Workshop Presentations
2008 California Building Energy Efficiency Standards
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Part 1: Furnace Fan Watt Draw and Airflow in Cooling Mode
Part 2: Air Conditioner Airflow, Refrigerant Charge, and TXVs

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Part 1: Furnace Fan Watt Draw and Airflow in Cooling Mode and Watt Draw in Air Distribution Mode

- Investigation and Supporting Data
- Cost Effectiveness
- New Prescriptive Standard
- ACM Changes
Field Survey

- 60 furnace systems in new homes

- 55 in production homes, 5 custom

- Measured air flow and fan watts by mode (heating and cooling) (zonal control)

- Measured static pressures by mode and component
Median Cooling Fan Watts = 632
Median Cooling Airflow = 358 CFM/ton
Median External Static Pressure = 0.8 IWC

Cooling External Static Pressure

- Median External Static Pressure = 0.8 IWC
- Diagram showing Cooling External Static Pressure with values ranging from 0.2 to 1.2 in of water, and the number ranging from 1 to 46.
Cooling W/CFM is related to AC size

![Box plot showing the relationship between Nominal Tons and Watts per cfm.]

- Nominal Tons: < 3, 3 to 4.5, 5
- Watts per cfm: < 0.35, 0.35 to 0.45, 0.45 to 0.55, 0.55 to 0.65, 0.65 to 0.75, 0.75
External Static Pressure Alone is Not a Sufficient Predictor of Watts/CFM
Lab Tests

- 6 furnaces, representative of survey results
- 3 ton and 4 ton airflows
- Permanent Split Capacitor and Electrically Commutated Moters
- Measured flow and watt draw over a range of external static pressures
Furnace Lab Experimental Apparatus
Furnace Air Handler Performance
High Speed

Watts/1000cfm

External Static (IWC)

Unit 2
Unit 6
Unit 3
Unit 1
Unit 4A
Unit 4
Unit 5
Manufacturers’ Data

- Compiled by LBNL
- Data from Manufacturers’ website or directly
- 841 model number and blower speed combinations that had blower power information
Permanent Split Capacitor Watts / CFM at High Speed and 0.8 IWC

Graph showing the relationship between watts per cfm and unit number. The x-axis represents unit number ranging from 0 to 146, and the y-axis represents watts per cfm ranging from 0.3 to 0.7. The graph shows a trend line indicating an increase in watts per cfm as unit number increases.
Permanent Split Capacitor Watts / CFM at High Speed and 0.5 IWC
Cooling W/CFM is related to AC size
Reducing External Static

- Component level external static reductions for average surveyed system to achieve 0.5 IWC total external static

<table>
<thead>
<tr>
<th>Component</th>
<th>Survey Median</th>
<th>Target</th>
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<tbody>
<tr>
<td>Supply Duct</td>
<td>0.18</td>
<td>0.18</td>
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<tr>
<td>Cooling Coil</td>
<td>0.27</td>
<td>0.20</td>
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<tr>
<td>Return Duct</td>
<td>0.15</td>
<td>0.05</td>
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<tr>
<td>Filter</td>
<td>0.15</td>
<td>0.07</td>
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<tr>
<td>Total</td>
<td>0.75</td>
<td>0.50</td>
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## Cost of Reducing External Static

- Cost increase for average system surveyed (3.5 ton) to achieve 0.5 IWC external static

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<thead>
<tr>
<th>Component</th>
<th>Modification Strategy</th>
<th>Cost increase</th>
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<tbody>
<tr>
<td>Supply Duct</td>
<td>No Change</td>
<td>40.00</td>
</tr>
<tr>
<td>Cooling Coil</td>
<td>5 ton coil</td>
<td>40.00</td>
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<tr>
<td>Return Duct</td>
<td>Increase diameter</td>
<td>11.76</td>
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<tr>
<td>Filter</td>
<td>25% Larger area</td>
<td>15.00</td>
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<tr>
<td>Overhead and profit</td>
<td>30%</td>
<td>37.00</td>
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</table>

Total: 123
Fan Watt Life Cycle Cost

- 100 Watt/1000 CFM reduction saves $172 PV in Climate Zone 12
- Cost delta for improved ducts is $123
Prescriptive Standard

- Cooling Mode in CTZ 10-15

- Central forced air system fans shall simultaneously demonstrate, in every zonal control mode, a flow greater than 350 CFM/ton of nominal cooling capacity and a watt draw less than:
  - .5 W/CFM  <5 nominal tons
  - .55 W/CFM  5 nominal tons)
Prescriptive Standard

- Air Distribution Mode in all Zones
- Central forced air system fans in Air Distribution Mode, a watt draw less than:
  - 0.5 W/CFM < 5 nominal tons
  - 0.55 W/CFM 5 nominal tons
ACM Modeling for Air Distribution Systems

- Air Distribution Schedule is 33% on every hour.

- Ventilation air inlets if not controlled
  - add ELA to proposed SLA
  - add return leak with vent CFM
Part 2: Air Conditioner Airflow, Refrigerant Charge, and TXVs

- Field Experience and Data
- Changes to Prescriptive Standard
- “Housekeeping” Changes
Field Reports

- Reports from HERS Raters and Evaluators

- Poor Installation Quality of TXVs Prevent Proper Operation
Data Analysis on TXVs
Superheat Distribution Indicates a Problem

- 4384 Field Tests
- Residential
- Split Units
- Correct Subcooling (indicating correct refrigerant charge)
Changes to Prescriptive Standard for AC Charge

- Eliminate TXV credit
- Always verify charge
- Verify TXV performance
- Set Adequate Airflow Credit at 350 CFM per ton
Appendix RD – Procedures for Determining Refrigerant Charge for Split System Space Cooling Systems

1. Remove TXV exemption
2. Add subcooling test method for TXVs and EXVs
3. Add metering device operation check for TXVs and EXVs
   a) superheat must be within manufacturer’s specified range if available
   b) superheat must be between $+4^\circ F$ and $+25^\circ F$ if manufacturer’s specification is not available
Housekeeping

- Clarify *minimum* airflow for refrigerant testing
  - Temperature split cannot be used for any purpose other than establishing minimum airflow for refrigerant testing

- Temperature Split Table clarification

- Inspectors’ (HERS Raters) tolerance for temperature split, subcooling, and superheat changed to 1°F greater than installers