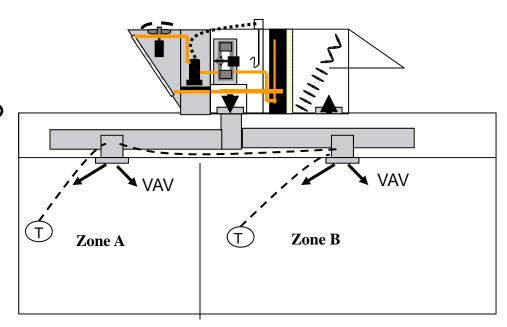
### Single Zone Variable Air Volume

### Single Zone Variable Air Volume

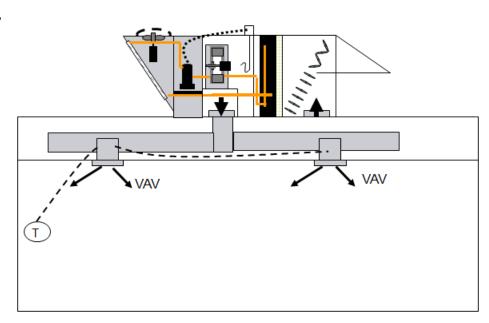
- □ Single Zone VAV Systems
  - What is Single Zone VAV?
  - Why should you use SZ-VAV?
  - What is Required for Precise Space Control and under what conditions is it required?
  - What is Required to Minimize Energy Consumption?

#### Traditional VAV Systems

- Traditional VAV systems feed multiple zones from one unit
- Supply airflow changes to maintain supply duct pressure
- Unit capacity changes to maintain supply air temperature
- VAV boxes control airflow into each zone depending on load



- Single Zone VAV systems feed one zone from one or more identical unit(s)
- Supply airflow changes based on space load
- Unit capacity changes to maintain supply air temperature (set point can be offset to maintain humidity control)
- No VAV boxes required



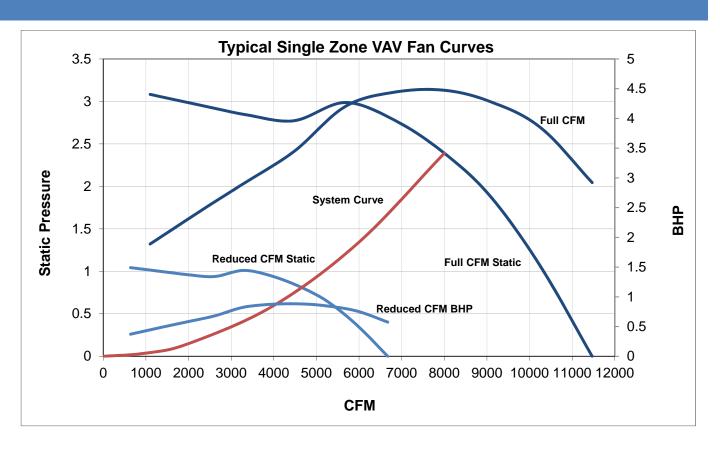
- What is required for single zone VAV equipment and under what conditions is it beneficial?
  - Variable speed supply fan
    - Variable frequency drive (VFD) with AC motor
    - Brushless DC motor (ECM)
  - Variable capacity compressor
  - Variable speed condenser fan motors
    - VFD with AC motors
    - Brushless DC motors (ECM)
  - Modulating hot gas reheat?

Full load 8000 CFM

Full load 4.5 BHP

Reduced load 4650 CFM 58% of full load

Reduced load 0.9 BHP 20% of full load



Another benefit to the airflow reduction is the reduction in fan noise due to change in speed

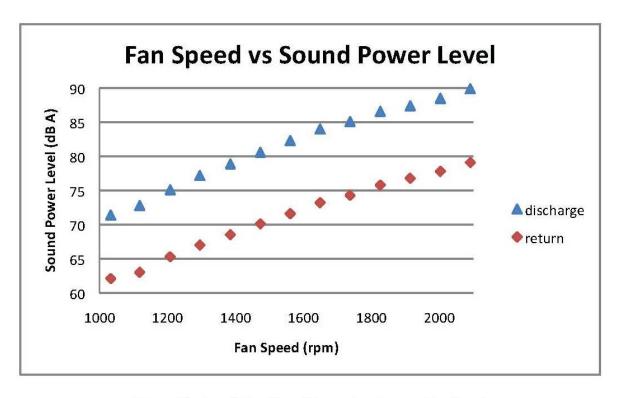


Figure 11: A-weighted Sound Power Level versus Fan Speed

#### Variable Capacity Compressor

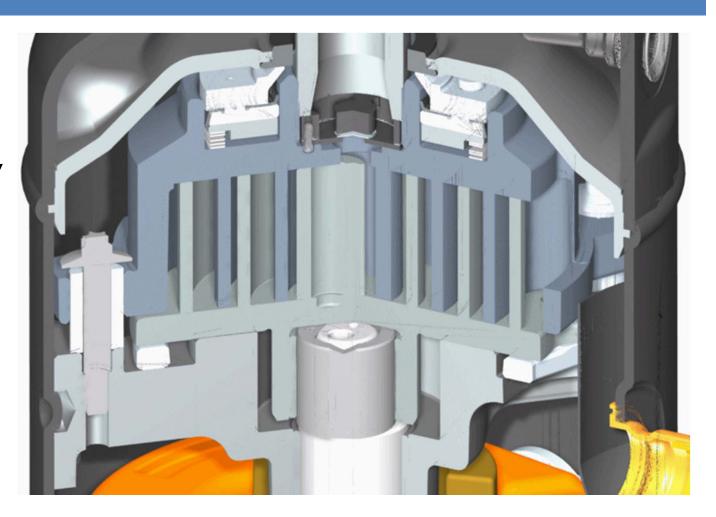


- Variable Capacity Scroll Compressor
- Pulsed Compressors Developedin 1995
- Introduced into Asian Mini-SplitMarket
- □ Introduced in 2003
- Today Available Capacities of 3 to 15 HP
  - Singles and Tandems
  - 10-100% capacity Modulation

Others do this with speed controlled compressors.

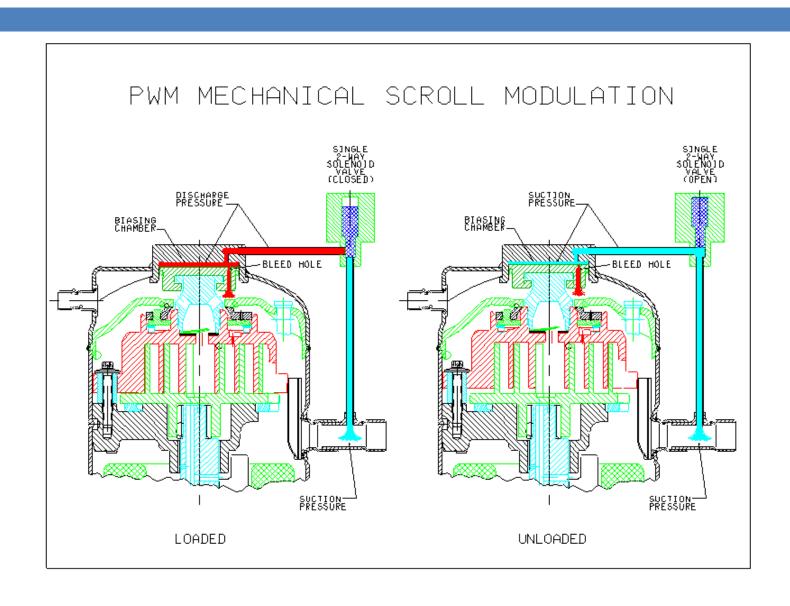
#### Variable Capacity Compressor

Internal view of Variable Capacity Scroll Compressor



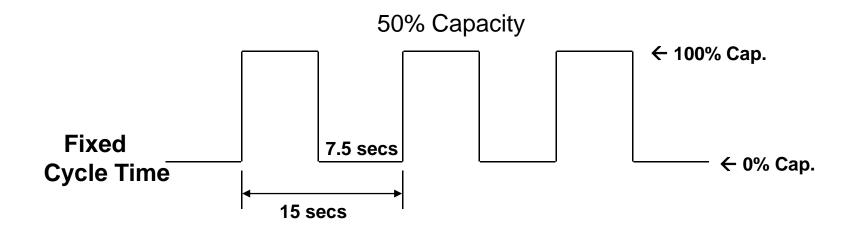
#### **Modulation Mechanism**

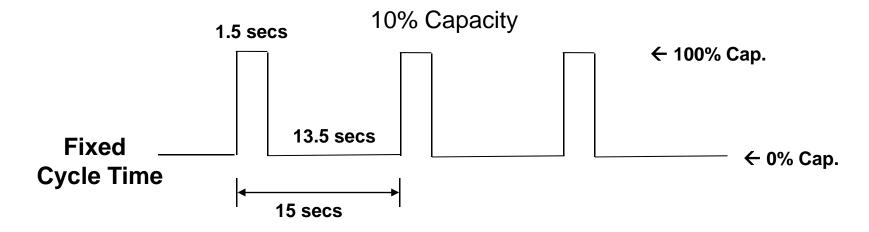




### Variable Capacity Compressor



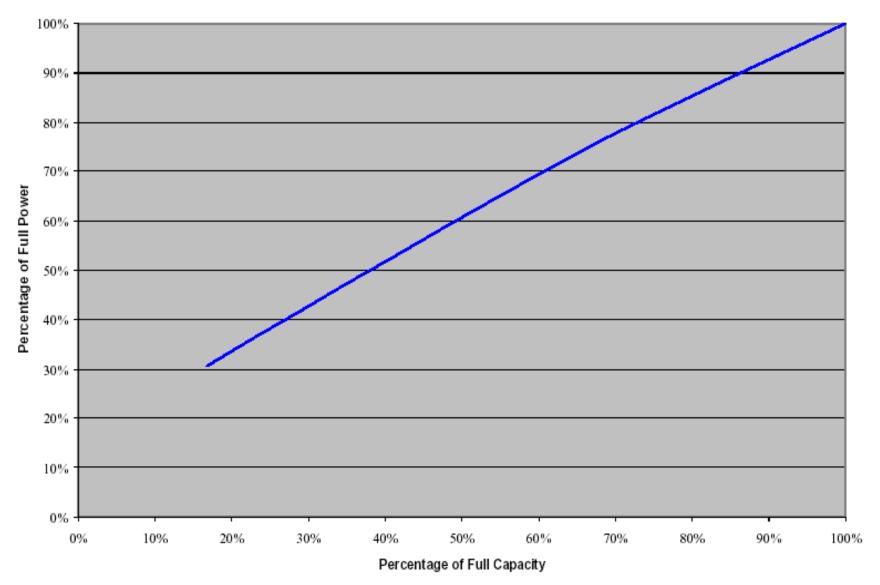




#### application engineering bulletin



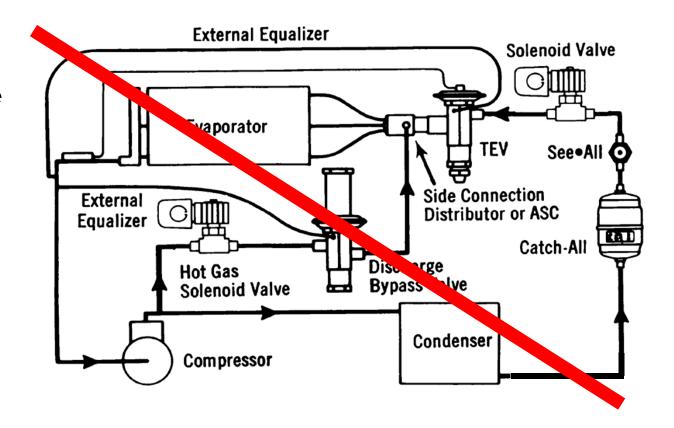
#### FIGURE 3 TYPICAL MODULATED POWER REDUCTION



#### Constant Capacity Compressor



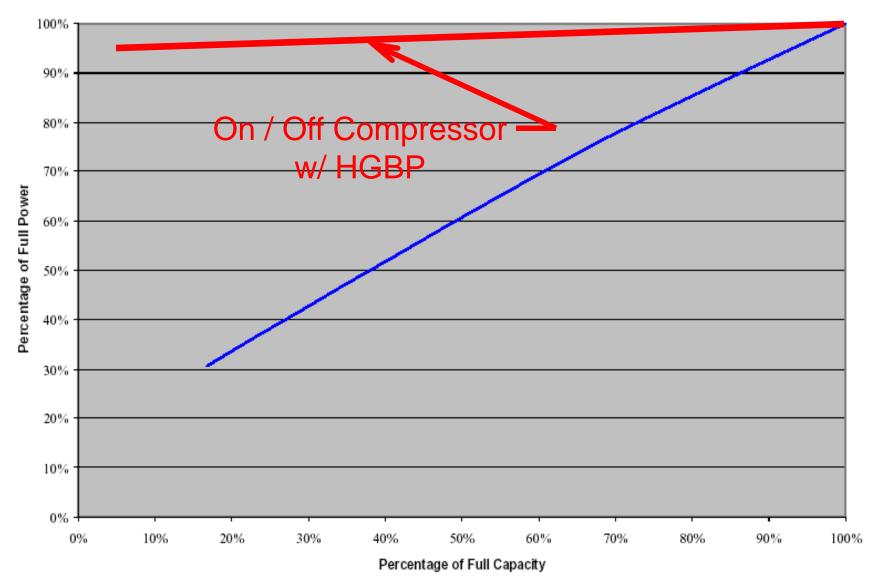
Hot Gas Bypass is not needed with the variable capacity compressor



#### application engineering bulletin



#### FIGURE 3 TYPICAL MODULATED POWER REDUCTION

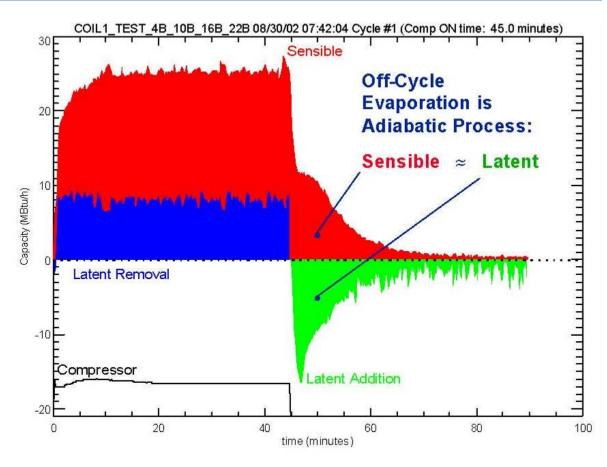


### On/Off Compressors

- On/Off compressors should not be used in VAV systems
- Require HGB to prevent freezing the evaporator coil
- Large temperature swings will occur due to airflow changes without the ability to adjust capacity
- Compressor cycling will increase when trying to maintain leaving air set point

### On/Off Compressors

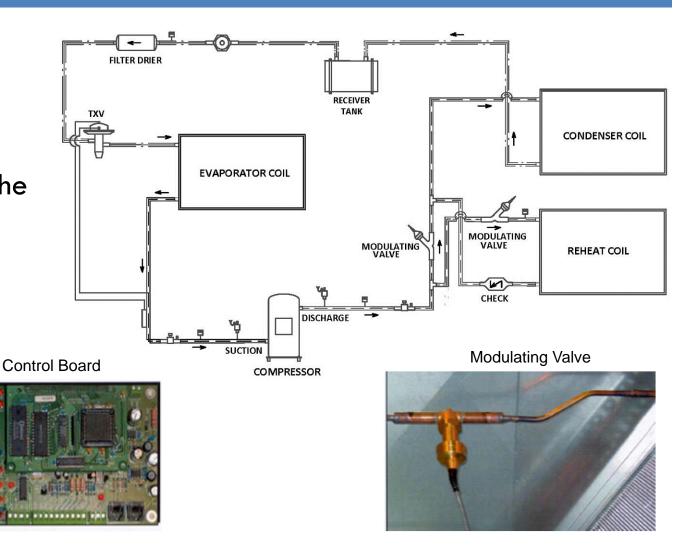
Evaporation effect of On/Off compressors due to cycling



Courtesy of DOE/NETL Project #DE-FC26-01NT41253

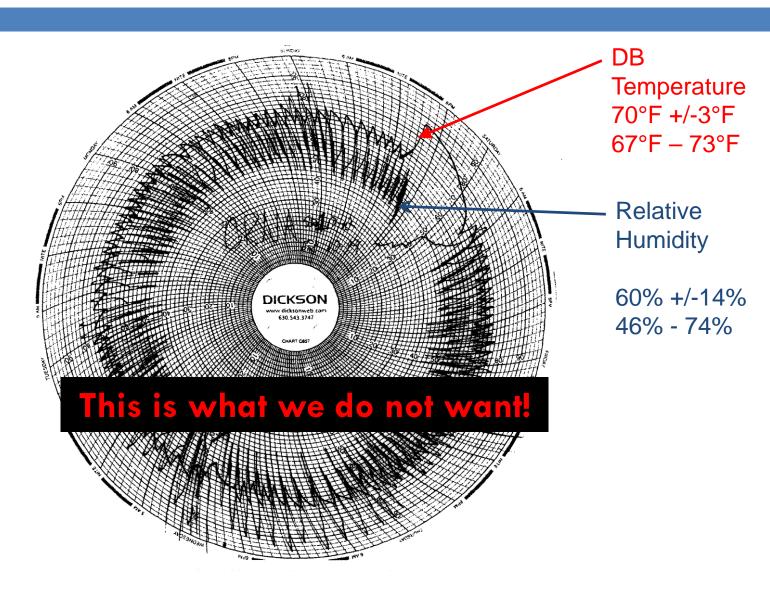
#### Modulating Hot Gas Reheat

Modulating Hot Gas
Reheat System may
be needed for SZVAV depending on the
application

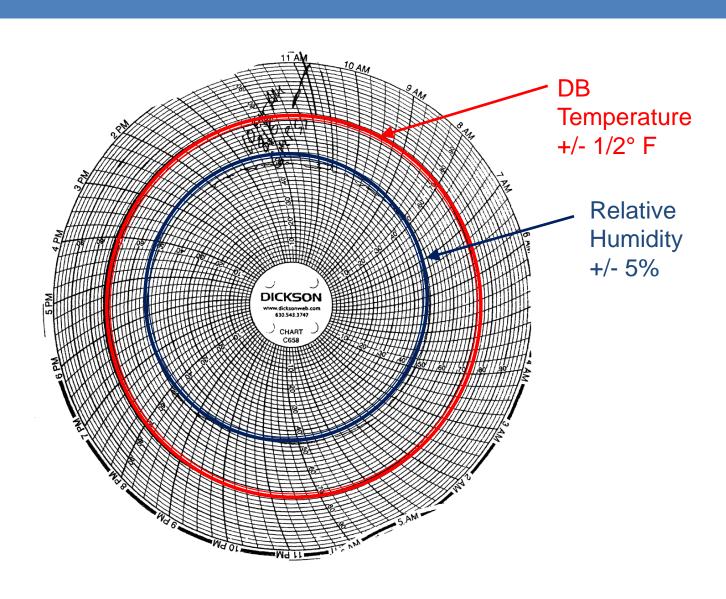


- Why use SZ-VAV?
  - Better space temperature and relative humidity control
  - Meet new code requirements
  - Lower energy usage
  - Lowers average sound pressure level

## DX On/Off System over 24 hours



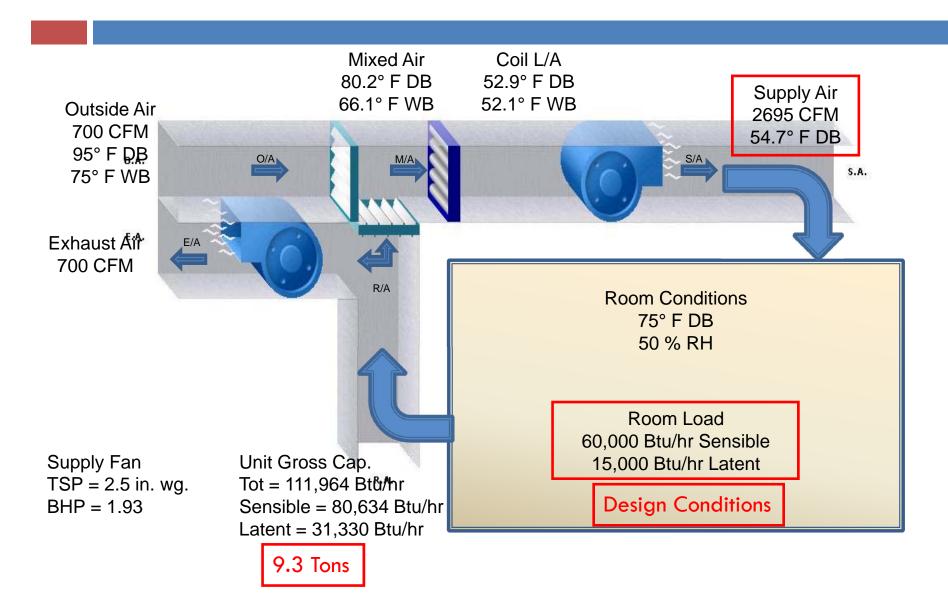
### DX Variable Capacity Compressor with Modulating Reheat over 24 hours

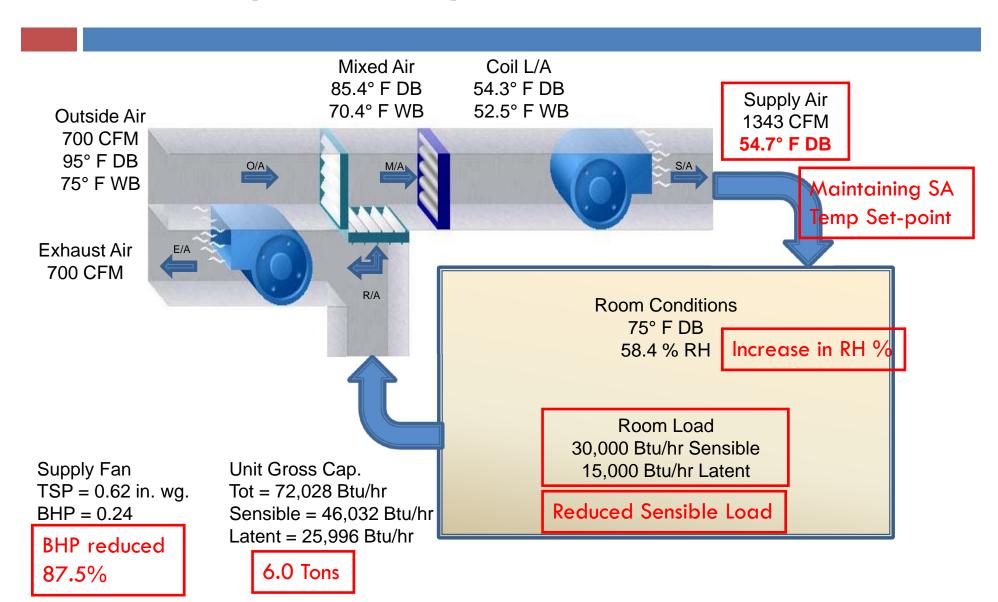


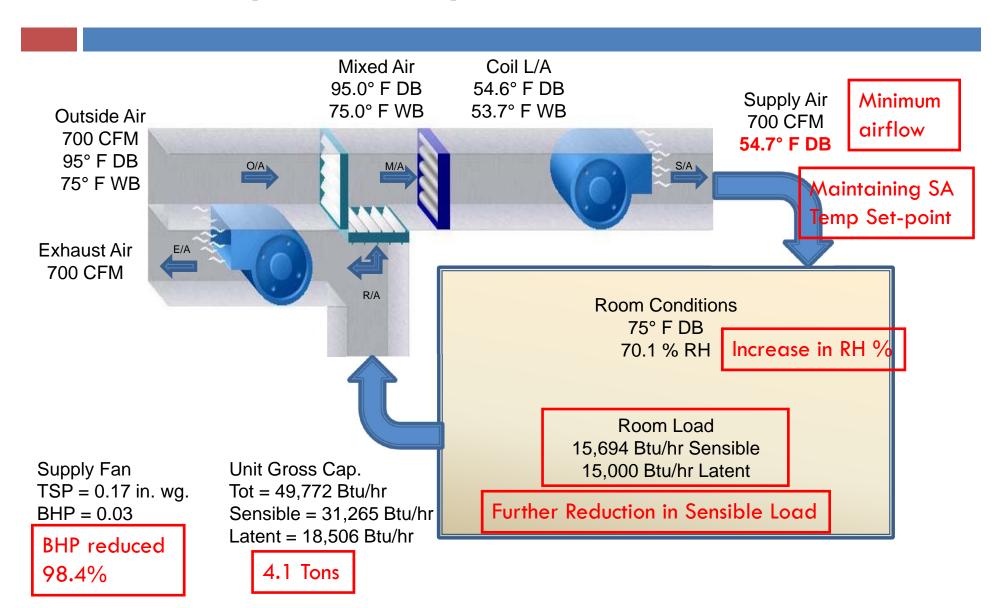
### ANSI/ASHRAE/USGBC/IES Standard 189.1-2009 Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

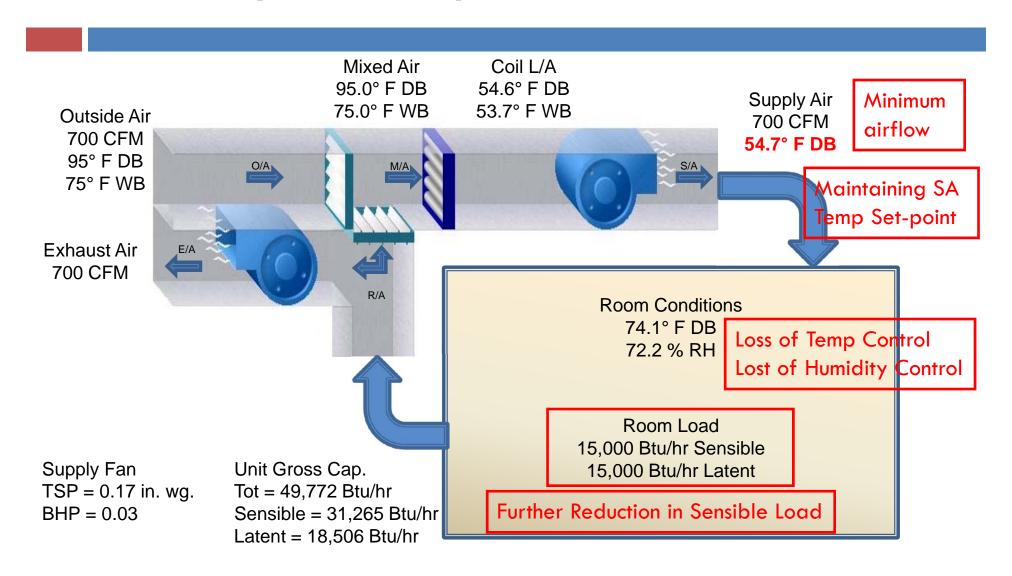
- 7.4.3.7.c. <u>All</u> air-conditioning equipment and air-handling units with direct expansion cooling and a cooling capacity at AHRI conditions greater than or equal to <u>110,000 Btu/h</u> (32.2 kW) <u>that serve single zones shall have their supply fans controlled by two-speed motors or variable-speed drives</u>. At cooling demands less than or equal to 50%, the supply fan controls shall be able to reduce the airflow to no greater than the larger of the following:
- 1.Two-thirds of the full fan speed, or
- 2. The volume of outdoor air required to meet the ventilation requirements of ANSI/ASHRAE Standard 62.1.
- d. All DX and chilled-water VAV units shall be equipped with variable-speed fans that result in less than 30% power at 50% flow.

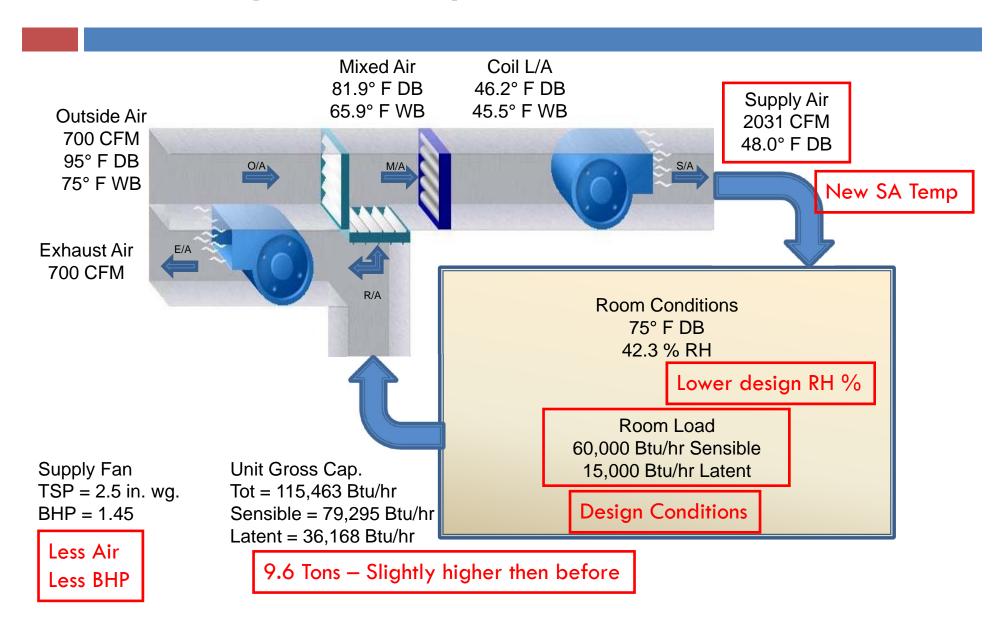
Exception: When air ventilation rates or air exchange rates require constant volume fan operation.

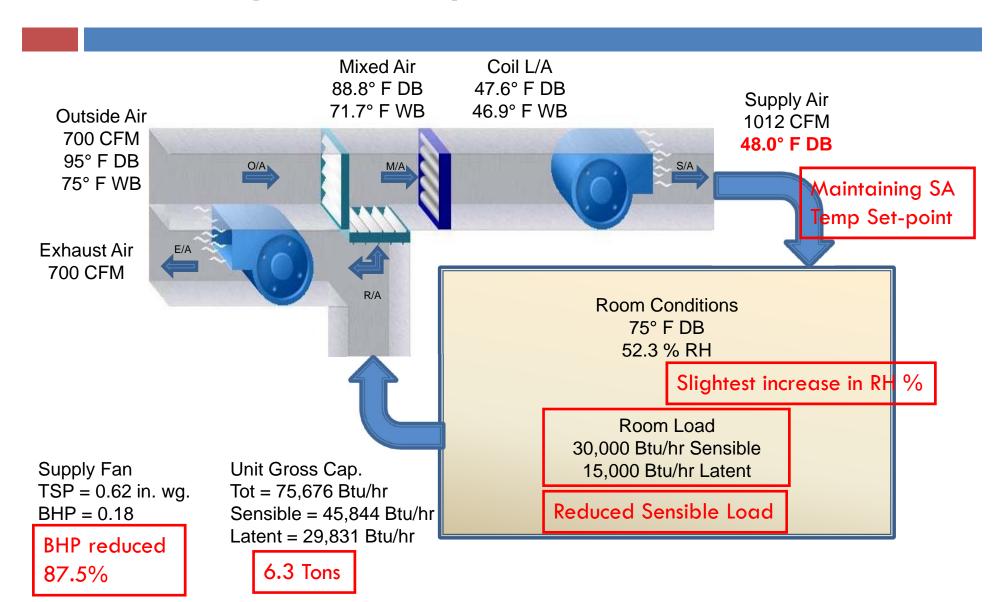


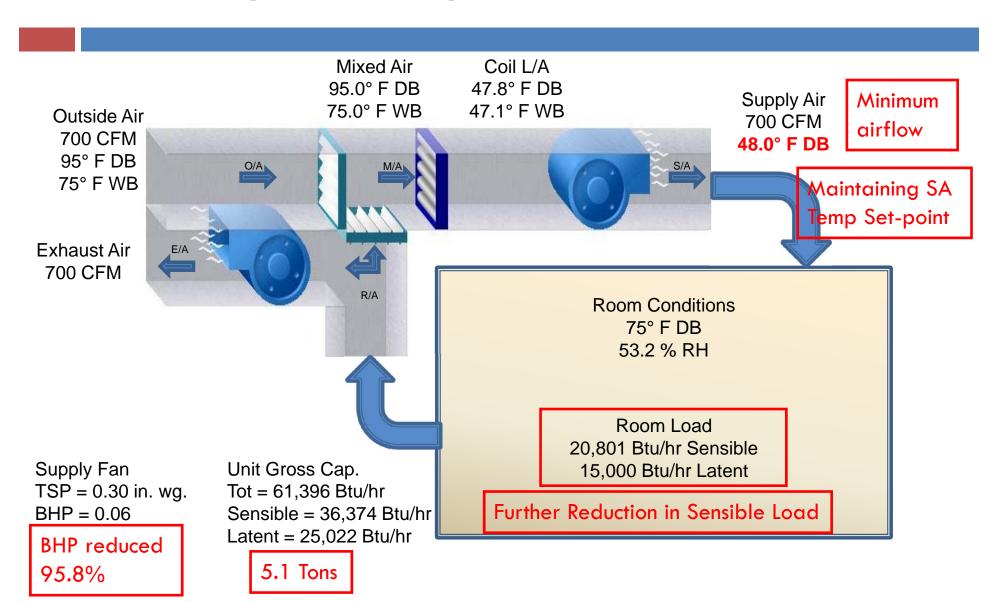


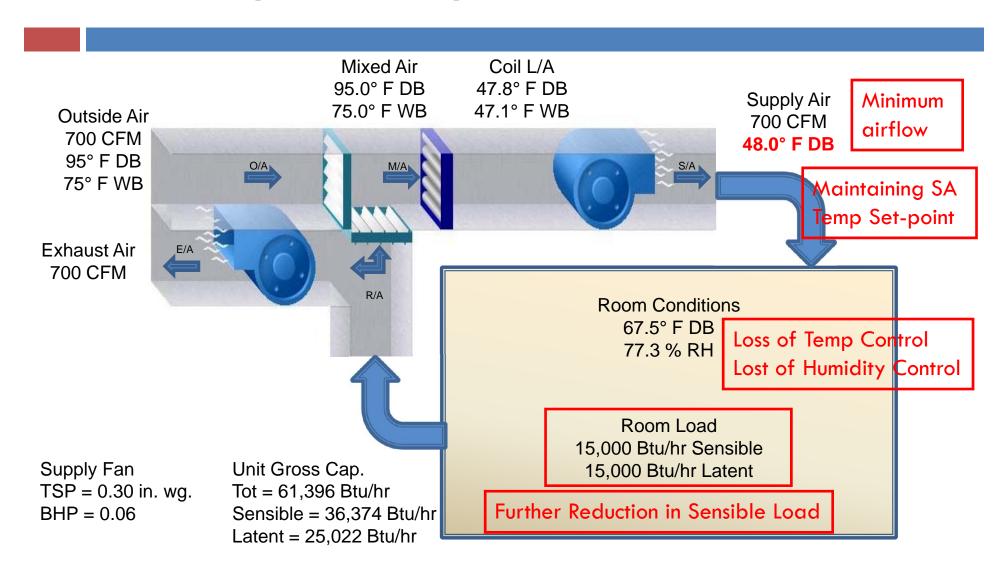


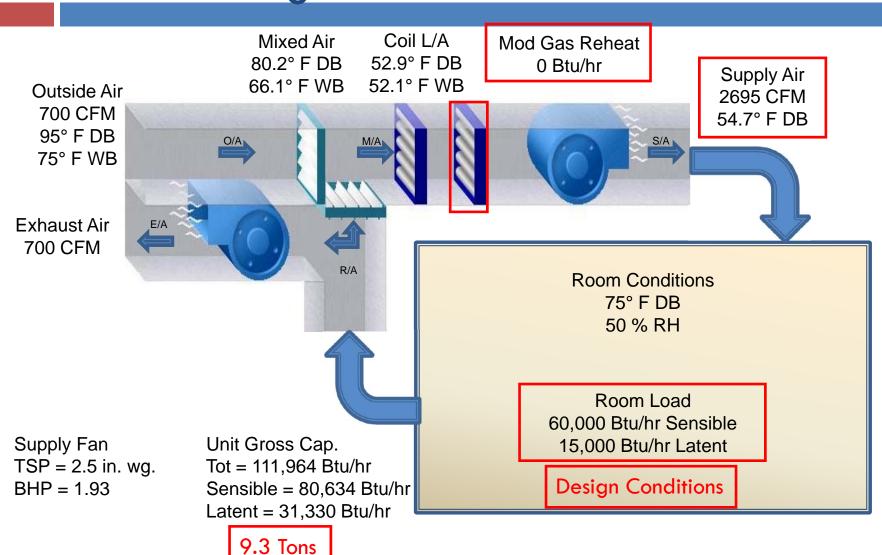


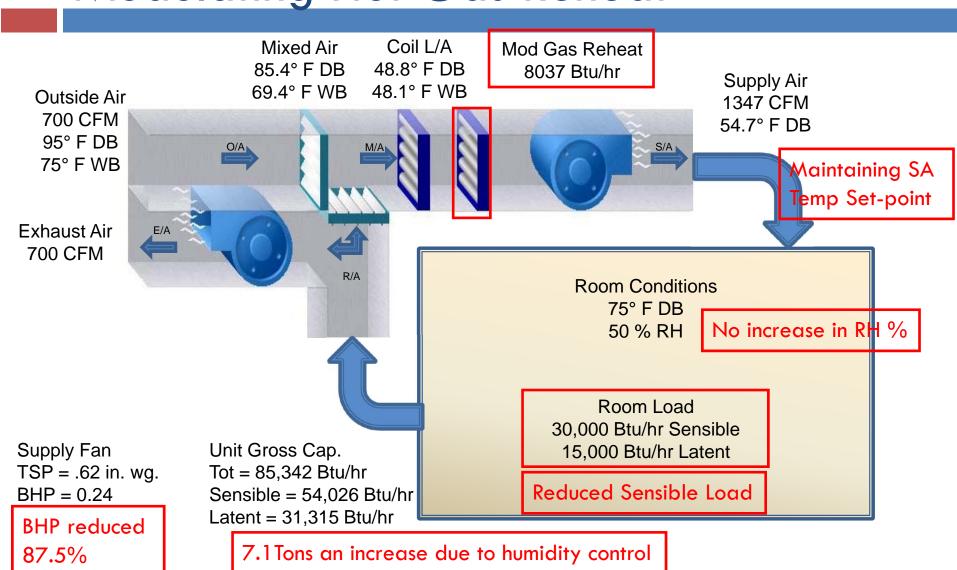


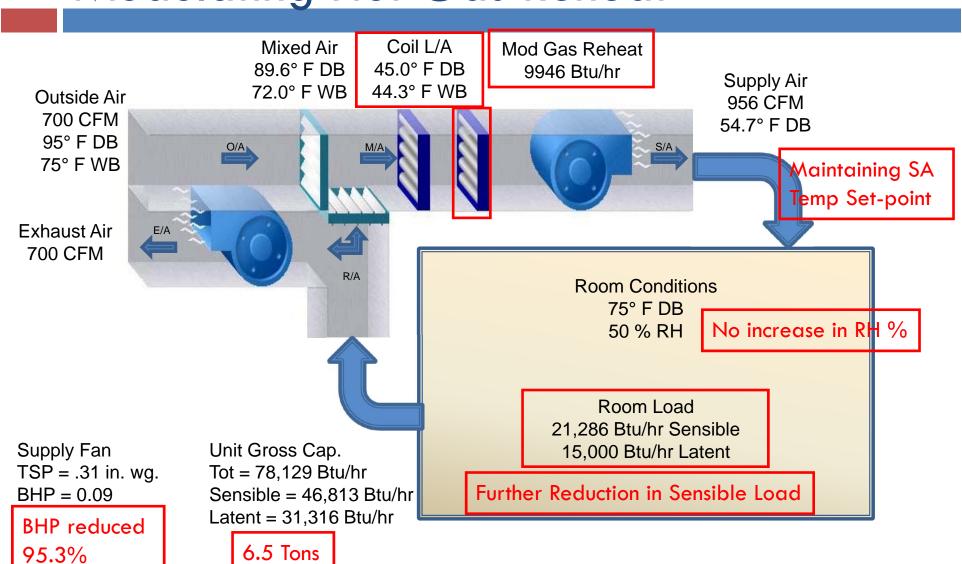


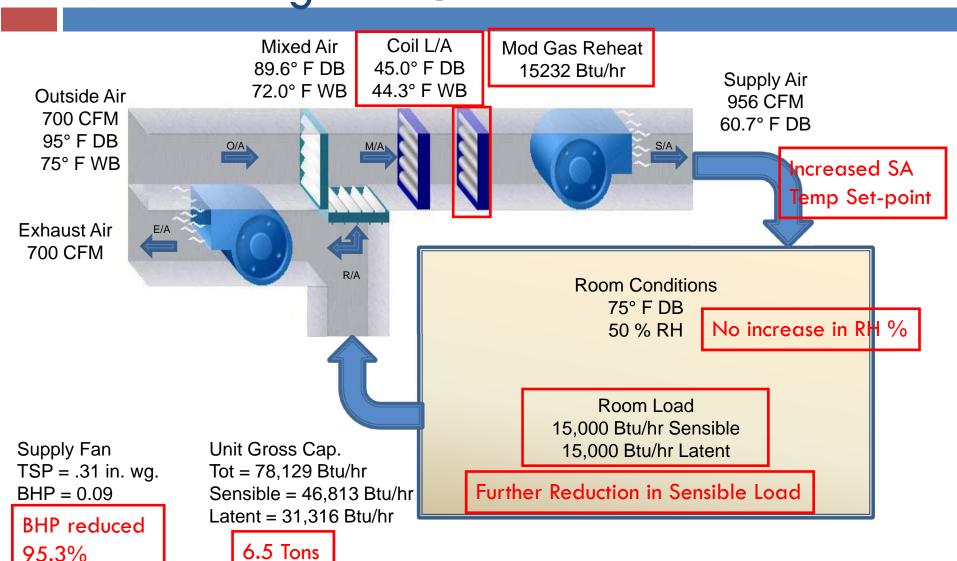






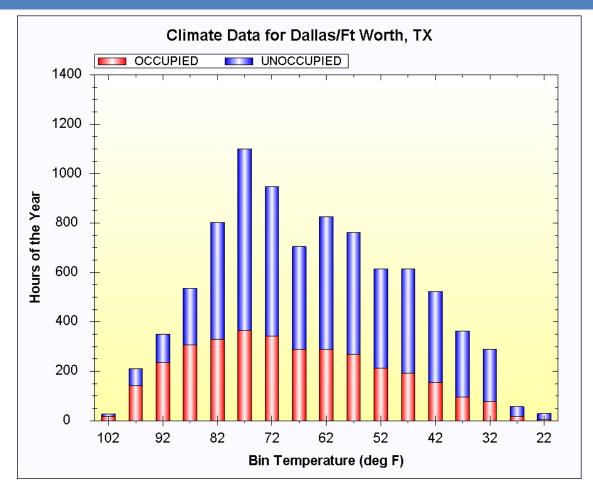






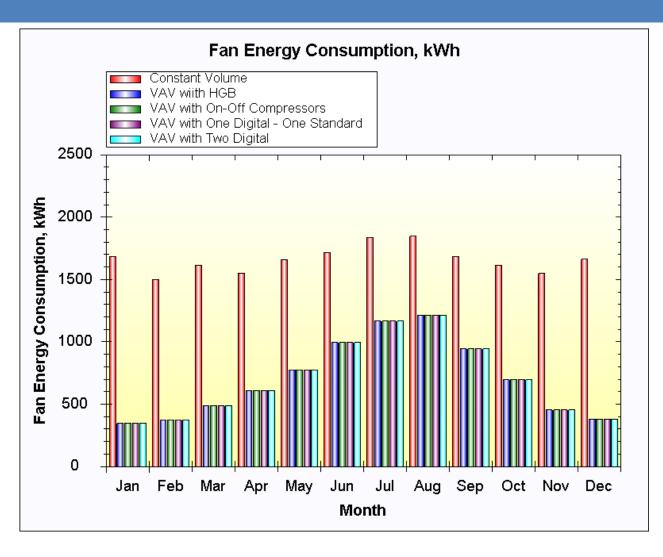
# Energy Consumption, Occupied/Unoccupied

8000sf Single Zone Building

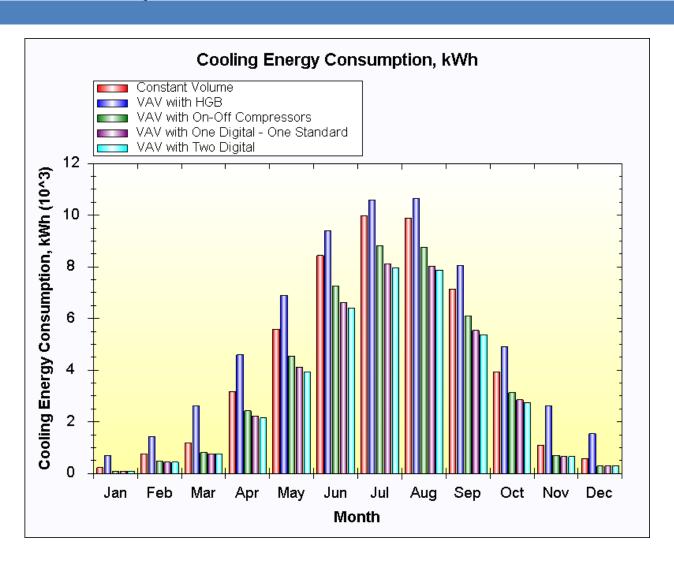


Occupied 3328 hours/year

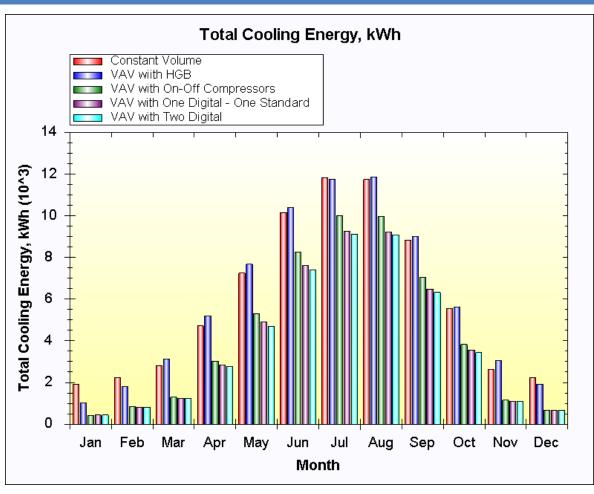
## Fan Energy Comparison for Dallas, TX.



## Cooling Energy Comparison for Dallas, TX.



### Total Cooling Energy Comparison for Dallas, TX.



**Supply Fan, Compressor, Condenser Fan Only** 

## Total Cooling Energy Comparison for Dallas, TX.

Location	Dallas, Texas				
Building Type	SZ	SZ	SZ	SZ	SZ
System Type	CAV	VAV	VAV	VAV	VAV
Compressor Control	Cycling	HGB	Cycling	Digital Lead Only	Digital Lead + Lag
	(kWh)	(kWh)	(kWh)	(kWh)	(kWh)
DX electric	51888	63988	43383	39670	38612
Fan electric	19906	8438	8438	8438	8438
Subtotal	71794	72426	51821	48108	47050
% Difference	0.0%	-0.9%	27.8%	33.0%	34.5%

Building Size: 8,000 sf

Hours Occupied: 3328 hrs/year

Peak Cooling Load: 25 tons

#### Summary

- Single Zone VAV Systems:
  - Use less energy than constant volume systems in all ASHRAE zones
  - Provide superior space temperature and humidity control
  - Meet the spirit and intent energy codes
  - Lower average sound pressure levels
  - Can serve small or large spaces

#### Literature

#### □ Single Zone VAV

