TWO DECK MULTIZONE SYSTEMS
SUBZONED WITH THERMA-FUSER™ VAV DIFFUSERS

GOALS

The objectives of upgrading are: (1) to gain individual room temperature control at an occupant chosen level between 70°F/21°C and 78°F/26°C; and (2) to reduce energy consumption. Conversion from constant volume to variable volume will make possible significant savings in energy if fan speed control is added. The waste of blending heated air with cooled air will be eliminated by sequencing heating and cooling rather than blending. If the system utilizes a so called "economizer cycle," conversion to VAV will greatly reduce the energy waste of heating the cold mixture of outdoor air and return air. See Reducing Economizer Cycle Energy *Waste* at the end of this brochure.

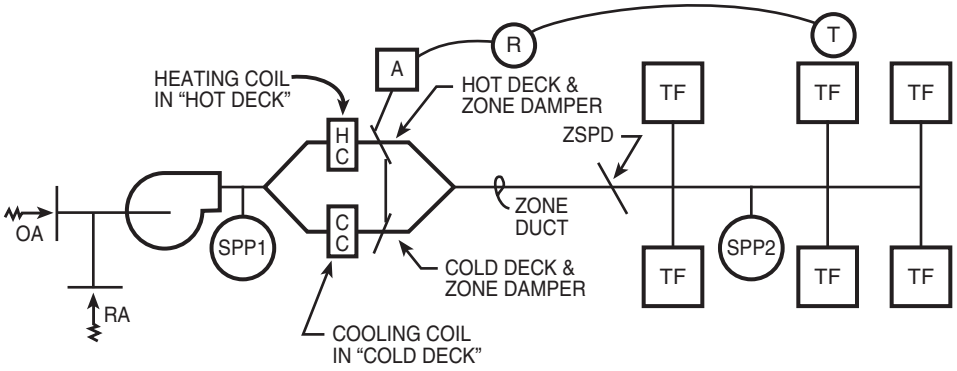
METHOD OF UPGRADING

Each room will be equipped with one or more Type –HC heating and cooling Therma-Fuser diffusers, each being a "Sub Zone." When supply air temperature is below 68°F/20°C, Type –HC diffusers will operate in the cooling mode and when supply air temperature is over 80°F/26.5°C, the Type –HC diffuser will operate in the heating mode. When upgraded, each existing zone will be a "Master Zone." Dampers will be controlled in a two position manner to provide warm air *or* cold air to Therma-Fuser diffusers. One master zone may be on heating while another is on cooling.

Changeover from cooling to heating and vice versa may utilize the existing zone actuator and existing pneumatic tubing or electrical wiring. In the case of pneumatic systems, the existing zone thermostat may be used. A new relay, pneumatic or electrical, at the actuator will cause that actuator to perform in a two position manner.

Changeover using the existing thermostat location should be satisfactory if the zone was well conceived; heating and cooling loads do not exist within the zone simultaneously to a troublesome degree. Systems with poorly conceived zones will need alteration of zone coverage and ductwork before the basic comfort goals of the retrofit can be achieved.

It is recommended that Therma-Fuser diffusers be used in the changeover room as well as other rooms. The Therma-Fuser diffuser and changeover thermostat should be adjusted such that the Therma-Fuser diffuser in the changeover room is nearly closed when changeover occurs, so that capacity to the changeover room does not change from full cooling to full heating causing rapid temperature change leading to rapid cycling. Do this by establishing a deadband in the temperature settings of the Type –HC diffuser used in that room and setting the changeover thermostat in the middle of the deadband.



NOTES

1) **Multizone units have two or more zones of control, each with zone dampers in hot and cold decks, actuator, room thermostat, zone duct and diffusers.**
2) **T = Room Thermostat**

   A = Zone Actuator

   R = Relay to cause actuator to operate in the two position manner; open cold deck damper and close hot deck damper or vice versa.

   SPP1 = Static Pressure Probe to control fan capacity.

   SPP2 = Static Pressure Probe to control ZSPD: one per zone. (Optional–See Static Pressure Control).

   ZSPD = Zone Static Pressure Damper, as near as possible to diffusers. (Optional–See Static Pressure Control).

   TF = Type –HC Therma-Fuser VAV Diffusers.
3) **Before upgrading, "T" modulates "A", operating hot and cold deck zone dampers to vary the temperature of constant air flow to zone.**
4) **After upgrading, "T" will (through "R") cause either the hot damper or the cold damper to be opened by "A," closing the other damper. Either heated or cooled air is made available to Therma-Fuser diffusers which modulate flow to control individual spaces.**
5) **SPP1 controls fan capacity to maintain static pressure at fan discharge. (See Fan Control).**
6) **SPP2 controls individual zone duct static pressure damper ZSPD. (See Static Pressure Control for a description of alternatives).**

(Continued on next page)

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Temperature Control People

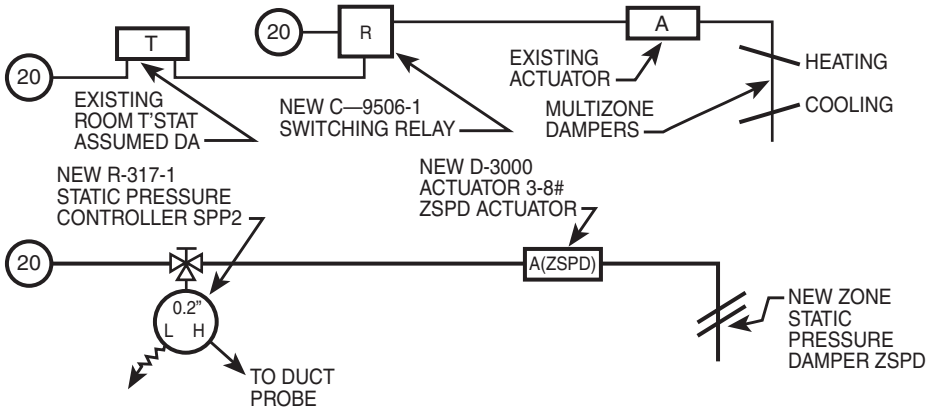
METHOD OF UPGRADING—*continued*

Examples:

Type –HC Settings		Changeover
Heating Stat	Cooling Stat	Thermostat
70/21	74/23	72/22
72/22	76/24.5	74/23
74/23	78/25.5	76/24.5

This is not as difficult as some situation requiring synchronization of controls, as one can easily see what a Therma-Fuser diffuser is doing simply by looking at the position of the damper.

Example of Pneumatic Connections Using Johnson Controls. Modify as Required to Retain Useable Existing Controls.



HOT & COLD DECK CONTROL

It will be necessary to control supply air temperature such that it is not higher than 120°F/49°C or lower than 50°F/10°C, which may call for high limit and low limit air thermostats on some multizone units such as DX units or those with steam hot decks.

ZONES WITHOUT HEATING LOADS

Zones without heating loads, as may be found in interior spaces, do not require heating and may be converted to a cooling only zone by sealing off the hot duct. The best approach is to seal the zone duct from the hot deck. This Master Zone can be subzoned with VAV cooling only (Type –C) Therma-Fuser diffusers.

STATIC PRESSURE CONTROL

The static pressure control method shown above uses zone dampers as described in Form 6.3 *Options of Static Pressure Control and Pressure Independence*. The deck dampers can be used for static pressure control if they can be separated and controlled with separate actuators. The zone thermostat then actuates one damper for static pressure control while it closes the other damper. Alternatively, zone balancing dampers may be used for static pressure control.

A bypass at the diffuser, R-Rings, will also provide pressure independence at the Therma-Fuser diffuser for plenum return systems and eliminate the need for fan control, but less energy will be saved.

Zone static pressure control may not be required if there is little variation in the resistance of the duct runs (equal length ducts).

FAN CONTROL

In converting a constant volume system to variable volume, some sort of static pressure control at the fan will almost certainly be required. One exception is the use of a R-Ring ceiling plenum bypass. This control may be as simple as bypass dampers or discharge dampers. It can be as energy efficient and easy to install as fan speed control. See Form 6.3 *Options of Static Pressure Control and Pressure Independence*.

GENERAL POINTS TO CONSIDER

The DX multizone may have adequate means to reduce refrigeration capacity at low load, but some systems depend on an elevated hot deck condition to impose a cooling load on the system. This method will not be available when the zone controls become two positioned and some means of capacity reduction such as hot gas bypass will be required.

Some multizone units control one deck or the other in a multipoint arrangement, such that the 'nearest to full heating' controls hot deck temperature. In some systems this control may remain, for example where the signal is a function of the thermostat branch line pressure. In other systems, the signal may come from an actuator-mounted potentiometer, which will not reflect zone needs when the actuator is retrofitted to two position duty.

The self-contained multizone units of some manufacturers have special controls and sequences not covered here. In dealing with these we recommend review of the Master Zone / Sub Zone concept, then, examining the details of the multizone unit to develop an interface procedure. Essentially the same principles will apply with each zone of the unit becoming a Master Zone, while each Therma-Fuser diffuser is the Sub Zone. Either cooling or heating will be supplied at one point in time by a Master Zone and static pressure to Therma-Fuser diffusers will be controlled.

In all retrofits of exiting multizones, we are "sub-zoning" the existing Master Zone, and a Sub Zone can

only heat or cool as the Master Zone allows. If within the existing zone there are simultaneous heating and cooling loads, simply varying the volume of the heating or cooling may not satisfy all needs.

A typical example is the cooling load caused by the addition of major computer hardware. This may create a new zone needing a dedicated cooling system.

It should be recognized that temperature may vary a few degrees during the period that the Master Zone thermostat location experiences near to zero load, the "changeover range." When the Master Zone is causing supply air to be in the mid 70s/24s, it will not be possible to hold a Sub Zone at 70°F/21°C when it has a cooling load, or one at 80°F/26.5°C when it has a heating load. In retrofit, we expect to improve an existing system, not to achieve perfect control all of the time.

REDUCING ECONOMIZER CYCLE ENERGY WASTE

All of the air handled by the multi-zone fan is a mixture of outdoor and return air at the supply air temperature required for cooling, usually around 55°F/13°C.

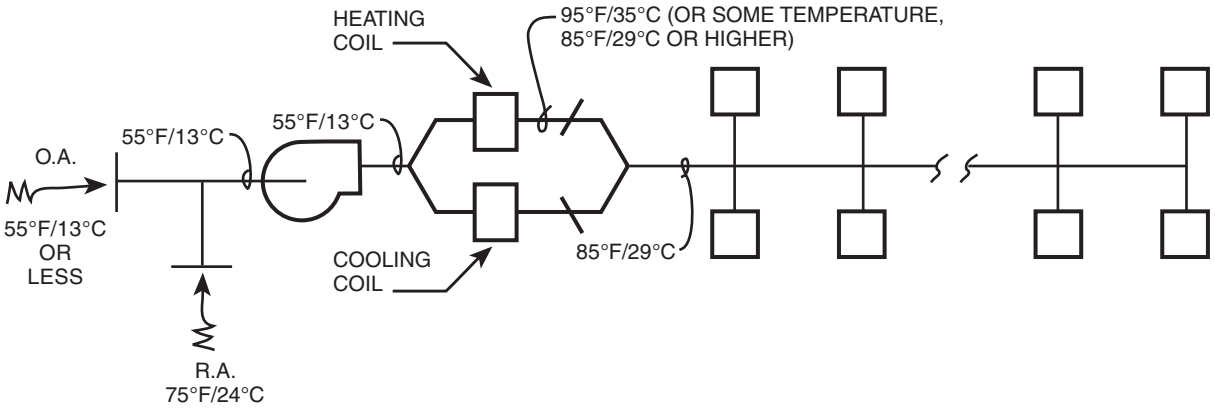
At times one of the zones may require 85°F/29°C air to meet the heating load, or a supply-to-room temperature differential of 10°F/5°C (assuming a 75°F/24°C room). With the economizer control, the air actually must be heated an additional 20°F/11°C from 55°F/13°C to 85°F/29°C, or a 30°F/16°C rise. In this example, the actual heating energy required is three times the heat loss of the zone.

When retrofitted to VAV, the zone will be served by a variable volume of constant temperature air. If the example zone has 4000cfm/1890L/s before retrofit and a heating load needing 85°F/29°C supply air then the waste due to the economizer is 4000 x (75-55) x 1.10 = 88,000Btu/h / 1890 x (24-13) x 1.23 = 25.6kW. In a VAV retrofit, the same load could be handled with 2000cfm/945L/s of 95°F/35°C supply air and the waste would drop to half that of the constant volume system or 2000 x (75-55) x 1.10 = 44,000Btu/h / 945 x (24-13) x 1.23 = 12.8kW.

People may try to reset the mixed air temperature to minimize waste, but in all likelihood little change can be made where interior loads are present. The interior does not care if it is 10°F/-12°C or 110°F/43°C outside. If it needs cold supply air in July, it will probably need that condition in January, forcing other zones to heat from that level.

Conversion to Therma-Fuser VAV fine-tunes energy usage to a minimum on both the heating and the cooling modes of operation.

One Zone of Conventional Multizone



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