Multi-Zone Systems

System Description

Multi-zone systems provide each zone with constant volume-variable temperature air. The air temperature is varied to meet the heat gain from equipment, lights, exterior and people loads. The air temperature can also be raised to provide heating to the zone.

Air Handling Systems

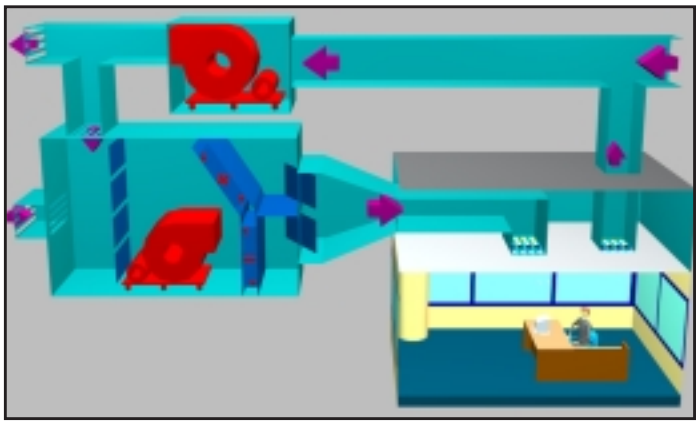
The air handling unit has both a heating coil and a cooling coil in parallel. Supply air can be diverted to pass through either the heating coil, cooling coil, or a combination of the two. This allows the supply air temperature to be varied to meet the requirements of the zone.

The multizone air handling unit has many sets of dampers which allow the total supply air volume to be divided as required among the zones it serves.

The air handling unit can incorporate economizers to take advantage of free cooling during mild weather. It may also have a preheat coil to provide the proper supply air temperature in cold weather.

The air handling systems are typically blow-through to facilitate air handling unit design. Blow-through units add the fan heat (usually equivalent to 2-3°F) before the cooling coil. The leaving air temperature from the cooling coil then becomes the supply air temperature. This provides the maximum temperature rise between the cooling air and the space design temperature. (The least amount of supply air will be required.) Since the air is often fully saturated and moisture may be an issue, blow-through should not be used with final filters downstream of the coils.

Traditional controls have the heating and cooling decks active at the same time, providing good zone temperature control and easy design and operation; however, this also creates a situation where simultaneous heating and cooling occur.



With more advanced controls, it is possible to avoid simultaneous heating and cooling by using only one deck at a time and maintaining good zone temperature control.

Three-Deck Multi-Zone Units

A modification of the two-deck system is the three-deck system, with the third deck being bypass air (return air with ventilation air introduced). The decks are arranged in such away that when the zone is calling for heating, bypass air and hot deck air are mixed to meet the zone requirements. In cooling, air from the cooling deck and bypass air mix to meet the cooling load. The result: no simultaneous heating and cooling.

IAQ Considerations

ASHRAE Standard 62.1-1999, Ventilation for Acceptable Indoor Air Quality, provides a procedure for calculating the minimum outdoor air volume for a system serving multiple zones.

Ventilation air is introduced at the air handling unit. Each zone receives constant air flow with a fixed percentage of ventilation air.

Different zones, however, will require different percentages of ventilation air, but the centralized air handling unit can provide only one outdoor air ratio.

System Pros

- Easy to design and operate. Straightforward controls.
- Good zone temperature control.
- Fixed supply air temperature maintains humidity control in space.
- Air-side economizers can be added to the design easily to minimize mechanical cooling during cooler weather, but two-deck systems may result in simultaneous heating and cooling.
- Three-deck multi-zone or two-deck multi-zone systems with advanced controls avoid simultaneous heating and cooling.

System Cons

- Poor energy consumption due to simultaneous heating and cooling and constant supply air volume.
- Providing each zone with the correct amount of outdoor air is more difficult.

Energy Considerations

Two-deck multi-zone systems that can have simultaneous heating and cooling are very inefficient. Since such systems are constant volume, they use a lot of fan work, which also uses more energy than other systems. Three-deck systems that avoid simultaneous heating and cooling are a major improvement. The following are some considerations outlined in ASHRAE Std. 90.1-1999.

- Simultaneous heating and cooling (such as constant volume terminal reheat, some perimeter induction systems, constant volume dual-duct or multi-zone systems) are not permitted. (6.2.3.9).
- Energy efficiency tables for HVAC equipment (6.2.1).
- Equipment must be scheduled off automatically during unoccupied hours (6.2.3.1).
- Demand Controlled Ventilation is required for systems with at least 3,000 cfm of outdoor air and occupant density greater than 100 people per 1,000 ft^2 (6.2.3.9).
- Air- or water-side economizers are required. There are several exceptions to this rule, particularly when dealing with heat recovery (6.3.1).
- Where humidification is required to maintain humidity above 35°F dewpoint, water-side economizers must be used when economizers are required. Introducing large amounts of cool, dry air while meeting the sensible cooling load adds significantly to the humidifier load. Process loads, including hospitals, are exempt (6.3.2.4).
- Energy recovery is required for systems with at least 5,000 cfm supply air and a minimum of 70% outdoor air. This is specifically aimed at schools and labs (6.3.6.1).
- For systems under 20,000 cfm, constant volume fans are limited to 1.2 hp/1,000 cfm. For systems over 20,000 cfm, fans are limited to 1.1 hp/1,000 cfm (6.3.2.1).

A thorough explanation of the Standard is beyond the scope of this document. The designer should have access to the Standard and a complete understanding of its contents. The ASHRAE 90.1-1999 Users Manual is also very helpful. ASHRAE considers Standard 90.1-1999 a high-profile standard and continuously updates it.

Typical Applications

Two-deck multi-zone systems are not commonly used in new construction because of their poor energy performance. They are more common in retrofit applications, since many schools were built with multi-zone systems in the past. Upgrading to a three-deck multi-zone system resolves many issues, while utilizing existing ductwork and controls.

Common applications include:

- Schools