

15.3 Addressing Common Building Issues

**Module 15: Existing Building Renovations
Part 3**

Objective: Identify common envelope and mechanical deficiencies that impact energy performance and describe common strategies to address these deficiencies.

15.3 Addressing common building issues: outline

A. Common residential buildings issues

- Envelope Leakage (older homes)
- Poor insulation installation
- Uneven air distribution
- Improper exhaust ducting
- Oversized HVAC equipment

B. Common commercial buildings issues:

- Envelope air leakage
- Duct air leakage
- Improper lighting/equipment
schedules
- Sensor failures or Programming
errors

A. Common residential building issues

Common residential issues



- Some common residential issues
 - Envelope Leakage (older homes)
 - Poor insulation installation
 - Uneven air distribution
 - Improper exhaust ducting
 - Oversized HVAC equipment

<https://www.energy.gov/eere/buildings/residential-buildings-integration>

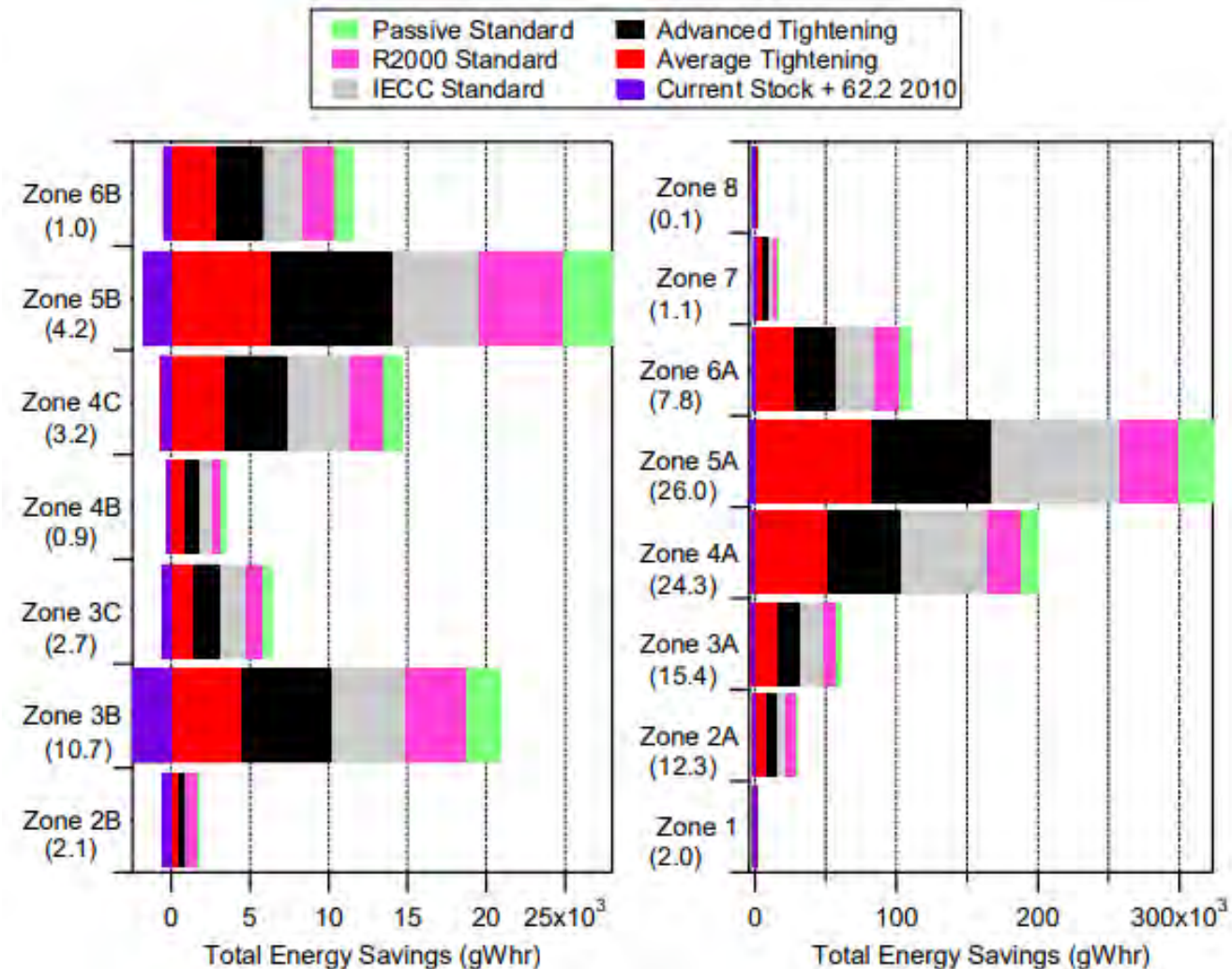
Envelope leakage impacts on energy costs

Charts show total energy savings from different target air leakage levels in residential homes.

IECC standard is 3 ACH, or about 25cfm/100 sq ft of envelope.

Achieving 3 ACH/home expected to reduce national energy cost by \$33.8 billion to \$35 billion/yr.

Average per home savings \$378/yr (varies significantly by climate zone).



Identifying envelope leakage and missing insulation

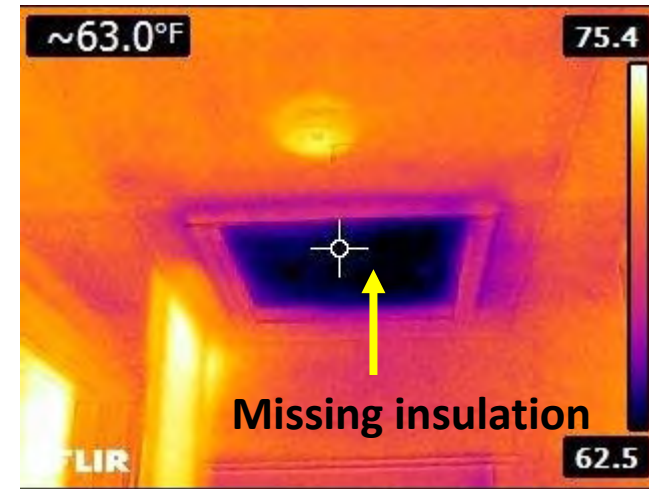
- Identify leakage & missing insulation through building depressurization (blower door) and IR imaging.
- In mild weather or climates without ~10-15°F temperature difference between indoors and outdoors, smoke tests may be better to identify leakage.
- Common locations: doors/windows, attic access, plumbing/electrical penetrations, attic level changes



<https://energyinformative.org/energy-audit-blower-door-thermographic-or-pft-testing/?mode=grid>



<https://www.greenbuildingadvisor.com/article/air-leakage-at-electrical-switches-and-outlets>



<http://structuretech1.com/wp-content/uploads/2017/01/Infra-red-missing-insulation-at-attic-access-panel.jpg>

Correcting residential air leaks

- Once leakage sites determined, solutions vary.
 - Window/door frame leaks can be fixed by caulking around frames.
 - Also, replace deteriorated weather stripping
 - Crawl/attic leaks can be sealed from those respective spaces
 - Foam board cut to fit for large openings
 - Caulk or expanding foam for cracks/seams and small holes
- Target attic and foundation leaks
 - Stack effect draws air in lowest leaks and expels air from highest leaks.



Correcting missing insulation

- Post-air sealing work, can add insulation to missing areas.
 - Attics, remove batts directly on ceiling and blow in insulation. Add batts back on top.
 - Prevents batt wrinkling from creating gaps.
 - Blow in cellulose, fiberglass, or foam to enclosed cavities.
- Improve insulation and air tightness simultaneously with injected foam insulation.
- Attic spray foaming can have similar combined insulation/air tightness benefit.
- Upgrading leaky single-pane windows also improves overall insulation and air tightness.



Residential ductwork – uneven air distribution

- Easily identified on walkthrough of home
 - Crack open a door to a room. Does it close/open itself? Feel a draft through the crack?
- Quantify leakage using a manometer.
- Uneven air distribution contributes to temperature differences.
 - Can also impact envelope leakage.
- Typically caused by duct leaks
- Potentially from improper duct sizing

	Factory-designed efficiency	Actual efficiency with unsealed ducts			
		2% or less (SEALED)	10% leakage	20% leakage	30% leakage
A/C and Heat Pumps	24 SEER	23.3	20.3	16.6	12.9
	22 SEER	21.3	18.6	15.2	11.9
	20 SEER	19.4	16.9	13.9	10.8
	18 SEER	17.5	15.2	12.5	9.7
	16 SEER	15.5	13.5	11.1	8.6
	14 SEER	13.6	11.9	9.7	7.6
Furnaces	95% AFUE	93	85	76	67
	90% AFUE	88	81	72	63
	80% AFUE	78	72	64	56

<https://comfortinstitute.org/blog/friday-feed/get-it-right-get-it-tight-duct-sealing-with-a-purpose/>

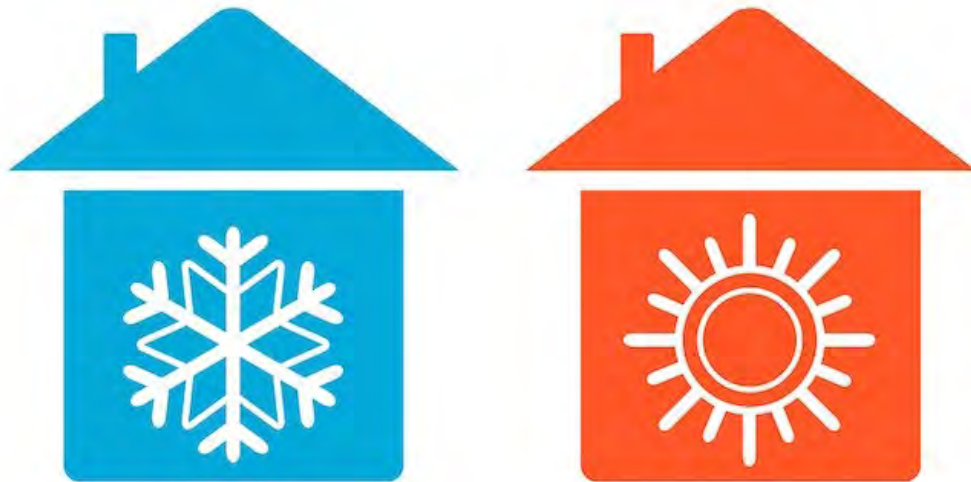
Residential ductwork corrections

- Resolutions for unbalanced flows depends on the issue:
 - Leaky ducts, seal where accessible.
 - Boot connections to floor/ceiling
 - Exposed ductwork in basements
 - Expensive, but effective option is aerosol sealant of ductwork.
 - Verify sealing with duct pressure test
- Return ducts often undersized.
 - Add more return ducts to pressurized spaces or upsize existing ducts.
- For central returns, ensure rooms have proper return path.



Residential HVAC sizing determination

- Usually, can determine due to poor humidity control
- Smart thermostat data can be used to determine loading, too
- Short cycling also good indicator
 - Units should run nearly continuously at design outdoor temperatures
- Use Manual J to properly size new equipment
- Only solution is new, properly sized equipment



<https://www.hvac.com/blog/understanding-hvac-system-heating-air-conditioning-ventilation/>

B. Common commercial building issues

Addressing common commercial issues

- Some common commercial issues*
 - Envelope air leakage
 - Duct air leakage
 - HVAC programming errors
 - Improper lighting/equipment schedules
 - Sensor failures

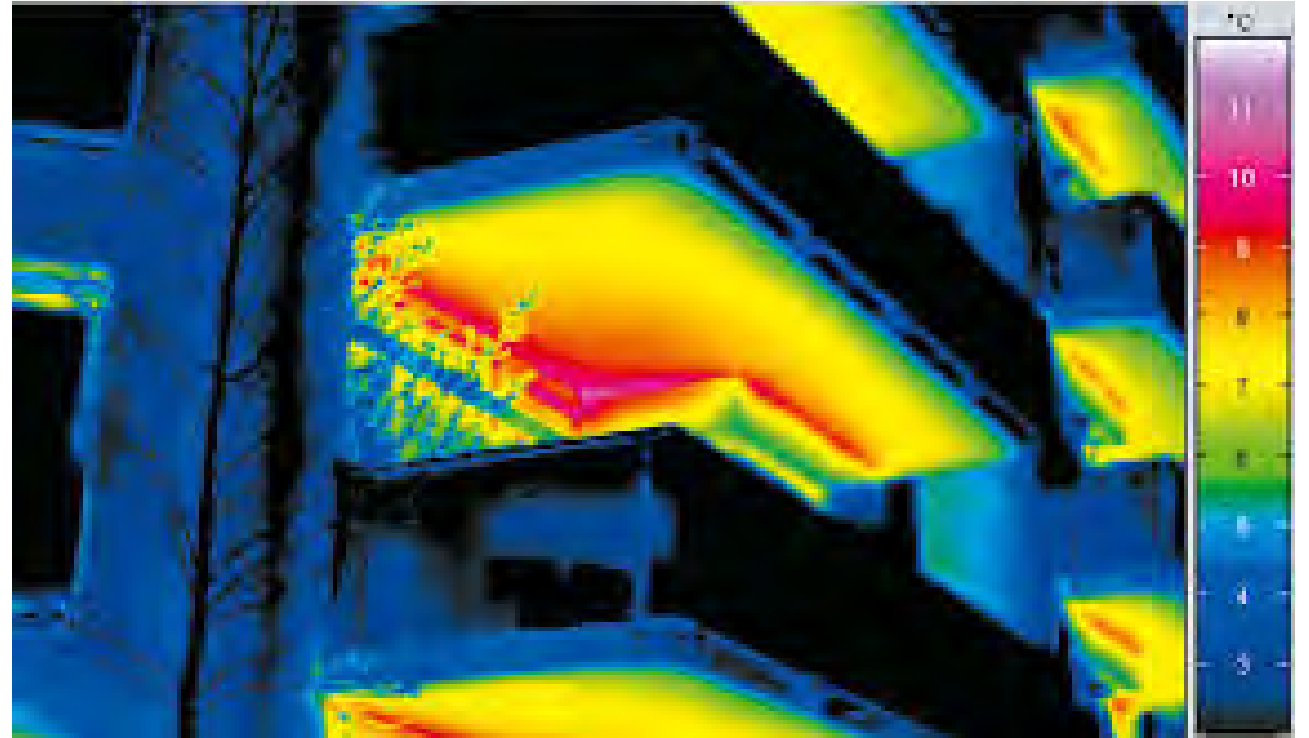
*Source data condensed from:
<https://www.nrel.gov/docs/fy18osti/70136.pdf>



Image source: <https://www7.eere.energy.gov/seeaction/topic-category/commercial-and-public-building-energy-efficiency>

Air leakage and insulation investigation

- Envelope insulation and air leakage can be investigated similarly to residential practices.
 - Pressure and smoke testing
 - IR imaging
- Insulation issues differ, usually related to structural issues instead of poor installation like residential.
- Scale may require testing in sections, but general solutions and diagnostic tests are similar.



<https://www.constructionspecifier.com/enhancing-energy-performance-with-balcony-thermal-breaks/>

Commercial duct leakage diagnostics

- Initial identification of leaks usually using IR imaging.
- Usually, systems are too large to test at once as in residential
- Portion of duct is isolated for testing.
- Similar fan pressurization used to residential on isolated portion.



Schedule verifications

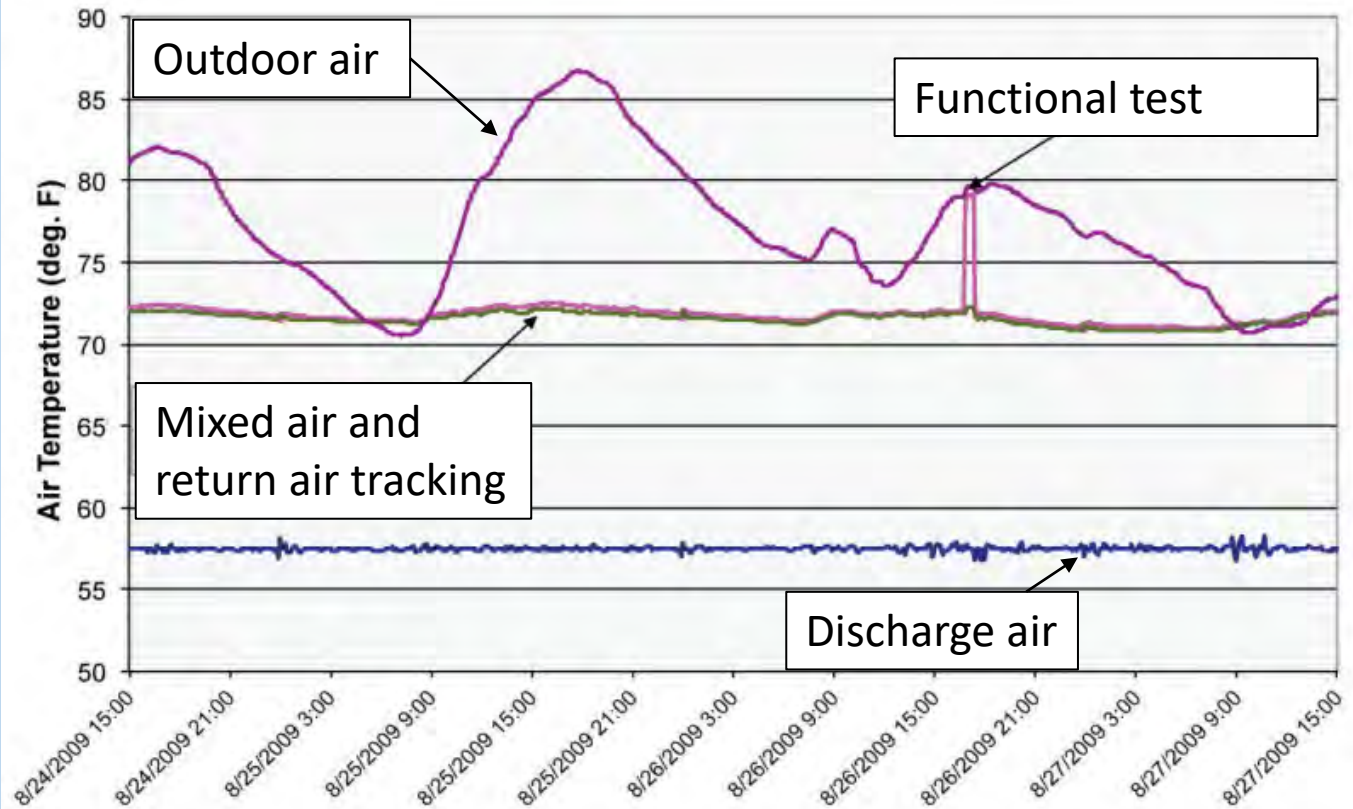
- Ever drive past a building late at night, all the lights on, but nobody present?
- Lighting often controlled by sensors that detect movement
 - Proper placement and orientation crucial to avoid false triggers
- Power outages can disrupt scheduled lighting programs
 - Need to occasionally verify correct operation



<https://www.ledsmagazine.com/home/article/16700795/lighting-control-requirements-will-drive-building-energy-reduction-magazine>

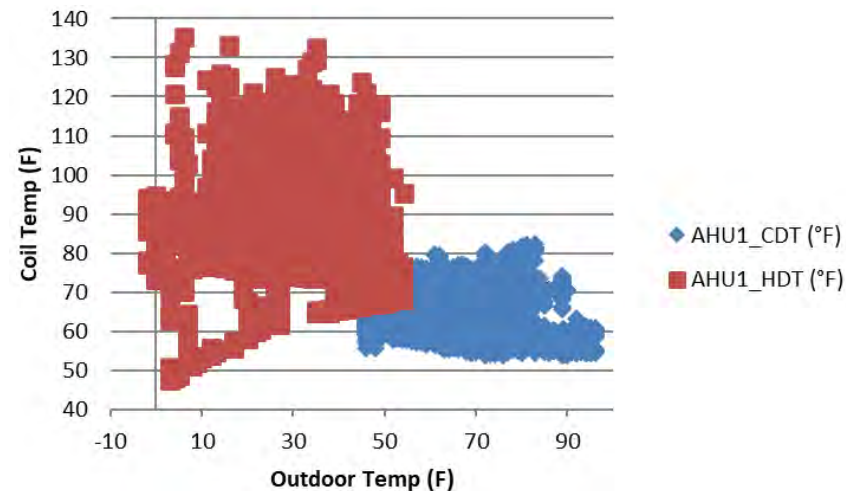
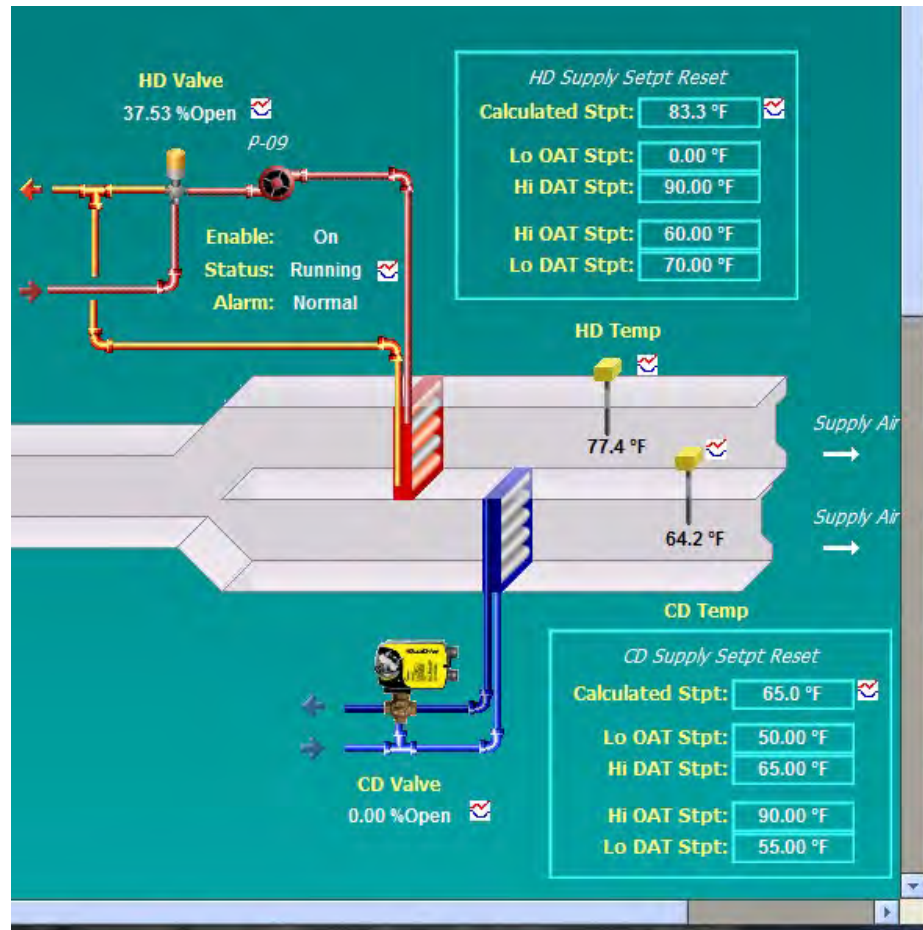
Commercial automation system analysis

- Discover issues through building retro-commissioning.
 - Organized process of using existing systems and hand-held sensors to track system performance
 - Use loggers to verify suspect sensors.
 - Use automation system trends to track schedules, performance, and loads.
- Spreadsheet analysis of trend logs can reveal many issues.

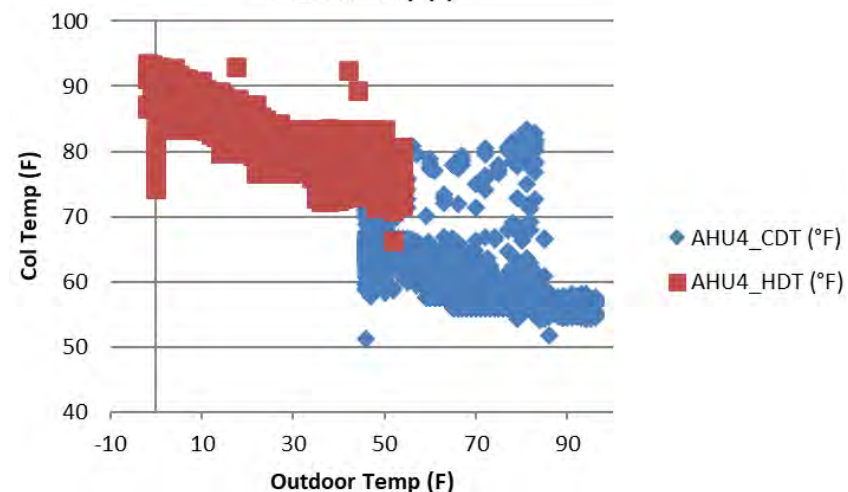


Use automation to check complex sequences

- Where data available, use to check sequence operation.
- Example shows temperature resets for dual-deck air handler.



Sequence not working



Sequence working

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<https://smartenergy.illinois.edu/community-college-energy-code/>