Anemostat's line of ***Replace-N-Save*** retrofit kits and valves, benefit both the building owner and facilities personnel responsible for maintaining the HVAC system and paying the electric bill.

Buildings constructed using air terminals with pre-1975 technology probably consist of either a single duct or dual duct constant volume system. These constant volume air terminals are tremendous workhorses, but unfortunately, they are also tremendous users of energy, due to their design and high operating pressures. Anemostat provides both internal and external retrofit solutions where the existing air terminals can be upgraded at a significantly lower cost as compared to a complete "tear-out & re-install" of new equipment. Good reasons to consider retrofitting an existing system:

1. ***Occupancy comfort / health / productivity***
   Older units are subject to wear and deterioration as is any equipment of the same age. This may mean that the original design intent and system capacities are no longer being satisfied. Poor productivity or high incidence of occupant illness may be related to poor thermal comfort and ventilation rates caused by equipment failure or lack of performance.
2. ***Energy Costs***
   Energy costs will never go down – the only way to combat increases in energy is with increased efficiency.
3. ***Minimized Disruption***
   External retrofits require minimal duct disturbance. Internal retrofits typically can be completed in less than 60 minutes, working through the access door in the bottom of the air terminal. Total building retrofit can be staged and completed during unoccupied hours, often by the building maintenance staff.
4. ***Equipment depreciation***
   Any tax depreciation benefit from the original equipment is long gone.

Energy Savings Analysis

In a conventional, constant volume dual duct air terminal with a mechanical constant volume regulator, the cold air capacity varies inversely to the hot capacity. Therefore, as the space temperature drops, the cold supply air capacity decreases and simultaneously the warm air flow rate increases and the total CFM delivered to the space is constant, see diagram 6. An Anemostat internal retrofit kit will reduce the capacities required for temperature control, while reducing the operating pressure requirements. Retrofit control loops are typically sequenced with the existing inlet dampers and a multitude of control strategies are possible. As the space temperature drops, the cold air volume is decreased to minimum capacity before the warm air damper opens. Thus, most of the temperature control is achieved by operating the air terminal with a variable capacity between minimum and 100% of the design capacity. Based on heating loads, the hot air volume may stay at minimum flow (diagram 7), or a dual maximum strategy can be utilized (diagram 8).

Energy savings occur with Anemostat retrofit kits because of reduced air flow rates, reduced operating pressures, and the elimination or reduction of simultaneous mixing of hot and cold air flows. With a typical operating setpoint at 75% flow through the cold duct, the fan discharge pressure can be reduced to less than 75% of the design requirements. Also, with a 25% capacity reduction, the fan operating power is reduced by 35%.

Many older constant volume systems may be operated as variable volume systems, with considerable energy savings, without any loss of occupant comfort. The conversion of the existing systems to variable volume often can be accomplished by the building maintenance staff, with minimal disruption to the occupants.

Typical Dual Duct Terminal
With Mechanical Constant Volume Regulator

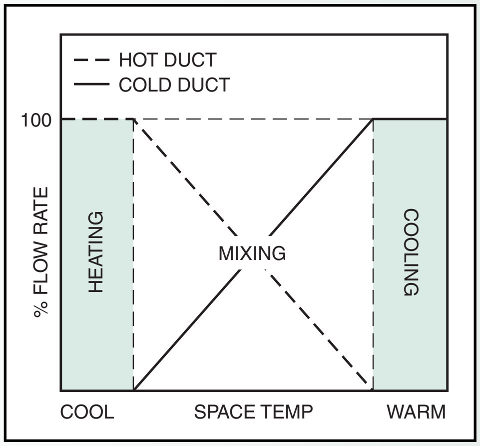


Diagram 6

Variable Total Air Flow
With Mixing At Minimum Flow

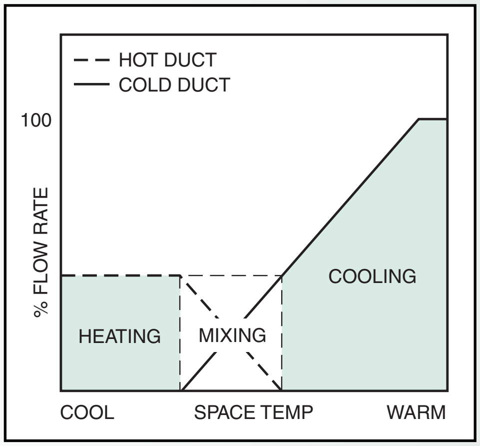


Diagram 7

Dual Maximum Variable Total Air Flow
With Mixing At Minimum Flow

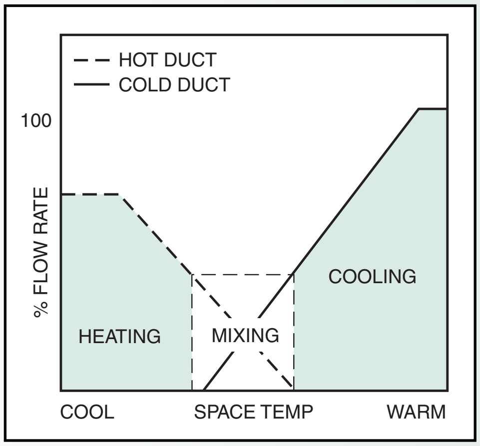


Diagram 8

EXAMPLE ENERGY SAVINGS CALCULATIONS

A constant volume dual duct air terminal is upgraded with (2) RF-3 retrofit kits as shown in figure 5:

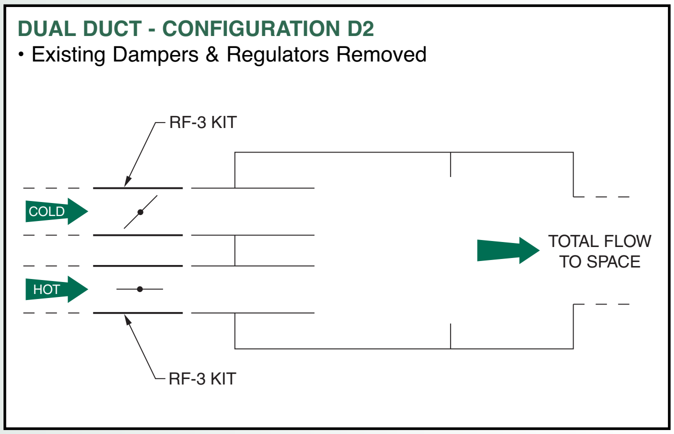


Figure 5

Constant Volume Cooling Cycle Assumptions

- 1000 ft^2 exterior zone
- 70% cold air / 30% warm air (return air) – average cooling cycle mixture
- Cooling ΔT = 20°F (75° space temp - 55° entering air temperature)
- Heating ΔT = 8°F (return air temp rise – return used for warm supply duct)
- 2 CFM/ ft^2
- 2000 CFM Constant Volume Air Flow
- 1250 hours of operation per 1/2 year
- $.10 / kWH
- 75° F space temperature

Calculate:

1. Total cooling load capability:
   100% x 2 CFM/ ft^2 x 1.08 x 20°FΔT = 43.2 BTUH/ ft^2
2. Cold & warm air mixture (during average cooling cycle condition):

   A = 70% cold air x 2 CFM/ ft^2 x 1.08 x 20°FΔT = 30.24 BTUH/ ft^2 Cooling

   B = 30% warm air x 2 CFM/ ft^2 x 1.08 x 8°FΔT = 5.18 BTUH/ ft^2 Heating
3. Average cooling load required:

   A – B = 30.24 – 5.18 = 25.06 BTUH/ ft^2 Cooling
4. With RF-3 retrofit kit installed on the cold duct, calculate CFM of cold air required to meet average cooling load:

   (25.06 BTUH/ ft^2 Cooling) / (1.08 x 20°FΔT) = 1.16 CFM/ ft^2 (a reduction from 2.0 CFM/ft^2)

Cooling Cycle Energy Savings:

Fan H.P. Reduction (based on 1000 CFM/HP):

(2.0 HP – 1.16 HP) x .746 kW / HP x $.10 / kWH x 1250 hours per 1/2 year = $78.33 / 1000 ft^2 / 1/2 yr

Refrigeration Savings: 5.18 BTUH/ ft^2 x 1 ton / 12,000 BTUH x 1 HP / .75 Ton x .746 kW / HP x $.10 / kWH x 1,000 ft^2 x 1250 hours per 1/2 yr = $53.76 / 1000 ft^2/1/2

Constant Volume Heating Cycle Assumptions

- 1000 ft^2 exterior zone
- 80% cold air / 20% warm air (return air) – average heating cycle mixture
- Cooling ΔT = 15°F (70° space temp - 55° entering air temperature)
- Heating ΔT = 30°F (100° entering air temp - 70° space temp)
- 2 CFM/ ft^2
- 2000 CFM Constant Volume Air Flow
- 1250 hours of operation per 1/2 year
- $.10 / kWH
- 70° F space temperature

Calculate:

1. Total heating load capability:
   100% x 2 CFM/ ft^2 x 1.08 x 30°FΔT = 64.8 BTUH/ ft^2
2. Hot & cold air mixture (during average heating cycle condition):

   A = 20% cold air x 2 CFM/ ft^2 x 1.08 x 15°FΔT = 6.48 BTUH/ft^2 Cooling

   B = 80% warm air x 2 CFM/ ft^2 x 1.08 x 30°FΔT = 51.84 BTUH/ft^2 Heating
3. Average heating load required: B – A = 51.84 – 6.48 = 45.36 BTUH/ ft^2 Heating
4. With RF-3 retrofit kit installed on the hot duct, calculate CFM of hot air required to meet average heating load:

   (45.36 BTUH/ ft^2 Heating)/(1.08 x 30°FΔT) = 1.4 CFM/ft^2 (a reduction from 2.0 CFM/ ft^2)

Heating Cycle Energy Savings:

Fan H.P. Reduction (based on 1000 CFM/HP):

(2.0 HP – 1.4 HP) x .746 kW / HP x $.10 / kWH x 1250 hours per 1/2 year = $55.95 / 1000 ft^2 / 1/2 yr

Heat Pump Savings: 6.48 BTUH/ ft^2 x 1 ton / 12,000 BTUH x 1 HP / .75 Ton x .746 kW / HP x $.10 / kWH x 1,000 ft^2 x 1250 hours per 1/2 yr = $67.14 / 1000 ft^2 / 1/2 yr

Summary of Savings:	1 Year Savings / 1000 ft^2
Cooling:	
Fan Horsepower	$78.33
Refrigeration Horsepower	$53.76
Heating:	
Fan Horsepower	$55.95
Heat Pump Horsepower	$67.14
Depreciation = Product Cost / Yrs Useful Life = $250 / 5	$50.00
First year savings / Air terminal	$305.18
plus any federal, state, or utility credits available	

(Savings will vary based on assumptions. A specific analysis should be performed for any retrofit candidate.)

INTERNAL RETROFIT KITS

1. Internal retrofit kits are installed without disturbing upstream or downstream ducts and are appealing for owners of occupied buildings. Conversion from constant to variable air volume can be accomplished in as little as 60 minutes per terminal. The work is normally done through a bottom access door, a typical feature included with many vintage air terminals.

2. Internal retrofit projects should include an initial investigation of the air terminals to be modified to verify accessibility, clearances, and model number / design configuration. Anemostat has a significant database of drawings of competitor's air terminals and typically, the retrofit kit fits into the unit as is intended.

3. Anemostat service personnel are available to assist with initial air terminal retrofit assessments as well as an installation demonstration and subsequent training.

TABLE 71: INTERNAL RETROFIT CONTROL SEQUENCES

Existing Air Terminal			Retrofit Sequence #
Type	**# of Damper Actuators**	**Sequence**	
Dual Duct	1 – Crosslinked	C.V. Mixing	ID1
Dual Duct	2	C.V. Mixing	ID2
Single Duct w/ Reheat	None	Constant Volume	IS1
Single Duct	1	VAV (Max to 0)	IS2

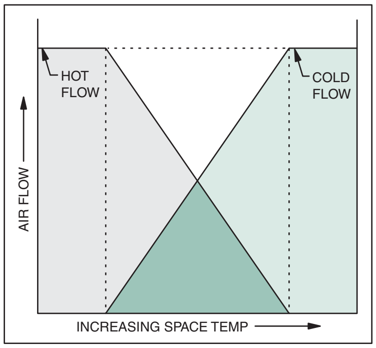


Diagram 11: Typical Flow Diagram For Existing Constant Volume Mixing Terminals. Configurations ID1 & ID2

DUAL DUCT - CONFIGURATION ID1 RETROFIT
- Constant Volume Regulator Removed
- RF-8 / RF13 Installed
- Common Inlet Damper Actuator Linked To Both Valves

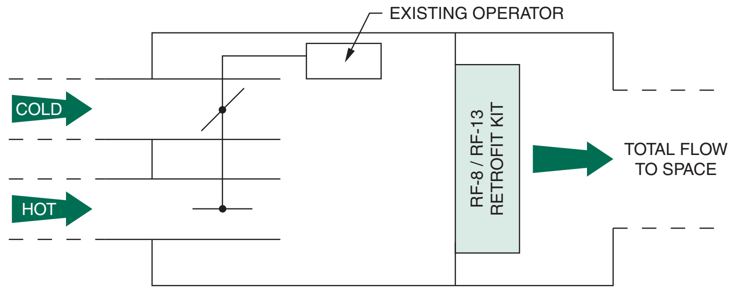


Figure 11

DUAL DUCT - CONFIGURATION ID2 RETROFIT
- Constant Volume Regulator Removed
- RF-8 / RF13 Installed
- Actuator On Each Inlet Damper

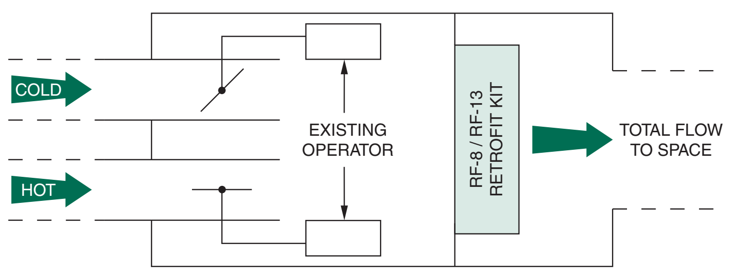


Figure 12

SEQUENCE ID1A, ID2A

No Mixing

- Replace internal regulator(s) with an RF-8 / RF-13 kit. Use existing actuator(s).
- VAV pressure independent cold & hot air flows
- Max Heating and Cooling flow rates are the same
- Existing actuator(s)-dampers change over from cold duct to hot duct flow

SEQUENCE ID1B, ID2B

VAV Cooling with Mixing at Minimum

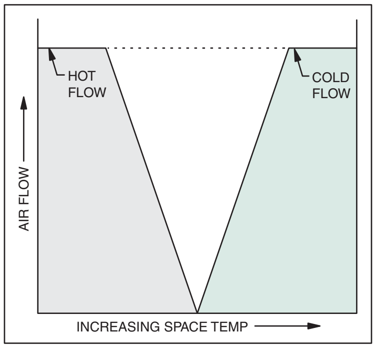
- Replace internal regulator(s) with an RF-8 / RF-13 kit. Use existing actuator(s)
- VAV pressure independent cold & hot air flows
- Existing actuator(s) are sequenced to modulate dampers at minimum mixing setpoint

SEQUENCE ID1C, ID2C

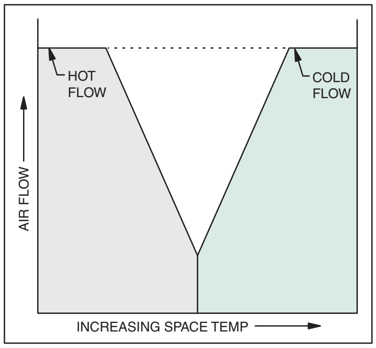
VAV Cooling with Dual Maximum

- Replace internal regulator(s) with an RF-8 / RF-13 kit. Use existing actuator(s)
- VAV pressure independent cold & hot air flows
- Max Heating and Cooling flow rates are the same
- Existing actuator(s) are sequenced to modulate dampers at minimum mixing setpoint

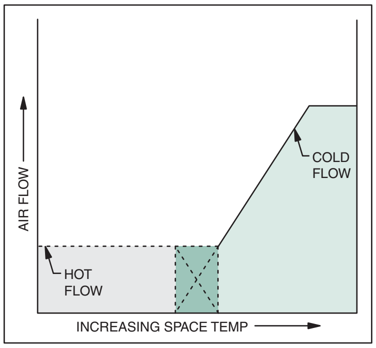
SEQUENCE ID1A, ID2A (0 MIN)



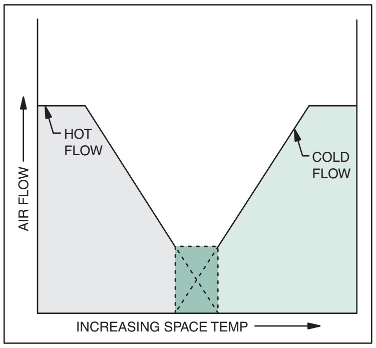
SEQUENCE ID1A, ID2A (MIN > 0)



SEQUENCE ID1B, ID2B



SEQUENCE ID1C, ID2C



Retrofit Kits & Valves

F

Anemostat

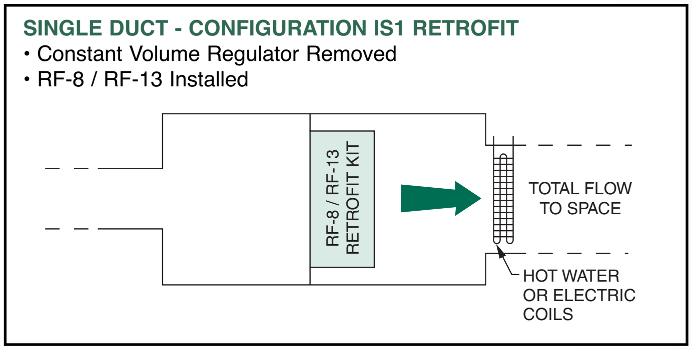
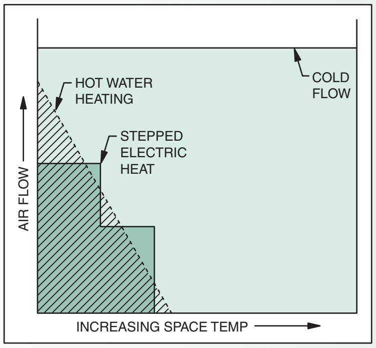


Figure 13



SEQUENCE IS1A

Max-Min VAV

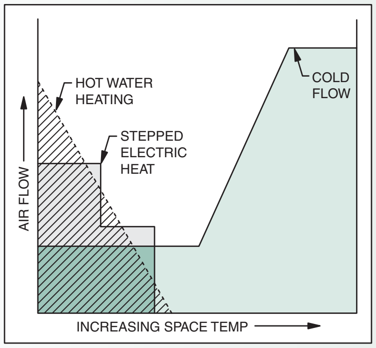
- Replace internal regulator(s) with an RF-8 / RF-13 kit.
- VAV pressure independent airflow with minimum flow for reheat.

SEQUENCE IS1B

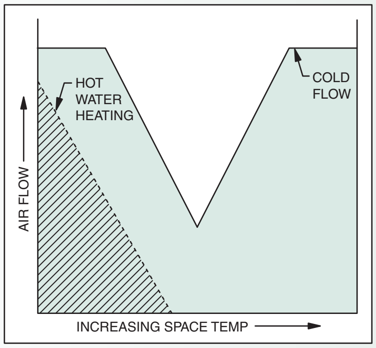
Dual Maximum VAV w / hot water heat

- Replace internal regulator(s) with an RF-8 / RF-13 kit.
- VAV pressure independent airflow with maximum flow for reheat

SEQUENCE IS1A



SEQUENCE IS1B



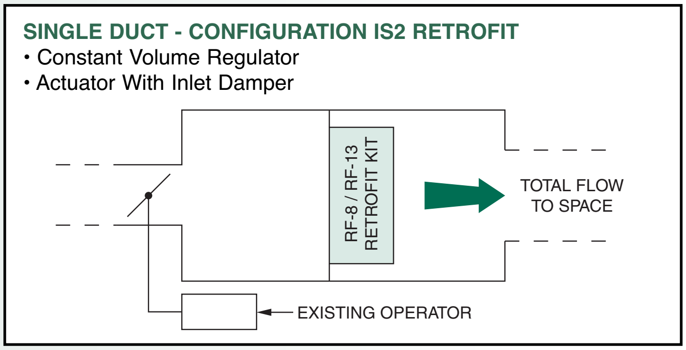


Figure 14

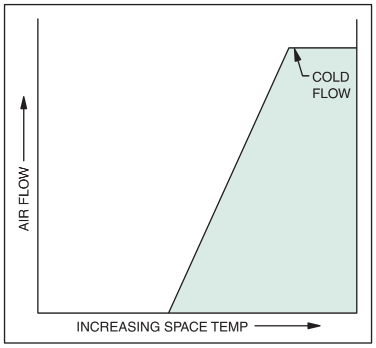


Diagram 12: Typical flow diagram for existing single duct terminal without reheat.

SEQUENCE IS2A

Max-Min VAV

- Replace internal regulator(s) with an RF-8 / RF-13 kit.
- Disable existing actuator – fix existing damper wide open.
- VAV pressure independent airflow

SEQUENCE IS2A