The Building Walk Down: Uncovering Hidden Opportunities for Savings

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Thank You to Our Funder

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Learning Objectives

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- Describe the benefits of building re-tuning
- Identify common re-tuning measures
- Describe the four steps to the re-tuning approach
- List the major focus areas of building re-tuning

Building Re-tuning Definition

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Building re-tuning is a systematic process to identify and correct no/low cost operational problems that lead to energy waste.

This is what resource conservation managers and energy managers do!

Life Cycle of Retro-Commissioning/Re-Tuning

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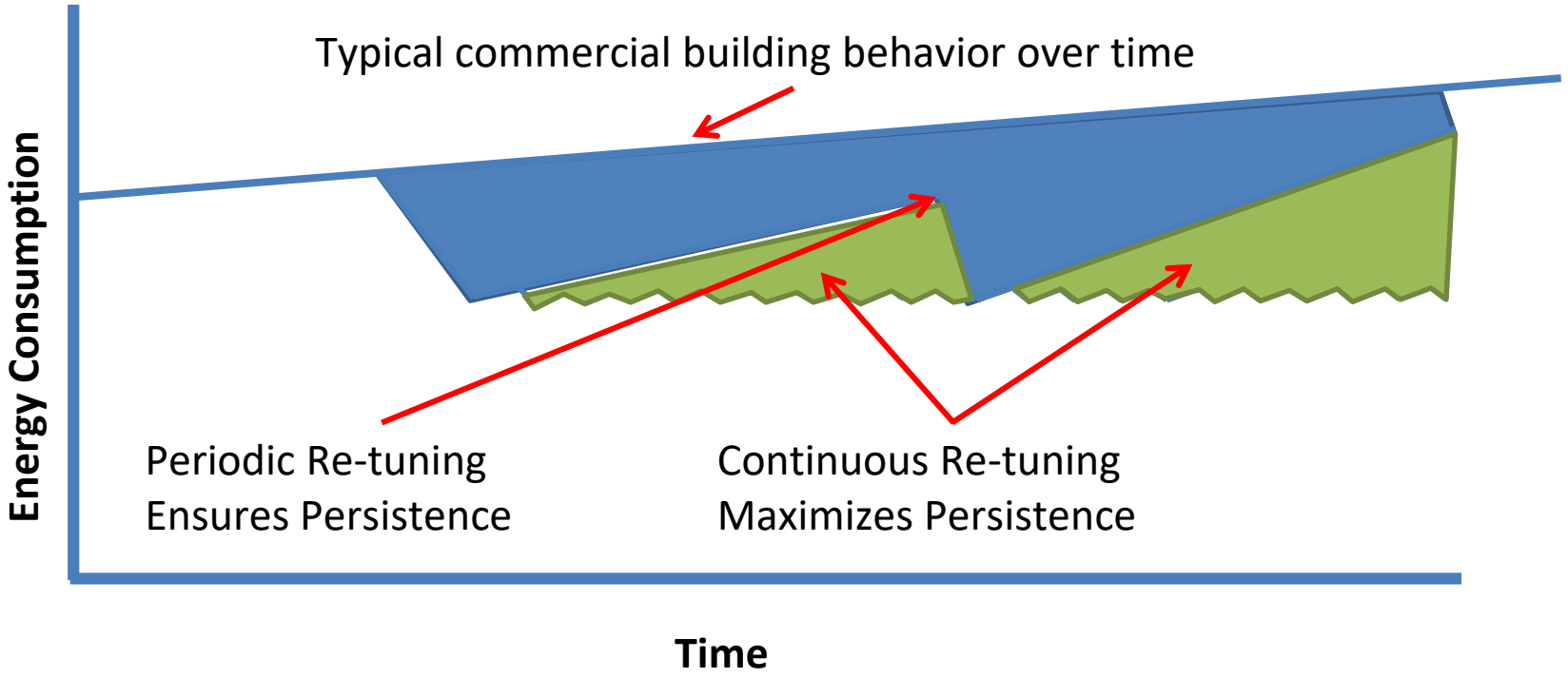

Common Re-tuning Measures: PNNL Analysis of 100 Buildings

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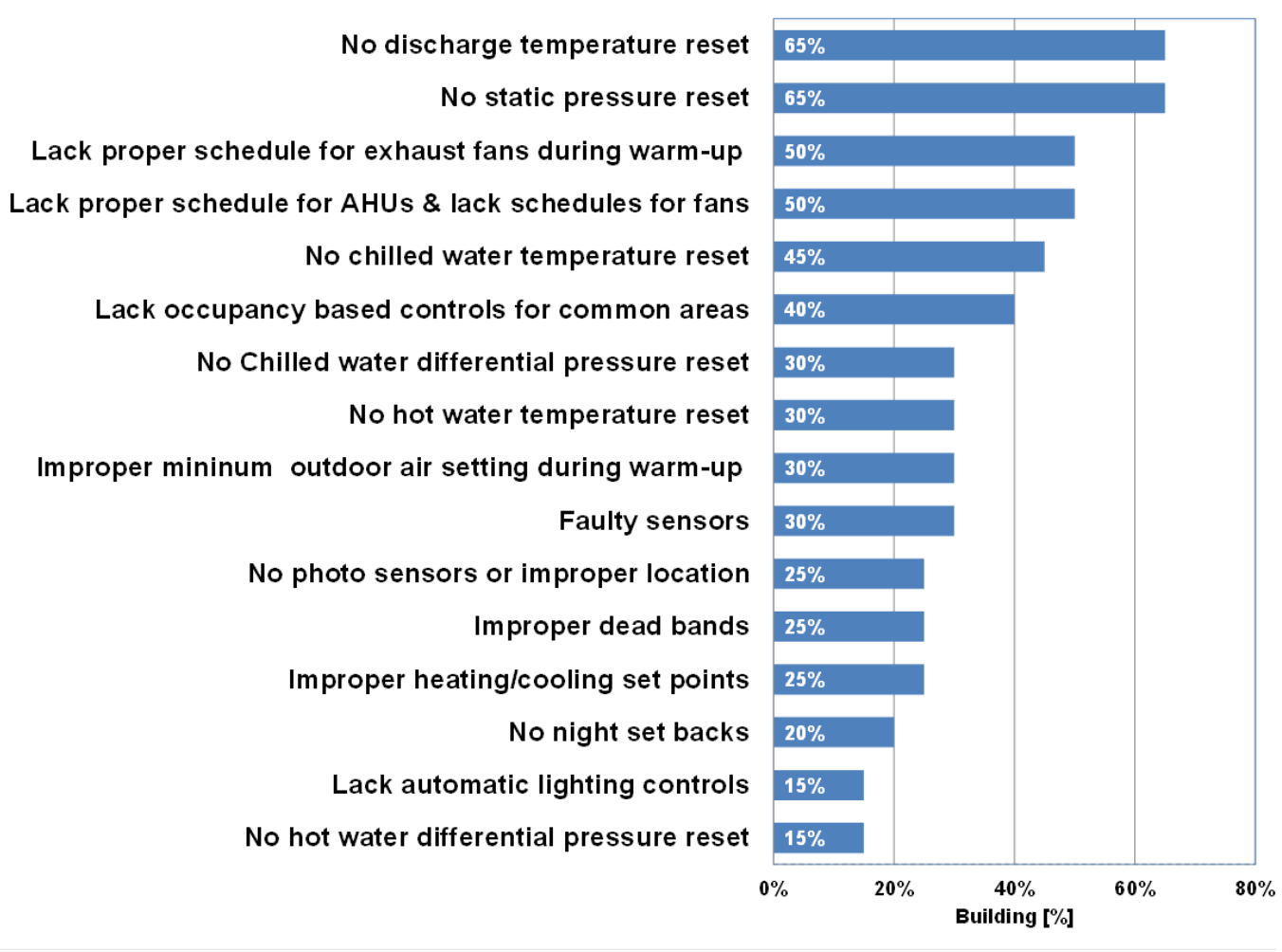

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Building Re-tuning Major Focus Areas

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1. Heating, Ventilation and Air-Conditioning (HVAC) Systems and Controls
2. Lighting System and Controls
3. Domestic Hot Water
4. Water Use
5. Building Envelope

Building Re-tuning Approach

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Use a **four step approach**

1. **Initial data collection phase:** Collection of information about the building
2. **Investigation phase:** Building walk down to identify and characterize the building operations
3. **Implementation phase:** Application of prescriptive re-tuning measures
4. **Documentation phase:** Reporting of measures implemented and calculation of energy savings

Building Re-tuning Basic Energy Management Principles

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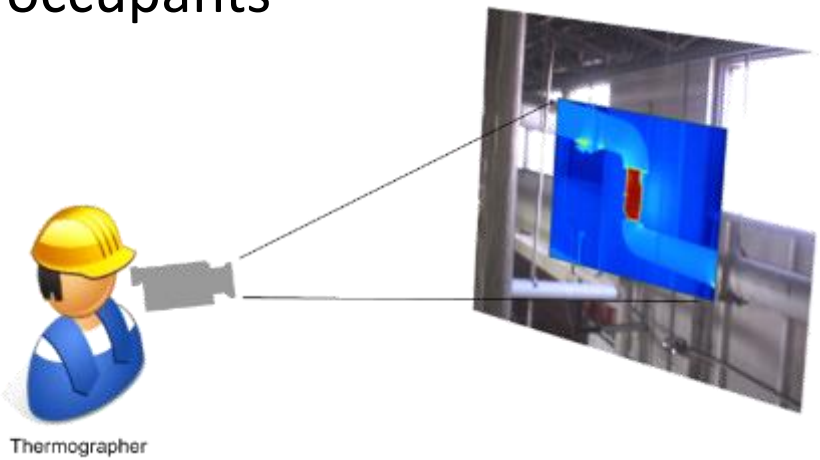
- If you don't need it, turn it off
- If you don't need it at full power, turn it down
- Make "smart" energy decisions when adjusting systems to the real building needs
- Save energy without negatively impacting the comfort of the occupants



Sampling is OK

Where there are multiple pieces of similar equipment use sampling in your investigation

- Observe and test 12% of equipment type
- But no fewer than a sample size of 10 for buildings <100,000 sf and no fewer than 20 for buildings >=100,000 sf

Hydronic Heat Pumps

VAV Terminal Units

VRF Terminal Units

Building Walk Down: Guidance

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- Use your senses – look, listen, smell and touch (be careful!)
- Perform the walk down during both occupied hours and unoccupied hours **(night walk down highly recommended)**
- Energy waste often occurs during unoccupied periods and holidays
- Walk down at least once during the heating season and the cooling season
- Log your observations

"You can observe a lot by just watching." —Yogi Berra

Building Walk Down: Tools to Carry

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Many monitoring and diagnostic tools are available to borrow free of charge from the Smart Buildings Center's Tool Lending Library https://www.smartbuildingscenter.org/tool-library/

HVAC Systems and Controls

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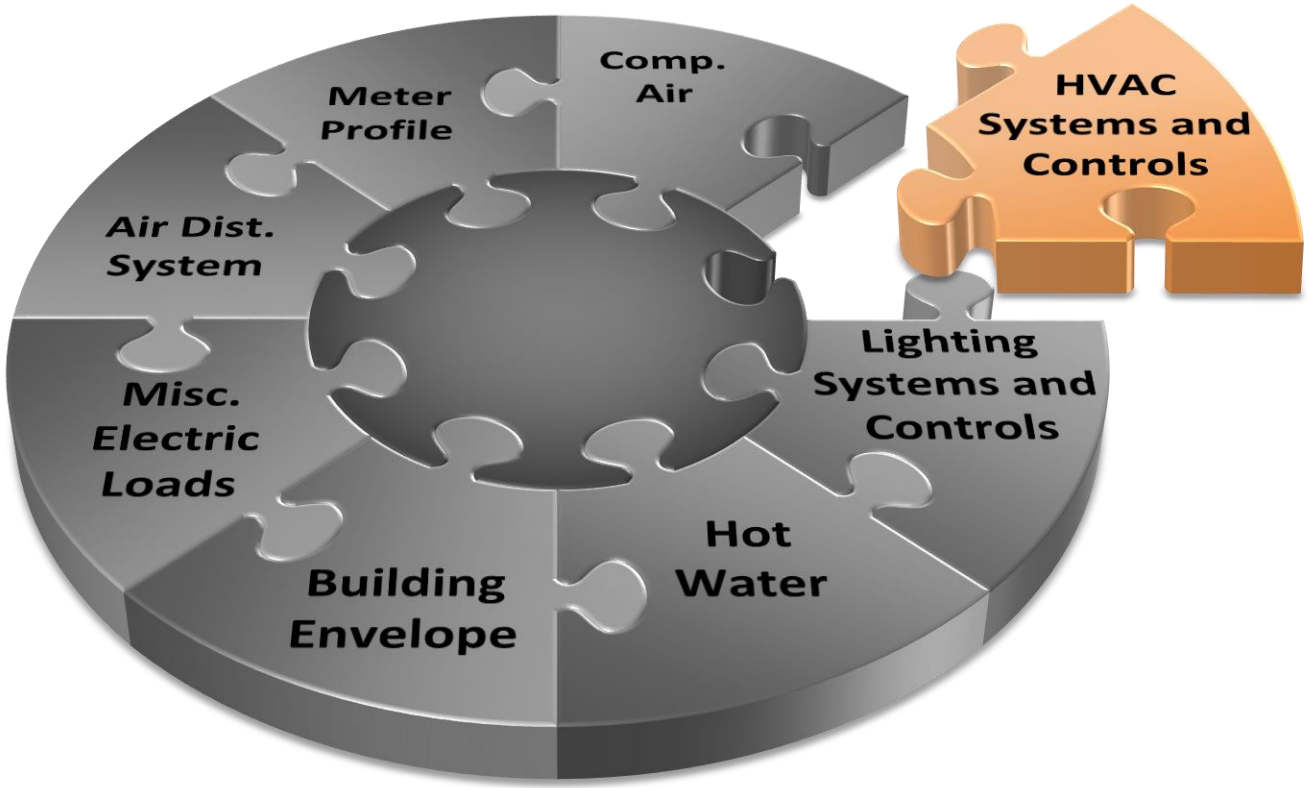

HVAC

- HVAC Systems
- Economizers
- Distribution systems
- Pumps
- Thermostats
- Controls
- Ventilation

Summary of PNNL Meta-Data Results Small Buildings Without BAS

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	Small Office	Medium Office	Strip Mall	StandAlone Retail	Primary School	Supermarket
EEM01: Re-calibrate Faulty Sensors	1%	0%	1%	1%	0%	0%
EEM04: Shorten HVAC Schedules	**6%**	**12%**	**9%**	**12%**	**8%**	**10%**
EEM05: Supply Air Temperature Reset		11%			4%	
EEM07: Exhaust Fan Control	3%	1%		2%	1%	
EEM08: Static Pressure Reset		4%			0%	
EEM14: Hot Water Temperature Reset					5%	
EEM15: Minimum VAV Terminal Box Damper Flow Reductions		19%			6%	
EEM16: Wider Deadbands and Night Setbacks	**12%**	**10%**	**11%**	**13%**	**16%**	**12%**
EEM27: Optimal Start	**6%**	**8%**	**10%**	**12%**	**6%**	
EEM28: Optimal Stop		0%	1%	2%	1%	

HVAC Equipment Scheduling

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- Small/medium-sized commercial buildings typically lack central controls
- Typically have wall mounted thermostats to control both heating and cooling systems
- While surveying the thermostats and their capabilities, check:
  - Type of thermostat?
  - Mechanical or digital?
  - If digital, is it programmable?
  - If mechanical, replacing it with a programmable digital thermostat will save energy, if it is properly programmed

Equipment Scheduling
Motor Logger

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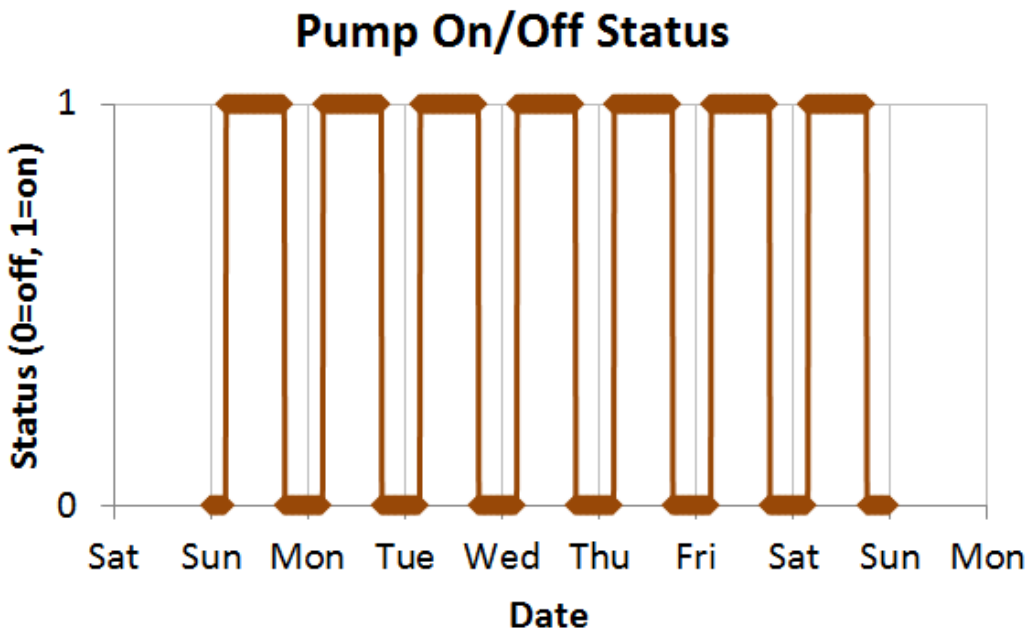
Use data logger (or BAS trend data if available) to verify start/stop scheduling of fans and pumps



Review Setpoints

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1. Zone temperatures
2. Discharge air temperature
3. Discharge air pressure
4. Minimum OA
5. HW & CHW supply
6. Condenser water supply
7. Differential pump pressure
8. Economizer changeover
9. OA lockouts
10. Miscellaneous equipment such as exhaust and process driven systems (elevator machine rooms, data rooms, garage exhaust, etc..)

Set or adjust to optimize function and energy efficiency – Use your judgement!

Sensor Calibration

Check sensor error for critical sensors

1. Outside air temperature
2. Discharge air temperature
3. HW loop supply & return temperature
4. CHW loop supply and return temperature
5. CO2 sensors
6. Condenser water supply and return temperature

Identify where sensors should be replaced. Adjust or replace as required.

HVAC Controls Functional Testing

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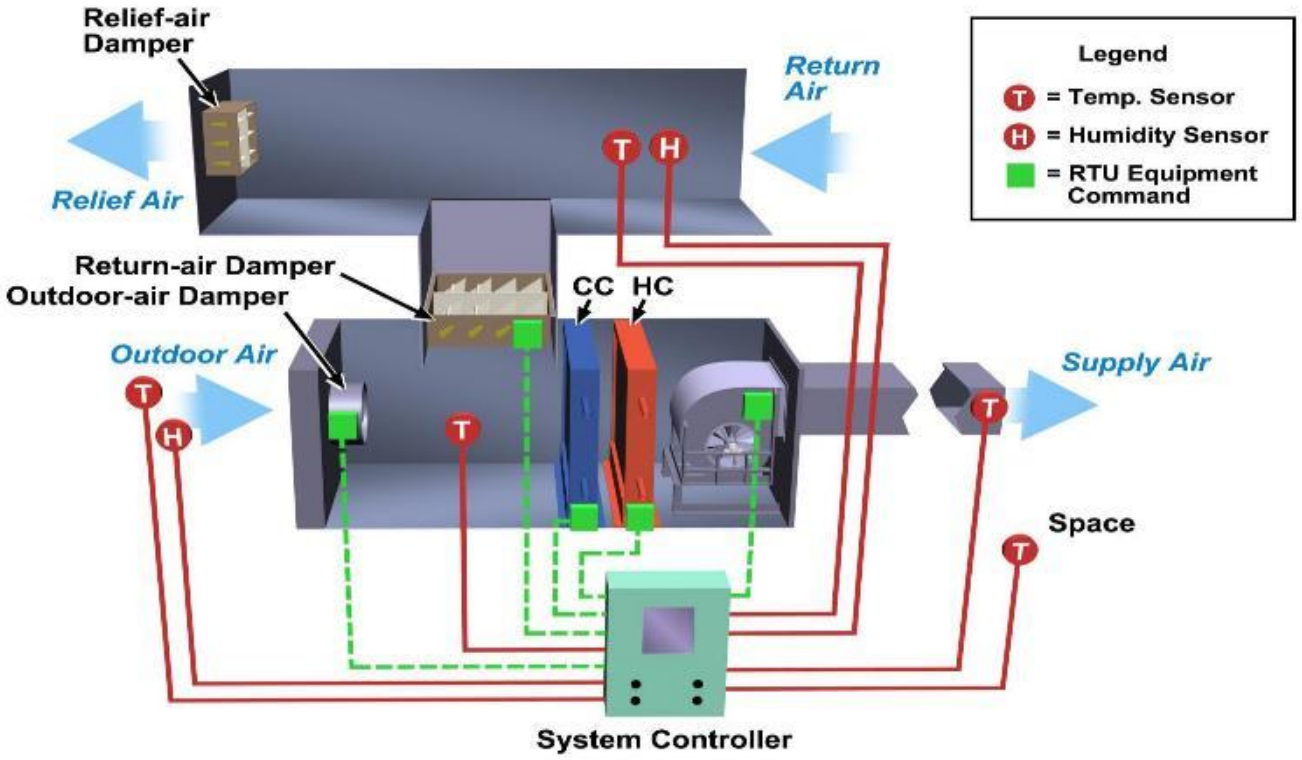

Functionally test all modes of operation

- Occupied
- Unoccupied
- Warm-up
- Over-ride
- Others…

Adjust control sequences as appropriate for current facility requirements

Simultaneous Heating & Cooling

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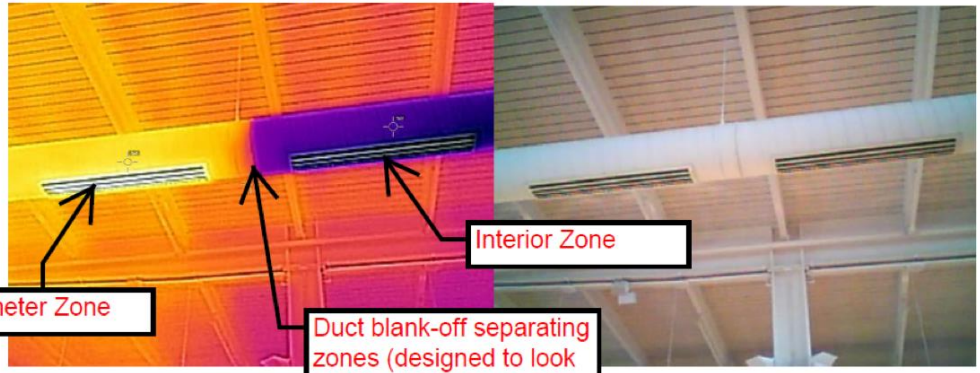
Review HVAC control sequences for unintended instances of heating and cooling

- IR images of coils
- Cooling with perimeter heat
- 4-pipe fan-coils
- Large open spaces with multiple HVAC systems
- Heat/cool lockouts

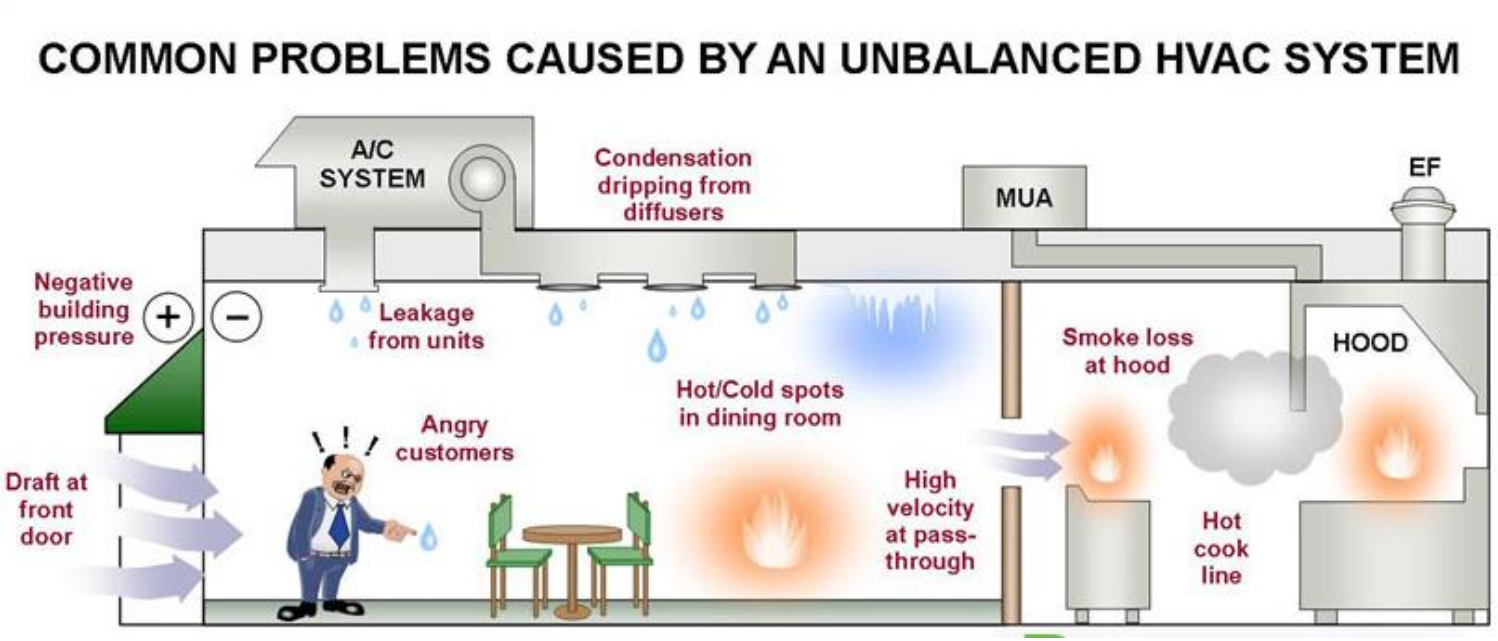
Open Office on Upper Level – VAV's serving same open area operating in both heating/cooling

Open Office on Upper Level – adjacent diffusers in heating and cooling



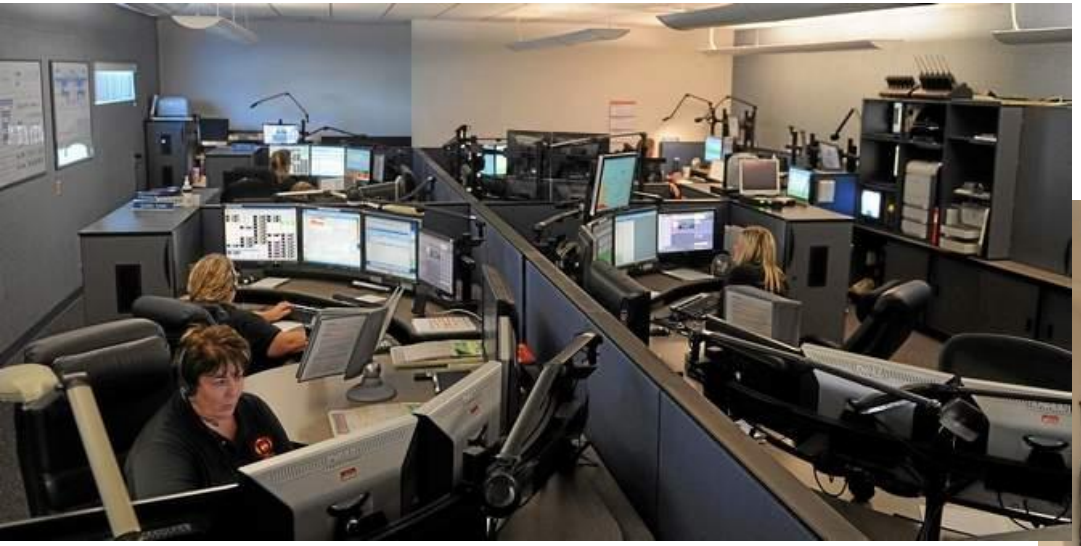
Adjust control sequences as to reduce or eliminate and unintended simultaneous heating & cooling

Air Balance Issues



Note any indications of significant air balancing issues. Recommend re-balancing where significant efficiency or comfort improvements can be achieved

Identify Zones Dominating Multiple Zone Systems



24/7 dispatch center in an office building

Server Rooms Served by Central HVAC

Identify zones that may be dominating multi-zone system operations. Recommend solutions to isolate these zones.

HVAC Maintenance, Cleaning & Repair

What to look for:

- Dirty filters, ducting, grilles, coils
- Missing or damaged panels/access doors or seals
- Missing or damaged mechanical items (fan motors/blades/belts, pulleys)
- Missing or damaged duct and pipe insulation
- Stuck HVAC dampers
- Equipment at the end of its service life

Clean or replace filters, repair damaged equipment, repair/adjust faulty dampers.

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Jammed/Frozen Damper

Disconnected Damper

Wired poorly

Building Retuning: Lighting

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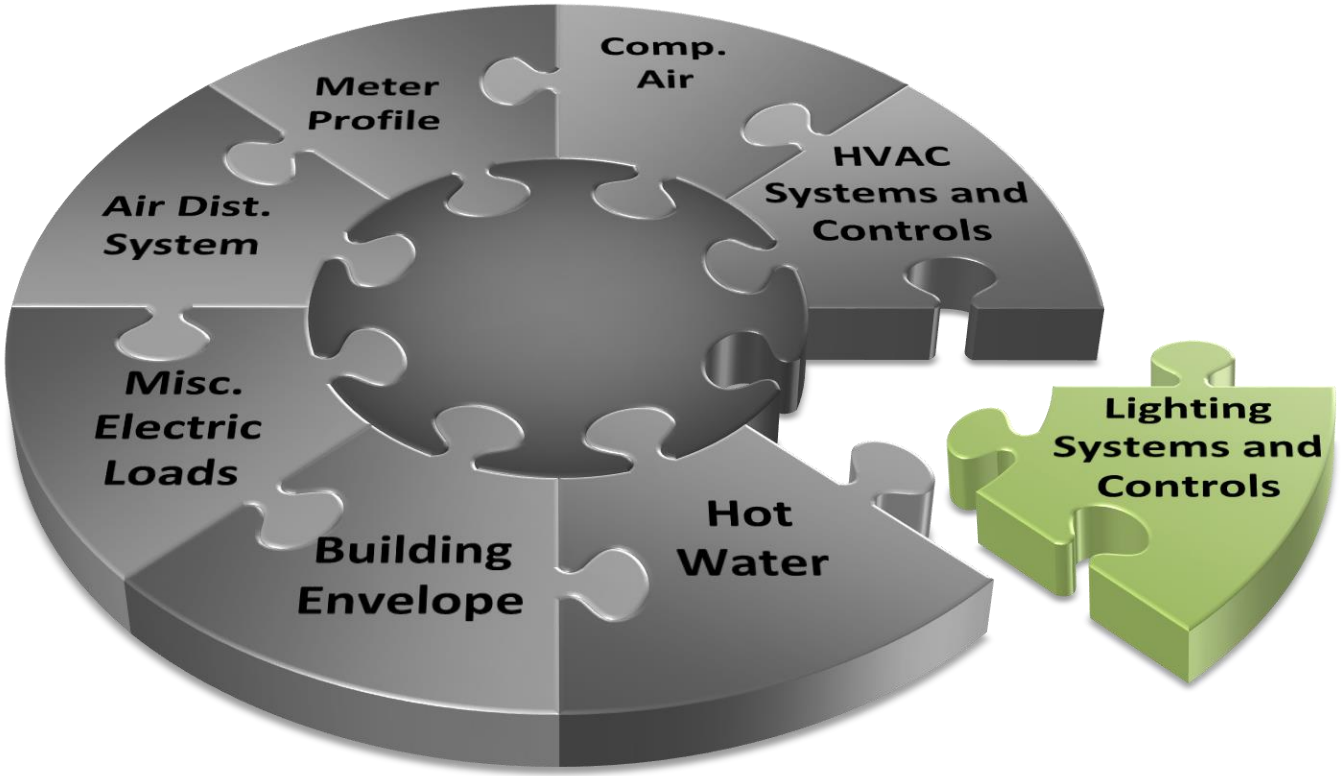

Lighting

- Interior Lighting Systems and Controls
- Exterior Lighting Systems and Controls

Lighting Levels

- Spot check lighting levels by use type
  - Recommend areas where the lighting power density could be reduced

Activity	Space Types	Recommended Illumination (lux)	Foot Candles (FC)
Public areas with dark surroundings	Parking garage	20 - 50	2-5
Simple orientation for short visits	Lobbies, storage areas, corridors	50 - 100	5-10
Working areas where visual tasks are only occasionally performed	Waiting areas, auditoriums	50 - 150	5-15
Easy Office Work, Classes	Certain offices and classrooms	200-300	20-30
Normal Office Work, PC Work, Study Library, Groceries, Show Rooms, Laboratories	Certain offices, classrooms, libraries	350-500	35-50
Retail	Supermarkets, Mechanical Workshops	300-800	30-80

Automatic lighting controls

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Automatic lighting controls

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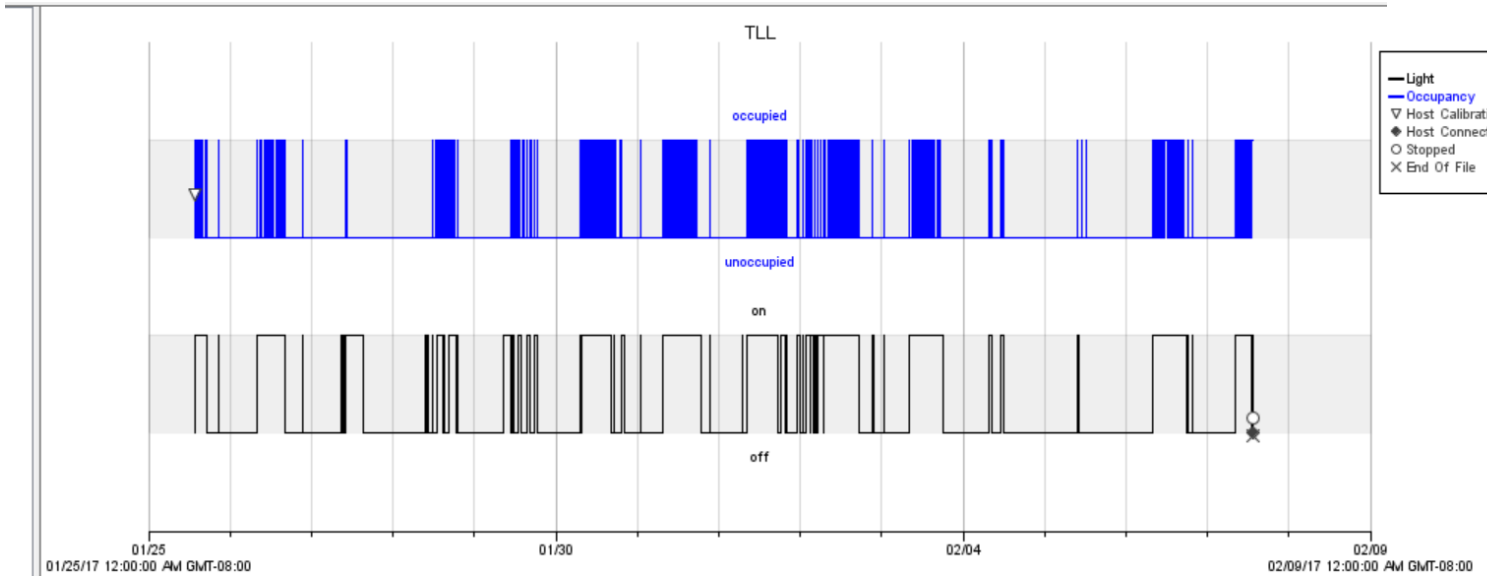
- Verify occupancy/vacancy sensors working correctly (sampling OK)
- Identify areas that could benefit from occupancy sensor or daylight harvesting
- Verify exterior lighting controls function

light/occupancy logger



Lighting Control Schedules

- Verify lighting on/off schedules match occupancy. Set or adjust as appropriate.
  - Stand-alone control or BAS interface?
  - Correct time and day?
  - Overrides?
  - Override length?
  - All lights controlled?

Lighting control panel

Lighting Maintenance

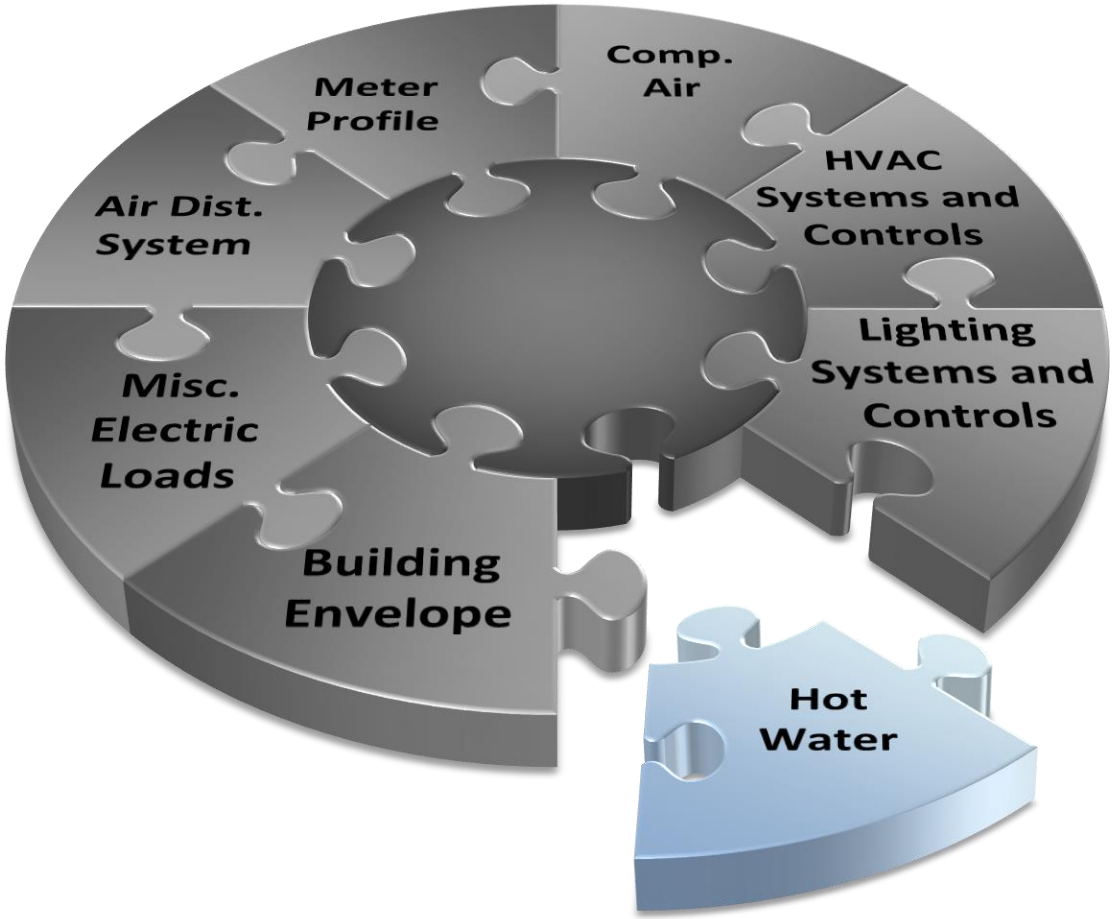
- Identify inefficient lighting equipment
  - Incandescent or metal halide fixtures
  - T12 fluorescent fixtures
  - Magnetic ballasts
  - Replace 32-watt T8 lamps with 28 or 25-watt T8 lamps

T-12 lighting

Ballast checker

Replace 32-watt T8 lamps with 28 or 25-watt lamps

Domestic Hot Water Systems



Hot Water

- Water temperature
- Recirculation pumps
- Piping Insulation

Domestic Hot Water Systems

- Measure hot water supply temperature
  - Adjust setpoint for occupancy and use if appropriate
  - Seattle Plumbing Code 407.3 maximum hot water temperature to public lavatories is 120F
- Review circulation pump controls
  - Set or adjust as appropriate
  - No controls, Integral control or BAS?

Control by BAS

No control

Integral control

Domestic Hot Water Systems

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- Pipe insulation for hot water in unconditioned spaces

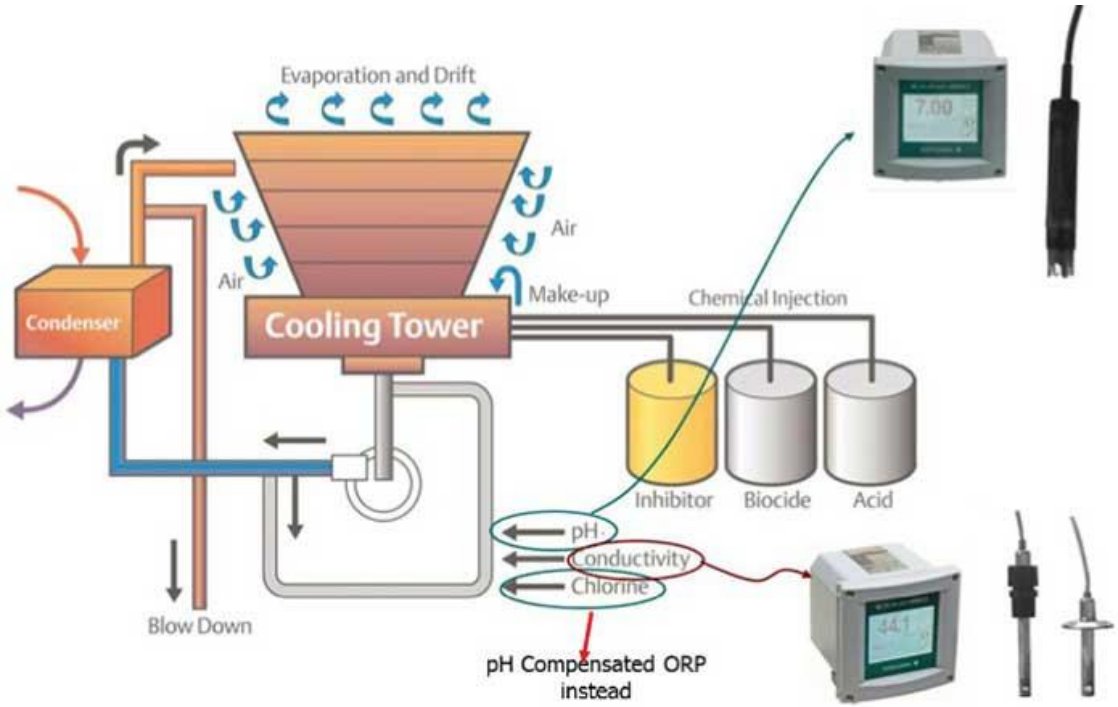
Water Usage – Irrigation Systems

- Irrigated area >500 ft2
  - Review irrigation schedule for improvements
- Verify irrigation sensors are functioning properly
  - Locate rain sensor. Override irrigation zone you can see and activate sensor
  - Test continuity
  - Adjust, calibrate or repair/replace as required

Rain sensor/switch

Water Usage – Cooling Towers

- Verify conductivity meter used to control blowdown is calibrated and functioning properly
  - Measure sump conductivity
  - Calibrate water treatment controller



Water Usage – Water Features

- Review water feature schedules
  - Set to shut-down during night time or unoccupied periods where appropriate

Water Usage – Maintenance, Cleaning & Repair

- Check irrigation system for leaks, overspray, broken heads, plugged nozzles or other operational problems
  - Adjust and repair as appropriate

Water Usage – Maintenance, Cleaning & Repair

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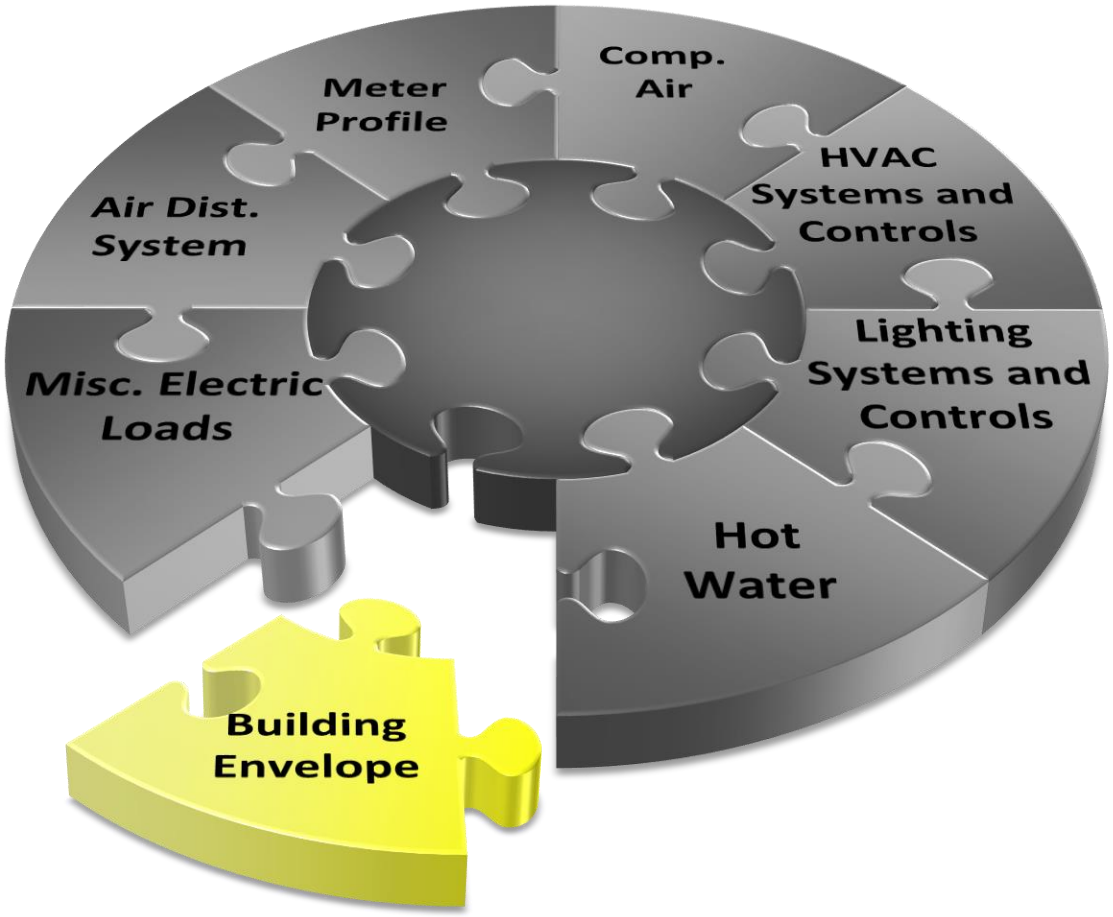
- Check hands free sensor-activated plumbing fixtures for proper operation
- Check water flow rate for fixtures
  - Recommend low-flow fixture or aerator replacement if appropriate
  - 2015 Seattle Plumbing Code Maximum Water Consumption
    - 0.25 GPM metered public faucets
    - 0.5 GPM public lavatories
    - 2.2 GPM private lavatories
    - 2.5 GPM kitchen faucet
    - 2.5 GPM shower head
  - Evaluate cooling towers for leaks and excess water consumption

Building Envelope



Envelope

- Walking down the outside and inside the building
- Doors
- Windows
- Openings
- Shades
- Exterior Plug Loads
- Insulation
- Roof
- Attic and Crawl Spaces
- Seal un-used penetrations in envelope (piping, duct work, etc.)

Building Envelope: Maintenance, Cleaning, Repair

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- Check for unsealed penetrations that allow for entry of air or water
- Check for missing weather-stripping at doors & windows
- Check elevator shaft dampers- stuck open or leaky
- Identify uninsulated attic areas or insulation damage
- Identify any significant duct leakage (disconnected ducting or holes)

Recommend repairs if scope of work is more than standard maintenance

Gaps under doorways

Failed roof insulation

IR Camera Applications

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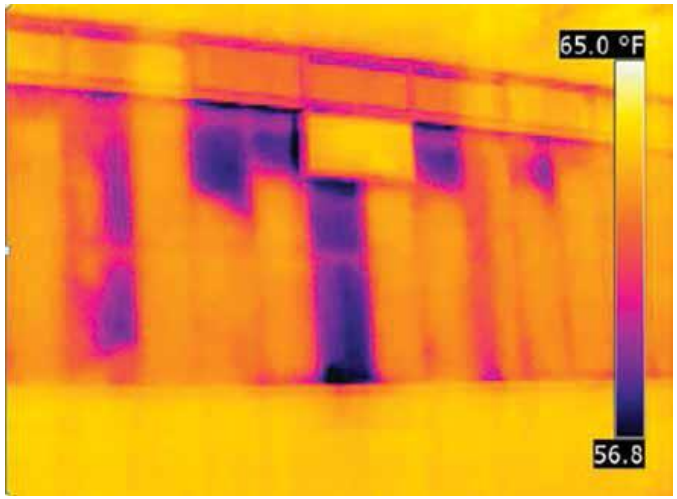

- Thermal bridges
- Missing or defective insulation
- Air leaks – penetrations, cracks
- Moisture trapped in insulation, walls, and roofs
- Find disruptions in district heating supply lines
- Locate water infiltration - flat roofs
- Detect construction failures

Source: FLIR

Review

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- Building re-tuning is a systematic process to identify and correct no/low cost operational problems that lead to energy waste
- Major focus areas are HVAC, Lighting, Domestic Hot Water, Water Usage, & Building Envelope
- Building re-tuning is observation and data driven

QUESTIONS ?

Energy Program
WASHINGTON STATE UNIVERSITY

Thank you!

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