

#### Single Zone Variable Air Volume

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#### 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 unit
- 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 Developed in 1995
- Introduced into Asian Mini-Split Market
- AAON introduced in 2003 & has used approx. 20,000 compressors
- Today Available Capacities of 3 to 15 HP
  - Singles and Tandems
  - 10-100% capacity Modulation

Others do this with speed controlled compressors.



Internal view of Variable Capacity Scroll Compressor









Hot Gas Bypass is not needed with the variable capacity compressor







- 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

AAON introduced Modulating Hot Gas Reheat option in 2002

Modulating Hot Gas Reheat System may be needed for SZ-VAV depending on the application Con





#### □ 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-</u> <u>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. <u>All DX and chilled-water VAV units shall be equipped with variable-speed fans</u> that result in less than 30% power at 50% flow.

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

#### **AAON Mini Controller**







#### **Design Requirements**



- Offer a low cost control solution.
- Offer through a wide range of equipment sizes.
- Designed to optimize efficiency incorporating the digital compressor and modulating supply fan.
- Easy navigation with 5 buttons
- Stand-Alone or Networked System Configurations
  BACnet, MS/TP Network





- AAON Mini Control can offer:
  - SZVAV-Single Zone Variable-Air-Volume application
  - CAV-Constant Air Volume application
  - CAV-Heat pump application
  - SZVAV-Heat pump application

# Mini Controller Product Range

- 2 30 Ton RTU's
  - New RQ series Roof Top Units
  - RN series Roof Top Units
    - A Box
    - B Box
    - C Box
- □ F1 series
- □ H3 series
- □ V3 series
- Include cond units



## SZ VAV Heating Options



- Mini Controller
  - Single Zone VAV Cool + CV Heat
  - Single Zone VAV Cool + VAV Heat
    - Requires a modulation heat option
      - Modulating SCR controlled electric heat
      - Modulating gas heat with stainless steel heat exchanger































#### 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



Supply Fan, Compressor, Condenser Fan Only

# Total Cooling Energy Comparison

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

ASHRAE Zone Map for the US

#### **Climate Zone**



#### Fan & DX Cooling Energy for ASHRAE Zone 3





Sample fan and DX cooling energy usage for ASHRAE Zone 3

Example city Tulsa, Oklahoma

#### Fan & DX Cooling Energy for ASHRAE Zone 5





Sample fan and DX cooling energy usage for ASHRAE Zone 5

Example city Omaha, Nebraska

#### 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





#### □ Single Zone VAV

#### AAON Mini Controller Installation Guide

AAON Mini Controller User's Manual







