Steam System Balancing and Tuning

Building America Stakeholder Meeting

Austin, TX

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March 2, 2012
Current collaboration with GTI as a part of the PARR Building America team

- Steam Systems Balancing and Tuning Study
- Heating season 2011-2012
In Chicago, heating is the focus of residential energy use.

Of the 470,000 multifamily units in the Chicago region, at least 70,000 of those are steam heated.

Old steam systems invariably suffer from imbalance:
- Tenants must use supplemental heat or open their windows to cool their apartments during the heating season.

Buildings are often overheated.
Steam heat was the best option for buildings constructed between 1900 and 1930.

Boiler cycle of single pipe steam systems.

Systems have been upgraded from coal to natural gas and many have undergone boiler replacement, but distribution systems remain largely the same.

Not designed for efficiency.

(Peterson, 1985)
Problem Statement
Background

- Contractors currently not commonly selling system balancing as a service or recommending it as a measure
- Not tangible – often just requires time and dedication rather than expensive equipment replacements
- Difficult to convince owners of its value
  - Balancing is a separate issue from boiler replacement
  - Natural gas is cheap, so it is not worth the time or effort
Cost-effectiveness

- Improving the balance of buildings provides
  - Opportunity for cost savings
  - Previous studies: 5-15% energy savings, 2-5 year payback
  - Increased resident comfort

(Peterson, G., 1985)
Research Questions

- How do steam balancing measures affect the temperature dynamics within units?
- Will steam balancing affect the average length of boiler cycles?
- How cost-effective are steam balancing measures?
Technical Approach

Steam balancing measures
- Replacing radiator vents
- Adding or upgrading main line air venting
- Boiler controls (4-6 sensors, indoor averaging)
Install steam balancing measures in 10 test buildings:

- Single-pipe steam
- 15-30 units
- Uneven heating throughout the building (based on observations from auditor, building manager, and/or tenants)
- Boiler in good condition
A single point of contact to provide multifamily building owners with access to:

- **Technical Assistance**
  - Utility bill analysis
  - Energy assessment
  - Cost-effective energy-saving recommendations

- **Financing**
  - Low-cost financing through our partner, the Community Investment Corporation

- **Construction Oversight**

- **Annual Performance Monitoring**
  - Two years post-retrofit
Technical Approach

Pre-Balancing Natural Gas Usage (For Heating) in Test Buildings

Energy Use Intensity (kBTU/sq ft/yr)

Buildings

(Data has been weather-normalized)
Technical Approach

- Retrieve pre-upgrade measurements and data for monitoring
  - Structural data
  - Boiler information/pipe structure/condition of vents/type of existing controls
  - Temperature data from units
  - Boiler run-time data
  - Tenant survey/heat calls

- Develop detailed scopes for steam balancing work to be done
  - Measures included replacing radiator vents, adding or upgrading mainline air vents, and installing boiler controls
  - Scopes included price breakdowns for each measure
Technical Approach

- Oversee general contracting
  - Inspection of work/quality control
  - Boiler control settings

- Collect post-upgrade data
  - Temperature data from units
  - Boiler run-time data
  - Tenant survey/heat calls

- Utility bill analysis comparing pre-upgrade and post-upgrade heating fuel use
  - Weather-normalized calculation of heating Energy Use Intensity (kBTU/sq ft/yr)
Project Status

- Pre-upgrade measurements and data collected
- Steam balancing measures installed in test buildings
- Pre-upgrade data being analyzed
- Post-upgrade data collected (in process)
Temperature control and steam systems behavior (pre and post-measure comparisons):

- Data from temperature loggers used to determine temperature distribution in building
- Temperature and boiler firing data used to determine average time for units to heat up
- Boiler run-time data shows the average length of boiler cycles
- Tenant comfort survey
Pre-Measure Data

Pre-Upgrade Unit Temperatures in Test Building

<table>
<thead>
<tr>
<th>Temperature (deg F)</th>
<th>3rd Flr, South Side</th>
<th>3rd Flr, North Side</th>
<th>2nd Flr, South Side</th>
<th>2nd Flr, North Side</th>
<th>1st Flr, South Side</th>
<th>1st Flr, North Side</th>
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Hour
Cost-effectiveness

- Average cost of balancing (radiator vents, mainline vents, boiler controls)

- Natural gas savings
  - Determined from boiler run-time data and utility bill analysis

- Natural gas savings converted to financial savings

- Calculation of simple paybacks from financial savings and measure costs
**Measure Costs**

<table>
<thead>
<tr>
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<th>Main line vents</th>
<th>Radiator vents</th>
<th>Boiler controls</th>
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<tbody>
<tr>
<td><strong>Average cost</strong></td>
<td>$1,800</td>
<td>$3,700</td>
<td>$5,100</td>
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* Averages of measure costs from 10 test buildings
Project seeks to:

- Determine the cost-effectiveness of steam balancing measures
- Develop steam balancing as a viable energy efficiency measure
- Provide guidelines to deal with some of the current barriers associated with steam balancing systems
Questions?
Thank you!

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