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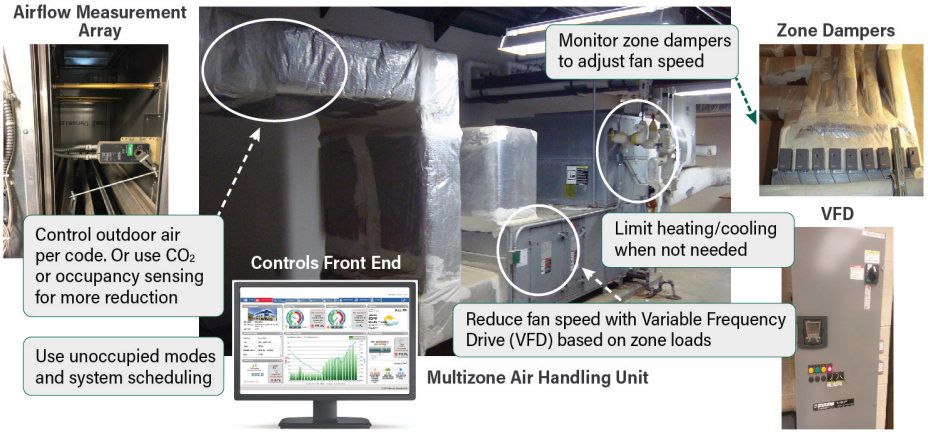
Controls Retrofit of Multizone HVAC Unit for Energy Efficiency

SAVING ENERGY BY TURNING COMPONENTS DOWN OR OFF WHEN NOT NEEDED



INEXPENSIVE VARIABLE VOLUME RETROFIT SAVES 24–60% ENERGY. TYPICAL PAYBACK 3–5 YRS. TECHNOLOGY TRANSFER TOOLS MAKE IMPLEMENTATION PRACTICAL.

Several older multizone air handling units (AHUs) underwent controls retrofits to increase energy efficiency at CERL in Champaign, IL and Ft. Bragg in NC. Many technology transfer tools were developed to facilitate adoption.

Retrofit Features

Novel Control—Zone damper signals adjust fan speed and heating/cooling coil capacity. Demand Controlled Ventilation (DCV) option adds to savings.

Few Components—Two pieces of hardware and controls programming needed for basic retrofit. Add CO_2 or occupancy sensors (Occ) for DCV.*

Multiple Applications—Nine system configurations specified:

Three unit types:
- Conventional Multizone
- Neutral Deck Multizone
- Bypass Multizone

X

Three ventilation approaches:
- Basic Variable Volume (VV)
- CO_2-DCV
- Occ-DCV

Quick Fix—Interim retrofit allows accruing savings now while delaying costly disruptive full-scale system change out, with no cybersecurity requirements.

Comprehensive Implementation Support—Easy documents and tools step user through entire process of evaluating, procuring, and using technology. Detailed scoping guidance avoids surprises, identifies needed complementary repairs/upgrades. Templates speed procurement for potential users.

**Consult appropriate UFCs on the application of CO_2 sensors.*

System Control

- The retrofit adjusts the fan speed based on the actual amount of heating and cooling needed by the zones
- Turns off heating/cooling coils when not needed
- Measures and controls outside airflow to ensure that the proper amount of air is provided
- Trims ventilation if DCV option chosen

Benefits of Retrofit

Remedies Inefficiencies—Reduces simultaneous heating & cooling, eliminates constant volume air flow

Substantial energy savings—24–60% energy at AHU in combined thermal and electric savings

Low cost—Retrofit cost of ~ $20K delays ~ $650K system change out

Short payback—SPB = 3–5 yrs. on typical units

Low hassle—Noninvasive retrofit does not require vacating building to construct

Extends useful life—With complementary repairs/upgrades of existing systems

Large DoD Impact—3–5 K units across DoD represent potential $15M/yr savings

Ideal Retrofit Candidates

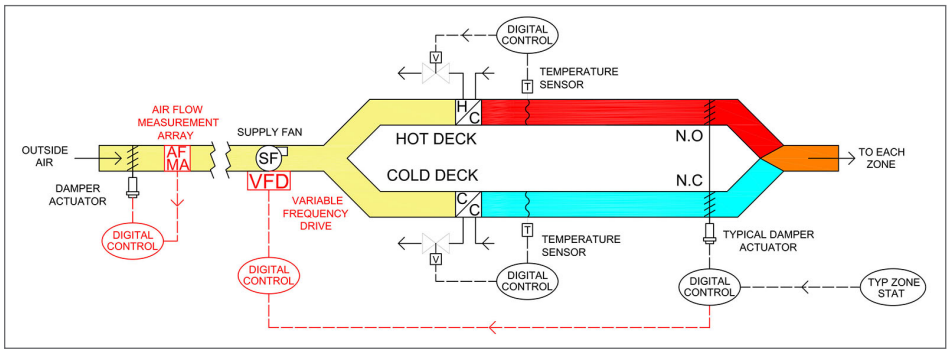
- Conventional (hot/cold deck) multizone
- Older units that can be repaired at reasonable cost
- Units already slated for controls upgrade to Direct Digital Controls (DDC)
- Larger units such as those serving >5,000 sq. ft. floor area
- Units serving variable occupancy spaces

Demonstration sites: Champaign, IL and Ft. Bragg, NC

Three Fort Bragg units were neutral deck multizones original to the 10-yr-old building, serving 3–5 KSF of office or classrooms. The two CERL units were conventional 2-deck multizones, original to the 40-yr-old building, with one serving 2.4 KSF of conference rooms, and the other serving 8.8 KSF of offices, conference/break rooms, and labs. Performance data were collected for 14 months while rotating operation through three different modes, switching daily:

Mode 0: replicated the pre-retrofit constant volume configuration
Mode 1: energy saving variable fan speed (basic VV)
Mode 2: energy saving variable fan speed with demand controlled ventilation (either CO_2-DCV or Occ–DCV)

	VV w/Fixed Ventilation (Mode 1)				VV w/DCV (Mode 2)			
MZ AHU	AHU Energy Savings Percent	Fan Cost Savings Percent	Chiller Cost Savings Percent	Boiler Cost Savings Percent	AHU Energy Savings Percent	Fan Cost Savings Percent	Chiller Cost Savings Percent	Boiler Cost Savings Percent
CERL 1	24%	5%	5%	17%	28%	6%	3%	28%
CERL 2	56%	1%	0%	57%	60%	1%	1%	61%
Bragg 1	47%	45%	14%	2%	50%	45%	14%	7%
Bragg 2	25%	33%	6%	0.4%	N/A			
Bragg 3	32%	37%	8%	5%	32%	36%	8%	5%



Additional Resources

Web Resources:

https://www.serdp-estcp.org/Program-Areas/Installation-Energy-and-Water/Energy/Conservation-and-Efficiency/EW19-5026

https://www.wbdg.org/ffc/army-coe/design-guides

Published Resources:

Schwenk, D., Bush, J., Clark, B., Mitsingas, C., and Wallace, S. 2017. *Converting Constant Volume, Multizone Air Handling Systems to Energy Efficient Variable Air Volume Multizone Systems*

Westervelt, E., Battisti, C., Morton, B., and Schwenk, D. 2021. *Multizone Air Handler Controls Retrofit for Energy Efficiency,* ASHRAE Winter Conference Paper

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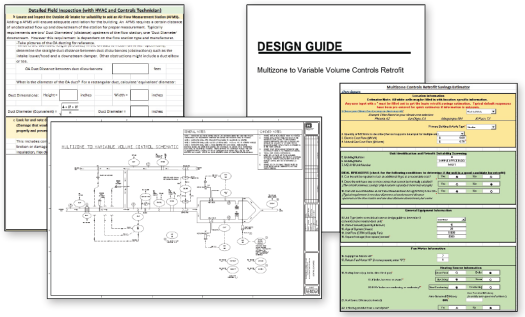
About ESTCP: The Environmental Security Technology Certification Program (ESTCP) is the U.S. Department of Defense's environmental technology demonstration and validation program. The program's goal is to identify and assess innovative technologies that address DoD's high-priority environmental requirements efficiently and cost-effectively.



Technology Transfer Tools

Evaluate Technology

- Poster—Big picture overview
- Technical Note—Distillation of the original ESTCP technical report
- Field Scoping Guide—Assess status, operation, and suitability for retrofit of units
- Estimator—Energy savings and cost of retrofit
- Pitch Briefing Slides—Inform decision makers

Streamline Procurement

Design Guide, specifications and drawing templates, sequences of operation, points schedule, and performance work statement

Operate and Maintain

Commissioning Guide—Spreadsheet tool for project familiarization, start up, and Performance Verification Test (PVT)

Conclusion

Retrofitting existing units is a simpler and more cost-conscience means of increasing energy efficiency than a full-scale system replacement.

Conventional units had the most significant utility bill savings, with the bulk of the savings in heating. Neutral decks showed adequate savings on 2 of 3 units, with most savings in fan energy. Expected payback on typical multizone applications is 3–5 yrs with SIR ~2.2 at average energy costs of $0.1054/kWh, and $0.72/therm.

The tools and documents developed as part of this project could help facilitate widespread adoption of the technology.