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Containment Strategies for Co-Location Data Centers

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Containment Strategies for Co-Location Data Centers

Introduction

Arrangement of IT equipment cabinets to maintain dedicated hot and cold IT equipment cabinet aisles has long been considered a basic element in computer room cooling design. Thus, a move toward isolating these hot and cold aisles to eliminate mixing of the cold (supply) and hot (return) air streams seems a natural progression as the industry strives for more energy efficient cooling methodologies. Containment in a purpose-built data center, where an owner can maintain some level of control over IT cabinet configurations, is generally fairly straight forward. However, implementing containment in a co-location data center environment brings with it a unique set of challenges.

Why Containment?

Simply stated, hot/cold air containment improves cooling to IT equipment cabinets and increases cooling system efficiency. In an open computer room environment with downflow computer room air conditioning units (CRACs) or air handling units (CRAHs) it is not unusual for only 75% of cooling supply air to get to where it is needed -- the inlet of the IT equipment cabinets. The remaining 25% is essentially lost due to uncontrolled floor openings and poor distribution of the supply air thought to be "controlled".

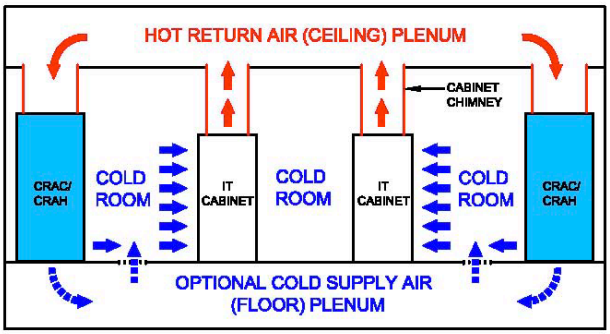
Closing up floor openings will significantly reduce wasted supply air, but without containment of either the supply or the return air stream the usable supply air remains uncontrolled because it is mixing with return air. By isolating the hot and cold air streams with containment of either air stream, the supply air is provided a fixed path to the IT equipment cabinets, eliminating cabinet bypass and hot/cold air mixing. A consistent supply air temperature is also maintained across the face of the IT cabinets, so all servers are more effectively cooled and hot spots are reduced or eliminated altogether.

With the supply air confined to where it is needed, oversupplying to compensate for uncontrolled air is no longer necessary. Air conditioning equipment fan speeds can be reduced to match server fan needs, saving significant energy. Putting fan laws to work, a 25% reduction in fan speed will result in a 48% reduction in fan power.

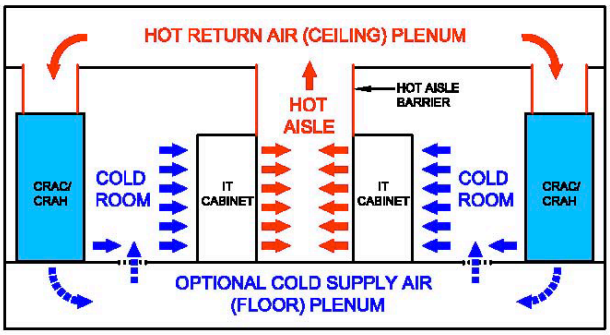
Similarly, with the cold supply air separated from the hot return air, degradation of the supply air temperature due to hot/cold mixing is eliminated. Thus, the temperature of the supply air leaving the air handling equipment can be elevated while still staying below ASHRAE's recommended 80.6°F (15°C) limit. Every 1°F rise in supply air temperature provides the opportunity for a corresponding 1°F rise in chilled water temperature. In turn, raising the chilled water temperature by 1°F increases chiller operating efficiency by about 2%. The net effect of these cascading savings is that a 10°F rise in supply air temperature (to only 65°F) can increase chiller efficiency by around 20%.

Containment Considerations

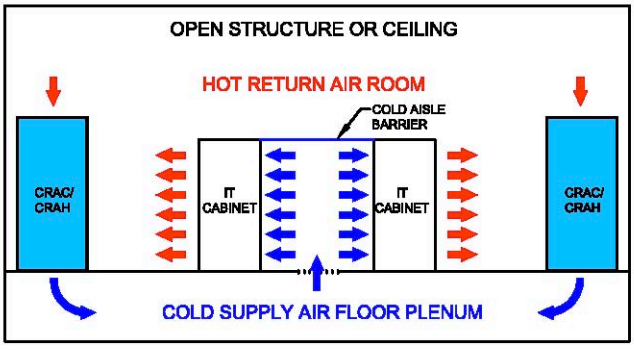
Several key factors must be considered in the selection of viable containment options for a data center, particularly when dealing with a co-location environment that must remain flexible to a wide range of clientele. Integral to these factors is the implementation of hot versus cold air containment. Although cold air containment is fairly limited in its application (using cold aisle containment), hot air containment is commonly applied using either IT cabinet chimneys or hot aisle containment. The diagrams below illustrate three basic containment applications.



HOT CABINET CHIMNEY CONTAINMENT



HOT AISLE CONTAINMENT



COLD AISLE CONTAINMENT

Industry vendors make compelling arguments for either cold or hot containment. However, **independent studies indicate that there is no appreciable energy savings advantage**

between hot and cold containment. There are, however numerous application considerations. As summarized in the table below, each of these containment strategies presents its own strengths and weaknesses.

FACTOR	HOT (RETURN) CONTAINMENT	COLD (SUPPLY) CONTAINMENT
Implementation	Suitable for whole-room implementation (for greatest energy savings). Suitable for part-room implementation to any percentage of IT cabinets in room. Room can also accommodate and cool uncontained equipment (tape libraries, PDUs, etc.).	Suitable for whole-room implementation (for greatest energy savings). Suitable for part-room implementation only at a low percentage of IT cabinets in room to ensure uncontained cabinets are not adversely affected by hot air expelled from contained cabinet rows. Room can accommodate and cool uncontained equipment (tape libraries, PDUs, etc.) only with part-room implementation.
Room Temperature	Room outside contained area is at the supply air temperature, which may be uncomfortably cold for personnel to work in.	Room outside contained area is at the return air temperature, which may be unsuitably hot for personnel to work in.
Cooling Equipment	Suitable for local CRACs or other units. Suitable for rooftop units. Suitable for exterior perimeter units. Suitable for in-row coolers (if employing aisle containment) as prime or supplemental cooling means.	Suitable for local CRACs or other units. Not generally suitable for rooftop units. Suitable for exterior perimeter units. Suitable for in-row coolers as prime or supplemental cooling means.
Room Architecture	Raised floor not required. Cooling supply air delivered directly to room or to raised floor. Controlled return air path required via return air ceiling or ductwork. This may be space- prohibitive.	Raised floor generally required, unless strictly using in-row coolers. Ceiling plenum not required.
IT Cabinet Configuration	Cabinet Chimneys -- Top air discharge required. Easily adapted to different cabinet configurations. Aisle Containment -- Rear air discharge required. Can be difficult to employ with dissimilar cabinets within a contained row.	Top or rear air discharge accommodated. Can be difficult to employ with dissimilar cabinets within a contained row.
IT Cabinet Access	Cabinet Chimneys -- Cabinet's front and rear are easily accessed within (cold) room. Aisle Containment -- Cabinet's rear access is within contained (hot) aisle.	Cabinet's front access is within contained (cold) aisle. Cabinet's rear is easily accessed within (hot) room.

FACTOR	HOT (RETURN) CONTAINMENT	COLD (SUPPLY) CONTAINMENT
	Cabinet's front is easily accessed within (cold) room.	
Telecom	Cabinet chimneys -- Top connections require careful coordination. Bottom connections easily accommodated Aisle containment -- Top or bottom connections easily accommodated.	Top or bottom connections easily accommodated.
Lighting	Cabinet Chimneys -- Additional lighting required on each side of chimneys. Aisle Containment -- Special lighting considerations likely within contained areas.	Special lighting considerations likely within contained areas.
Fire Protection	Cabinet Chimneys -- Additional detection/suppression likely required on each side of chimneys. Aisle Containment -- Special detection and/or suppression systems may be required by local Fire Marshal within contained areas.	Special detection and/or suppression systems may be required by local Fire Marshal within contained areas.

Conclusion

With containment considerations outlined, final selection of an appropriate containment strategy for a co-location data center will still be influenced by the IT deployment status of the data center. For a new data center facility, a containment strategy can be tailored to suit the anticipated clientele by weighing each of the tabulated factors relative to leasing agreements, client needs, and facility requirements. Containment options in an existing data center may be limited, but containment is viable to some degree in almost any existing environment with minimal modification to existing mechanical systems, particularly with respect to controls and balancing. More extensive containment may also require modifications to existing architectural, lighting, and fire protection systems. Keeping in mind that any elevation in supply air temperature correlates to energy savings, employing even partial containment can pay for itself fairly quickly.