

An Overview of Commercial Building Re-tuning

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Presentation Outline

- ▶ Why is Building Retro-Commissioning Training Important?
- ▶ Distinction Between Building Retro-Commissioning and Building Re-tuning
- ▶ Overview of Building Re-tuning Training, Including an Online Version of the Training
- ▶ A Look at a Couple of Re-tuning Focus Areas in Detail
- ▶ Lessons Learned



Why is Building Retro-Commission Training Important?

Retro-Commissioning Literature

- ▶ A number of studies have shown that retro-commissioning buildings can lead to significant energy savings – 5 to 30%
- ▶ Cost of retro-commissioning varies between 0.1\$/sf to 0.6\$/sf
- ▶ Cost savings can range between 0.1\$/sf to 0.75\$/sf
- ▶ Simple payback ranging from 3 months to 3 years
- ▶ A number of the measures addressed by retro-commissioning relate to our inability to control the building operations

Why is Retro-Commissioning not Widely Used?

- ▶ There is a perception that retro-commissioning can be expensive
 - It can be expensive, but typically has less than 3 year paybacks
- ▶ There is a perception that measures addressed during retro-commissioning do not persist for a long time (>6 months)

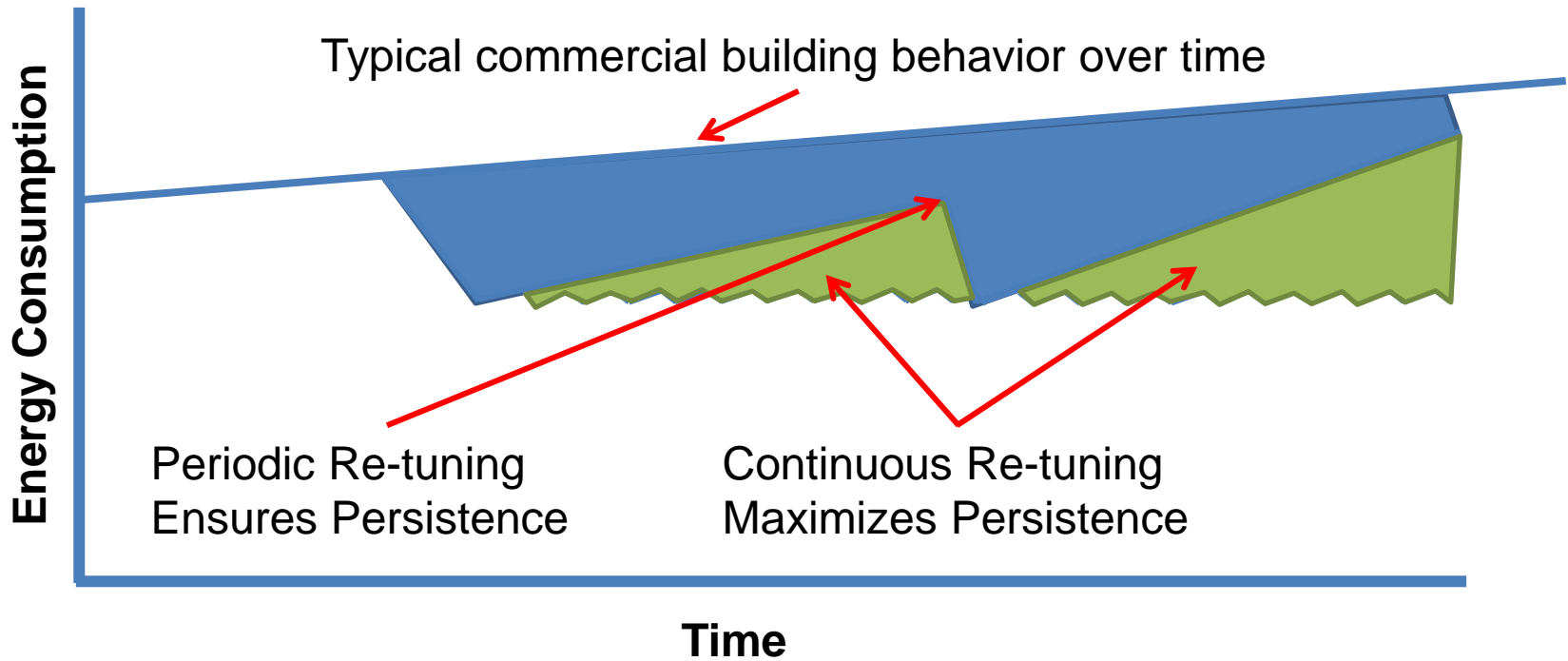
What is Re-tuning?

- ▶ A systematic process to identify and correct building operational problems that lead to energy waste
- ▶ Implemented primarily through the building control system at no cost other than the labor required to perform the re-tuning process
- ▶ Includes small, low-cost repairs, such as replacing faulty sensors
- ▶ Includes identifying other opportunities for improving energy efficiency that require investment
- ▶ Might be thought of as a scaled-down retro-commissioning focused on identifying and correcting operational problems

Re-tuning can Fill the Gap

- ▶ Building re-tuning training is targeted at building operations staff
- ▶ Once the staff are trained to re-tune buildings, it will address both the cost and the persistence question
- ▶ Because re-tuning is implemented by leveraging information from building automation systems and primarily targets operational problems, cost of implementation is significantly lower than retro-commissioning
- ▶ Because re-tuning costs a fraction of retro-commissioning, it can be periodically done to ensure persistence

Life Cycle of Retro-Commissioning/Re-tuning



U.S. Department of Energy Building Re-tuning Training Outreach

- ▶ Building re-tuning training was originally developed as part of a project funded by Washington State (www.retuning.org)
- ▶ Extending training outreach beyond WA State (www.pnl.gov/buildingretuning) with U.S. Department of Energy funding
- ▶ Intended for building operations staff, retro-commissioning providers and energy service providers
- ▶ Recently converted the training into an online interactive training



Major Focus Areas in Re-tuning

- ▶ Occupancy scheduling
- ▶ Discharge-air temperature control
- ▶ Discharge-air static pressure control
- ▶ Air-handling unit (AHU) heating & cooling
- ▶ AHU outside/fresh air makeup
- ▶ AHU economizer operation
- ▶ Zone conditioning
- ▶ Meter profiles: whole building electricity and gas consumption
- ▶ Central plant



Purpose of Re-tuning

- ▶ Improve the building's energy efficiency through low-cost and no-cost operational improvements (mostly control changes)
- ▶ Identify opportunities to further increase the building's energy efficiency
- ▶ Identify problems requiring physical repair
- ▶ Catch the big energy saving opportunities

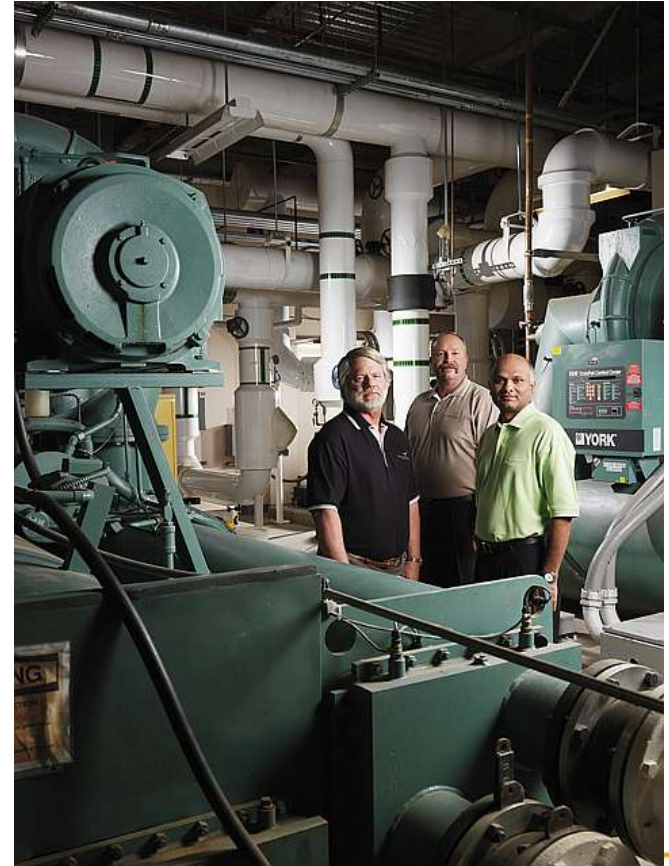
Overview of Building Re-tuning Training

Building Re-tuning Training

- ▶ Training consists of two parts
 - Classroom training - 6 to 8 hours; limited to 20 to 25 people
 - Field training - 1 to 2 days, depending on the size of the building; limited to 6 to 10 people
- ▶ Intent of the training
 - Provide an in-depth training of the re-tuning approach
 - Prepare the participating technicians for hands-on field training
 - Provide an opportunity to ask questions and get clarification on any aspect of the re-tuning process

Six Primary Steps of Re-tuning

- ▶ Collecting Initial Building Information: Basic building information
- ▶ Pre-Re-tuning Phase: Trend-data collection and analysis
- ▶ Building Walk Down: Getting to know the building
- ▶ Re-tuning: Identifying and correcting operations problems
- ▶ Post Re-tuning: Reporting re-tuning findings
- ▶ Savings Analysis: Determining and reporting the impacts



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Trend-Data Collection & Analysis: Purpose

- ▶ Detect potential operational problems even before visiting the building
- ▶ Identify problems that require time histories to detect – incorrect schedules, no use of setback during unoccupied modes, poor economizer operation



Major Steps in Analysis Using Energy Charting and Metrics (ECAM) Tool

- ▶ Download trend log data files from BAS
- ▶ Format data files for compatibility with the ECAM spreadsheet analysis tool - <http://www.pnl.gov/buildingretuning/resources.stm>
- ▶ Open data files in ECAM spreadsheet analysis tool and automatically generate graphs
- ▶ Review graphs to identify operational issues
- ▶ Record operational issues for reference during re-tuning



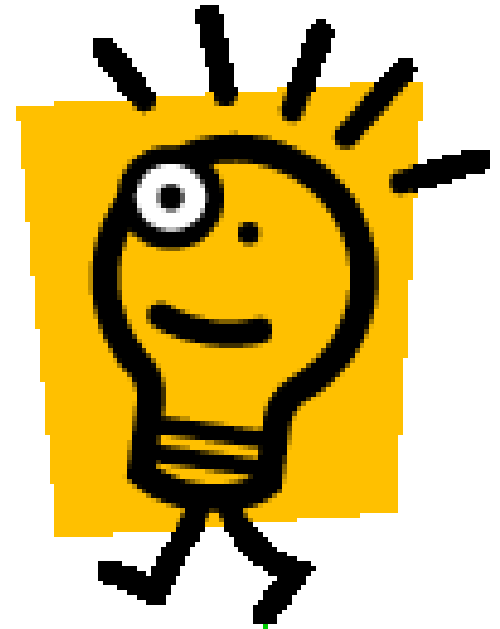
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Building Walk Down: Purpose

- ▶ Get to know the building better
- ▶ Develop a general impression of:
 - Overall building condition
 - Overall building design
 - HVAC system design
- ▶ Collect some basic data on the building systems at a level of detail greater than the initial data collection



Building Walk Down: Major Steps

- ▶ Review electrical and mechanical prints
- ▶ Walk the outside of the building
- ▶ Walk the inside of the building
- ▶ Walk down the roof
- ▶ Walk down the air-handlers
- ▶ Walk down the plant area
- ▶ Review the DDC system (BAS) front end

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Using the knowledge learned from trend-data analysis and building walk down to start the building re-tuning process



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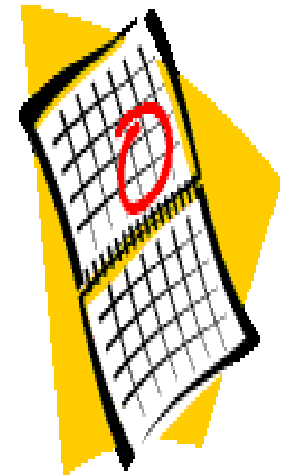
Occupancy Scheduling

▶ Purpose

- Determine whether night and weekend set back is being used
- End-use loads are following occupancy schedules

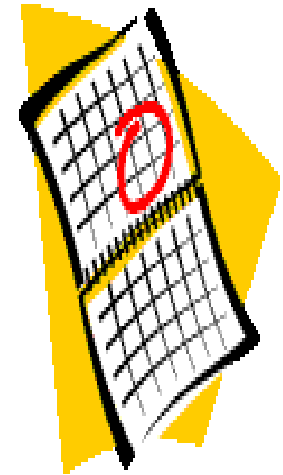
▶ Approach

- For each major end use, review plots of consumption vs. time or temperature vs. time or status vs. time or static pressure vs. time



Occupancy Scheduling (continued)

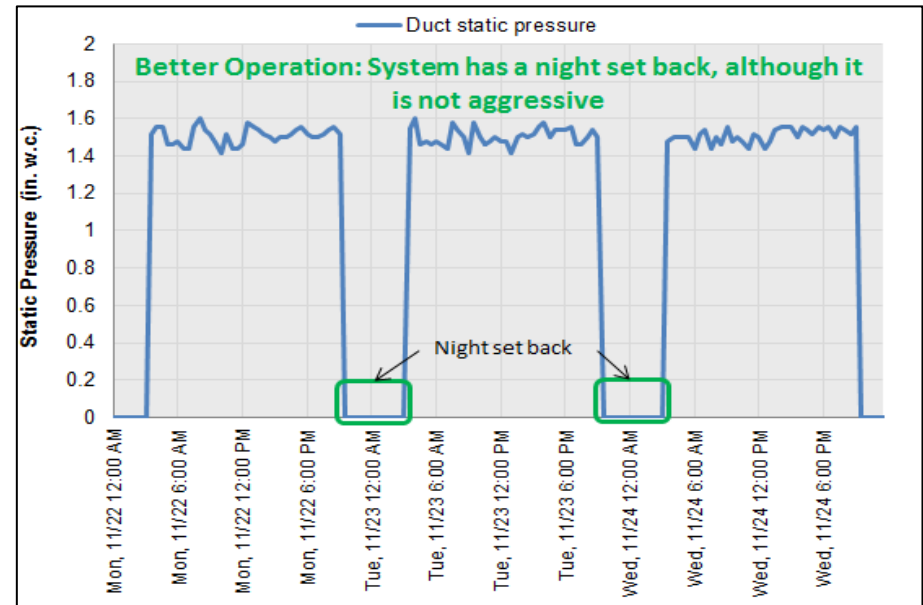
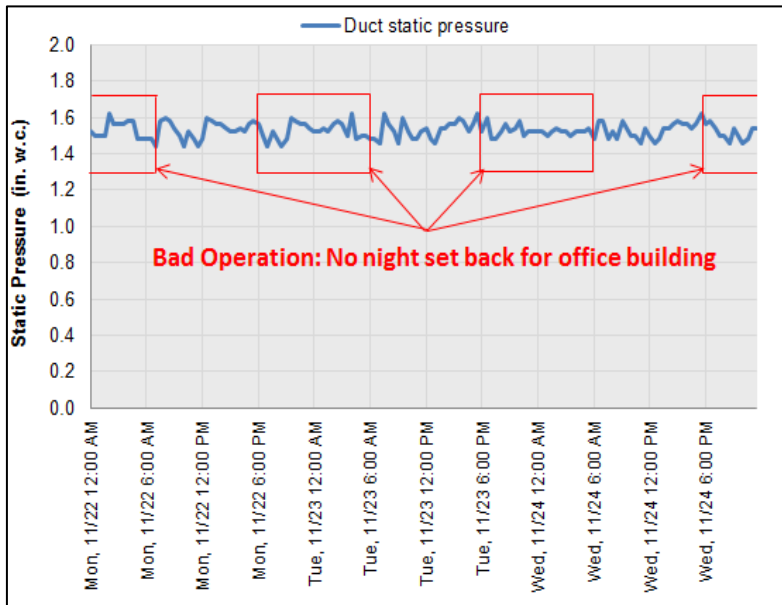
- ▶ Shut off systems whenever possible
 - Night unoccupied schedules
 - Weekend unoccupied schedules
 - Daytime no or low use unoccupied schedules
 - Auditorium, classrooms, conference rooms
 - Includes lighting
 - Includes specialized exhaust
 - Do not restart too early
 - Use a startup schedule based on building needs
 - Do not use fresh air during warm-up except last 30 minutes for flushing building



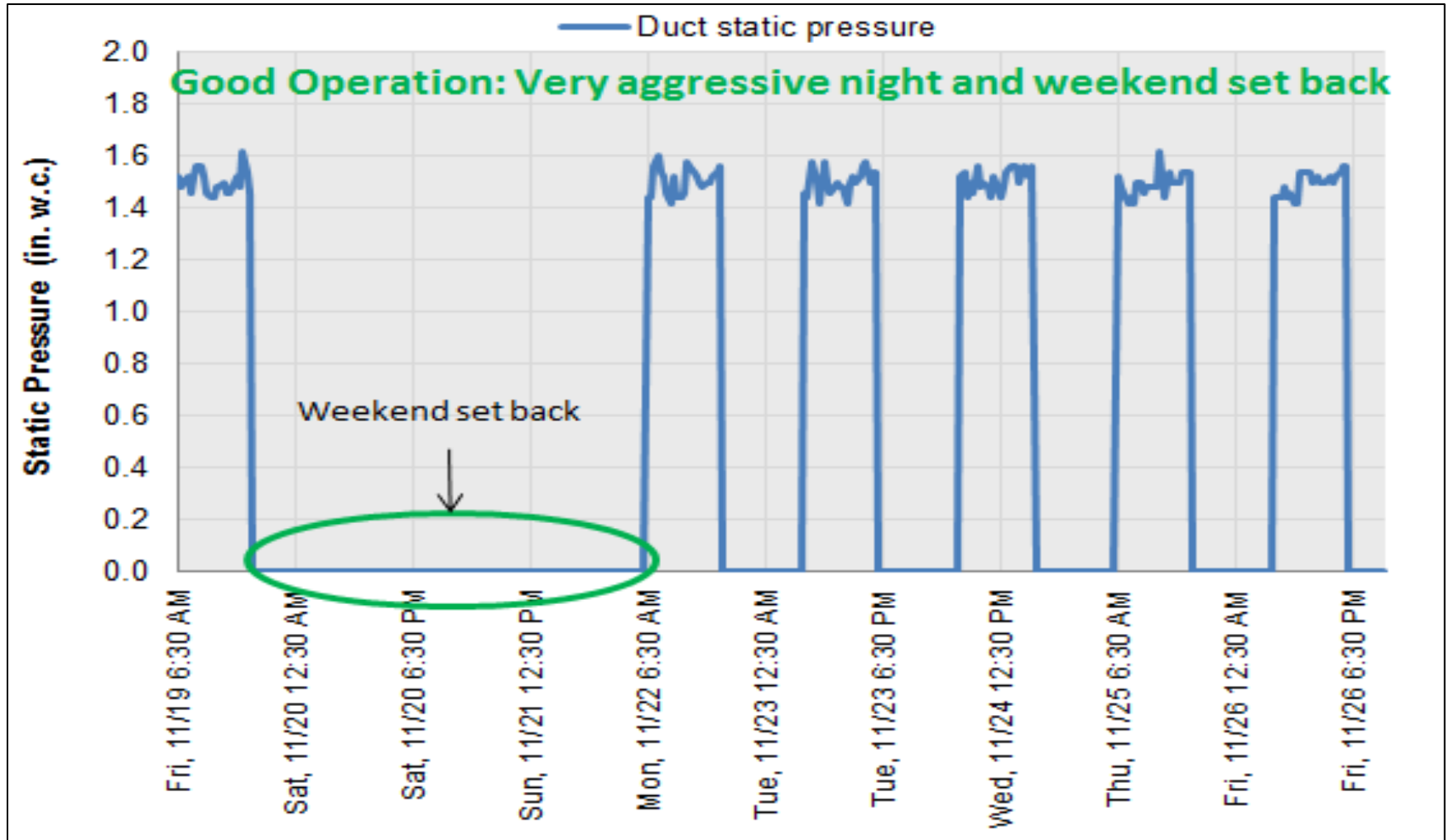
Occupancy Scheduling (continued)

- ▶ Building electric consumption should show significant energy drop for nights/weekends
 - Signifying set backs are active on all HVAC systems
 - Base load versus peak loads should be at least 50% difference and as much as 80% with aggressive setbacks
- ▶ Trended data for zone temperatures should show 5-10°F deviations from set points when set backs are active during non-shoulder months
 - Winter zone temperatures should drop down to 60-65°F and summer zone temperatures should rise to 80-85°F

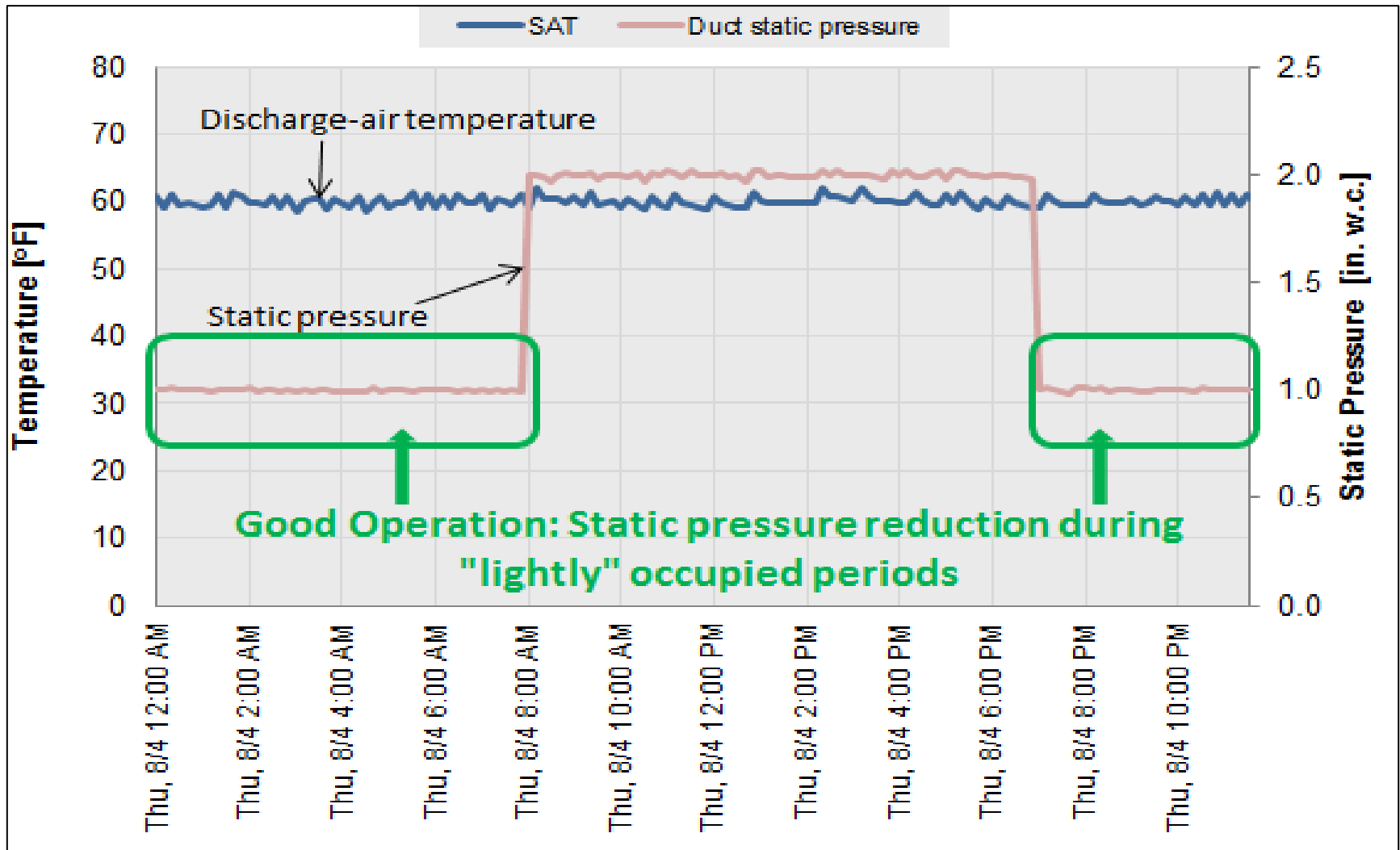
Examples of Occupancy Scheduling: Bad and Better



Examples of Occupancy Scheduling: Good



Examples of Occupancy Scheduling: Good



Static Pressure Operations and Zone VAV Box Dampers

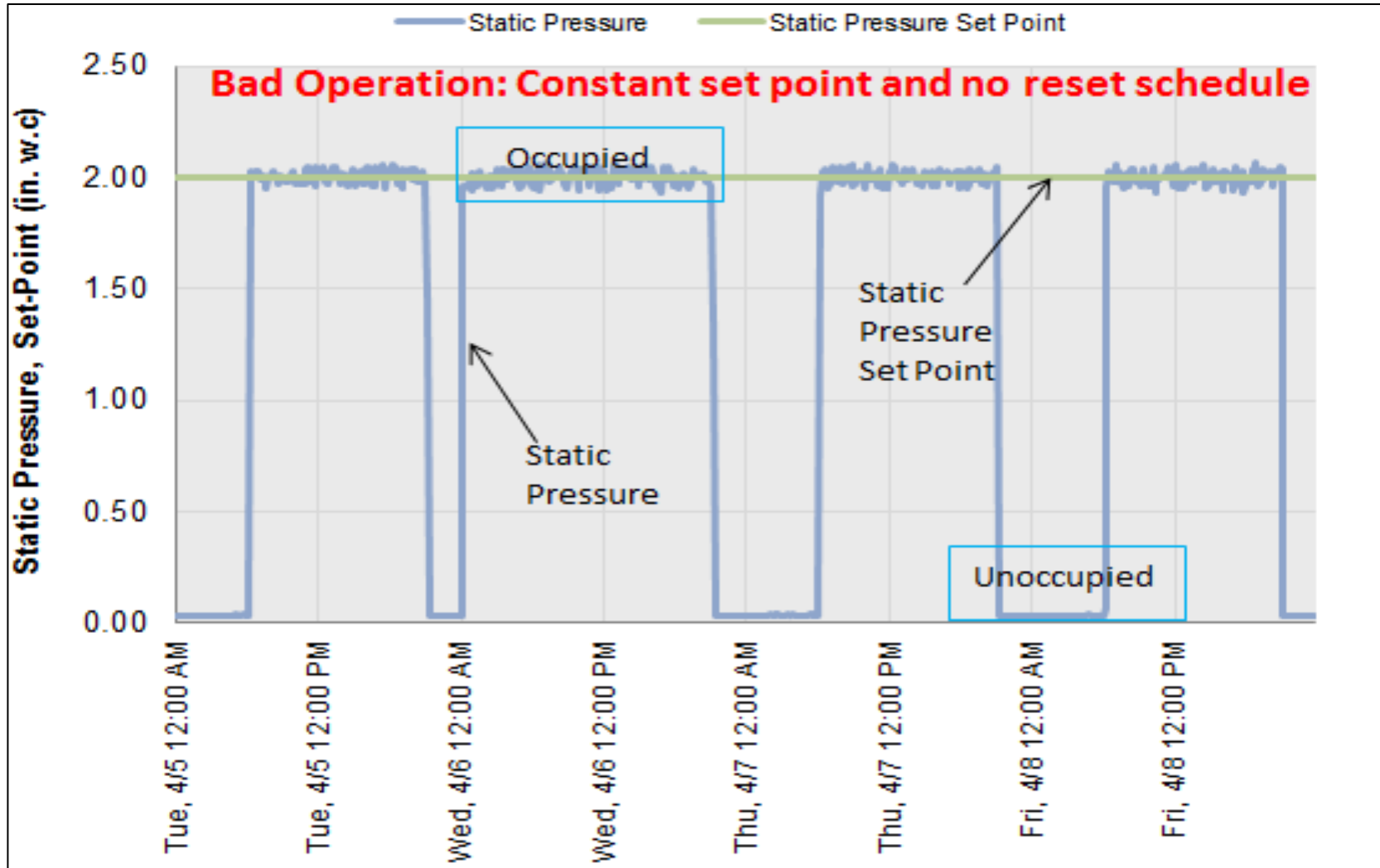
▶ Purpose

- Determine whether static pressure set point is too high or too low

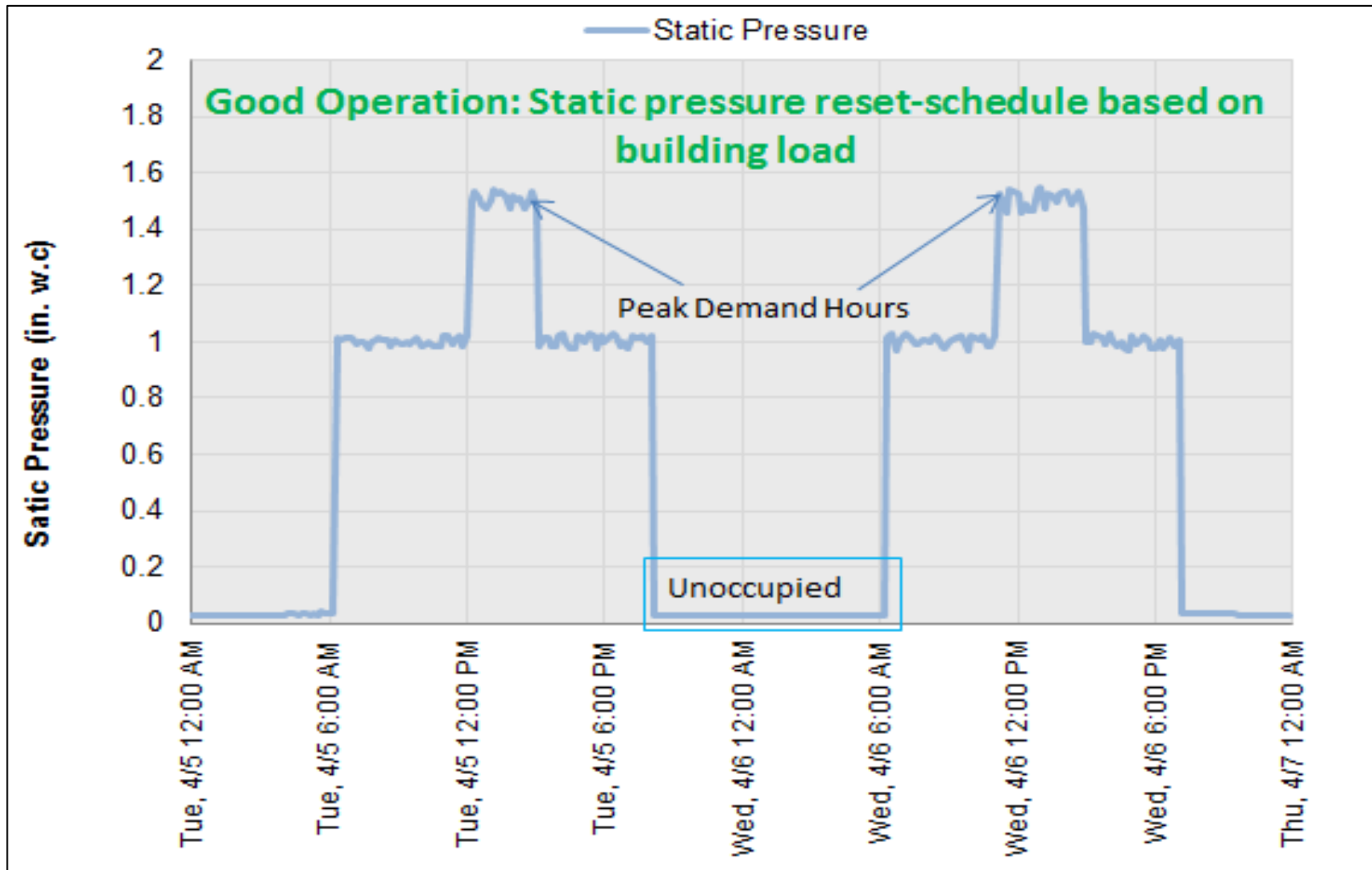
▶ Approach

- For each air handler, review a plot of the damper position of all zone VAV units vs. time

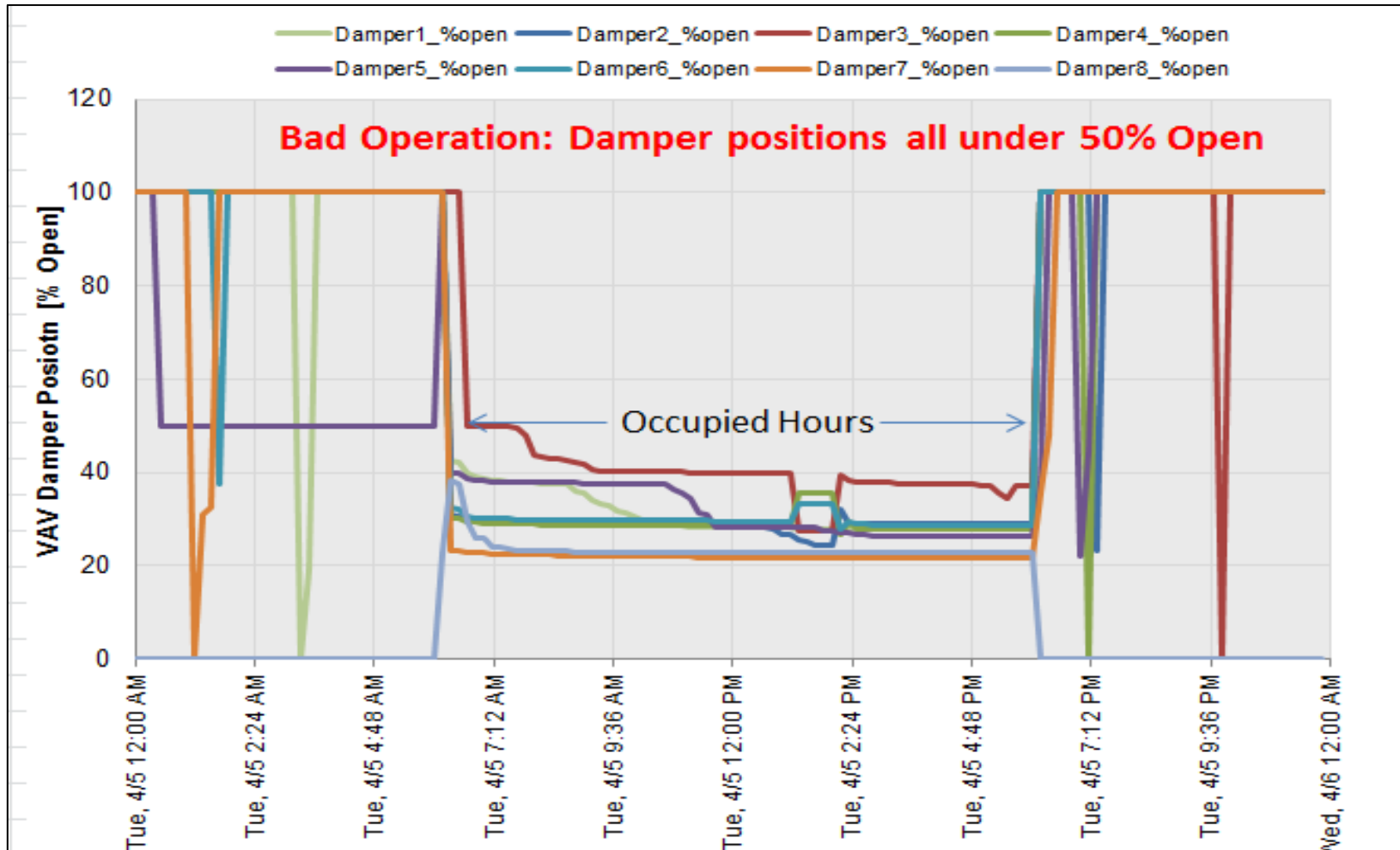
Static Pressure Operations: Constant Static Pressure



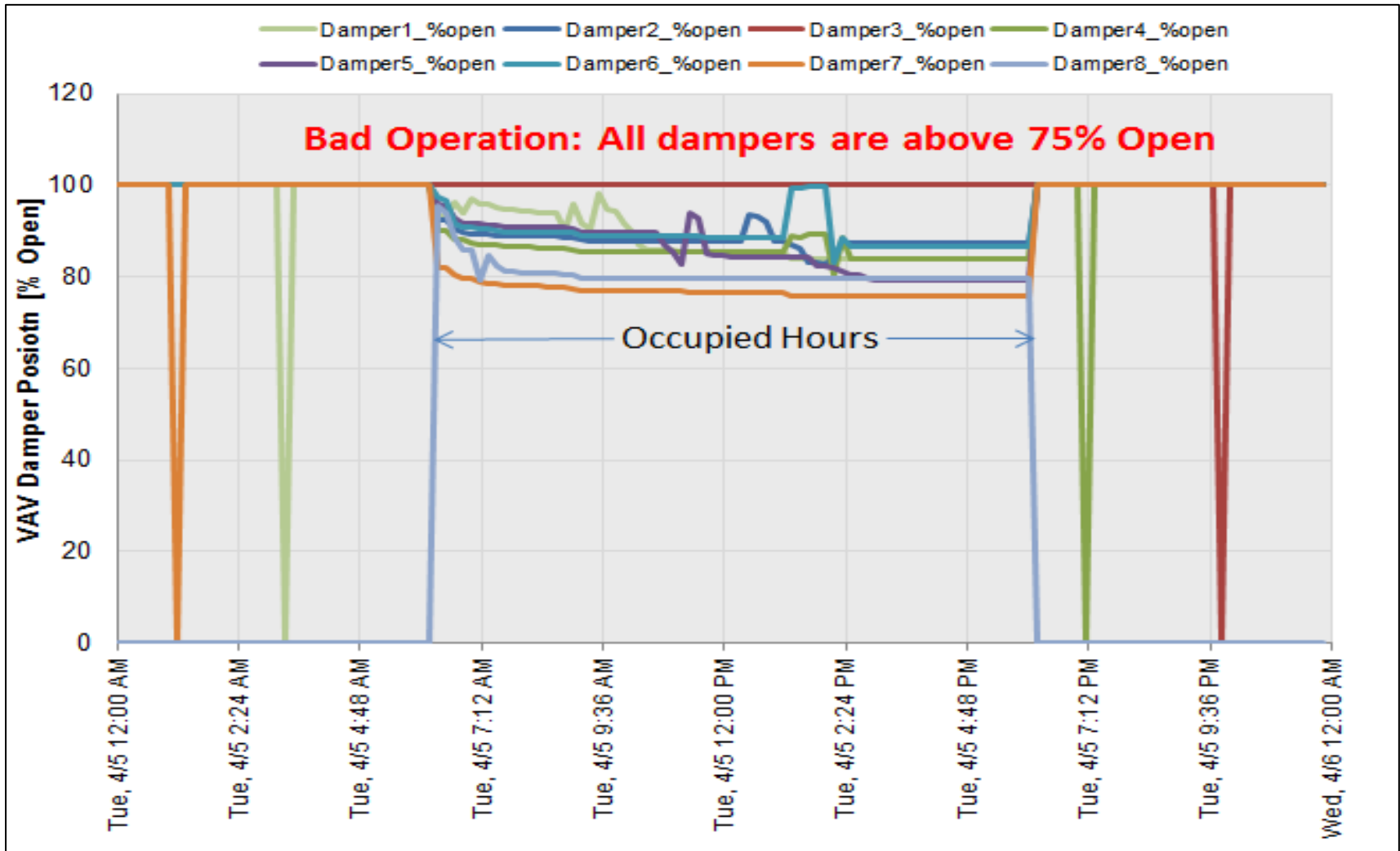
Static Pressure Operations: Constant Static Pressure



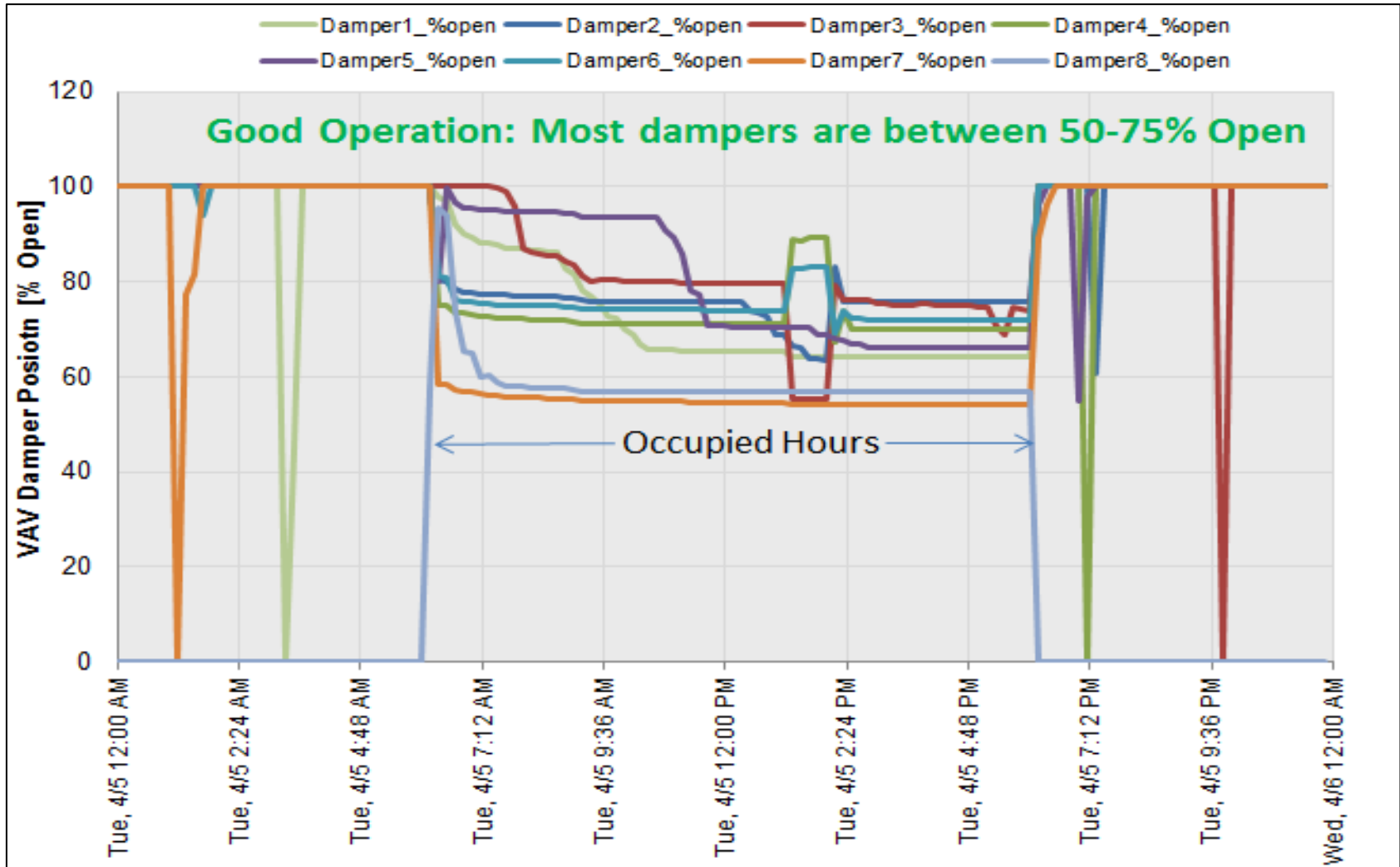
Static Pressure Operations: Zone VAV Damper Position vs. Time



Static Pressure Operations: VAV Damper Position vs. Time



Static Pressure Operations: VAV Damper Position vs. Time



Highlights of Re-tuning

- ▶ Every set point adjustment made will have an impact of some sort on the utility meter
- ▶ Can save energy and keep occupants comfortable
- ▶ It takes time to tune a building
- ▶ There are no magic set points that work all the time
- ▶ Always monitor the utility meters (gas & electric) to see what affect you have had
- ▶ Look at the big picture when making adjustments
- ▶ Watch the meter profiles weekly
- ▶ Learn and know the building's personality

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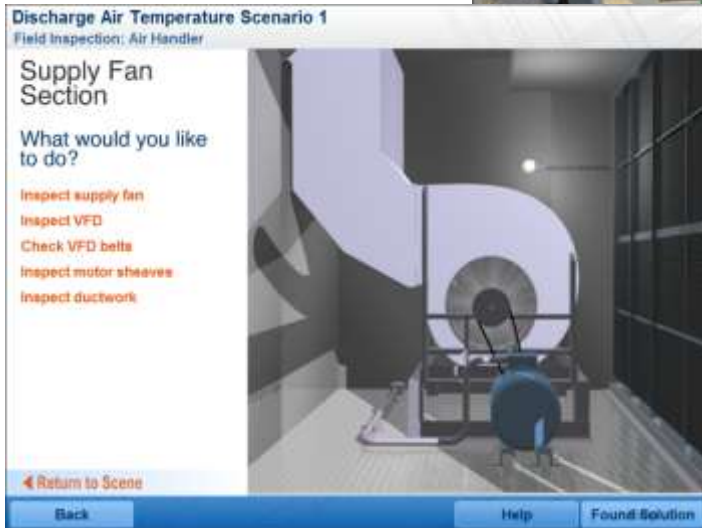
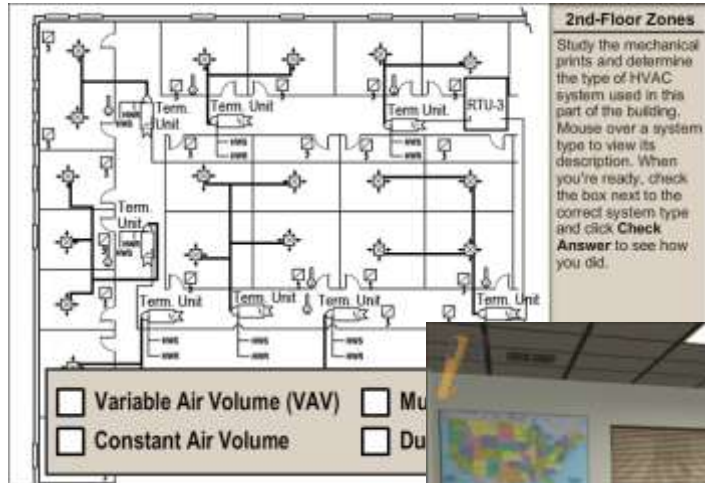


Building Re-tuning e-Learning

- ▶ Adds more reach to instructor-led classroom and field training
- ▶ Available for free
- ▶ Provides learners:
 - A step-by-step walk through of the building re-tuning process
 - Opportunity to practice meaningful re-tuning activities in real-world contexts and situations
 - A variety of downloadable resources (checklists, templates, example plans, etc.) to use on the job
 - <http://retuningtraining.labworks.org/>



Building Re-tuning: Learn by Doing



- ▶ Work within a virtual, 3D commercial building
- ▶ Collect and analyze building prints and trend data
- ▶ Perform a virtual building walk down
- ▶ Interact with building occupants
- ▶ Work through a variety of interactive scenarios designed to target specific re-tuning issues throughout the building

Lessons Learned from Building Re-tuning Training

Building Re-tuning Trainings

- ▶ Over 35 building re-tuning training sessions provided
- ▶ Composition of the classes
 - Building operators, energy service providers and retro-commissioning agents
 - Most field training sites were office buildings, but a few institutional, school, retail and healthcare buildings as well
- ▶ Every training included field training in a building – to put concepts learned in the classroom to practice
- ▶ A number of opportunities were identified in the training buildings

Common Problems Found

- ▶ Occupied schedules longer than they need to be
- ▶ Equipment running during unoccupied periods (e.g. exhaust fans)
- ▶ Discharge-air set points too low
- ▶ Heating/cooling set points too close
- ▶ Static pressure too high
 - Especially during partially occupied periods
- ▶ No resets of either discharge-air set points or static pressure
- ▶ Economizer problems
- ▶ Lack of resets on distribution loops (both hot and chilled water)

Issues for Successful Application of Re-tuning

- ▶ Important to make adjustments during the re-tuning process. Do not defer implementation until later
- ▶ Building operations staff need to know that they have the authority to implement minor operational changes without risk of reprisal
- ▶ Building operation staff need to have confidence in the process. To develop comfort, operators can make small incremental changes over time and observe the responses of occupants

... Key Lessons Learned...

- ▶ Many commercial buildings have array of operational problems
- ▶ Trained building operations staff can re-tune buildings, if empowered
- ▶ Building re-tuning can yield energy savings of 5 to 20% through implementation of no-cost and low-cost measures
- ▶ But, the human factor is a real issue in realizing re-tuning benefits in practice
- ▶ In the long run, automation is key to persistence of “optimal” building operation

Questions?

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