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Building Technologies Program

Building America
U.S. Department of Energy
Research Leading to Zero Energy Homes

Introduction to the Gulf Coast Demonstration Homes (Part 3)

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Industrialized Housing Partnership
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Building Technologies Program

High Performance Package

- Comfort & Energy Strategies
  - Provide even comfort
  - Reduce direct energy use
    - Cooling & Heating Efficiency
    - Appliances & Lighting Efficiency
  - Reduce Cooling & Heating Loads
    - Reduce Heat gain/loss
    - Control air flow and humidity
- IAQ Strategies
  - Prevent death & aggravation of common health conditions
- Durability Strategies
  - Protect equipment, materials, assemblies

Gulf Coast High Performance Affordable Demonstration Houses

Indoor Air Quality Features

- No atmospheric combustion heating or water heating equipment *(therefore, no combustion safety measures required)*
- Low radon potential *(therefore, no mitigation system recommended)*
- Indoor humidity and infiltration control strategies *(estimated natural ach < 0.35)*
  - House wrap, air sealing, and insulation checklist and inspection *(ENERGY STAR Thermal Bypass Checklist)*
  - Top plate and exterior wall penetrations sealed
  - For frame floors: bottom plate and floor deck penetrations sealed
  - Passive, positive pressure ventilation when Heat/AC operates
  - Heating and cooling equipment right-sized with ACCA Manual J
  - Kitchen and bath exhaust fans ducted to outside for humidity control
  - Interior air handler closet (sealed and separated from attic/crawl space)
  - R-13 wall insulation - dense pack cellulose or batt (fiberglass or recycled cotton) installed to meet RESNET Class I quality requirements
  - Sill seal under bottom plate
  - Can lights (when present) are air tight insulation contact (ATIC) Rated

Durability* Features

- Definitive drainage plane
- Air handler in conditioned space *(less harsh environment than attic)*
- Water heater located in attached storage room *(less harsh environment than attic)*
- Long life fiber cement siding
- Ship-lapped window and door flashing
- Kitchen and bath exhaust fans ducted to outside for humidity control
- 2'0" overhangs to direct water away from house
- Slab raised to promote drainage away from foundation

Energy Efficiency Features (HERS Index ~73)

- R-30 blown cellulose attic insulation
- R-13 wall insulation meeting RESNET Class I requirements
- Low-E double pane windows
- At least 75% fluorescent lighting
- ENERGY STAR refrigerator *(412 kWh/year)* and ceiling fans (when present)
- High efficiency heat pump, *(at least SEER 14, HSPF 8.5)*
- Interior air handler closet (sealed and separated from attic and crawl space)**
- Radiant barrier decking
- Sealed air distribution duct system *(Qn,out = 0.03 or less)***
- Light colored exterior finishes
- Insulated exterior doors with double pane lites
- Energy Star Thermal Bypass Checklist
- Mechanical system sized using ACCA Manual J or equivalent
- Building America Benchmark savings of 30% (HERS Index range 70-75)

**Disaster resistance measures are addressed by prevailing local codes and are outside the scope of this Department of Energy activity.*

Note: Some features are mentioned in more than one category.

Improvement: Switch from attic mounted electric resistance heating to minimum efficiency heat pump (SEER 13 HSPF 7.7)

- Savings :
- 7.8% for attic air handler
- 7.1% for interior closet.
- 800 to 900 kWh
- $108 to $96 per year.
- Discussion: Although these units will save energy, homeowners used to gas furnaces or electric resistance heating may not like heat pumps due to the cooler temperature of the air supplied to the rooms. If the units are not sized correctly and commissioned carefully they may be prone to freeze-up in the winter, causing them to go into defrost mode more often than they should, causing excessive energy use and comfort complaints.

Improvement: Increase amount of fluorescent lighting from 10% to 75%. CFL bulbs meet requirement.

- Savings :
- 5.5%
- 616 kWh
- $74. .
- Discussion: First costs are higher than incandescent bulbs, but the life expectancy of these bulbs is significantly longer than incandescent bulbs. Not only do fluorescent bulbs use less energy per lumen produced, they also do not have as much waste heat production as incandescent bulbs, lowering A/C loads in the summer. There may be disposal issues, as CFLs have mercury in them. Home Depot has a CFL recycling program in all of their locations. EPA fact sheet on CFL disposal: http://www.energystar.gov/ia/partners/promotions/change_light/downloads/Fact_Sheet_Mercury.pdf

Improvement: Replace refrigerator with ENERGY STAR refrigerator.

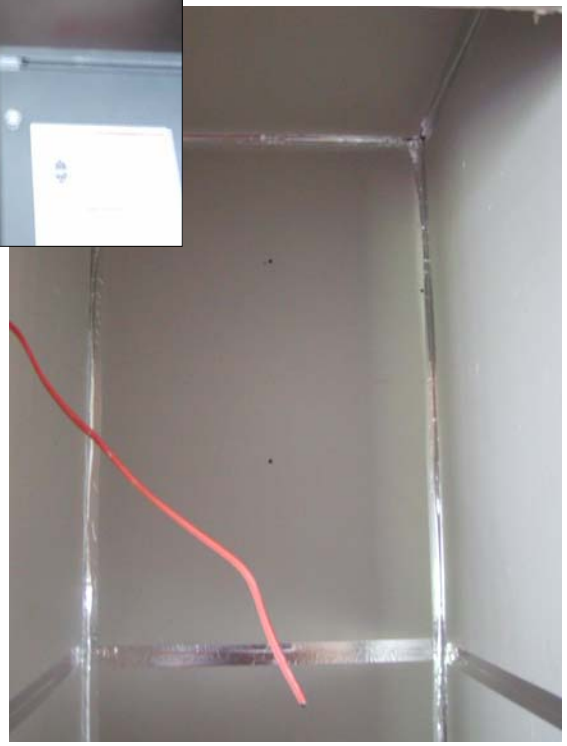
- Savings:
- 3.5%
- 355 kWh to 395 kWh
- $43 to $48.
- Discussion: The default refrigerator used for calculations is rated at 775 kWh per year, which may be higher than the smaller sized HFH type refrigerator. Whirlpool's donated ENERGY STAR refrigerator uses 380 to 420 kWh per year (depending on which unit is selected) If this refrigerator only saves 15% of refrigerator energy (definition of ENERGY STAR appliance), then this represents a savings of approximately 90 kWh per year, or $11

Improvement: Increase heat pump efficiency from SEER 13, HSPF 7.7 to SEER 14, HSPF 8.5

- Savings:
- 3.2%
- 275 kWh
- $33
- Discussion: If replacing SEER 13 straight cool with strip heat, the savings is between 1075 kWh and 1175 kWh per year, or $129 to $141 per year. HVAC contractors have reported that SEER 14 units are about the maximum efficiency that can be reached without using expensive and complicated technologies such as multi-speed fans and variable speed or multiple compressors.

Improvement: Install air handler in a sealed interior closet, not the attic.

- Savings:
- 1.9%
- 216 kWh
- $26
- Discussion: This improvement also affects indoor air quality and longevity of the air handler. By installing the unit in the conditioned interior the unit is not subjected to the extreme temperatures found in attics, with less wear and tear on the unit. Any air leakage found in the air handler will not pull in dirty attic air, improving IAQ, and lengthen the life of the air handler by keeping the coils cleaner.



Improvement: Use radiant barrier (RBS) decking for roof (as opposed to non-RBS decking)

- Savings:
- 1.9%
- 208 kWh
- $25
- Discussion: All affiliates building demonstration houses were already installing RBS decking. These savings numbers would be higher if attic installed air handlers are used, but the Building America team does not recommend attic installed air handlers.

Improvement: Decrease duct leakage from the national average to "essentially leak free" (Qn = 0.08 to Qn = 0.03)

- Savings:
- 1.0%
- 115 kWh
- $14
- Discussion: This improvement has many advantages beyond saving energy. Duct leakage is one of the driving forces behind infiltration of outside air into a house. Duct leakage causes pressure imbalances in a house, which leads to increased infiltration. Increased infiltration causes a degradation of indoor air quality, increased humidity loads in the house, and prematurely wears out the A/C equipment. Leakage of cold supply air into the attic can cool metal surfaces such as truss plates and nail heads to dew point – leading to condensation and material wetting.

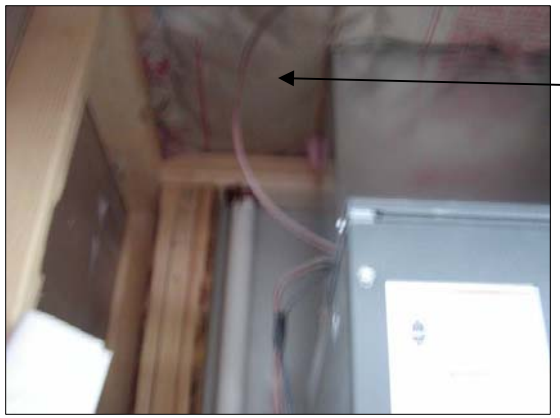
Improvement: Reduce estimated natural infiltration from 0.4 air changes per hour (ACH) to 0.25 ACH

- Savings:
- 0.7%
- 84 kWh
- $10
- Discussion: This improvement is accomplished by establishing a continuous air barrier around the house which includes the slab or floor decking, sill seal, house wrap, top plates, ceiling drywall, and sealants at all penetrations. Reducing infiltration has many advantages beyond saving energy. Reducing infiltration reduces the amount of uncontrolled air flow into the house.. This uncontrolled air which passes through holes in the house air barrier can introduce many pollutants into the house, either from outside, or from building cavities. These air flow paths also allow entry of pests which are another source of allergy and asthma triggers. Building America recommends the inclusion of a filtered and dampered outside air source introduced to the air conditioning return, controlling outdoor air introduced to the house to provide some fresh air into the house. This also provides a filtered, controlled air flow path for make up air when exhaust fans are operated.

Improvement: Increase insulation value of floor from R-19 to R-30

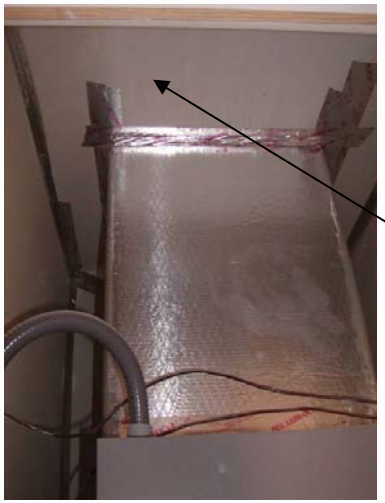
- Savings:
- 0.5%
- 61 kWh
- $7
- Discussion: This improvement was recommended by Building America to reach our 30% savings goal without having to go to a higher efficiency A/C system. Although it has a very small payback, it has the advantage of a better installation. When R-19 is installed in a 2X8 or 2X10 floors it is often installed so there is an air space both above and below the insulation, dramatically curtailing its performance due to an increase of convection around the insulation. If R-19 insulation is used, it should be installed with the Kraft paper towards the crawl space, and inset stapled.

Critical Detail: Air Handler Closet



Slidell
Insulation as "ceiling"
– not an air barrier

New Orleans
Closet open to attic *by design*
RA plenum also connected to attic (shown in next slide)



Baton Rouge
AHU Set in Attic

Mobile (exemplary)
Drywall ceiling and walls.
Seams and penetrations sealed with foil tape.

New Orleans Area HFH

AHU closet has no ceiling – so it's connected to attic by design;
* Numerous openings connect closet to interior walls

Interior wall open to return air plenum under platform (no drywall in RA plenum)
There fore, the RA Plenum is connected to the attic

Mobile County Habitat AHU Closet Details

Air Handler Closet from Outside

AHU Closet from Inside

Mobile County Habitat AHU Closet Details

Supply Plenum Sealed to Ceiling

Return undersized
Switching to smaller door
And larger return

Going forward…

- Building America - High Performance Affordable Demonstration Houses: www.baihp.org/gulfcoast
- Building America – Habitat Partnership
  - www.baihp.org/habitat
- Energy Star New Homes Program
  - www.energystar.gov – click on "New Homes"
- Local Home Energy Raters
  - http://www.natresnet.org/directory/raters.aspx
  - Look for the "Volunteer Rater" emblem
- Building America Best Practices Documents
  - www.buildingamerica.gov (right hand margin)
- Janet McIlvaine and David Beal
  - janet@fsec.ucf.edu and david@fsec.ucf.edu
  - please include "Habitat" in your subject line
  - 321-638-1434 and 321-638-1433

Components of Ventilation System for Habitat for Humanity Affiliates

- OA intake located in soffit near side door or porch ceiling (with step ladder access for changing/cleaning filter)
- Heavier gauge filter back grille for OA intake (similar to those at www.registers.com) connected to…
- Standard box/boot with collar appropriate for connecting to…
- 2” thin wall PVC pipe or 4” flex (if length exceeds 25,’ use 6” flex) Note, seal around PVC or flex where it penetrates the ceiling of air handler closet with expanding foam, mastic and mesh, or caulk. Connect pipe/duct to
- Manual damper with fittings in an accessible location with pipe/duct continuing to…
- Collared opening in air handler cabinet within 6” of AC coil on the return side of the coil. This requires the mechanical contractor to cut a hole in the air handler and provide a fitting to connect to the PVC or Flex. Seal joint at pipe/duct to collar with mastic and fiberglass mesh.
- A motorized damper or gravity fed back draft damper may (with override control) may be substituted for the manual damper.

Outdoor Ventilation Air Pipe/Duct Sizing Rationale:

- Using ASHRAE Calculation Formula for Recommended Flow:
- 7.5cfm/person + 10cfm/1000sq ft
- Estimating the number of people using the number of bedrooms plus one, we get the following recommended flows:
- 2 Bed Room 950-1050 sq ft
- Flow=32 cfm (Approximately 30cfm)
- 3 Bed Room 1050-1150 sq ft
- Flow=41cfm (Approximately 40cfm)
- 4 Bed Room 1150-1250 sq ft
- Flow=49 cfm (Approximately 50cfm)
- The size pipe/flex recommended above will accommodate these levels of flow. The manual
- damper may be adjusted to reduce or increase the flow if occupant desires.

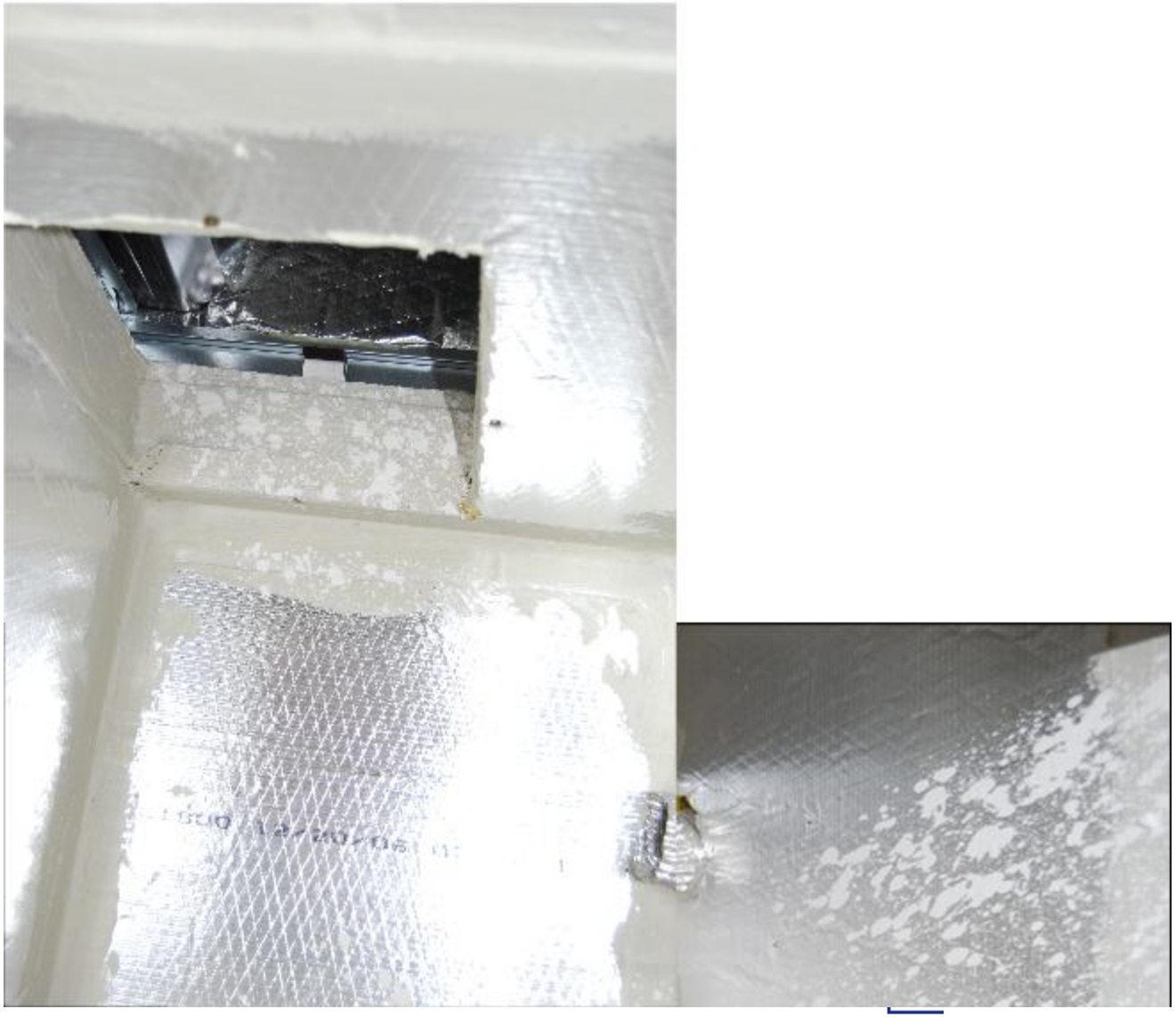
Outside Air System Details – Filter-back Intake

Outside Air System Details – Filter-back Intake

Outside Air System Details – Intake Boot


Outside Air System Details – OA Duct


D-1785




PE FL 7200 2" PVC TYPE 1 SCH 40 ASTM D-2665 NSF-dwv ■ PVC 1120 PR 280 PSI @