HVAC Equipment Sizing Strategies: Taking Advantage of High-Performance Buildings

EEBA Excellence in Building Conference

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www.buildingscience.com

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Other Resources

- Proctor Engineering Group (San Rafael, CA)
  www.proctoreng.com

  Article: “Bigger is Not Better: Sizing Air Conditioners Properly”

- Florida Solar Energy Center (FSEC)
  www.ucf.fsec.edu

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Benefits of 'Right-sizing' Equipment

- Reduces short cycling (lower efficiency)
- More moisture removal (latent load)
- Reduces electrical peak load
- Smaller and simpler HVAC system—easier to fit inside conditioned space
- Comfort & noise—"blast of cold air" effect & mixing
- *Lower equipment cost—recoup costs of energy-related upgrades*

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Reasons for Equipment Oversizing

- Rule of thumb sizing strategies (e.g., 400 sf/ton)
- Tradition—always done this way
- Avoiding callbacks (covers up problems with underperforming equipment)
- Room for expansion or for unforeseen loads

- **Oversizing from rule of thumb is worse in buildings with high-performance envelopes**

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So how is equipment sized correctly?

- Load calculation: ACCA Manual J
- Computes heat flow in/out of the building at design conditions (1% design temperature)
- Manual J has safety factors built in—fudging above that load is unnecessary

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Components of a load calculation

- Regular heat conduction—walls, roofs, floors
- Windows—add radiation (sunlight)
- Air movement—infiltration & ventilation

- Latent load—moisture/humidity to be removed by cooling system

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Heat conduction

- **U x A x ÄT = heat flow through wall/roof/etc**

- U = 1 / R-value (e.g., R-30 ˜ U=0.033)
- A = area
- ÄT = temperature difference

- Be sure that upgraded building components (e.g., 2x6 walls, insulating sheathing) are accounted for

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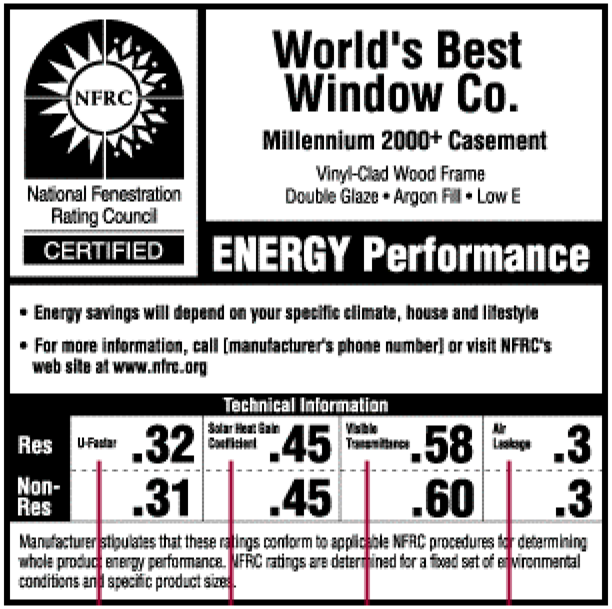
Windows



- 1/3 to 2/3 of cooling load typically from windows
- U-value (insulation)
- SHGC (solar heat gain coefficient) or SC (shading coefficient)
- Shading—external and internal
- House orientation—if known, use it.

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Air movement

- Infiltration—unintentional air movement. Measured in ACH (air changes per hour)
- Ventilation—intentional air movement. Measured in CFM (cubic feet per minute)

- Well-sealed buildings have lower infiltration—0.1 ACH measured in Building America houses

  Therefore lower infiltration loads.

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Other Items

- Latent load—don't use "30%" rule of thumb
- Duct losses—vary with location and insulation level. Are zero with ducts inside conditioned space.
- "Swing multiplier"—used to account for equipment capacity loss at high outdoor temperatures. Sometimes used incorrectly as general fudge factor.

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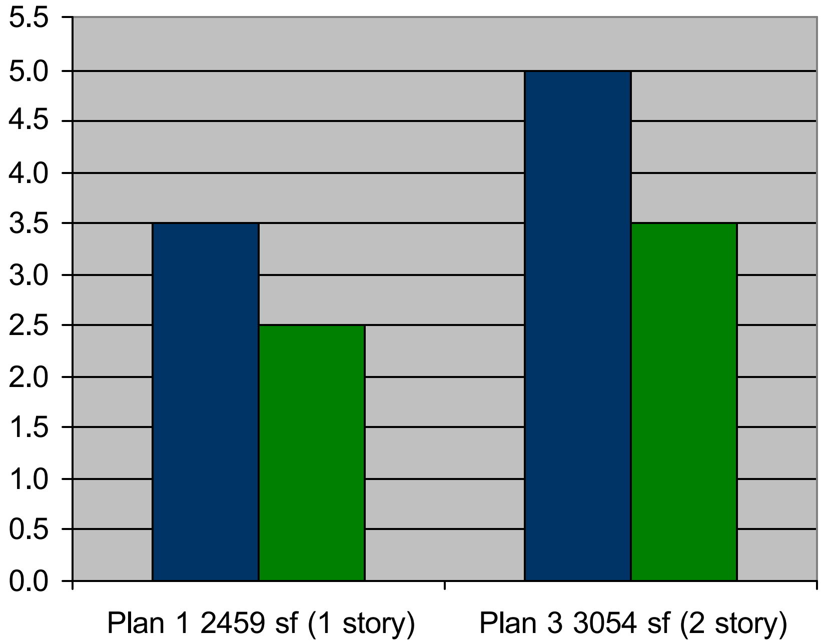
Equipment Resizing Example (Northern CA)



Modifications included:

- Spectrally-selective windows
- Unvented roof/ducts inside conditioned space
- Tighter building envelope
- Thicker wall insulation

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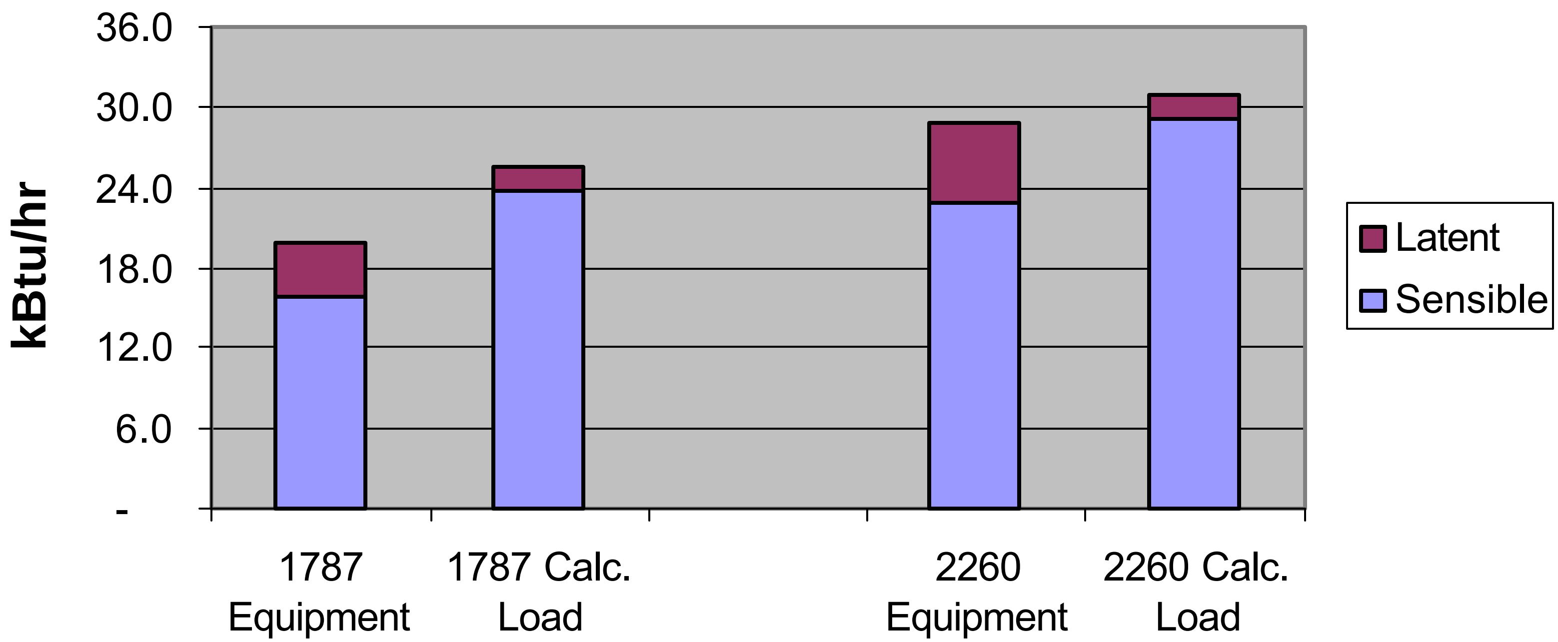
Sizing equipment below Manual J Loads: Las Vegas, NV (Arbor View)



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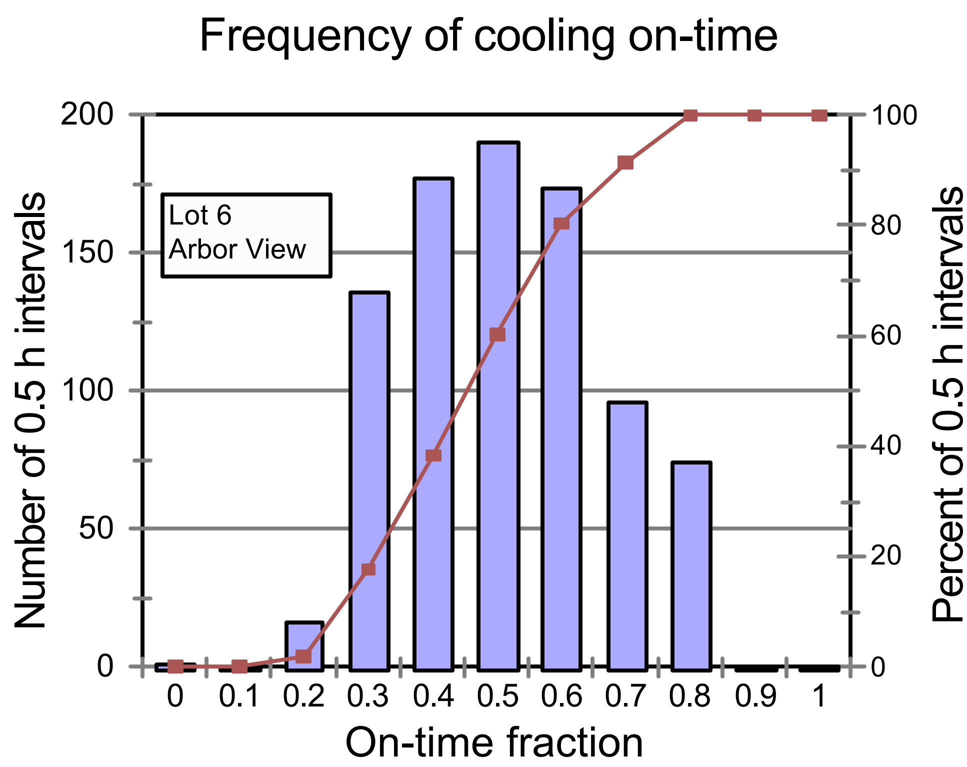
Arbor View Plan 2260 On-Time Frequency



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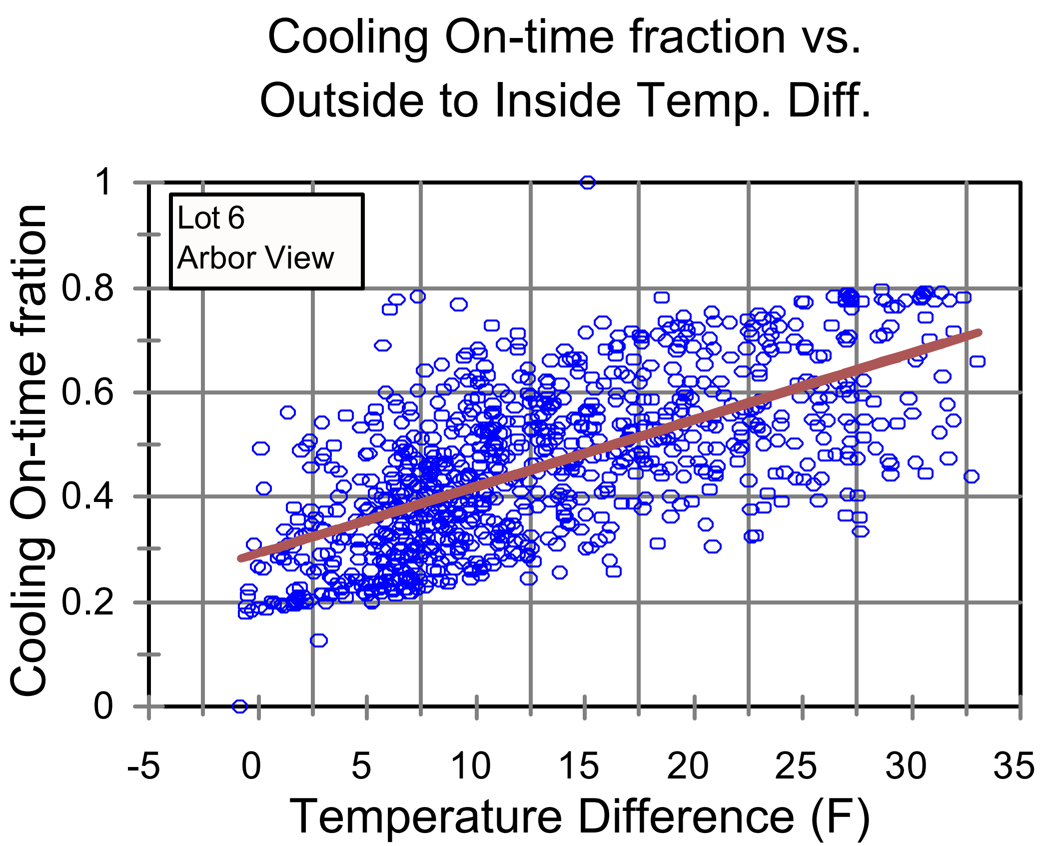
Arbor View Plan 2260 Runtime vs. ÄT



Problems Seen When Resizing Equipment

- Customer perceptions—"Why do I have 3 tons when my neighbor has 5 tons?"
- Customer complaint—"Why is my equipment running so long? Its never done that before."
- Greater vulnerability to poorly installed systems—duct leakage, improper refrigerant charge, or low airflow.
- Higher recovery times from deep setbacks—instruct customers to "set & forget" thermostats.

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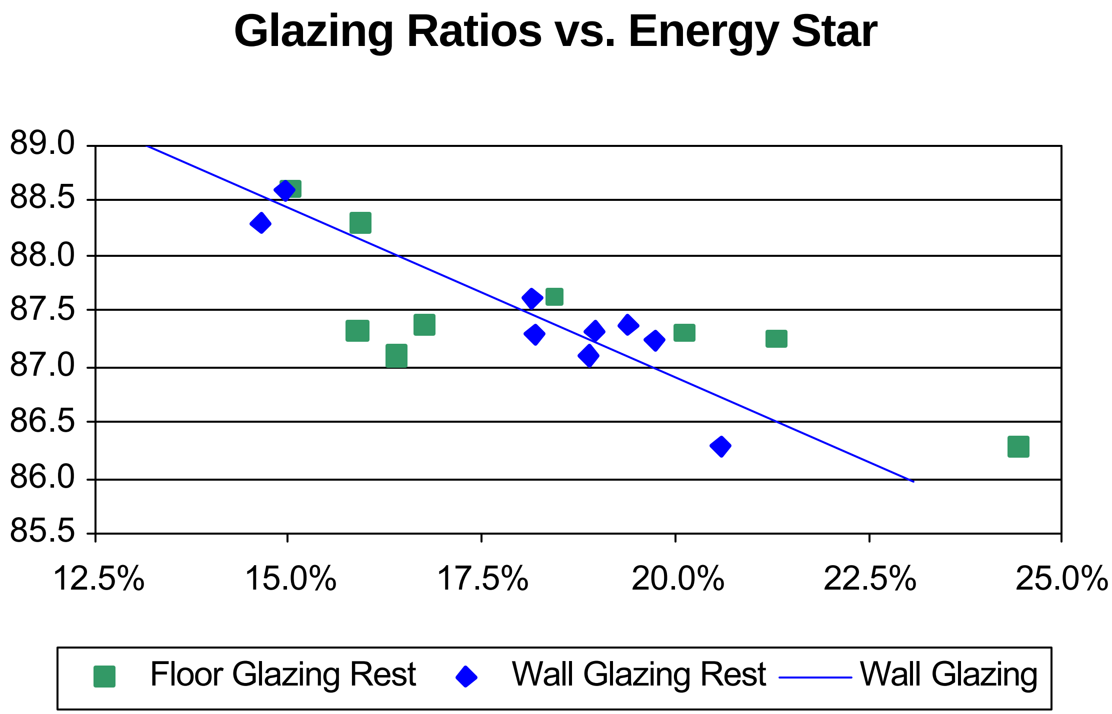
Window Effects on Loads & Efficiency



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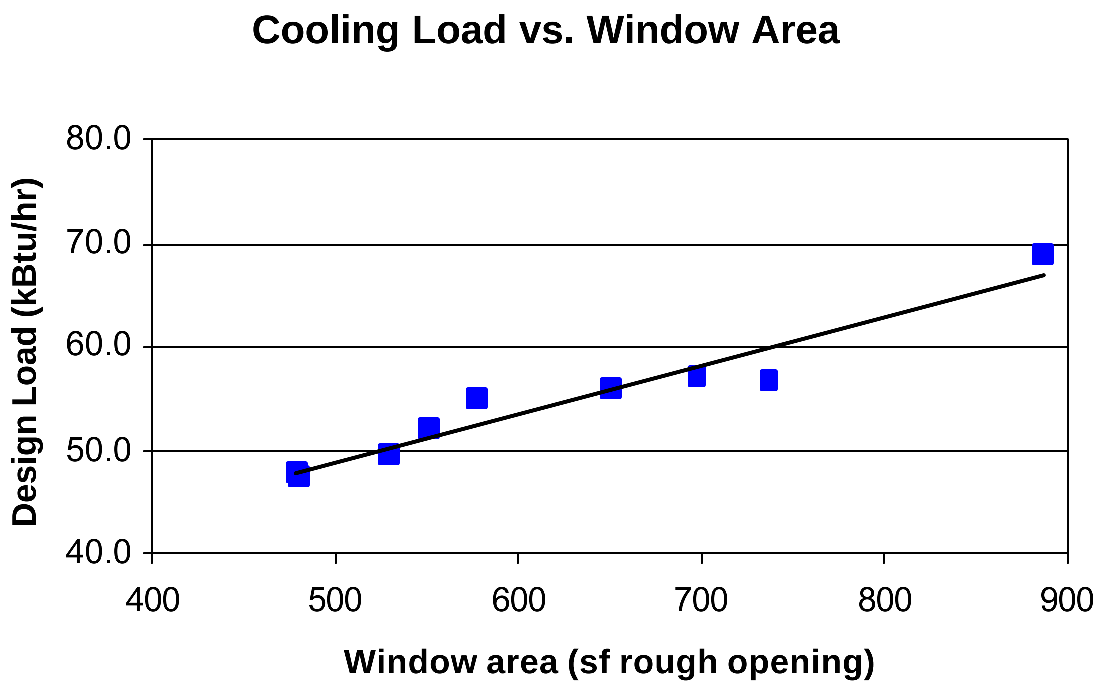

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