Revisions to the Residential ACM Calculations

June 15, 2007

Bruce Wilcox

^ 9.5 Tons on a Fresno house

~10 KW compressor

1.7 kW furnace fans

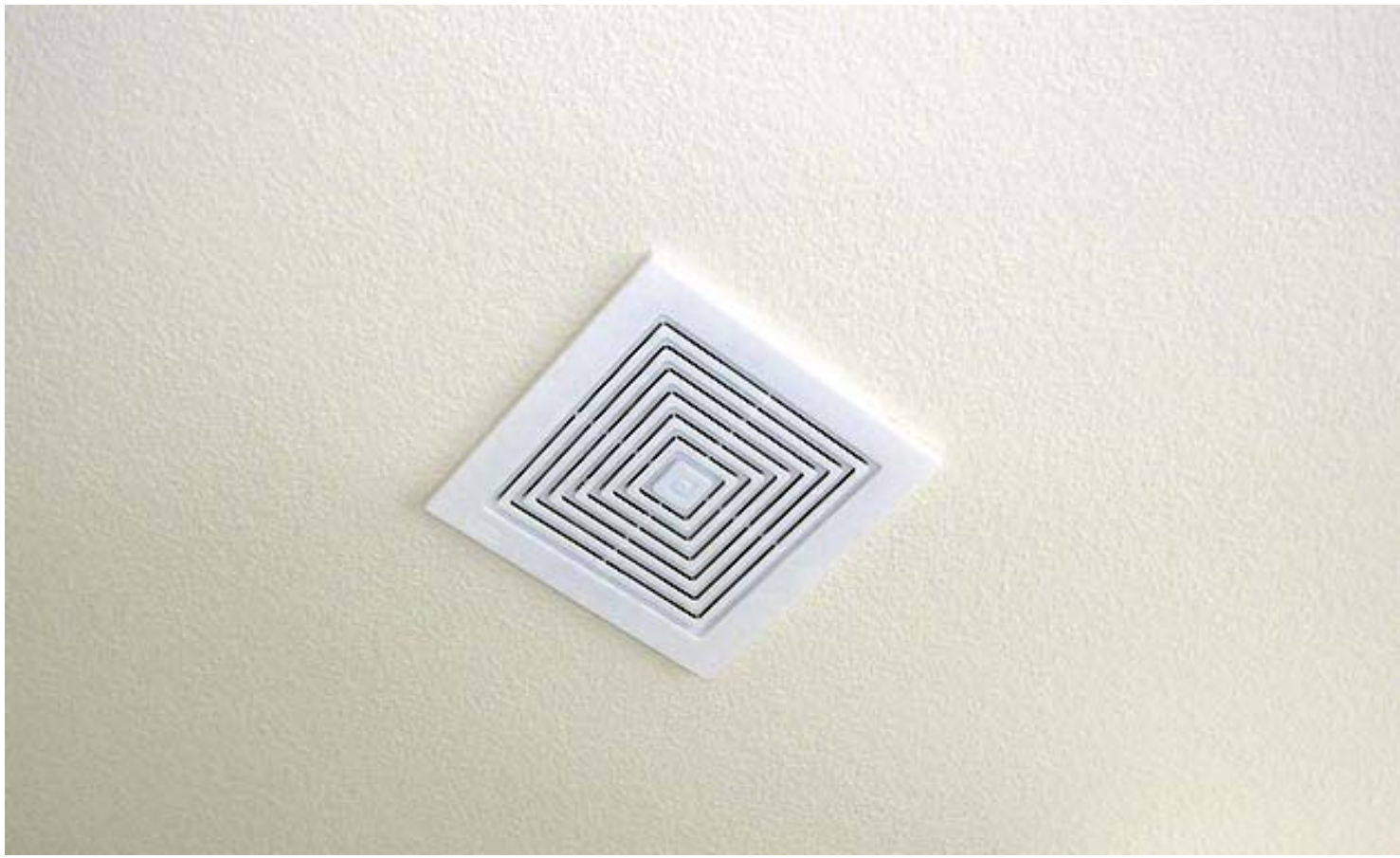
13 tons AC on a 3763 ft2 Palm Springs house

282 ft2/ton - 2.2 kW furnace fans

ACM Change Topics

- Air tightness and ventilation
- Furnace fan
- Duct leakage
- Slab edge

Air Tightness and Ventilation



Air Tightness

- Current default Specific Leakage Area (SLA) 4.4 (sealed ducts) based on California houses built in 1984-1987
- Typical houses are getting tighter
  - RCQ Study average SLA = 3.2 – 3.5
  - Wilson, 76 2002 homes in Southern California, average SLA = 2.8
- Proposed new default and Standard Design
  - SLA = 3.8 with sealed ducts
  - SLA = 3.2 with no ducts in unconditioned space

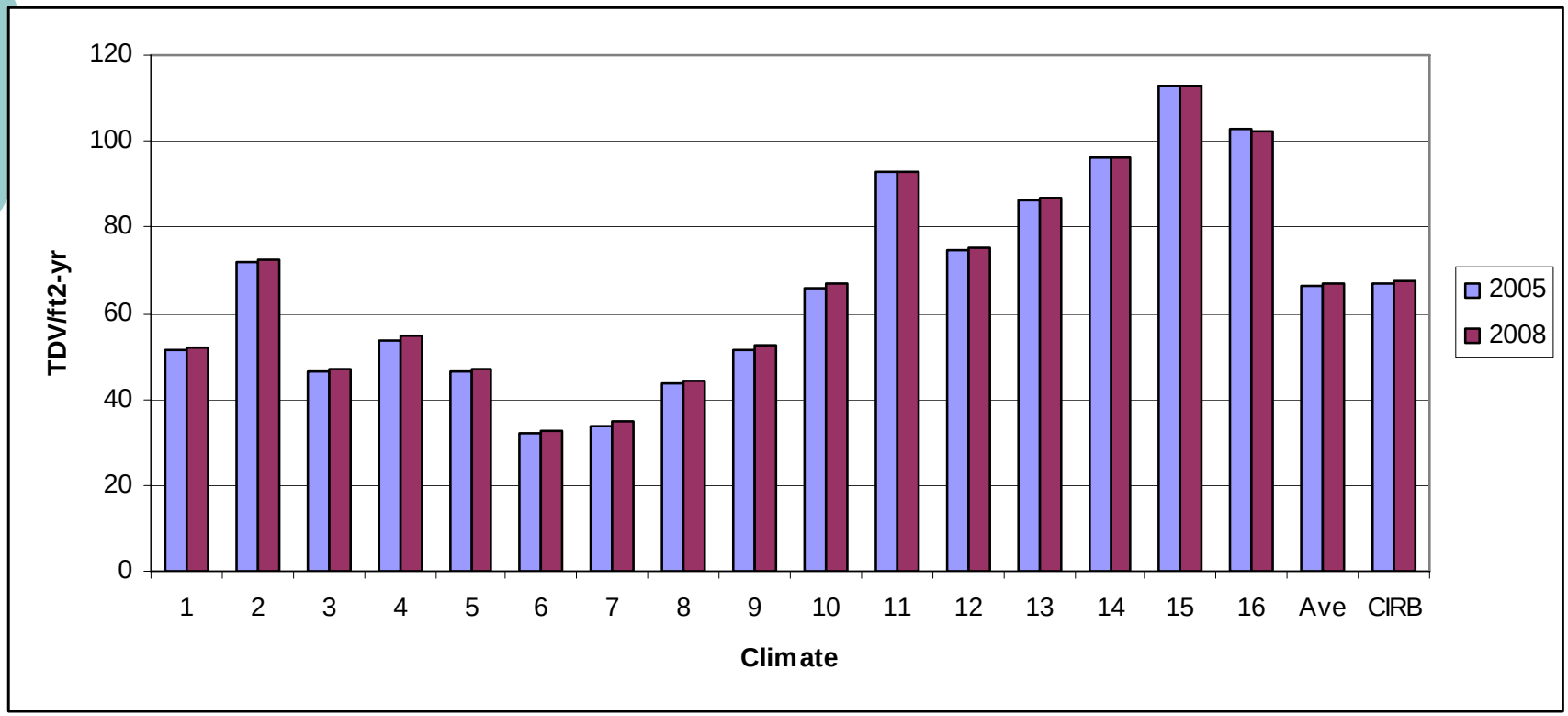
Mechanical Ventilation

- Mandatory ASHRAE Standard 62.2
- Default is continuous exhaust fan
- Default Ventilation Rate is
  - 0.01 * conditioned floor area
  - + 7.5 * number of bedrooms + 1
  - 48 CFM in the 1761 Prototype
- Default W/CFM is 0.25
  - 12 Watts in the 1761 prototype
- Standard Design W and CFM is same as proposed up to a maximum of 1.2 W/CFM

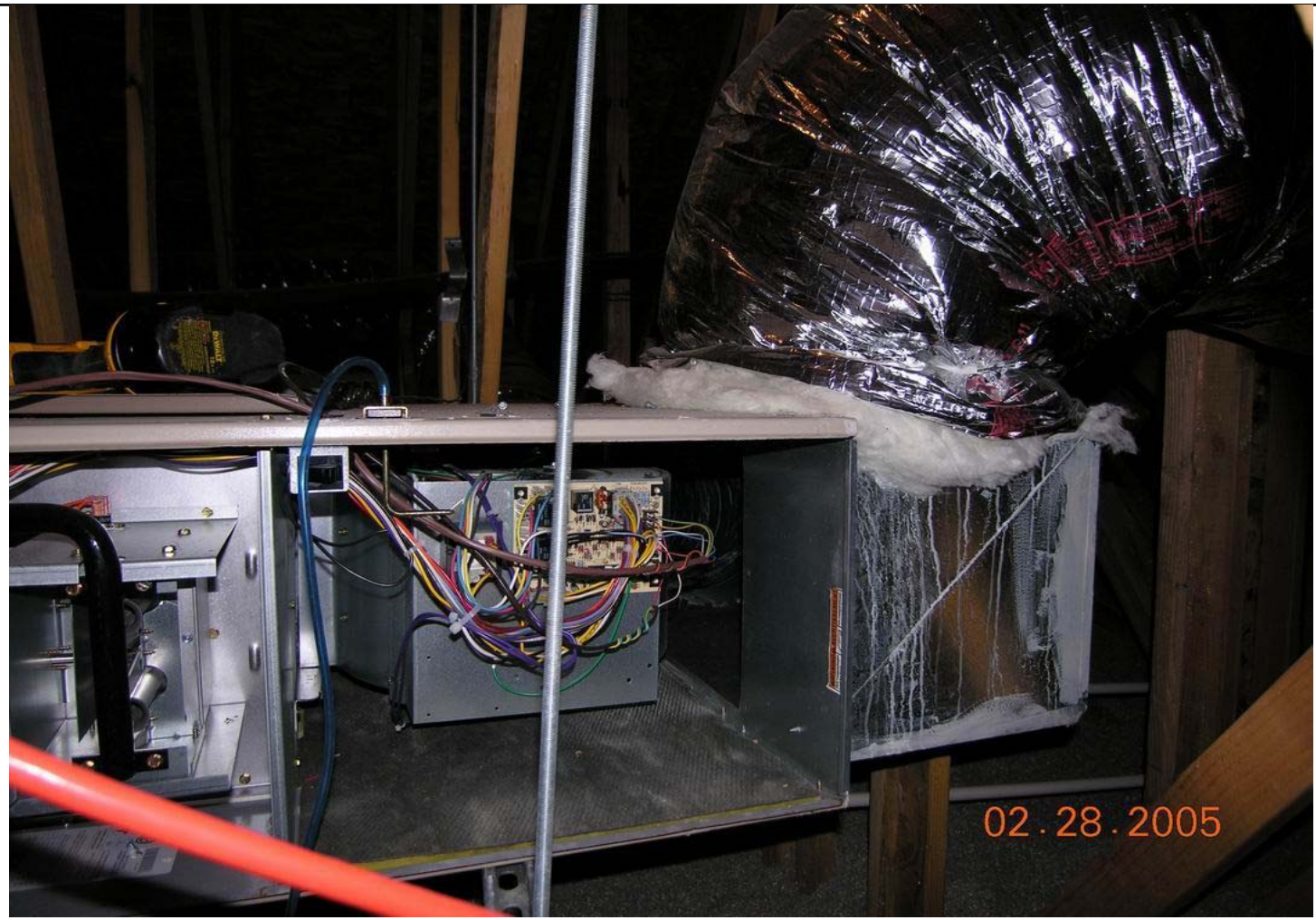
Old Ventilation Model Removed

- No more ACM window openings for IAQ (windows still open for cooling)
- No more ventilation and adverse energy impact of low SLA

Default IAQ Ventilation Increases Annual TDV 1%



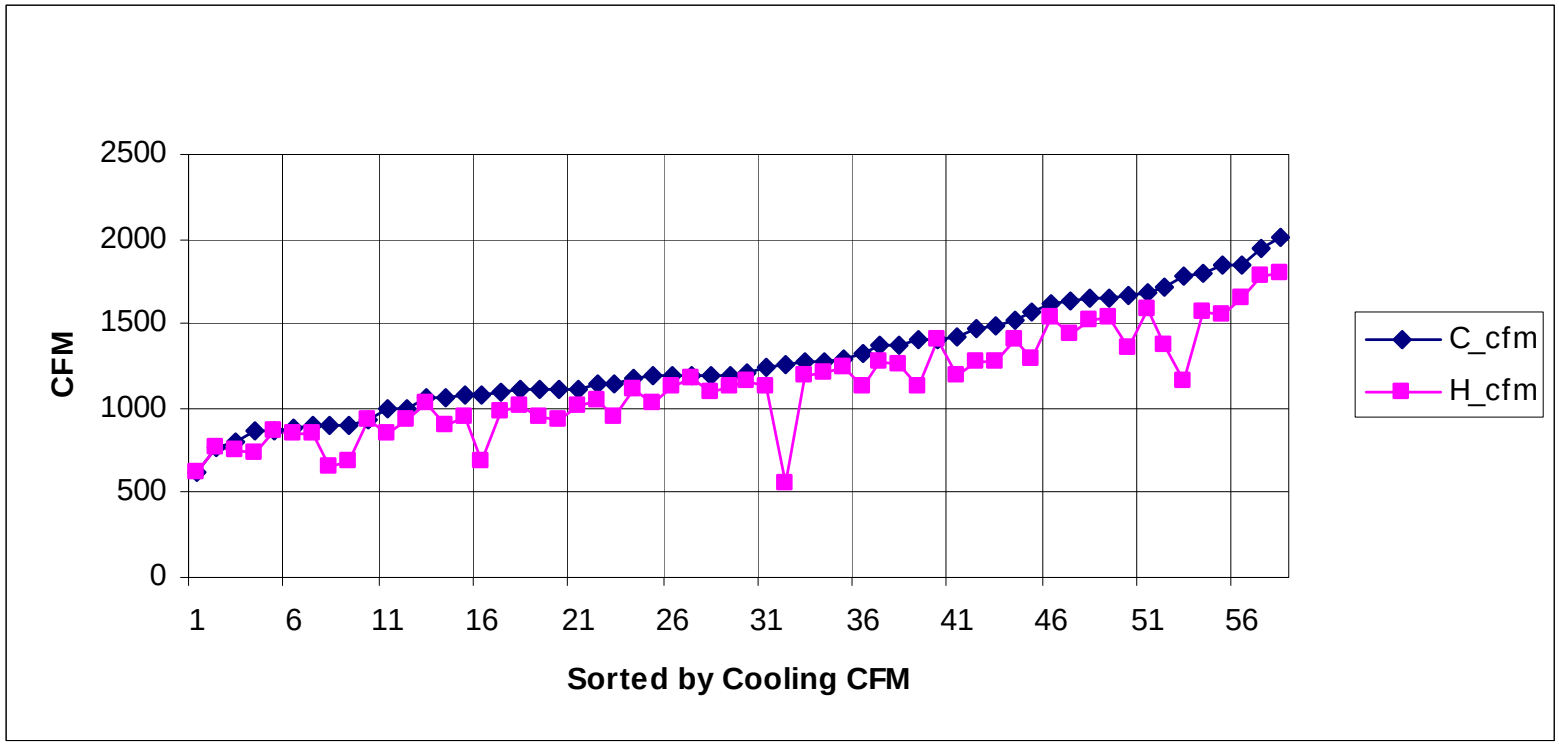
Furnace fan



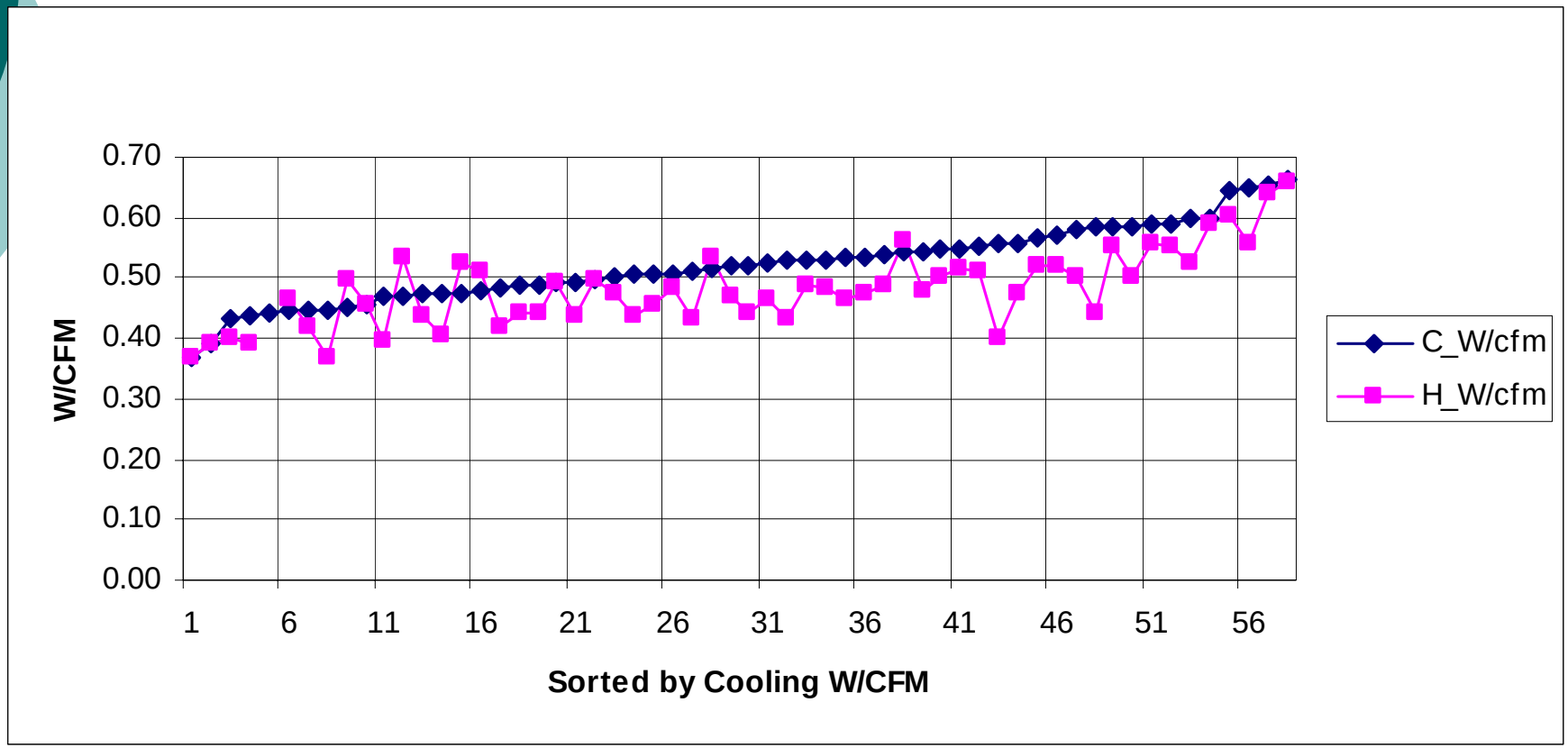
Background

- 2005 ACM models fans for air conditioning using a W/CFM and CFM per ton based model.
- 2005 ACM says fan energy is fixed at .005 x heating output
- There is no heating mode 2005 credit for an efficient distribution system

Field Survey Heating CFM as Function of Cooling CFM



Field Survey Heating W/CFM Function of Cooling W/CFM



Proposed Heating Fan Model

- CFM Heat = 0.93 * CFM Cool
- W/CFM Heat = 0.88 * W/CFM Cool
- Cap Heat = 1.08 * CFM Heat * 40
- W/BtuHeat =
- (CFM Heat * W/CFM Heat) / Cap Heat

Air Distribution Systems

- Central AC fan runs on schedule to distribute IAQ ventilation air to meet the 62.2 requirement
- User inputs distribution rate
- Standard Design 0.58 W/CFM
- Runs min 20 minutes each hour
- Proposed has default fan or actual fan if tested

Duct leakage

Duct leakage Topics

Low Leakage Air Handlers

Low Leakage Ducts

Ducts in Conditioned Space

Ducts in the UZM model

Leaky Air Handlers

- Air handlers are a significant source of distribution system air leakage
- Raters report that leaky air handlers are one of the reasons systems fail duct sealing criteria
- Field applied air handler sealing, especially around access panels, may not be reliable

Low Leakage Air Handlers Proposed Credit

- Florida code testing definition for now. ASHRAE test standard under development.
- Manufacturers test and certify to the Commission
- HERS Verification is required for credit
- Credit must be combined with verified duct leakage

Low Leakage Air Handlers Florida Definition

A factory sealed air handler unit tested by the manufacturer and certified to the Commission to have achieved a 2 percent or less leakage rate at 1-inch water gauge when all air inlets, air outlets and condensate drain port(s), when present, are sealed at an air pressure of 1-inch water gauge with no greater than 2-percent of design cubic foot per minute discharge.

Low Leakage Air Handlers Two ACM Credit Methods

- Credit with verified duct leakage
  - Test to 6% (current criteria)
  - Use 6% leakage in ACM calculations (instead of 8%)
- Credit with specified lower duct leakage
  - Select a leakage level <6% for ACM run
  - Test to specified total duct leakage level or lower
  - Provides a way to do better than current leakage rate if done in conjunction with a low leakage air handler

Low Leakage Ducts in Conditioned Spaces

- Ducts in conditioned space can provide significant energy savings
- Current ACM rules separate conduction and air leakage losses
- Ducts qualifying as being in conditioned space have conduction losses set to zero, but still have same air leakage losses to outside as other ducts

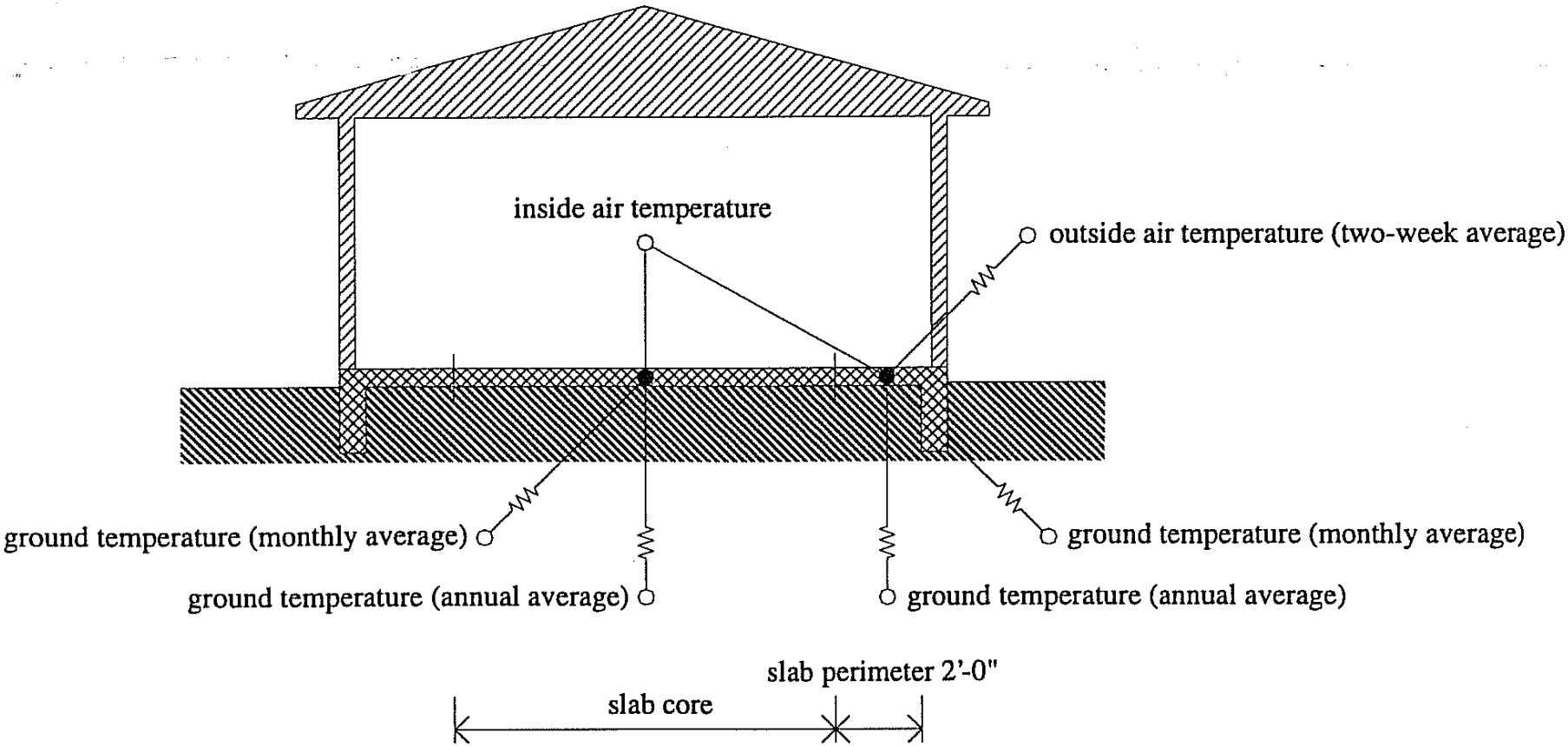
Ducts in Conditioned Spaces 0% Leakage in ACM

- Use test method described in Appendix RC.4.3.3, *Duct Leakage to Outside from Fan Pressurization of Ducts*
- Threshold of 25 cfm to meet definition of low leakage to account for practical measurement issues
- HERS Verification is required for credit
- Credit must be combined with verified duct in conditioned space

Ducts in the UZM Model

- Same as current inputs except:
- Cooling supply CFM for each zone
  - Defaults and Standard Design based on calculated AC capacity
  - Default 300 CFM/ton
  - Standard Design 350 CFM/ton
  - Proposed with verification is 350 CFM/ton or greater

Slab Heat Flow



CEC Slab Loss Model

- Developed in 2000 by Huang et. Al. at LBNL
- Simplified model for hourly simulation
  - Based on results of detailed 2D model
  - Regression coefficients for conductance to annual, monthly and weekly temperatures
  - Carpeted and hard surface slabs
  - Prototype implemented in DOE2

Residential ACM

- Keep current slab inputs
  - Area carpeted and hard surface
  - Perimeter length of each
- Adapt for Residential ACM
  - Apply to bottom of slab
- User selects library input for slab edge insulation
  - Location/type
  - R and depth of insulation

    Include shallow insulation for floating slabs