Powerful Business

Facing a Dynamic Energy Future

Track 1 • Session 2

HVAC & Controls

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Main Mechanical Systems Overview & Orientation to Optimization

Jim Merfeld, United Energy Engineers

A Simple Guide for Using DOC Systems To Improve VAV System Efficiencies

Main Mechanical Systems Overview and Orientation to Optimization

HVAC System Optimization

POWERFUL BUSINESS – May 24th , 2007

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Discussion Topics:

- Brief overview of mechanical systems to be analyzed for optimization opportunities.
- In-depth examination of each system for system specific optimization.
- Goal of today's session is to provide 'tools' for you to take back to your buildings to improve your system's performance.
- This discussion is 'open'….questions are welcome at anytime.

Main Mechanical Systems Discussed:

- Constant Volume Unit
- Variable Air Volume (VAV) System
- Variable-Air/Variable-Temperature (VVT) System
- Dual-Duct VAV System
- Multi-zone System
- Other ???....easy….just ask !!!

Constant Volume System

Widespread Usage With Many Applications:

- CV Units Serve Single Zones, Large and Small.
  - 'Big Box' stores.
  - Lunchroom Rooms & Lobbies.
  - Lab Areas.
  - Open Production Areas.
  - Small Buildings With Multiple Zones Use CV Units For Cost Effective HVAC Installation.

Variable Air Volume (VAV) System

Typically Associated With Commercial Office Space,

Widespread Usage:

- Small commercial office space.
- Mid-rise buildings.
- High-rise buildings.
- Mechanical system ‘standard’ in many-zones buildings.

Variable-Air/ Variable-Temperature (VVT) System

Typically Associated With Small to Medium Commercial Office Space But Sometimes Seen In 50K sqr'+ Buildings.

Widespread usage (but not as widespread as VAV):

- Hybrid of CV unit and VAV system.
- Considered a 'value engineered' VAV system.
- Applied correctly…..this system works well.

Dual Duct (VAV) System

Typically Associated With Commercial Office Space,

Popular In The 80's And Into The Early 90's:

- Small to mid-size commercial office space.
- Characterized by separate cooling and heating air ducts with associated separate cooling and heating supply units.
- Rarely seen (if ever?) anymore in new construction.

Multi-zone System

Typically Associated With Older Commercial Office Buildings Like Banks, etc.

Popular In The 50's, 60's And Into The Early 70's:

- Small to mid-size office space, seems like many banks have multi-zone systems.
- Characterized by central unit and zone dampers all located at the central unit.
- Rarely seen (if ever?) anymore in new construction.

‘Quick’ Systems Overview Complete

Everybody Okay With The Systems Described?

Quick Poll Of Systems Described To Group’s Systems In Their Buildings:

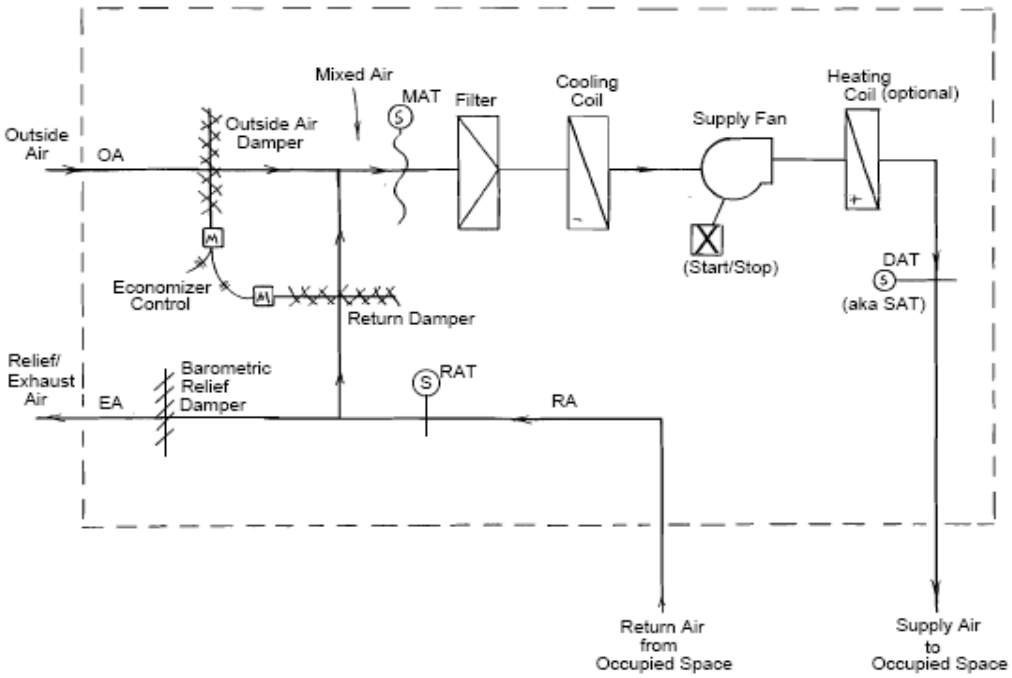
- CV Systems?
- VAV Systems?
- VVT Systems?
- Dual-Duct Systems?
- Multi-zone Systems?
- Missing Any Specific System(s)?

Start: Detailed System View

First Up: Constant Volume (CV) Systems:

- Typically provide both heating and cooling to a single zone.
- Central fan supplies continuous, unchanging amount of airflow to the zone.
- Comfort is maintained by heating or cooling the air supplied to the zone.
- Typically CV units have ‘free cooling’ capability, also know as the Economizer.
- View one-line drawing now.

Constant Volume (CV) Unit



Constant Volume Systems, cont.

First…Go For The Low-Hanging-Fruit 'optimization':

- Typically, poorly performing mechanical equipment has incorrectly operating basic system components like…..the economizer.
  - If the economizer is not operating correctly your not getting FREE COOLING.
  - Test your equipment for correct operation.

Constant Volume Systems, cont.

More….'optimization':

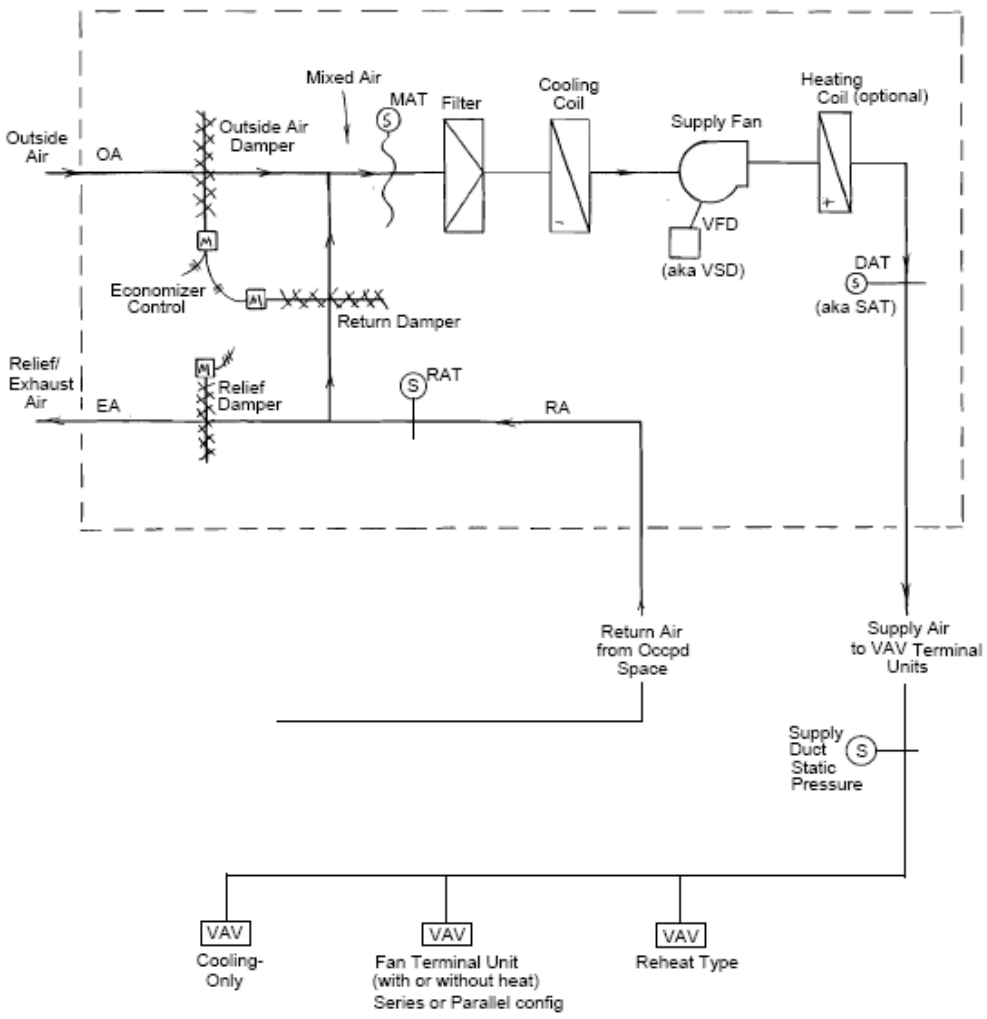
- Occupancy time scheduling:
  - Does your current occupancy schedule match the correct (and not more) occupancy periods for your buildings?
- Make sure the units are adequately and correctly maintained.
- CV systems are fairly straightforward, a little continuous diligence goes a long way towards efficiency.

VAV System View

Variable Air Volume (VAV) Systems:

- Single system typically provides cooling to many zones.
- Each system has VAV terminal units that manage the airflow to each zone.
- Comfort is maintained by varying the airflow into each zone.
- VAV systems are more complex than CV systems, and, as such, offer more opportunities for optimization.
- View one-line drawing now.

Variable Air Volume (VAV) Unit



Two 'flavors' of the above zone(s) types: a: Pressure-dependent (pre Pressure-independent)
b: Pressure-independent (defacto standard)

Variable Air Volume Systems, cont.

Again…Go For The Low-Hanging-Fruit ‘optimization’:

- Verify correct economizer operation.
- Verify correct occupancy scheduling.
- More complex optimization……..

Variable Air Volume Systems, cont.

……..More complex ‘optimization’:

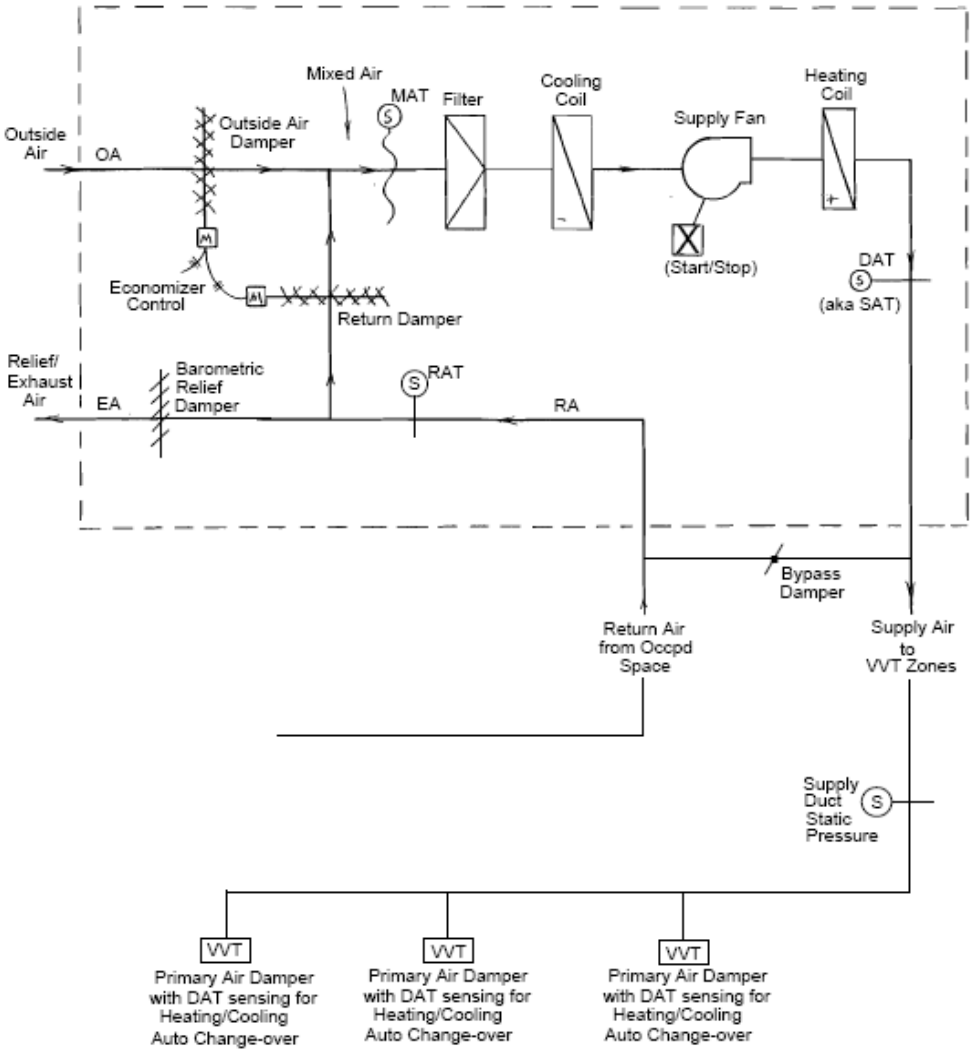
- Requires programmable DDC control system.
  - Supply duct static pressure reset program.
  - Supply air temperature reset program.
  - Identify-and-correct ‘bad boy’ zones.
- Lower duct pressure setpoint for systems with series VAV zone boxes.
- If equipped…..consider gas heat morning warm-up.

VVT System View

Vari-Air/Vari-Temp (VVT) Systems:

- Single system typically provides cooling to many zones.
- Each system has VVT terminal units that manage the airflow to each zone.
- Comfort is maintained by varying the airflow into each zone.
- VVT systems are more complex than CV systems, and, as such, offer more opportunities for optimization.
- View one-line drawing now.

'VVT' Configured Constant Volume Unit



Two 'flavors' of the above zone(s) types: a: Pressure-dependent (standard)
b: Pressure-independent (retrofit standard)

VVT Systems, cont.

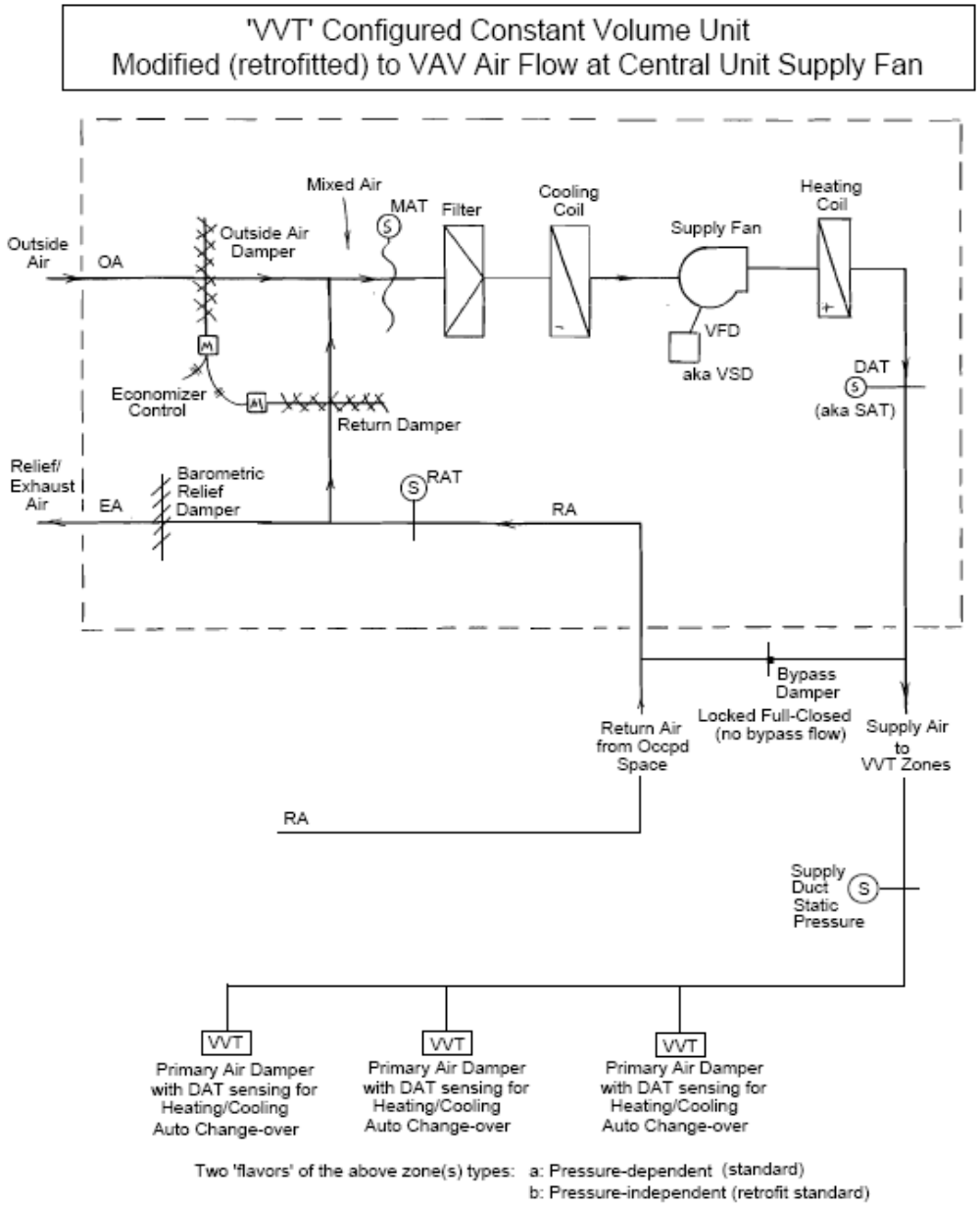
Again…Go For The Low-Hanging-Fruit:

- Notice…..L-H-F is common throughout the different mechanical system configurations.
- Verify correct economizer operation.
- Verify correct occupancy scheduling.
- More complex optimization……..

VVT Systems, cont.

…….…..More complex ‘optimization’:

- Requires programmable DDC control system.
  - Retrofit CV supply fan with VFD and lock bypass damper closed. Control duct static pressure with supply fan capacity control.
  - Retrofit VVT zone dampers with pressure-independent controllers for more accurate and efficient airflow (note: this is more comfort related than energy savings).


'VVT' Configured Constant Volume Unit
Modified (retrofitted) to VAV Air Flow at Central Unit Supply Fan
Outside Air
OA
Outside Air Damper
Mixed Air
MAT
Filter
Cooling Coil
Supply Fan
Heating Coil
VFD
aka VSD
DAT
(aka SAT)
Economizer Control
Return Damper
Relief/ Exhaust Air
EA
Barometric Relief Damper
RAT
RA
Bypass Damper
Locked Full-Closed (no bypass flow)
Return Air from Occpd Space
Supply Air to VVT Zones
RA
Supply Duct Static Pressure
VVT
Primary Air Damper with DAT sensing for Heating/Cooling Auto Change-over
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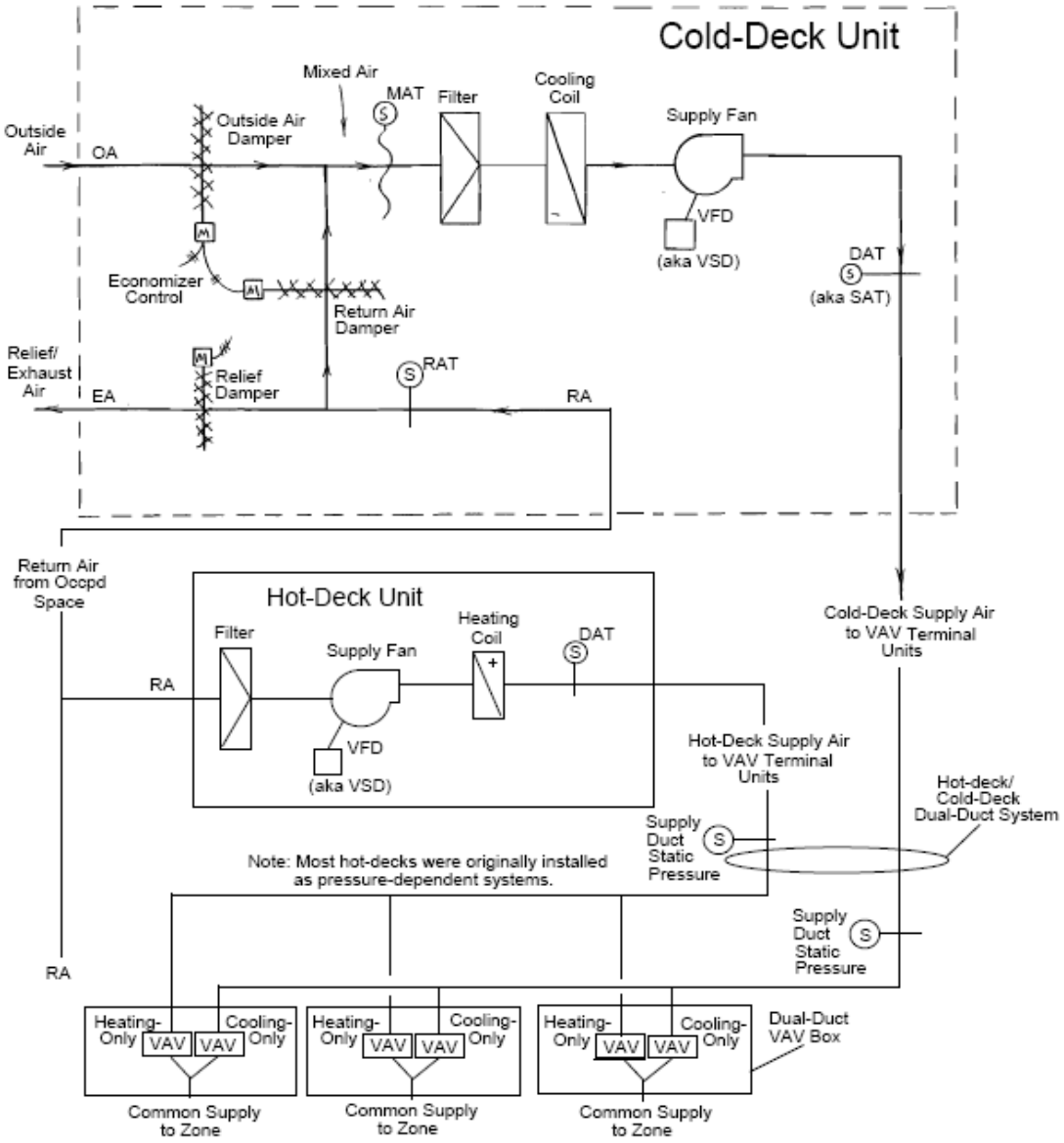
Primary Air Damper with DAT sensing for Heating/Cooling Auto Change-over
Two 'flavors' of the above zone(s) types: a: Pressure-dependent (standard)
b: Pressure-independent (retrofit standard)

Dual-Duct VAV System View

Dual-Duct VAV Systems:

- Separate main air handling unit for cooling duct and heating duct.
- VAV terminal units have separate heating and cooling air valves that may, or may not, be physically connected. If they are physically connected this adds complexity to any terminal unit retrofit plans. DO YOUR HOMEWORK !
- Share the same functional characteristics as a standard VAV system…..and same savings opportunities….x 2 (almost…..the hot deck does not have an economizer).
- View one-line drawing now.

Dual Duct VAV System



Two 'flavors' of the above zone(s) types: a: Pressure-dependent (pre Pressure-independent)
b: Pressure-independent (defacto standard)

Dual-Duct VAV System, cont.

Again….L-H-F ‘optimization’:

- Verify correct economizer operation.
- Verify correct occupancy scheduling.
- More complex optimization…….…

Dual-Duct VAV System, cont.

……..…..More complex ‘optimization’:

- Requires programmable DDC control system.

Similar opportunities as ‘regular’ VAV system:

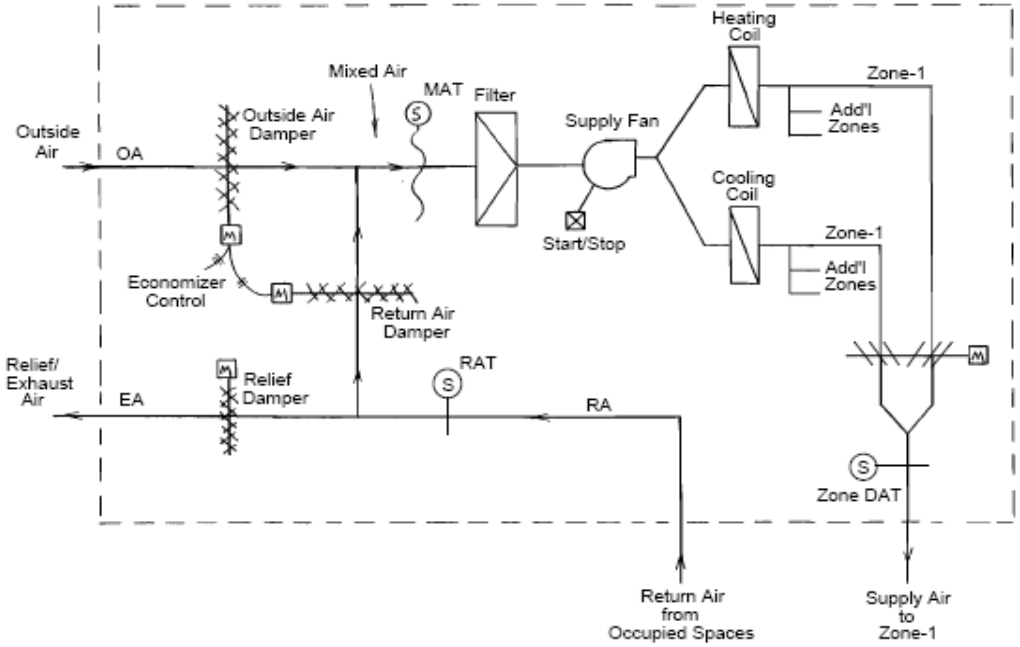
- Maximize supply fan capacity control efficiency on both the hot deck and cold deck….add VFD’s if not already installed.
  - Supply duct static pressure reset program.
- Supply air temperature reset program.
- Identify-and-correct ‘bad boy’ zones.

Multi-zone System View

Multi-zone CV Systems:

- Single main air handling unit for separate cooling and heating air valves serving a single a zone.
- Many multi-zone CV units can be retrofitted to functionally operate very similar to a dual-duct VAV system…..and enjoy some of the same optimization strategies.
- View one-line drawing now.

Multi-Zone Constant Volume Unit



Multi-zone, cont.

System ‘optimization’, same approach applies:

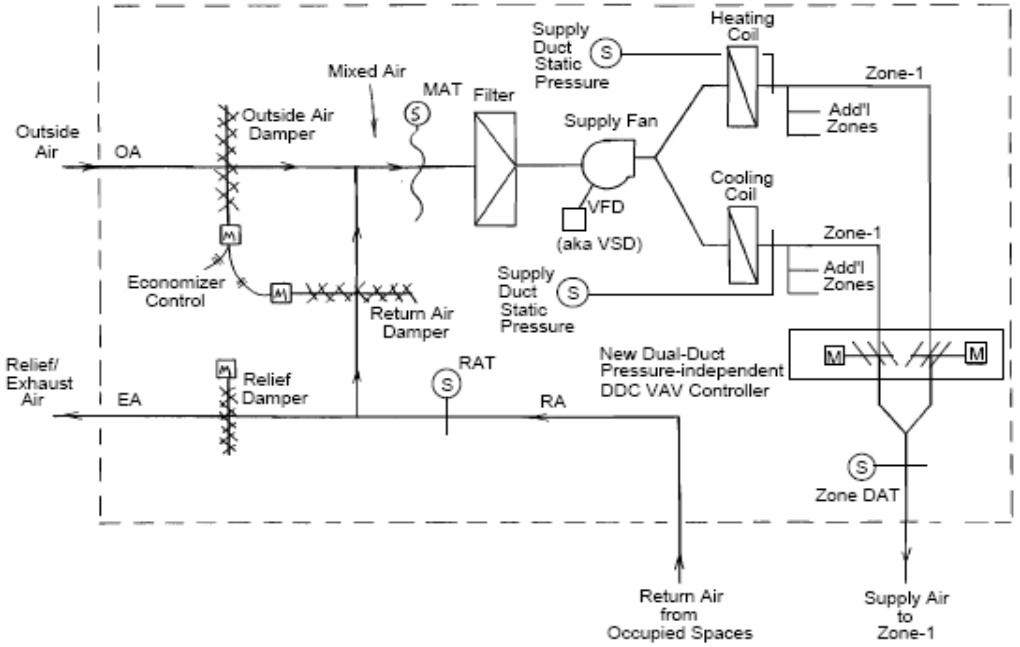
- L-H-F.
- More complex optimization….

Multi-zone System, cont.

Requires programmable DDC control system.

- Retrofit zone dampers to Dual-Duct VAV.
- Supply air temperature reset program.
  - Hot deck and cold deck.
- VFD for supply fan capacity control then…
  - Supply duct static pressure reset. Reset to meet highest demand….but no more than that.
  - Identify-and-correct ‘bad boy’ zones.

Multi-Zone Variable Air Volume (VAV) Unit



Systems Overview Review:

Always..Go For The Low-Hanging-Fruit 'optimization':

- The low-hanging-fruit items were common throughout all the systems examined.
  - They are all relatively easy to pursue and the savings are typically there.
- Use your systems tools (exp: DDC control system) to monitor, analyze and correct system operation. Jim Merfeld to expand.
- Ladies and gentlemen….Please meet Jim Merfeld with United Energy Engineers.