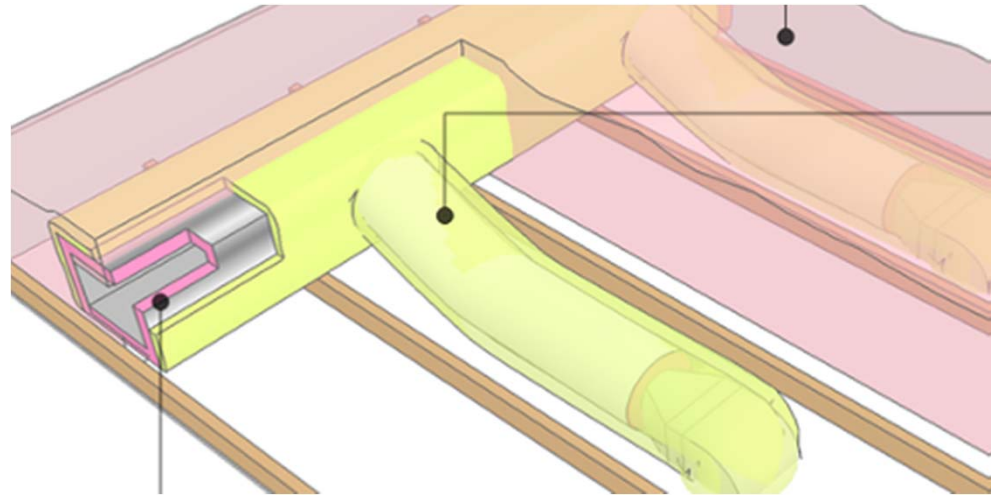


Encapsulated and Buried Ducts



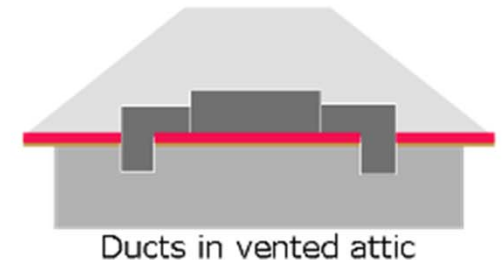
Robb Aldrich
Steven Winter Associates, Inc.



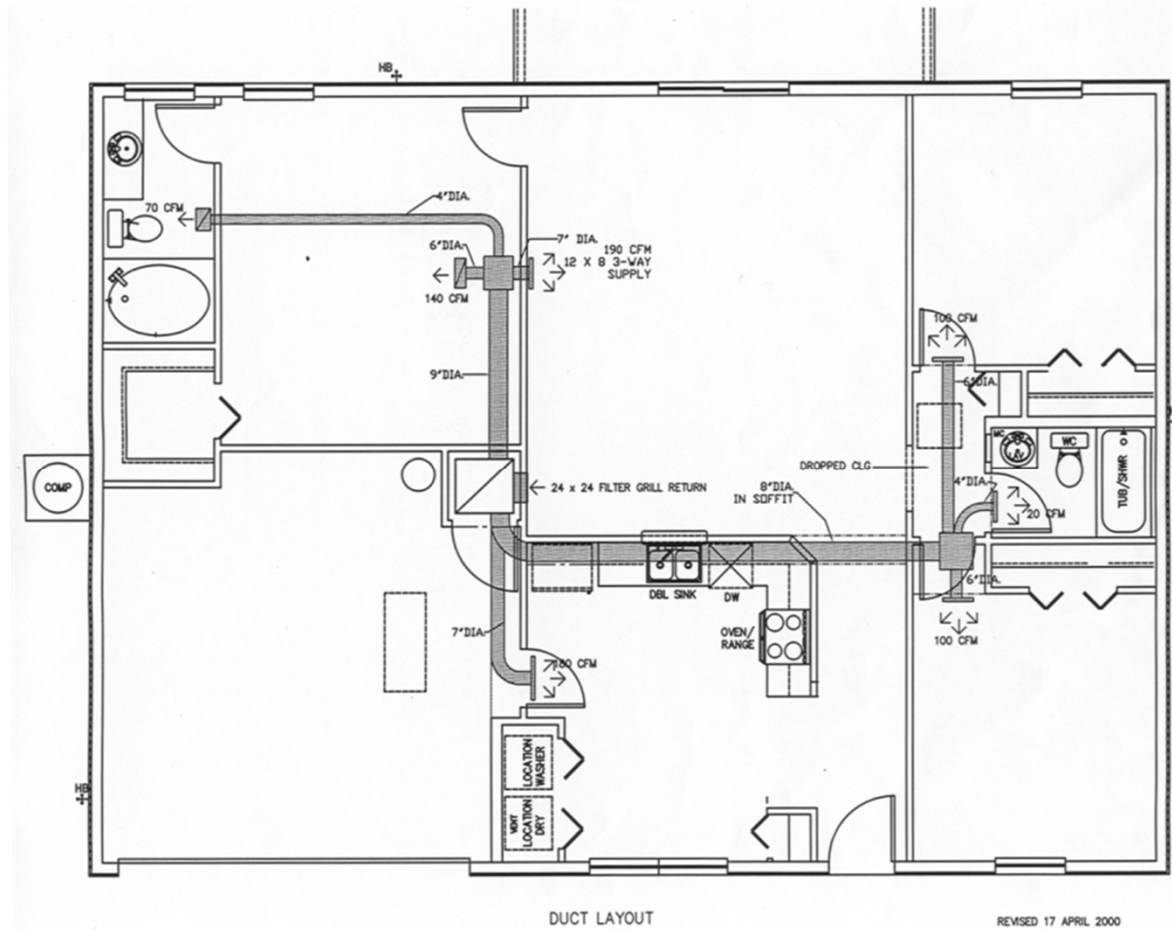
Why Buried Ducts?

- Ductwork thermal losses can range from 10-45%
- Interior ducts current solution, but may be impractical, expensive, or increase envelope loads

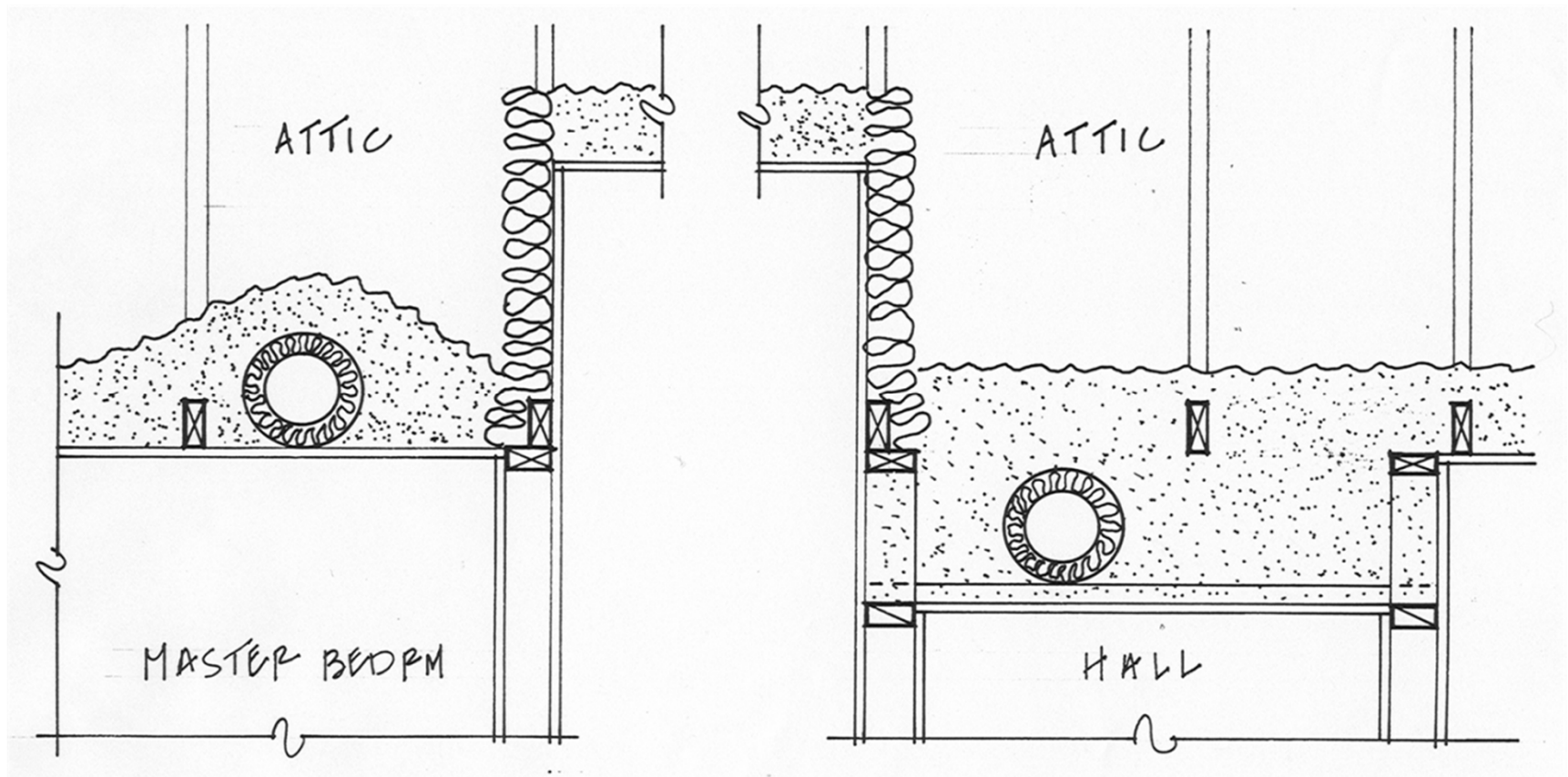
— Insulation & Air Barrier



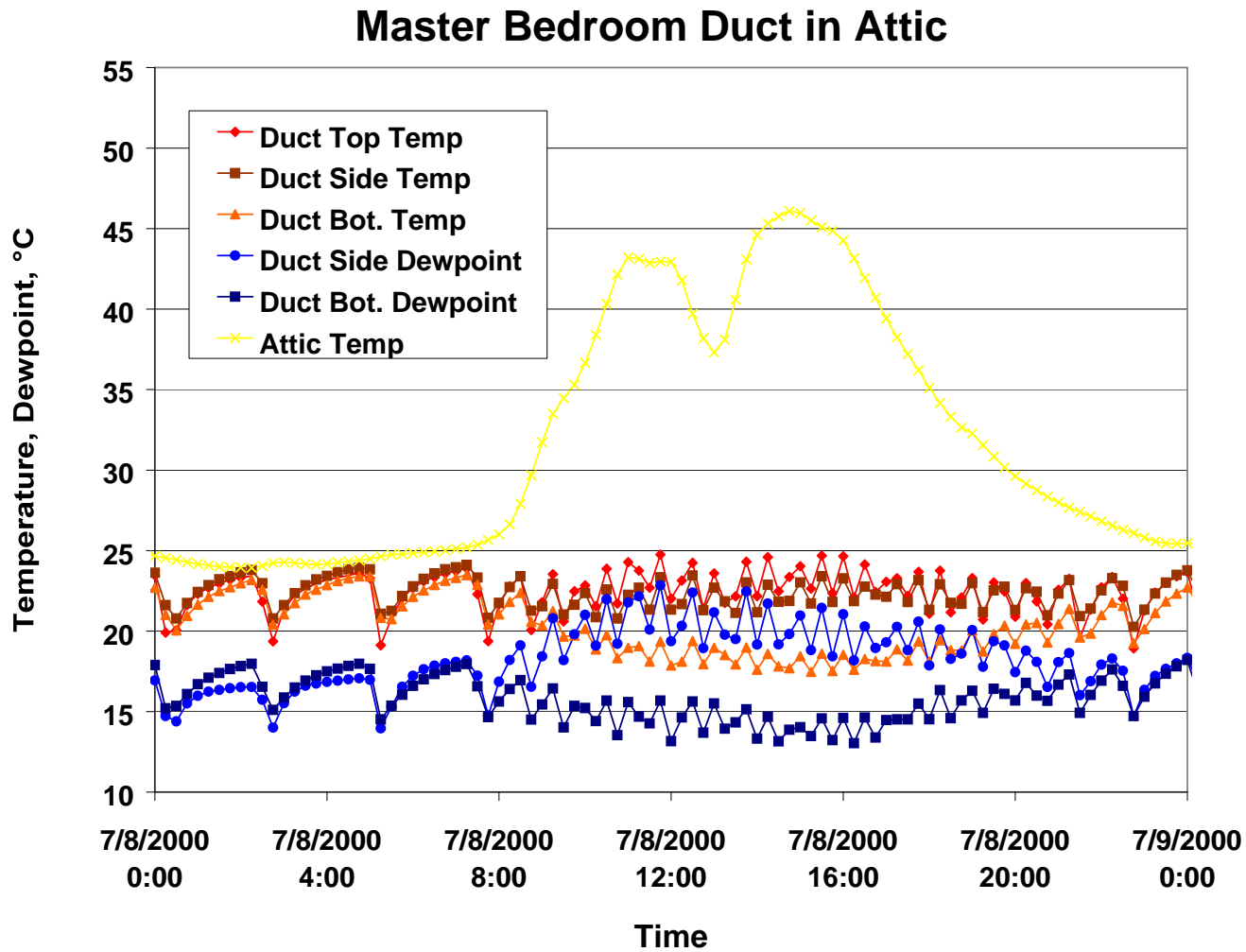
First Tests – Florida



Early Buried Duct Tests (FL)



Condensation?



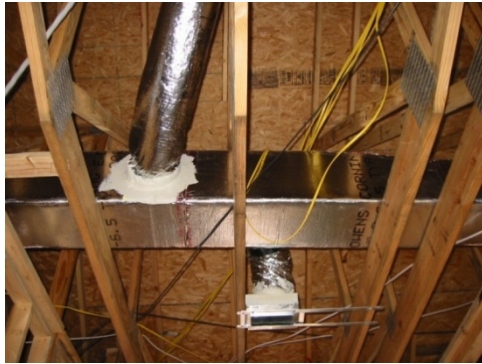
California: Much drier, no Problem



Implementation



Getting it Right... in Florida



A Solution for Humid Climates



Encapsulated, then Buried

Research Questions



- What are the effective R-values?
- What is the improvement in distribution system efficiency?
- Do buried & encapsulated ducts mitigate the risk of condensation on duct surfaces?
- What are the total costs and energy savings?
- What are obstacles and implementation issues?

Retrofits with BASF: Jacksonville, FL



**House 1: Buried
& Encapsulated**

**House 2: Buried
& Encapsulated**



**House 3:
Encapsulated**



Retrofit Homes – Jacksonville, FL

- Monitored pre- and post-retrofit temp and RH:
 - Duct jacket, ccSPF, and boot surfaces
 - Supply registers
 - AHU supply
 - AHU return
 - Attic
 - Living space
 - Outdoor
- Measured duct leakage and airflow

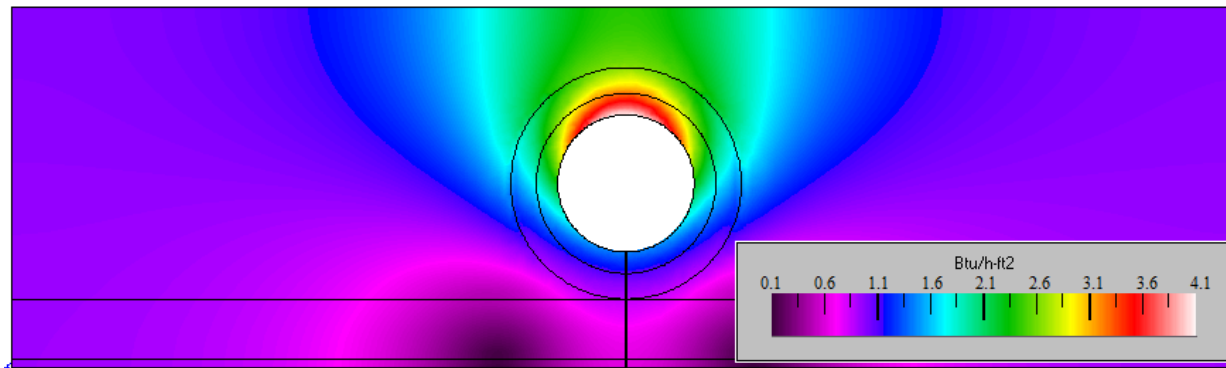


After Encapsulation

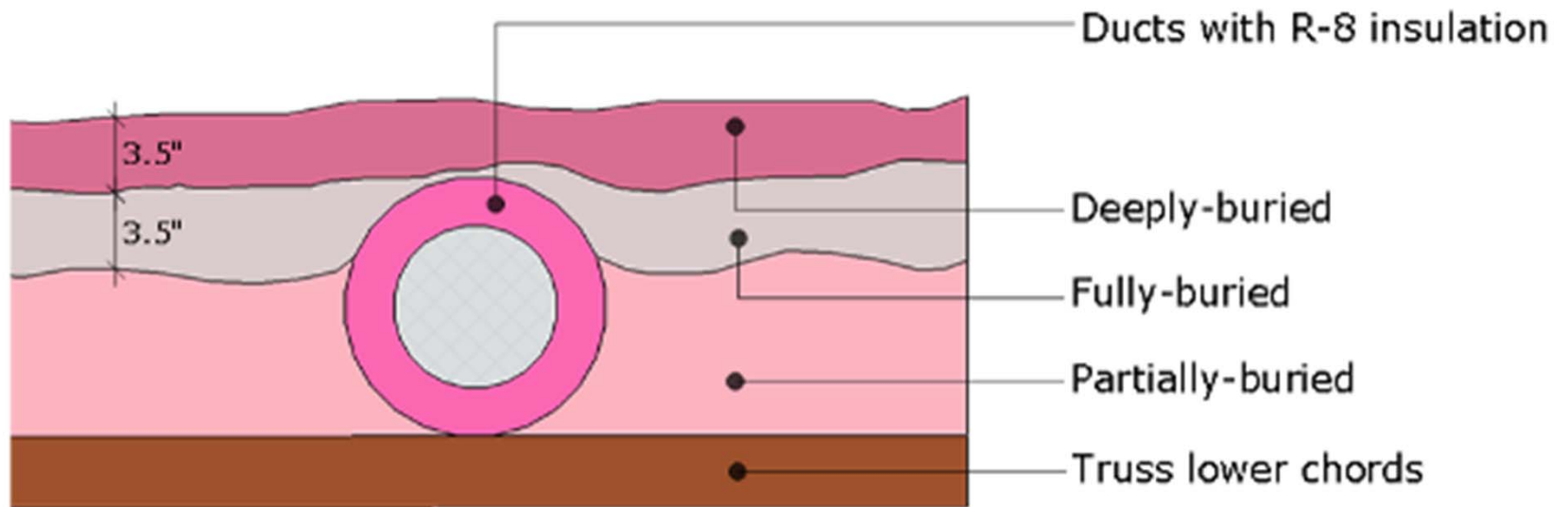


Effective R-values

- R-value metrics:
 - ▣ Nominal – listed values for duct insulation
 - ▣ Effective – heat loss/gain from duct to attic
- Buried duct effective R-values calculated using FEA



Effective R-values



Effective R-values

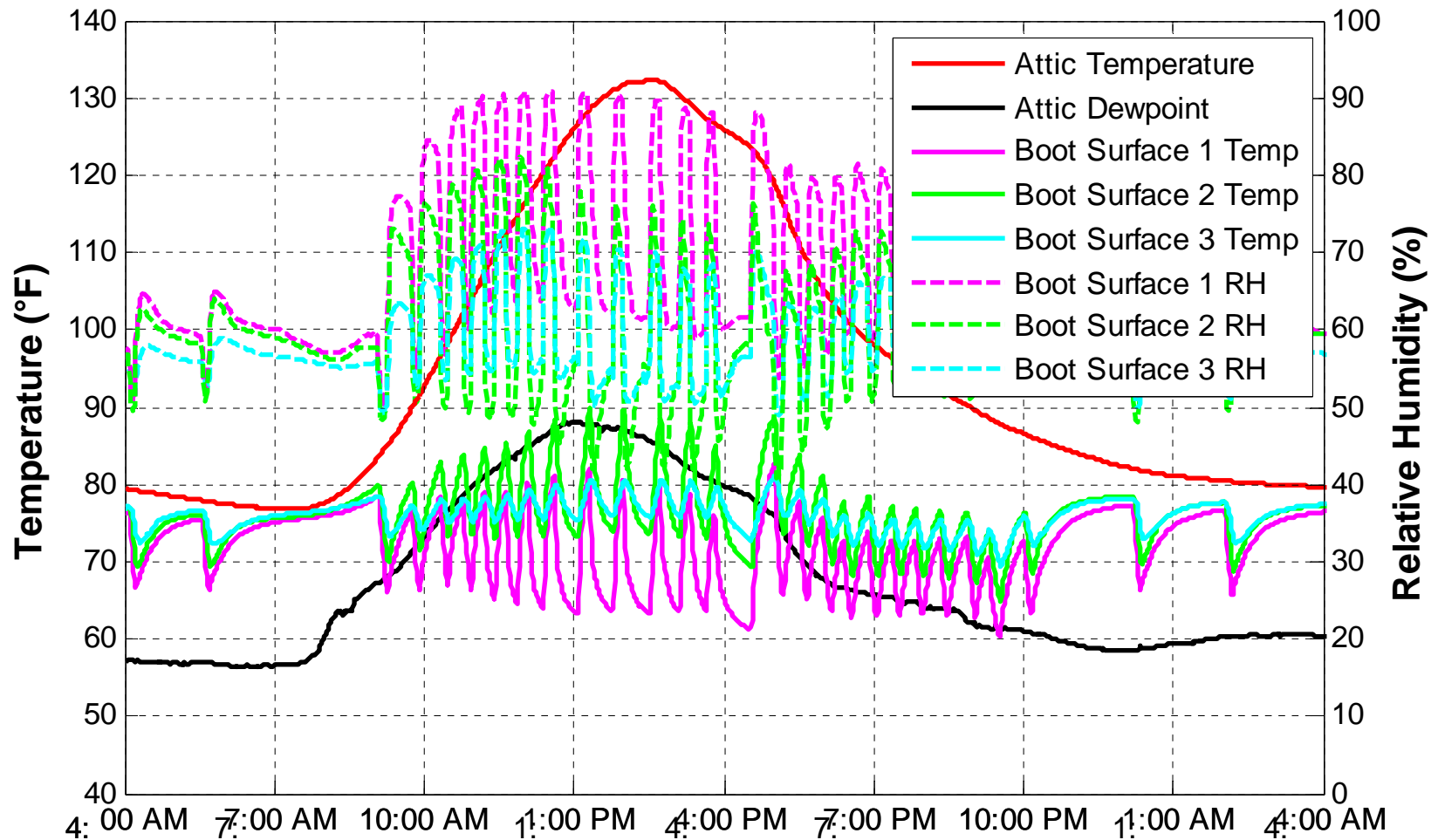
Duct Configuration	R-4.2 Ducts	R-6 Ducts	R-8 Ducts
Traditional hung ducts	4.6	5.9	7.2
Hung ducts encapsulated in 1.5" of ccSPF	11.3	12.0	12.7
Partially-buried	8.1	10.2	12.3
Fully-buried	12.0	14.1	16.2
Deeply-buried	20.7	22.1	23.5
Encapsulated in 1.5" of ccSPF and partially-buried	18.4	19.7	21.0
Encapsulated in 1.5" of ccSPF and fully-buried	22.6	23.8	25.0
Encapsulated in 1.5" of ccSPF and deeply-buried	29.6	30.3	31.1

Delivery System Efficiency

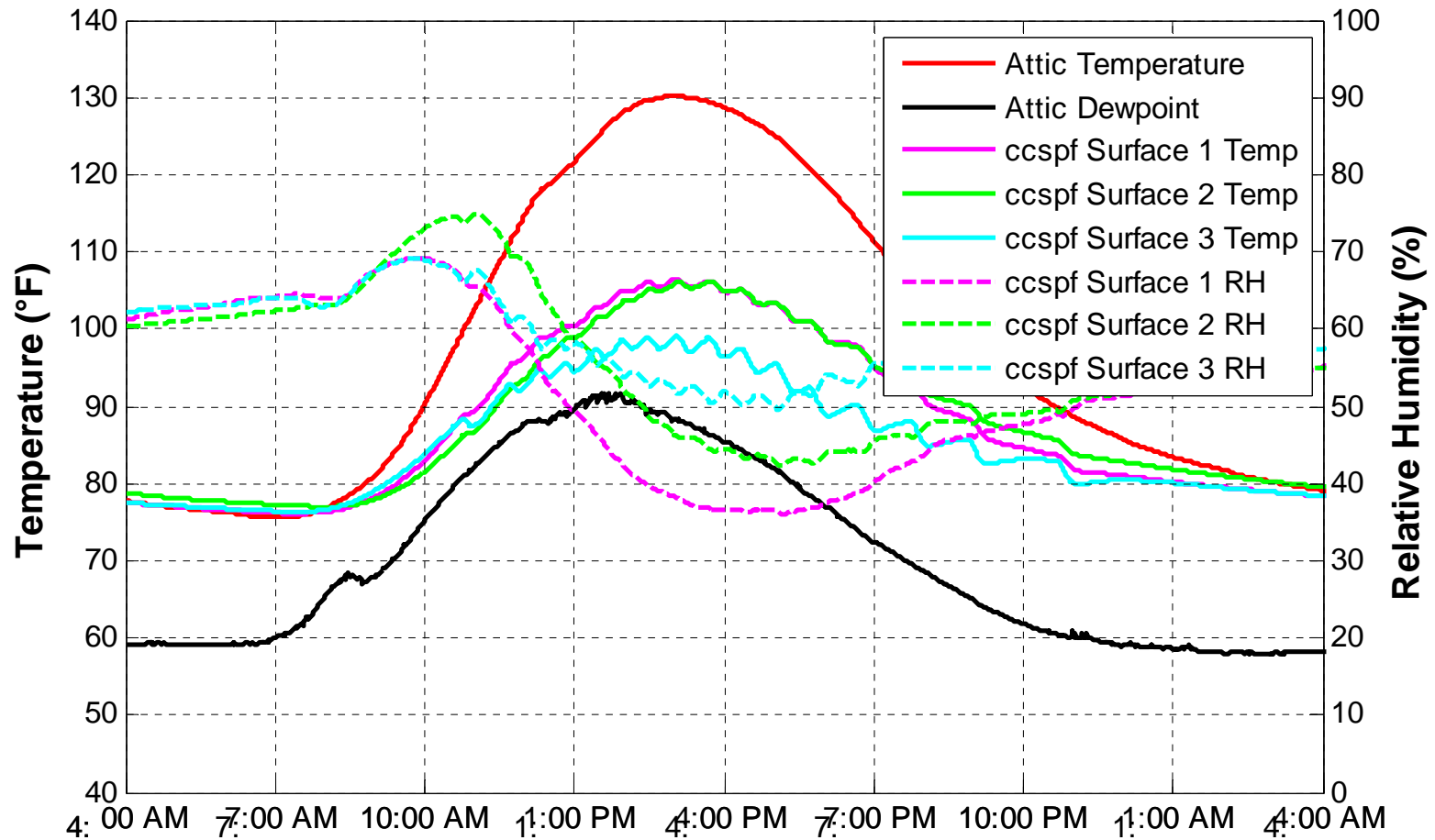
- ASHRAE Standard 152 determines “the efficiency of space heating and/or cooling thermal distribution systems under seasonal and design conditions.”



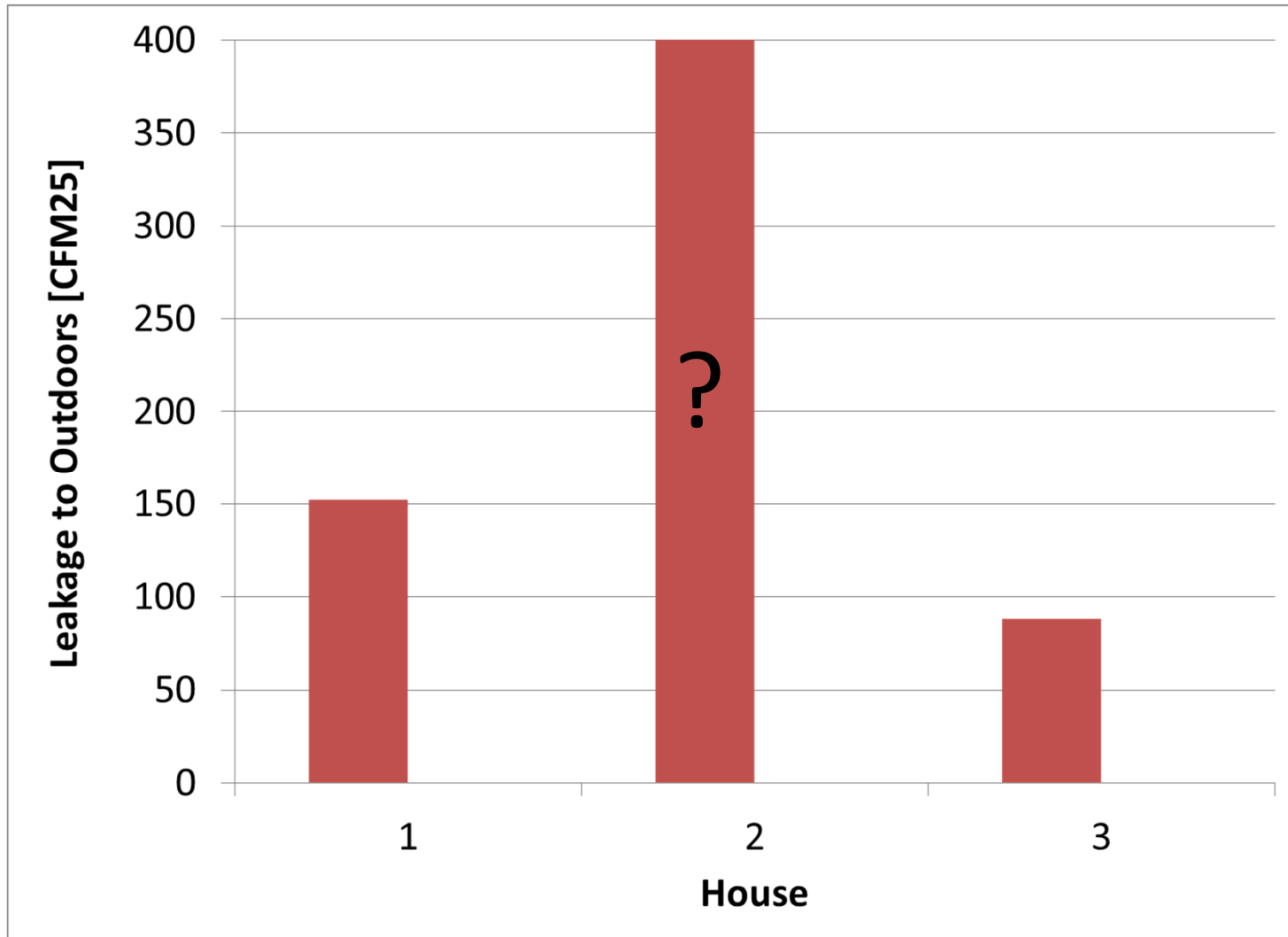
Condensation Potential (Before)



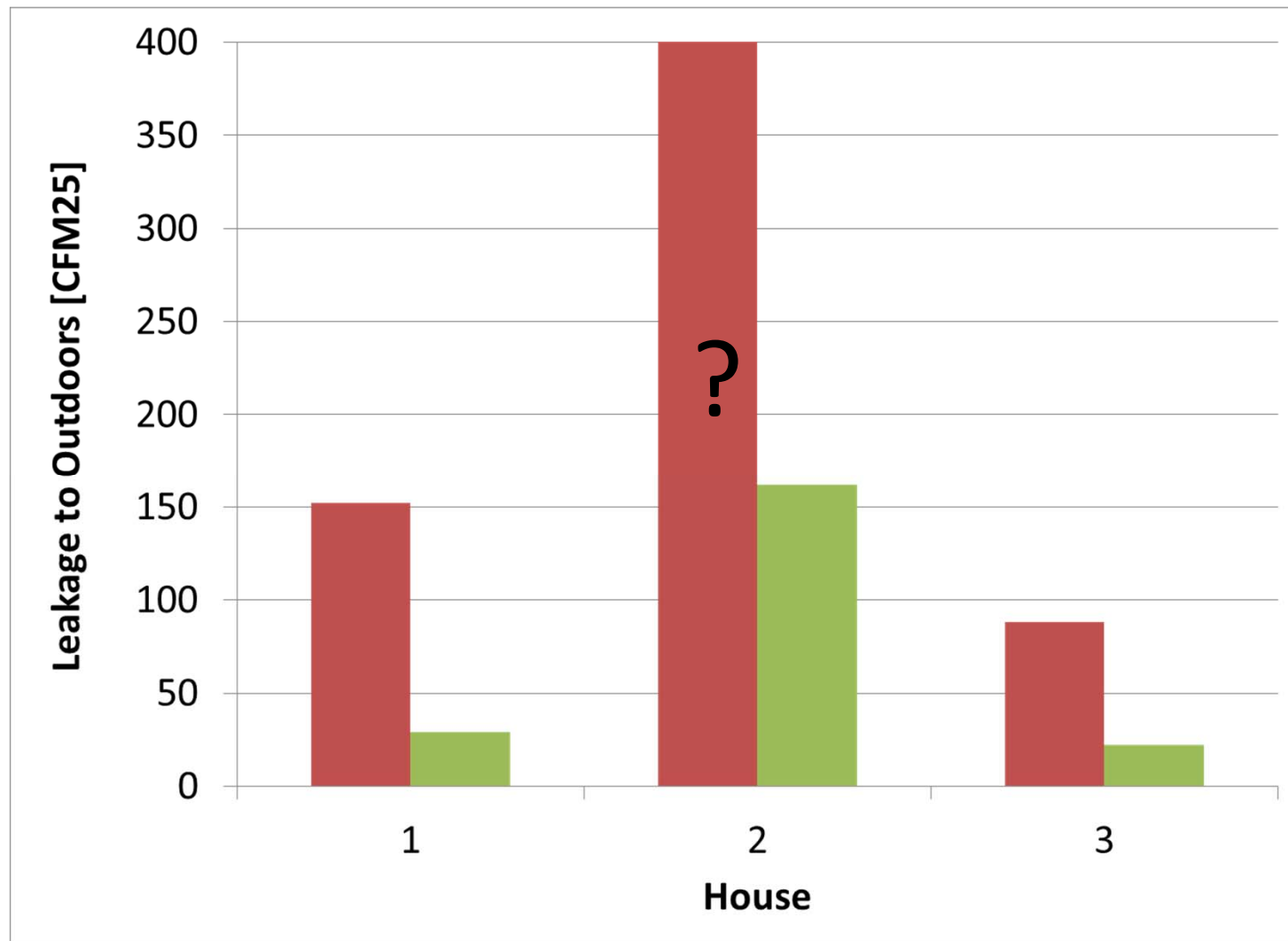
Condensation Potential (After)



Duct Leakage (pre)



Duct Leakage (post)



Energy Savings

	Predicted Energy Savings from BEopt	
	Cooling	Heating
House 1	14 %	12 %
House 2	23 %	26%
House 3	12 %	17%

Cost and Savings

	House 1	House 2	House 3
Retrofit Costs	\$2,290	\$3,806	\$956
“Streamlined” Costs	\$1,730	\$3,391	\$530
Utility Bill Savings	\$127	\$571	\$129
Net, Annualized Savings*	\$10	\$513	\$141

* 30 yr analysis period, 3% inflation rate, 3% real discount rate, 7% 5-year loan

Retrofit Issues – Quality Control



Electrical wiring permanently spray-foamed in place



Supply plenum box inadequately spray foamed

Existing flues must be protected



Retrofit Issues – Quality Control



Exposed underside of duct



Well-sealed ductwork

Resources



- Code-related considerations:
 - ▣ IRC Sections M1601.3, R316.5.3, R316.5.4
 - ▣ Title 24 of California Code of Regulations
 - ▣ DOE Challenge Home
- Technical References:
 - ▣ Several papers since 2000
 - ▣ Recent BA Technical Report
 - ▣ BA Measure Guideline through peer review

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