MULTI-STAGE AIR VOLUME OVERVIEW:

The MSAV™ (Multi-Stage Air Volume) Supply Fan Option is available exclusively on the Strategos™ rooftop unit 10, 20 and 24 ton models. The MSAV option uses a variable frequency drive to vary the airflow provided by the unit to match the cooling load required. The VFD alters the frequency and voltage delivered by the power supply to run the supply fan at up to 7 different speeds. An MSAV supply fan can have up to four cooling stage speeds, one heating stage speed, one ventilation stage speed, and an extra speed for when one of the smoke alarm options is used. As the unit switches from different stages of cooling, the supply fan will either slow down or speed up to match the cooling demand. For example, if a unit only requires first stage cooling to satisfy the space's cooling load, the supply fan will reduce the airflow delivered to the space. If the space demand requires second stage cooling, then the unit will increase the supply fan's airflow to match the cooling demand.

The fan stages are set in the factory as percentages of the fan's maximum RPM. For example, let's say the second stage cooling supply fan speed is set at 45%. This means the supply fan will run at 45% of the supply fan's maximum RPM during this cooling capacity. These set points can be increased up to 100% of the supply fan's maximum RPM. These percentages can be field modified to fit the specific application. Please see an example operation of a 20-ton MSAV unit without an economizer in the chart below:

Cooling Demand	**Cooling Operation**	**Supply Fan Speed (% of Maximum RPM)**
One	Compressor #1	35%
Two	Compressor #1 and 2	45%
Three	Compressor #1, 2 and 3	60%
Four	All Compressors	73%

NOTE – 20 Ton MSAV operation.

20-Ton MSAV Operation Without an Economizer

The number of fan stages available differs depending on which control mode the unit is setup for. For example, a 20 ton unit with a standard 2 stage heat and 2 stage cooling thermostat can only run 5 supply fan speeds: 2 speeds for cooling, 1 for heating, 1 for ventilation, and an extra speed for when one of the smoke alarm options are used. When zone sensor mode is used, the 20-ton MSAV unit can take advantage of up to 7 available supply fan speeds (4 cooling, 1 heating, 1 ventilation, and 1 smoke alarm).

Since the supply fan adjusts to match the cooling demand, the application which MSAV units are used must be examined. Un-ducted applications are simpler since there are limited restrictions regarding static pressure. When MSAV units are used on ducted applications there are some duct design guidelines that should be followed to maximize the performance of the unit.

DUCT DESIGN CRITERIA

There is some duct design criteria that should be followed at all times when designing the air distribution for MSAV applications. First, make sure to design a duct system to deliver adequate airflow to sustain proper heating and cooling. Just like a constant air volume system, the duct design must allow the unit to sufficiently heat and cool the space or spaces. Second, design a duct system that will provide a minimum resistance to air flow by reducing the static pressure that is created. This is critical because the volume of air is delivered in up to seven different volume increments. Lastly, select registers and diffusers that provide proper air distribution at low and high speed to the space.

For example, lets examine the operation of a 10-ton unit with the MSAV option. Using a standard two stage cooling or heating thermostat, the supply fan can operate at two cooling speeds. During the first stage of operation, the system will operate at a reduced static pressure, velocity, and will have shorter throws from the diffusers. If a duct system is designed to operate optimally in this stage of operation, then when the system switches to full capacity the supply fan will increase the CFM delivered. This will cause higher static, velocity, and create longer throws than what the duct system was designed to optimally operate. The converse situation can also happen. If a distribution system is designed to work properly in full capacity operation, when the supply fan slows down to deliver less CFM the air flow will now have lower static, velocity, and shorter throws than the optimal design conditions. This can cause components to be much cooler and more apt to attract condensation and cause distribution issues.

To address these issues, it is important to design a system to enhance these two scenarios. This will allow the system to deliver comfort throughout the full range of operation. A perfect solution would use diffusers that deliver less airflow when operating in partial cooling stages and more airflow and throw air further when operating at full capacity. As long as these factors are considered when designing the distribution system, MSAV units can run effectively and efficiently in ducted systems.

CHANGING THE FIRST STAGE SETPOINT

One solution regarding the different levels of airflow might be to increase the CFM that the supply fan will deliver during the first stage of cooling. An example of this would be changing the first stage cooling supply fan set point from its default value of 35% of maximum supply fan RPM to around 40% of the maximum RPM. This would ease some of the distribution design challenges but can create other issues that must be addressed. Since the supply fan is now delivering more CFM at the first cooling stage than the factory default settings, the unit is now moving air faster than the first stage compressor can remove heat. This causes the discharge air temperature leaving the evaporator to be warmer and in turn the unit will start to lose its ability to remove latent heat or “moisture”. Increasing the amount of CFM delivered in the first cooling stage should only be done in applications where the humidity levels are low but the sensible temperature is high.

AVERAGE APPLICATIONS

There are some applications that are a better fit for Strategos™ MSAV units than others. Retrofit jobs with a concentric duct system that replace a constant volume unit with a Strategos™ MSAV unit should be handled cautiously. Some concentric diffusers do not throw air well no matter what type of system is used. As mentioned before, applications where units will operate in low capacity for long periods of time in a high humidity environment should be evaluated carefully. Other applications to pay special attention to are building prototypes where the shelving or other barriers can restrict proper airflow. These barriers can make even the most efficient duct designs ineffective. Retrofit applications with high static duct configurations and older style concentric duct diffusers should also be cautiously approached due to potential distribution and noise problems. More specific applications to be very careful are:

- Libraries – due to shelf height and potential sound issues.
- Recording Studios – due to the sound and variable air flow issues.

GREAT APPLICATIONS

Some applications are a great fit for Strategos™ MSAV units. Prototype building where the designer plans to use duct socks as a distribution system are a great application for MSAV units. The Duct Sock system is a very good distribution network for all variable air volume systems. Projects that use round duct instead of square are particularly good for MSAV units. Round ductwork minimizes the amount of static pressure created. Any application where air noise is not an issue would also be a good fit for MSAV units because of the potential noise problems due to the varying the airflow. Applications that require a 20 or 24-ton MSAV unit that will operate mostly in the second and fourth stage should be targeted as well. Because Strategos™ units have a coil configuration that allows a great deal of moisture removal, the supply fan can be adjusted to run at lower speeds in these two stages. Finally any application with a low total static pressure is a great fit for MSAV units. Some specific applications to pursue are:

- Warehouses
- Retail Spaces
- Super Markets
- Museums