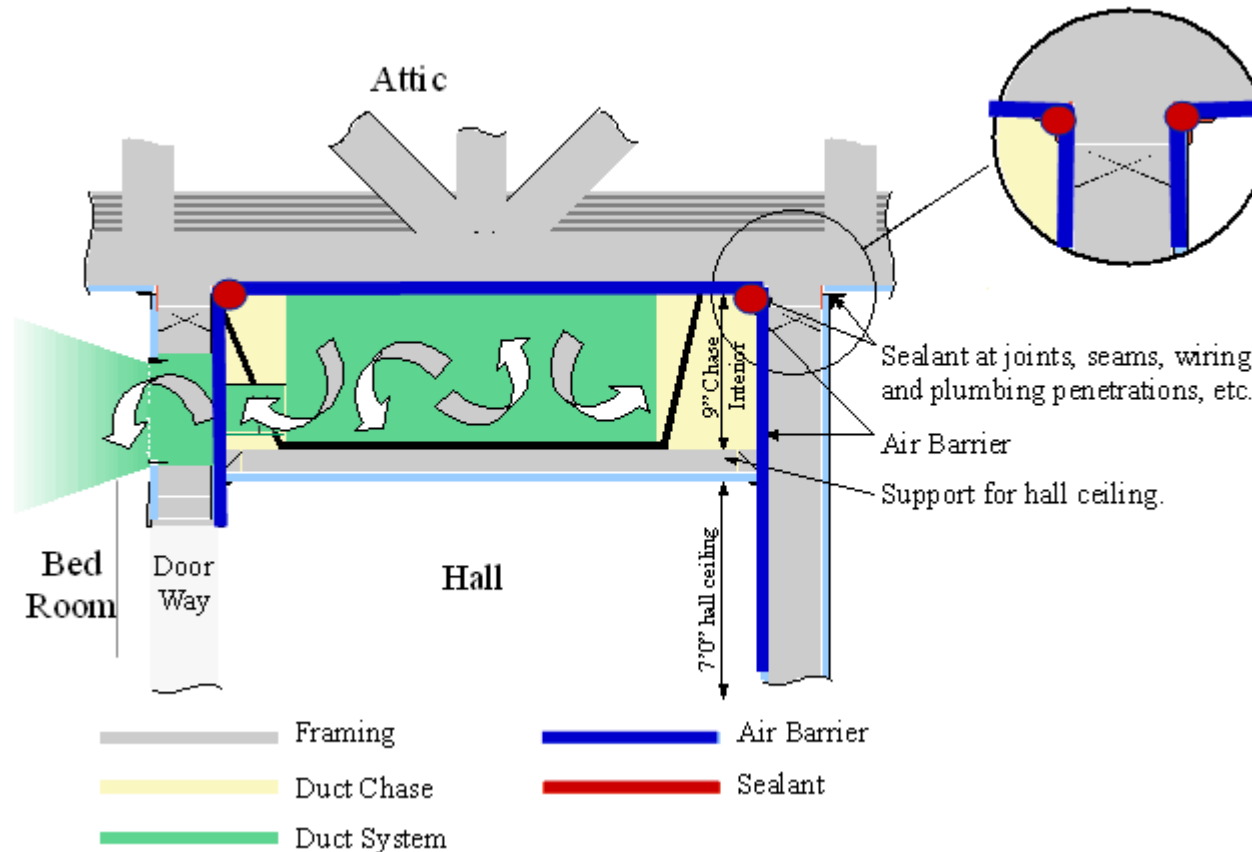
- ❖ Interior Duct Systems – move the air distribution system to the inside of the house's thermal and air barriers.



Interior Ducts - Schematic



Interior Duct System — Fur Down in Hallway





Interior Duct Chases





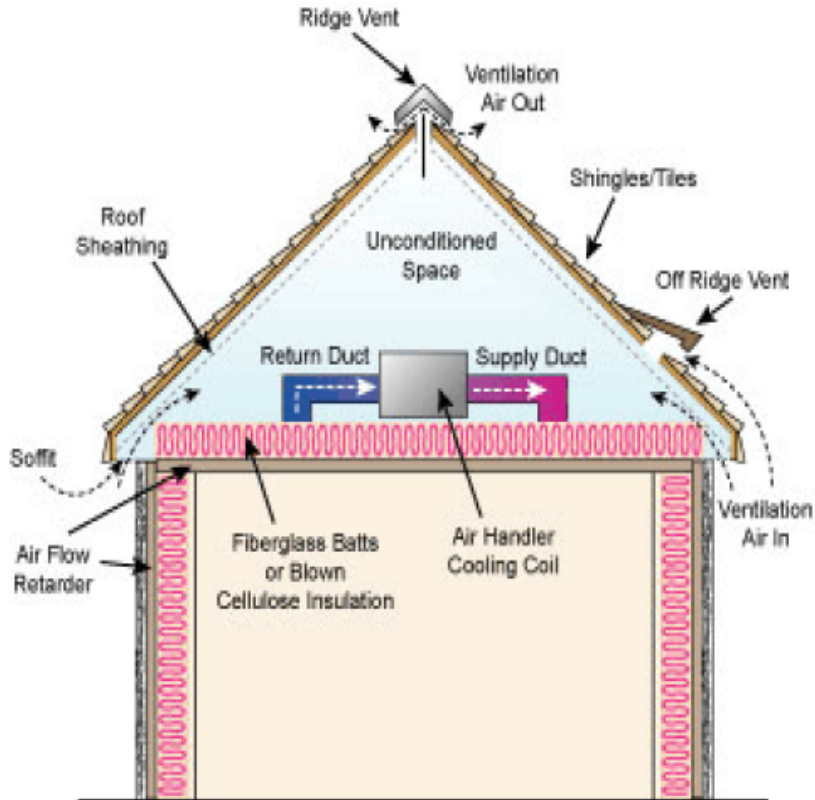
Cost Effectiveness



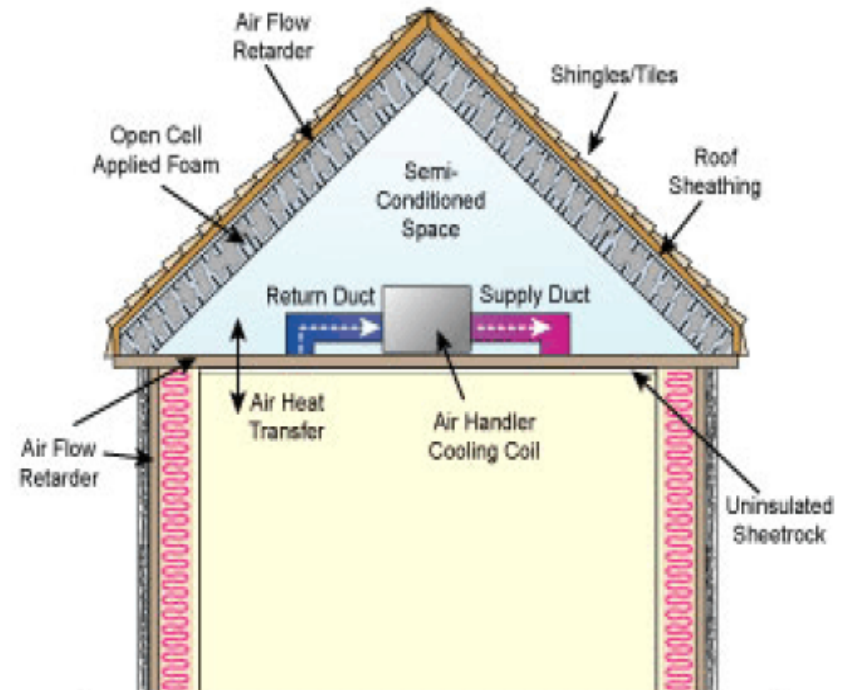
- ❖ Example Economics from North Carolina Houses
 - **\$0** No incremental cost for duct installation
 - **+\$200** Drywall for miscellaneous air barriers
 - **\$0** Ceiling insulation will be thermal barrier
 - **+\$350** Labor + materials to install and seal air barrier
 - **- \$250** ~1/2 ton reduction in heating/cooling
 - **\$300** FIRST COST increase
- ❖ Annual Savings = \$86
- ❖ Simple payback...less than 4 years!



Vented & Sealed Attic Thermal Processes



Vented attic



Sealed attic



Sealed or Unvented Attic



- Equipment
- Storage
- Future expansion
- Energy Savings
- Dry Ducts
- Easy Inspection



7 Habitat Homes



Case Description	Cooling Savings		Peak Demand Reduction	
	kWh	Percent	kW	Percent
RGS (Control)	0	0%	0	0%
RWS (White Shingle)	300	4%	0.48	17%
RSL (Sealed Attic)	620	9%	0.13	5%
RTB (Terra Cotta Tile)	180	3%	0.36	13%
RWB (White S-Tile)	1,380	20%	0.92	32%
RWF (White Flat Tile)	1,200	17%	0.98	34%
RWM (White Metal)	1,610	23%	0.79	28%

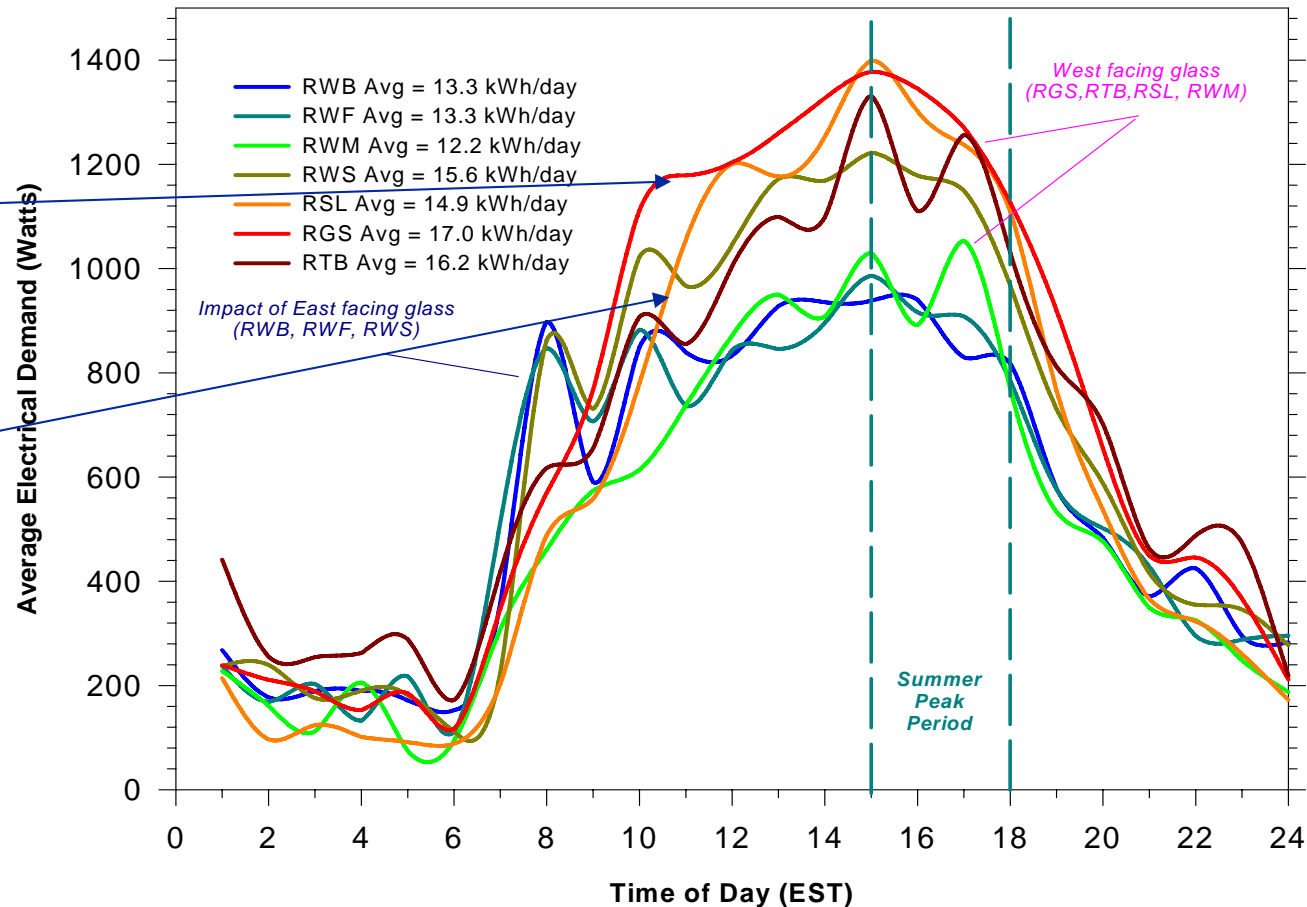
* Percentages relative to typical values for average sized detached S. FL homes



Average Cooling over Unoccupied Period



- (RGS) Standard dark shingles (control home)
- (RWB) White "Barrel" S-tile roof
- (RWS) Light colored shingles
- (RWF) White flat tile roof
- (RSL) Standard dark shingles with sealed attic & R-19 roof deck insulation
- (RTB) Terra cotta S-tile roof
- (RWM) White metal roof

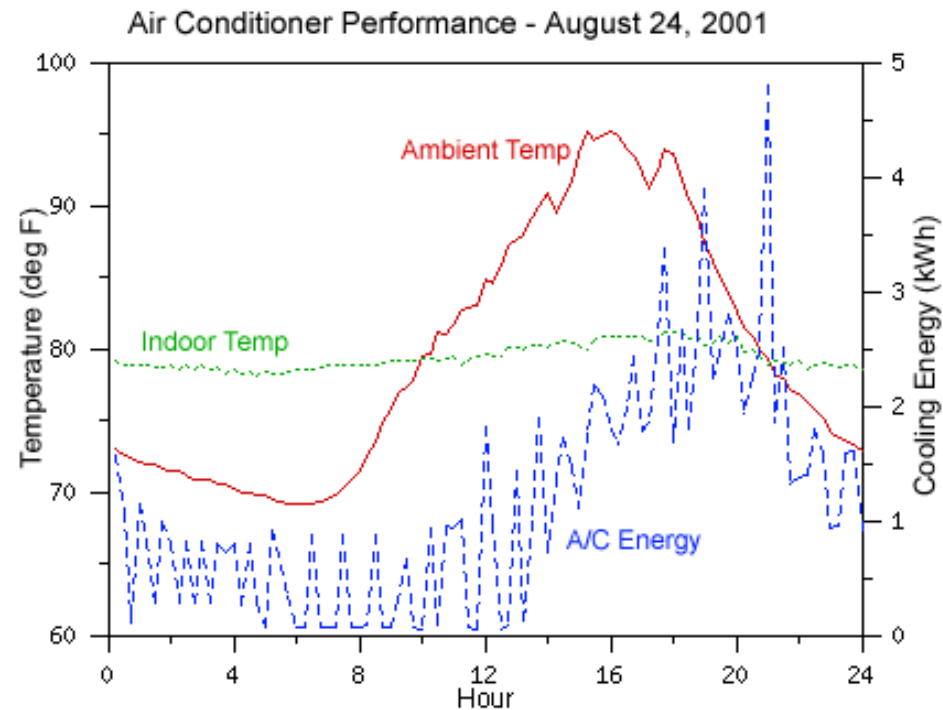




Case Study: The Hoak Residence



- ❖ 4,250 sqft 2-story w/basement
- ❖ 2-speed compressor, 2.5 - 5 ton & variable speed air handler unit
- ❖ Heat Pump water heater
- ❖ ERV w/backup dehumidifier





Unvented Attic Benefits



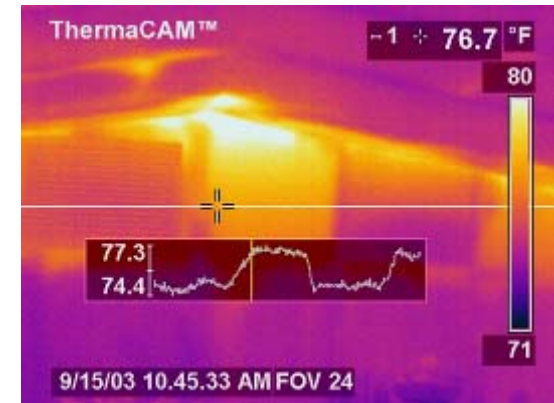
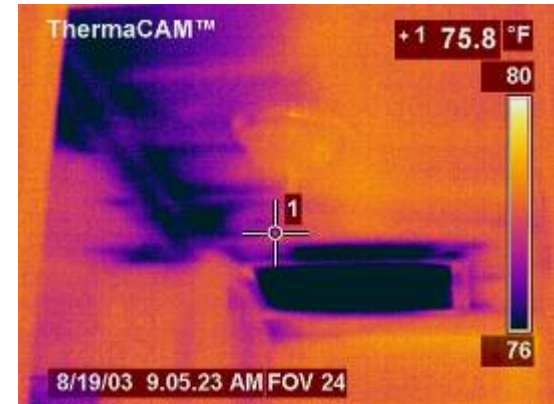
Bonus room conversion



Ducts in conditioned space



Convention Insulation Anomalies

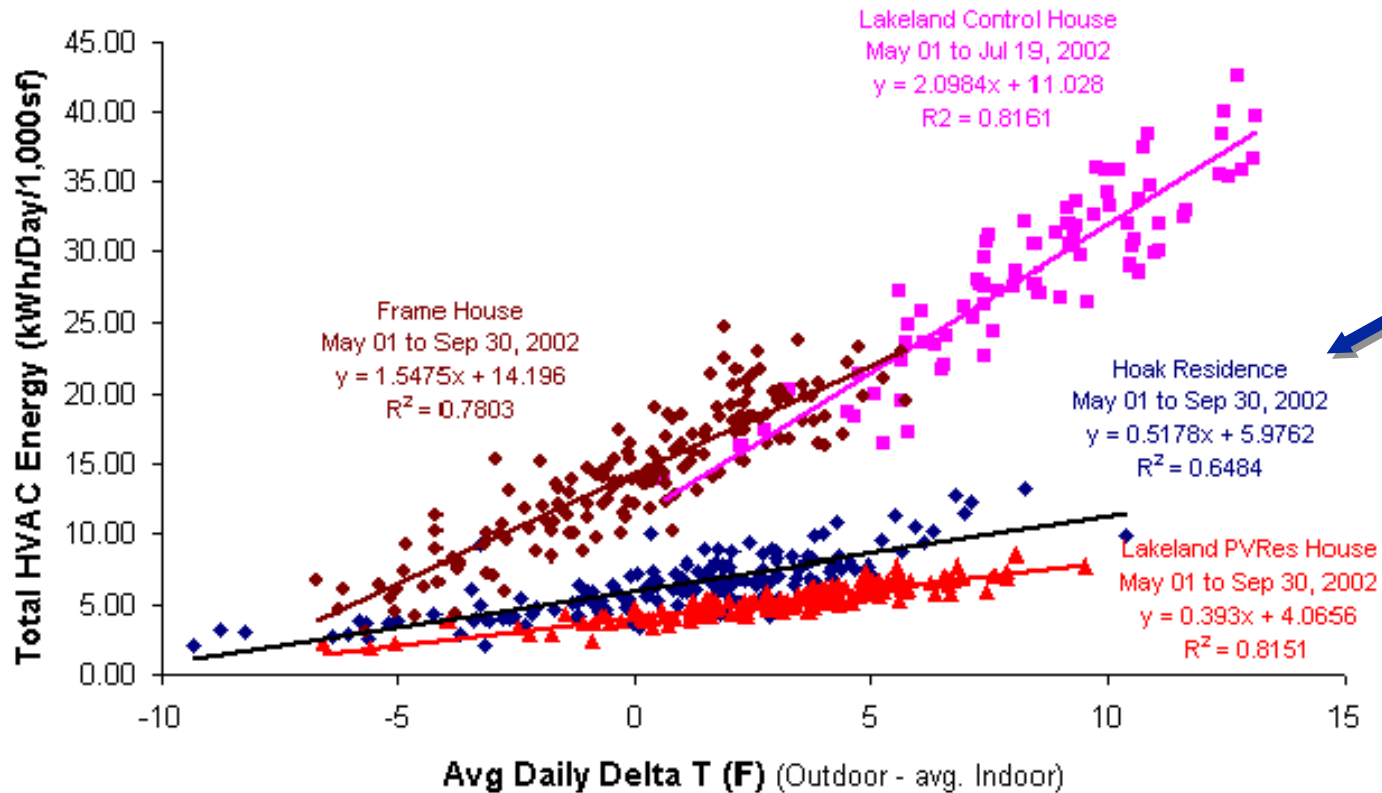




Normalized Energy Use




(HVAC Energy / 1,000 sf) vs Delta T







USDOE Building America




Research that Works
 November 2004 • NREL/TP-550-36960

Building America Best Practices Series: Volume 1
 Builders and Buyers Handbook for Improving New Home Efficiency, Comfort, and Durability in the Hot and Humid Climate





 HOT & HUMID CLIMATE ZONE

U.S. Department of Energy
 Energy Efficiency and Renewable Energy
 Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Building Technologies Program

Less Cost	← Conventional	→ More Cost
Unvented Roof		
	• <i>Moving insulation</i>	+\$700 ADDED COST
-\$100 SAVINGS		• <i>No need to install vents</i>
Advanced Framing		
-\$250 SAVINGS		• <i>2x6s @ 24" o.c. instead of 2x4s @ 16" o.c.</i>
High-Performance Windows		
		+\$300 ADDED COST
Right-Sized Air Conditioner System		
-\$750 SAVINGS		• <i>2-ton reduction</i>
Controlled Ventilation System		
		+\$150 ADDED COST
Dehumidifier		
		+\$250 ADDED COST
COST DIFFERENCE		+\$300 ADDED COST

Source: Edminster, Pettit, Ueno, Menegus, and Baczek 2000.



After the Aftermath 2004



Soffit failure = water entry

Charley - Francis - Ivan - Jeanne





Florida Building Code, Residential, 2005 Supplement



CHAPTER 8 ROOF-CEILING CONSTRUCTION

R806.4 Conditioned attic assemblies: Unvented conditioned attic assemblies (spaces between the ceiling joists of the top story and the roof rafters) are permitted under the following conditions:

1. No interior vapor retarders are installed on the ceiling side (attic floor) of the unvented attic assembly.
2. An air-impermeable insulation is applied in direct contact to the underside/interior of the structural roof deck. “Air-impermeable” shall be defined by ASTM E 283.
3. Shingles shall be installed as shown:
 - a. For asphalt roofing shingles: A 1-perm (57.4 mg/s . m2.Pa) or less vapor retarder (determined using Procedure B of ASTM E 96) is placed to the exterior of the structural roof deck; i.e. just above the roof structural sheathing.
 - b. For wood shingles and shakes: a minimum continuous ¼ inch (6 mm) vented air space separates the shingles/shakes and the roofing felt placed over the structural sheathing.

