VAV System Design: What is your style?

NAILOR INDUSTRIES INC.

MATTHEW CRUMP, PE

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Background

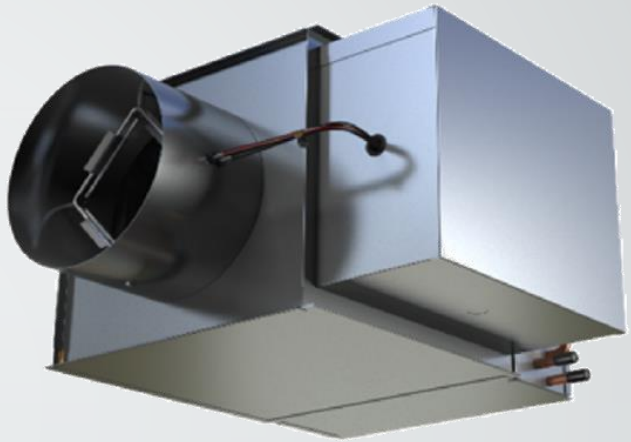
- The NYC, Houston, Seattle, and Washington DC markets largely specify series fan-powered terminal units in all zones.
- Dallas and Portland, OR, specify parallel fan-powered units on the exterior and single duct units in the interior.
- Equipment and configuration of selected terminal units are a matter of style.
- Multiple reasons why different areas have different design standards.
- Analyzing one style over the other provides value to the design.

Equipment Reminder

- Terminal units are used within a Variable Air Volume (VAV) System to control the airflow and temperature delivered to a zone.
- Single duct, parallel fan-powered, and series fan-powered units are connected to an air handling unit (AHU) that supplies the terminal units with cooled and dehumidified air.

Single Duct Terminal Units

- Single duct terminal unit consists of a flow sensor, actuator, damper, and in some cases a heating coil.
- When the controlling thermostat calls for additional cooling, the actuator will open the damper to provide cool air to the room.
  - During this operation, the terminal unit relies on airflow delivered by the AHU.
- When heating, single duct unit operates in the same way, but a heating coil reheats the air to maintain the space set point.

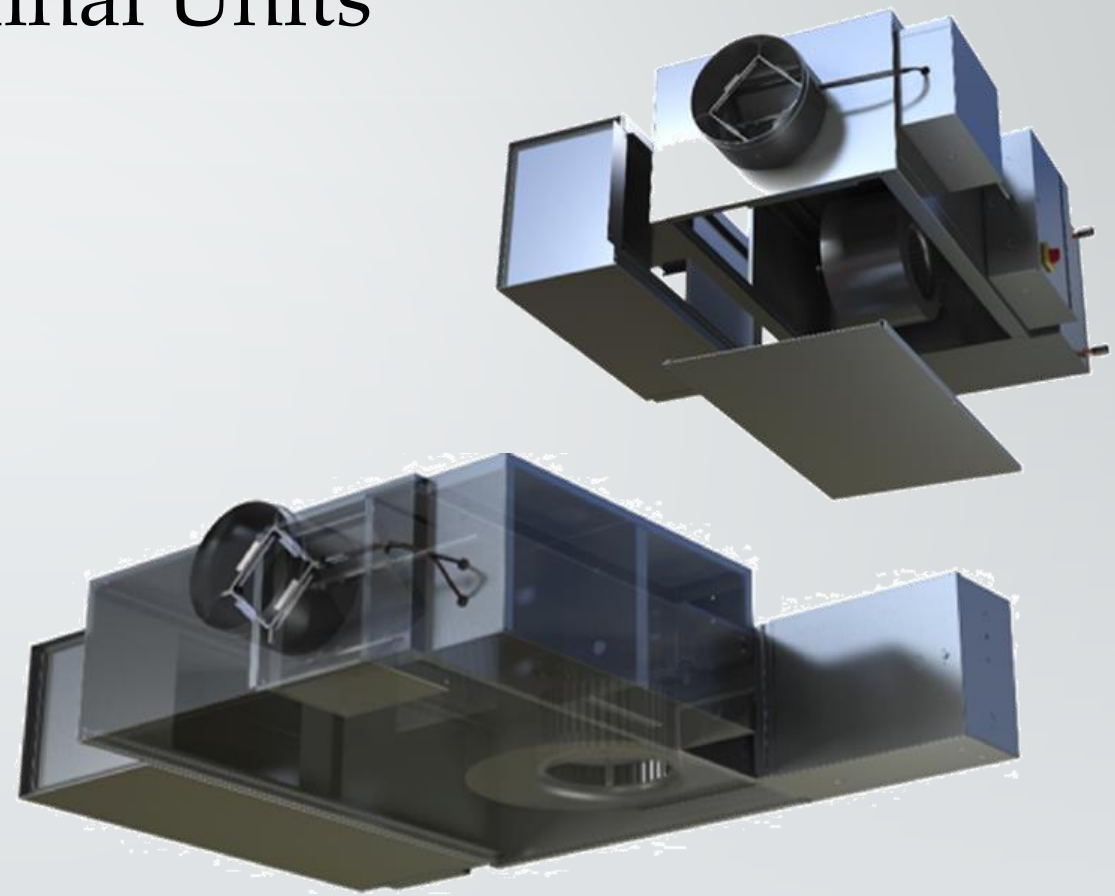


Parallel Fan Powered Terminal Units

- Parallel FPTUs act as a single duct box during cooling.
- During heating, the primary damper closes to the minimum ventilation rate, and the fan/heating coil starts. The fan pulls air from the plenum to make up the required airflow to satisfy the heat in the space.
- The Parallel unit needs pressure from the air handling unit, like the single duct, to serve the space during cooling.

Series Fan Powered Terminal Units

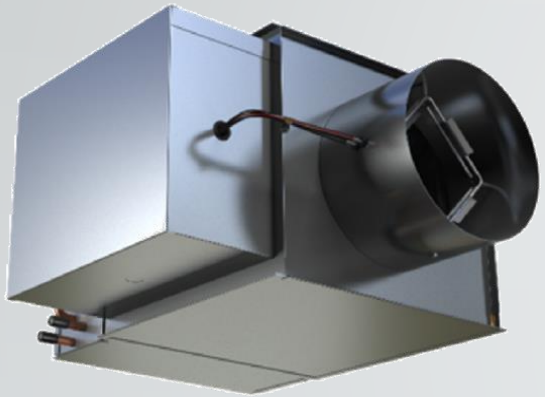
- Series FPTUs have a fan located in the primary airflow.
- When the AHU is operating the Series unit fan must be operational so that the primary airflow makes it to the room.
- Because the airflow is delivered to the room through the unit fan, the AHU is only required to deliver air to the terminal unit.

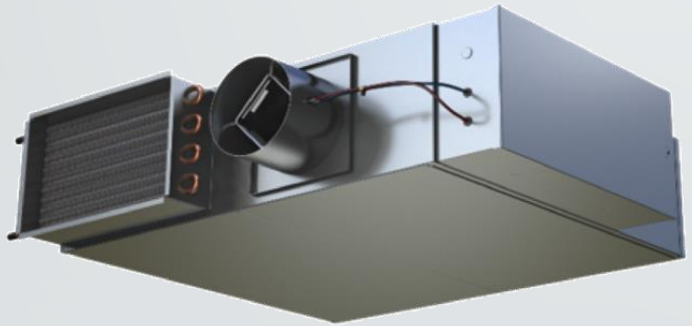


Building Loads

- For office building design
  - exterior zones require the ability to heat and cool their zones
  - interior zones only require cooling.
- Exterior zones handle the environmental building loads
- Interior zones handle internal loads (computers, people)
- Increase in energy efficiency in lighting/equipment leads to drop in heating loads from equipment in the space
  - This allows the minimum ventilation rates for interior zones to over-cool the room.
- Interior zones are sometimes equipped with heating coils to maintain occupant comfort.

System Style- Parallel + Single Duct





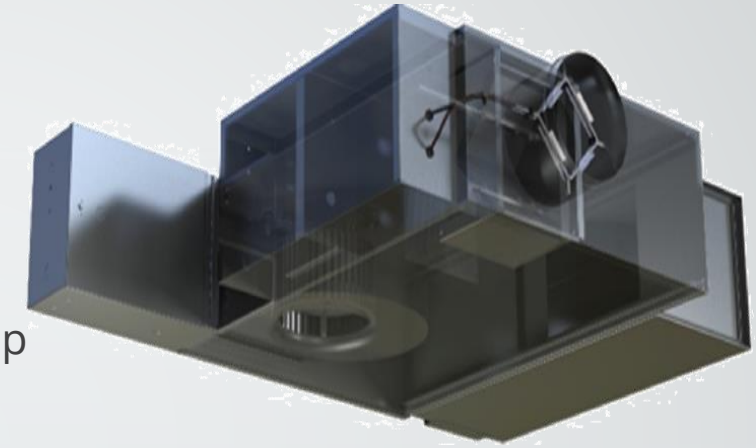
- Parallel units cover the exterior zones
- Single duct units serve the interior.
- These two unit types work well together as they require similar pressures from the AHU to operate.

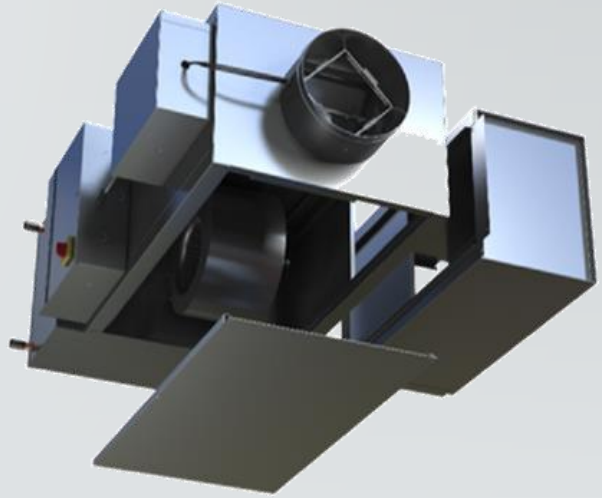
System Style- Parallel + Single Duct Pros & Cons

- **Pros**
  - Parallel fan doesn't run continuously, reducing energy use
  - Single duct does not require a fan, reducing interior noise
  - Single duct is less expensive
- **Cons**
  - Higher pressures required from the AHU fan
    - Larger fan/motor
    - Higher fan/motor energy use
    - Higher duct leakage
  - Parallel relies on backdraft damper during cooling to eliminate unit leakage
  - Single duct engages heating coil for higher temperatures

System Style- Series Units

- Used on both interior and exterior zones.
- Requires little to no pressure at the inlet to operate
- Reduces required pressure from the air handling unit, at times up to 1" w.g.
  - Money is saved through either a smaller fan and motor or the fan and motor operating at a slower speed
- When a space is slightly over-cooled, the fan can increase and induce more plenum air into the airflow.
  - Increase in plenum air can warm the airflow, reducing the use of the heating coil.
- Most benefits are lost when pairing series units with single duct units,
  - AHU pressure has to increase to accommodate requirements of the single duct units.





System Style- Series Units Pros & Cons

- **Pros**
  - Lower pressure from the air handling unit
    - Smaller motor/fan
    - Lower motor/fan energy use
    - Lower duct leakage
  - No leakage from unit
  - Interior zones offset heating load from plenum air induction
- **Cons**
  - Energy use is continuous during cooling/heating
  - Interior placed units will have a higher up-front cost over single duct

Scientific Study in conjunction w/ Texas A&M ASHRAE Journal, Nov. 2017

- **Purpose:** How the decision on what type of fan-powered terminal units used could affect the overall building energy load.
- **Method:** Compared EC Motor Series FPTUs with constant volume and variable volume controls and Parallel Units with EC Motors to a baseline of PSC series units.
- **Results:**
  - Utilizing variable volume series units with EC Motors saved the building 6-10% of total HVAC energy costs.
  - Using Parallel units saved 9-10% in an ideal world where the unit didn't leak, which is never the case.
  - most units leaked 5-10%; reduced energy savings to -1-6%.

TABLE 1 Estimated annual HVAC energy savings for different fan powered terminal unit options in a small office application in three cities in a small five zone office building.[5]

OPTION	PERCENTAGE ANNUAL HVAC ENERGY SAVINGS		
	HOUSTON	PHOENIX	CHICAGO
PSC Series Baseline	–		
Fixed Airflow ECM Series	2.2%	2.6%	1.8%
Variable Airflow ECM Series	8.6%	10.1%	6.0%
ECM Parallel – No Leakage	9.9%	10.8%	9.2%
ECM Parallel – 5% Leakage	4.7%	5.6%	6.0%
ECM Parallel – 10% Leakage	-1.0%	-0.2%	2.4%

Part Two Fan-Powered VAV Terminal Units ASHRAE Journal 11/2017 Faris, Int-Hout, O'Neal, Yin

Contact the Experts

- Learn more about Nailor Industries, Inc. Single Duct, Parallel & Series Fan Terminal Units along with their entire air handling/ air distribution line by going to https://nailor.com/products/terminal-units
- Contact the Technical Air Systems' Sales Engineering Team at 973-285-0333 or by email at solutions@technicalair.com

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