CABINETS: THERMAL MANAGEMENT

WHITE PAPER

Thermal Management In CPI Cabinet Systems

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Thermal Management In CPI Cabinet Systems

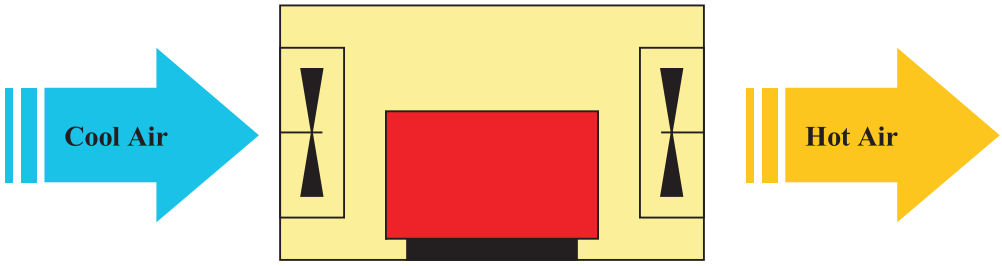
CPI Cabinet Systems are used in data centers to store rack-mount computer and data storage equipment.

Rack-mount computer and data storage equipment generates heat during normal operation. When equipment is enclosed in cabinets, heat generated by the equipment can concentrate within the cabinet and cause equipment to overheat and shut down.

Thermal Management Solutions for CPI Cabinets control the movement of air through the cabinet to enhance the cooling of equipment resulting in a more efficient use of available cool air and better overall heat transfer away from equipment.

How Equipment Is Cooled

Heat is removed from rack-mount equipment using forced air convection. Internal fans draw or push air through the equipment chassis front-to-rear over the heated components within.



The air acts as a heat sponge, transferring heat from the internal components to the outside of the equipment.

Improving Heat Transfer Through Equipment

Increasing heat transfer in rack-mount computer and data storage equipment is the key to better cooling efficiency. Heat transfer in equipment is improved when the temperature of cool air is decreased or when airflow over internal components is increased.

Airflow over internal components is controlled by and limited to the capacity of internal fans, so, the main focus of the thermal management solution should be delivering a high volume of low temperature air directly to equipment.

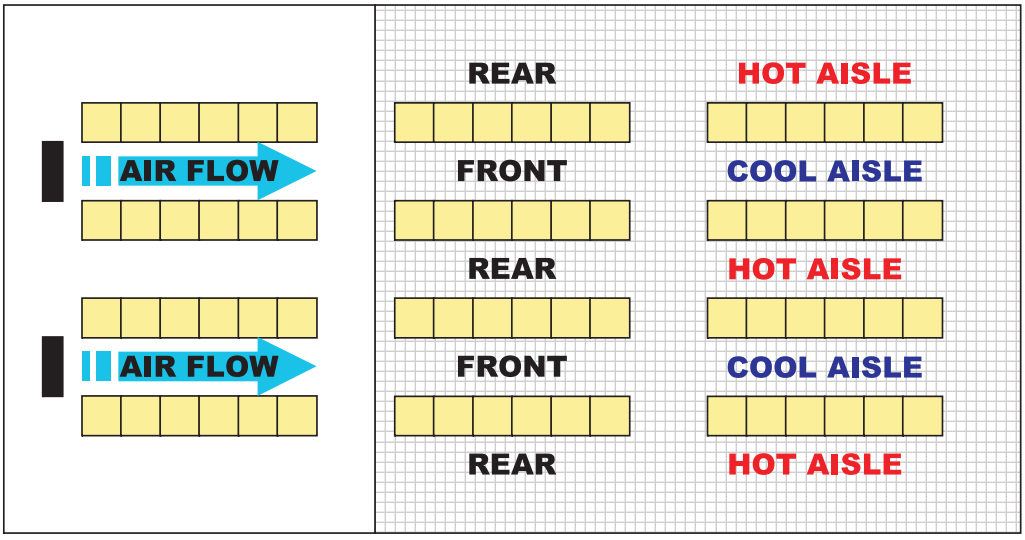
The thermal management system within the cabinet should also prevent the mix of cool and hot air between the front and rear of the cabinet, and exhaust hot air from the rear of the cabinet.

Careful management of airflow through the room and cabinet will direct the lowest temperature air - air directly from the air conditioning system - through equipment first. Assuming the air conditioning system has sufficient capacity to remove the additional heat transferred, cooling efficiency will be improved.

Improving Air Flow In The Data Center

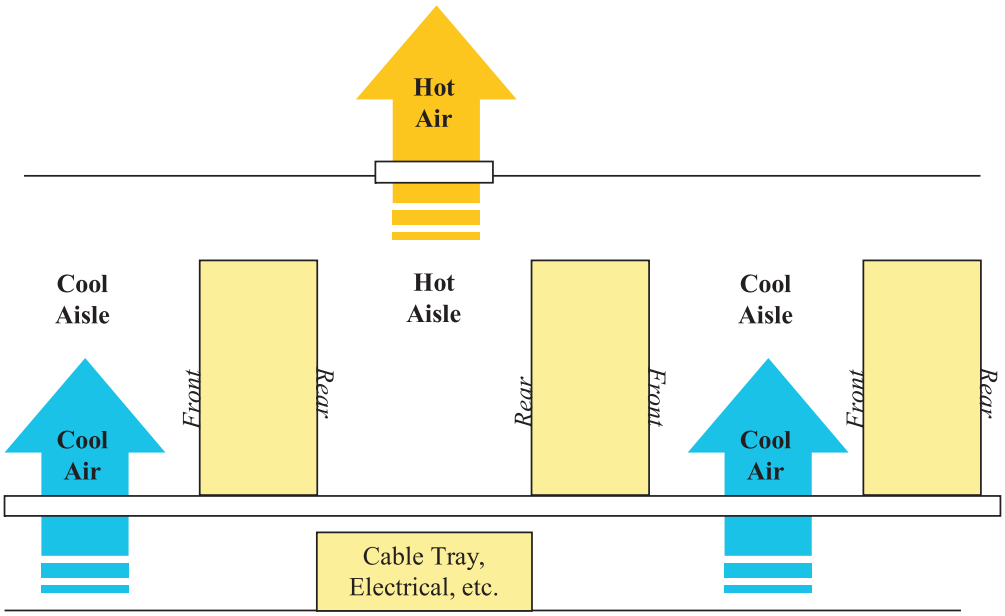
A raised floor plenum is typically used to deliver cool air into the Data Center. The challenge is to deliver the highest volume of cool air to the equipment first.

To improve cool air delivery to equipment, arrange cabinets in multi-cabinet rows parallel to the airflow under the raised floor. The fronts or rears of adjacent rows of cabinets should face each aisle so that the intakes or exhaust of equipment are concentrated on cool or hot aisles respectively.



Airflow from the air conditioning units should be concentrated under the cool aisles (fronts of cabinets), and air-handling units should not be placed perpendicular to each other.

Cool air is introduced into the room through vented floor tiles positioned at the front of cabinets (cool aisles) or, preferably, directly under cabinets. Hot air returns are located over the rear aisles (hot aisles). Services, if any, should be routed under the hot aisle so that they do not block airflow of cool air under the cool aisle.

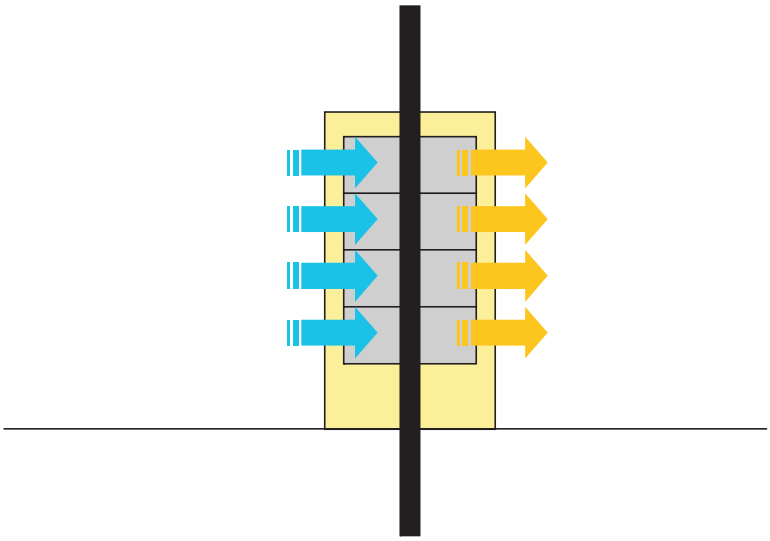


Positioning and quantity of vented floor tiles is very important. Vented floor tiles control airflow entering the data center from the plenum space under the raised floor. Decreasing the number of vented tiles increases the static pressure at the remaining vented tiles assuming other sources of air leakage from the plenum space, like holes for cables, are minimized. The effect is increased airflow through the remaining vented floor tiles.

Position vented tiles directly under cabinets when possible so that airflow is increased through the cabinet. Additionally, air that enters the cabinet base directly from the plenum space is generally lower in temperature than air that enters the cabinet through the front door because it has not absorbed heat from the surrounding air within the room.

Improving Airflow Through The Cabinet

The cabinet design must encourage front-to-rear airflow through equipment using the equipments' internal fans, and should prevent or limit the mixing of cool air at the front of the cabinet with hot air at the rear of the cabinet.



The thermal management solution for CPI Cabinets:

- Concentrates cool air in front of equipment
- Prevents the mix of cool air and hot air around equipment within the cabinet
- Prevents the movement of hot air to adjacent cabinets
- Removes heated air from the rear of the cabinet quickly

Cool air may enter the cabinet through the front door or through the bottom of the cabinet. Chatsworth has a solution for both scenarios.

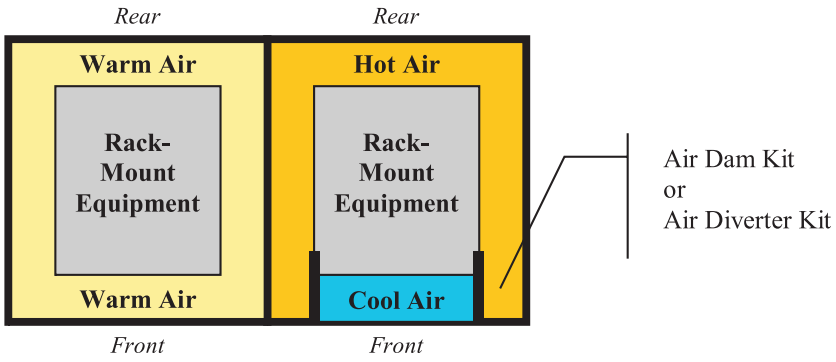
Concentrating Cool Air At The Front Of Equipment

CPI Cabinets have integrated cable management space along both sides of the cabinet. When equipment is added to the cabinet, there is airspace on all sides of equipment – right, left, front and rear. Chatsworth cooling solutions begin with a series of baffles – Air Dam Kit or Air Diverter Kit – which seal the space between the front door and equipment. Filler panels are added to open rack-mount spaces to prevent airflow through open rack-mount spaces. Then, cool air is directed into the space in front of equipment (see the diagram below). By concentrating cool air in front of equipment, a higher volume of lower temperature air passes directly through equipment.

Preventing The Mix Of Hot Air Around Equipment

CPI Air Dam Kit or Air Diverter Kit also simultaneously divides the space around equipment within the cabinet into cool air space and hot air space. The space between the front door and equipment (within the baffles) is cool air space. The space at the rear and along both sides of the cabinet is hot air space. The baffles prevent hot and cold air from mixing front-to-rear around equipment. The result is lower temperature air concentrated at the front of equipment where it is needed most.

Top View Of Cabinets



Prevent The Movement Of Hot Air To Adjacent Cabinets

Side panels should be used to prevent hot air from exiting the side of the cabinet or from entering adjacent cabinets in a multi-cabinet bay. Minimize the number and size of penetrations in the side panels for routing cables cabinet-to-cabinet by implementing a zone cabling solution in the data center and by routing cables through the tops of cabinets.

Exhausting Hot Air From The Cabinet

It is important to remove hot air from the rear of the cabinet so that it does not mix with cool air and reduce the overall effectiveness of the thermal management solution. Cables and cable management arms often block airflow at the rear of equipment. The distance between the rear door and the back of equipment also impacts the flow of air through the cabinet. At minimum, High-Flow Perforated Metal Door must be used on the rear of cabinets to allow hot air to escape from the cabinet, but Intelligent Fan Door is the preferred solution for exhausting hot air from the cabinet.

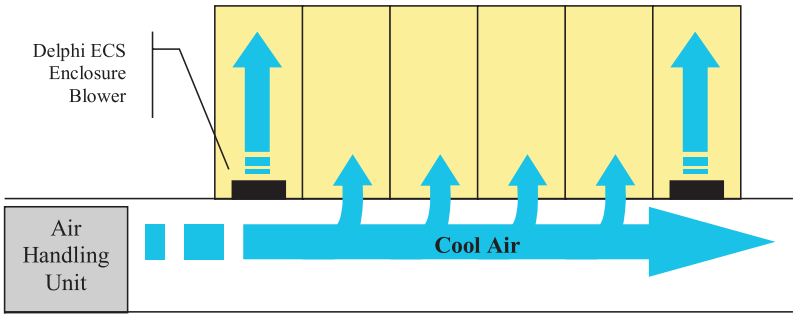
Intelligent Fan Door maintains airflow through the cabinet by reacting to temperature changes to remove hot air that may otherwise become trapped in the cabinet. Intelligent Fan Door compensates for obstacles that block the airflow created by the equipments' internal fans.

Compensating For Low Airflow

The cooling capacity of the cabinet is dependent on the airflow entering the cabinet. Since rack-mount computer equipment is becoming more powerful and more compact, the heat load within some cabinets may exceed the normal or planned cooling capacity of the cabinet. The solution is to increase the amount of cool air entering the cabinet.

In some cases, an additional vented floor tile or a vented floor tile with a larger percentage of openings will solve the problem. If this does not work, there is not enough static pressure under the cabinet to provide additional airflow into the cabinet. A fan must be added to direct additional airflow into the cabinet.

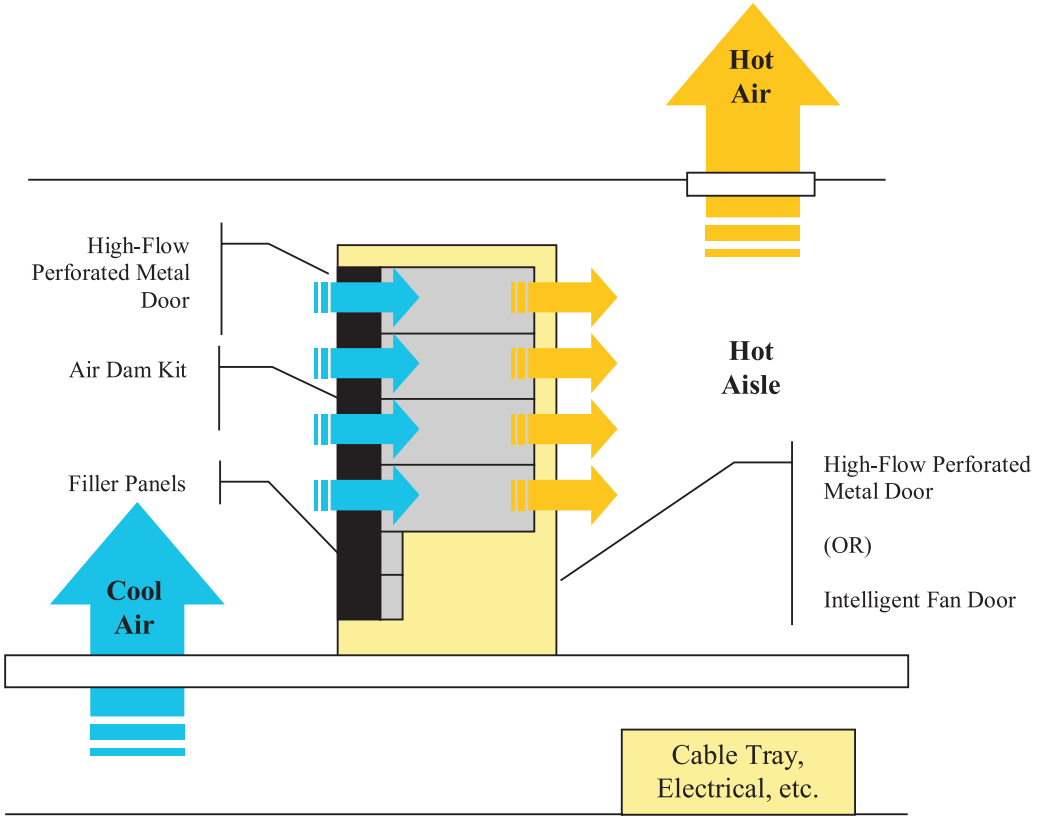
Air delivery across a row of cabinets also varies. Cabinets close to the air-handling unit may be starved for cool air because the cool air velocity may exceed the full potential of the openings in the floor tile. Cabinets at the end of the air handlers throw may also be starved for cool air because of low air velocity. Use Delphi ECS Enclosure Blower to increase airflow in cabinets.



Note: ECS Blower should not be used to compensate for an air handling system that is under capacity (i.e. in every cabinet). This could cause hot air from the room to be circulated back through the floor instead of through the air conditioning system.

Scenario 1: Cool Air Enters The Front Door

When cool air enters the Cabinet through the front door, use a High-Flow Perforated Metal Door on the front of the cabinet for maximum airflow. Use Air Dam Kit to seal the space between the door and the equipment. Then, close all open rack-mount spaces with an appropriately sized Filler Panel so that cool air passes through equipment, not around equipment. This also keeps hot air at the rear of the cabinet. Use Side Panels in between bayed cabinets to prevent hot air at the rear of one cabinet from entering an adjacent cabinet. Use High-Flow Perforated Metal Door on the back of the cabinet to let hot air escape. Substitute Intelligent Fan Door to actively remove hot air from the rear of the cabinet.



Note: This solution may be used when there is no raised floor.

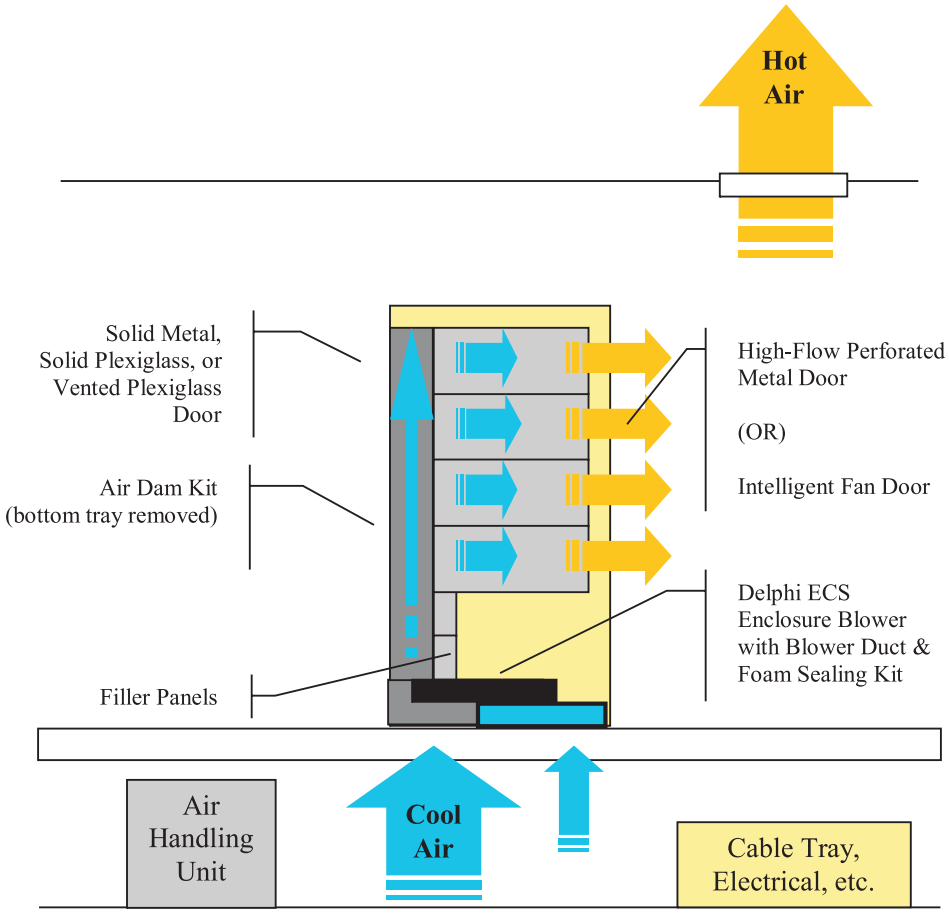
Heat Load[1]	Airflow[2]	Recommended CPI Cabinet Configuration		
		Front Door	Rear Door	Accessories
1.5 kW	300 CFM	Perforated	Perforated	
2.0 kW	300 CFM	Perforated	Perforated	Air Dam Kit and Filler Panels
4.0 kW	700 CFM	Perforated	Fan Door	Air Dam Kit and Filler Panels

1. Estimate Heat Load per cabinet by adding the equipment power requirements in Watts and dividing by (3).

2. Minimum Airflow per 2' x 2' floor tile opening, assumes a 15ºF temperature change through equipment.

3. If Airflow is 700 CFM, consider scenario 2 on Page 9.

To increase airflow through the cabinet, use Delphi ECS Enclosure Blower with Air Dam Kit and close all open rack-mount spaces with the appropriately sized Filler Panel. Use a Solid Metal, Solid Plexiglass or Vented Plexiglass Door to direct airflow to the front of equipment. Place the cabinet over a vented floor tile. Seal the base of the cabinet to the floor with the Foam Sealing Kit and offset the blower air intake to the rear of the cabinet with the Blower Duct.



Note: Blower Duct and Delphi ECS Enclosure Blower direct additional active airflow to the front of the cabinet. Reserve the bottom three rack-mount spaces (3 RMU) for the blower and duct.

Heat Load[1]	Airflow[2]	Recommended CPI Cabinet Configuration		
		Front Door	Rear Door	Accessories
2.5 kW	300 CFM	Solid Metal	Perforated	ECS Blower, Air Dam Kit and Filler Panels
3.0 kW	300 CFM	Vented Plexi	Fan Door	ECS Blower, Air Dam Kit and Filler Panels
5.0 kW	700 CFM	Vented Plexi	Perforated	ECS Blower, Air Dam Kit and Filler Panels

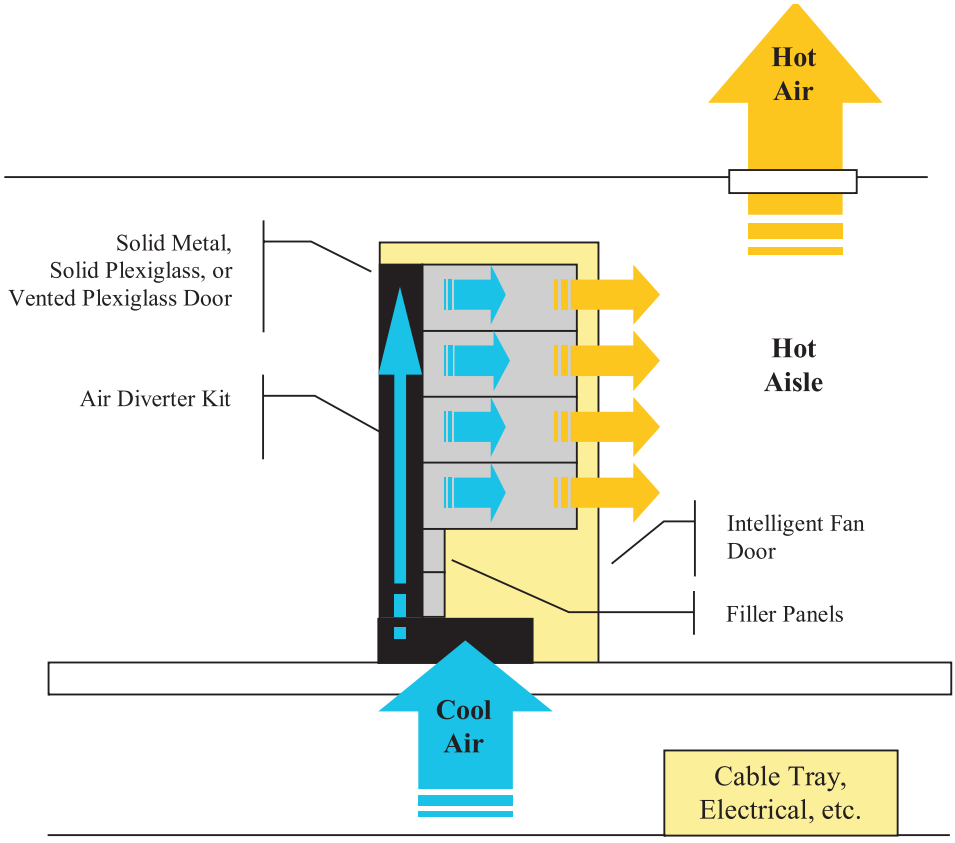
1. Estimate Heat Load per cabinet by adding the equipment power requirements in Watts and dividing by (3).

2. Minimum Airflow per 2' x 2' floor tile opening, assumes a 15ºF temperature change through equipment.

3. If Airflow is 700 CFM, consider scenario 2 on Page 9.

Scenario 2: Cool Air Enters The Bottom Of The Cabinet

When cool air enters the bottom of the cabinet through vented tiles in the raised floor plenum, use the Air Diverter Kit to seal the space between the door and equipment and to divert cool air entering the bottom of the cabinet through the raised floor to the space between the door and equipment. Use a Solid Metal Door, a Solid Plexiglass Door, or a Vented Plexiglass Door on the front of the cabinet. Then, close all open rack-mount spaces with an appropriately sized Filler Panel so that cool air passes through equipment, not around equipment. This also keeps hot air at the rear of the cabinet. Use Side Panels in between bayed cabinets to prevent hot air at the rear of one cabinet from entering an adjacent cabinet. Use Intelligent Fan Door to actively remove hot air from the rear of the cabinet.



Note: Reserve the bottom two rack-mount spaces (2 RMU) for the Air Diverter.

Heat Load[1]	Airflow[2]	Recommended CPI Cabinet Configuration		
		Front Door	Rear Door	Accessories
6.0 kW	700 CFM	Vented Plexi	Fan Door	Air Diverter Kit and Filler Panels
7.5 kW	900 CFM	Solid Metal	Fan Door	Air Diverter Kit and Filler Panels*

1. Estimate Heat Load per cabinet by adding the equipment power requirements in Watts and dividing by (3).

2. Minimum Airflow per 2' x 2' floor tile opening, assumes a minimum 20º temperature change through equipment.

** Requires 900-1000 CFM @ 55ºF, no high heat electronics in bottom 6 RMUs and 5" mounting-rail set-back.*

Conclusion

In the Data Center, the air conditioning system, cabinet and equipment must work together to control airflow so that the maximum amount of the lowest temperature air is continuously delivered to the front of rack-mount equipment.

Improving airflow through the cabinets by carefully arranging the position of cabinets and vented floor tiles relative to the air-handling units increases the volume of low temperature air available at the cabinet for cooling equipment.

The thermal management solution for CPI Cabinets guides the resulting higher volume of cool air through the cabinet, to the front of equipment, not around it, which increases heat transfer at equipment, and therefore, overall cooling efficiency.