

## Passive Cooling, A Safe And Effective Solution To Overcome Thermal Management Challenges

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Whether managing a small computer room or a large high-density data center, one thing is evident - equipment is becoming more compact, which means more power and heat in every cabinet. As equipment densities continually increase, thermal management has become a major operational and facilities management challenge.

The primary goal of thermal management in the data center is to maximize the performance, uptime and life expectancy of your equipment. This goal is accomplished by managing the cold air delivered to each piece of equipment so that the internal temperature of equipment in the data center never exceeds the manufacturer's maximum allowable operating temperature.

Airflow distribution within the data center has a significant impact on the thermal environment and by simply having the ability to control this airflow will solve thermal management challenges. Passive cooling is an innovative and critical technique for integrating all the parts of the data center to control the flow of air through cabinet spaces and provides 2-20+ kW of cooling without the use of supplemental liquid or active cooling systems. This solution allows you to reclaim control over airflow so that cool air can be directed where it is needed, eliminating the formation of hot spots and reducing bypass and re-circulation of hot exhaust air.

The most common cause of hot spots is the mixing of cool air with the heated exhaust air expelled from equipment. The temperature rise of air through any specific piece of equipment is essentially constant; therefore as exhaust air re-circulates through equipment it will continue to get hotter, causing equipment to run at higher operating temperatures. The maximum recommended air temperature to avoid hot spots is 75°F (24°C) - 78°F (26°C). Unfortunately, you cannot simply set the thermostat twenty degrees below the hot spot level, pump a volume of air into the room that exceeds the

total demand of equipment and achieve desired cooling results. In fact, most data centers have more than two and a half times their required cooling capacity and still experience numerous hot spots. Fortunately, passive cooling eliminates the formation of hot spots by increasing the total cooling capacity delivered to equipment and minimizes exhaust air available for re-circulation.

Bypass airflow is another wide-spread condition that occurs when cold source air bypasses equipment and travels directly into the hot exhaust air stream, reducing the amount of air available where it is needed in the front of racks and cabinets. This can also result from incorrectly located access floor tiles or unsealed cable holes. The reduced availability of chilled air means that equipment will pull in heated air from the room at large. This situation wastes energy, adds to humidity control problems and indirectly contributes to re-circulation. The technique of passive cooling reduces bypass airflow by isolating cold source air from hot exhaust air and forces chilled air to be routed through heat-producing equipment.

Re-circulation also contributes to thermal management issues and is caused when hot exhaust air travels back into the equipment intake air stream, which increases intake air temperatures and forces equipment to run at higher operating temperatures. Another source of hot air re-circulation is the presence of open rack space, as well as openings along the sides of equipment and inside the top and bottom of the cabinet. Equipment fans draw air from all sources and these openings allow the heated exhaust air to be pulled around to the front of equipment where air intakes are located. Hot air re-circulation also occurs when the volume of cool air needed by equipment exceeds the volume of air that can be delivered through perforated access floor tiles in front of the cabinet. In this case, all chilled air is consumed at the bottom portion of the cabinet and the make-up air is pulled up over the top of the cabinet from the hot aisle by equipment located in the top of the cabinet space. Hot air re-circulation is reduced when you use passive cooling solutions. Passive cooling blocks return air through unused RMU space, around the sides of rack-mounted equipment and between that equipment and the cabinet side panels. It delivers supplemental chilled air volume to the upper areas in the cabinet that would otherwise be consuming re-circulated return air and even removes return air from the room.

Passive cooling overcomes hot spots, bypass airflow and re-circulation of exhaust air, giving you the ultimate thermal management solution that can achieve various kilowatts of cooling by following a few simple steps. These steps allow you maximize effective cooling capacity, control the airflow in your cabinet and manage hot exhaust air.

### Eliminate Hot Air Recycling Through the Cabinet

You can attain a low heat density passive cooling solution (2-4 kW) by eliminating hot air from recycling through your cabinet. This is possible by blocking airflow through open RMU spaces with filler panels so that less hot air is re-circulated to the front of the cabinet. However, hot air can still go around the sides, top and bottom of equipment mounting spaces. Solve this issue by using an air dam or equivalent structure to block re-circulation. It is also important to use a perforated front and back door and solid side panels to eliminate hot air from recycling through the cabinet. Air can still re-circulate over the cabinet, but airflow now travels one-way through equipment. This passive cooling solution will effec-

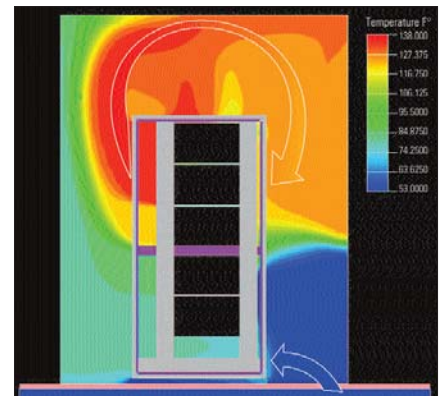


Figure 1. This CFD1 model shows a typical data center server cabinet without passive cooling. Hot air is re-circulating over the cabinet causing top servers to incur air in excess of 100°F (38°C).

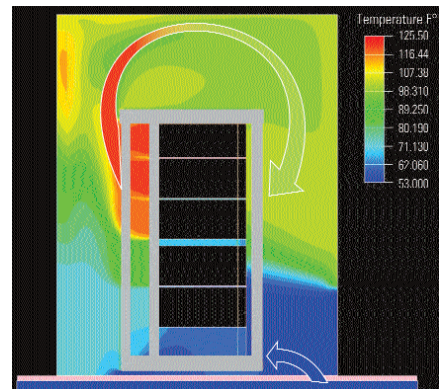


Figure 2. This CFD model shows a server cabinet with filler panels and an air dam to eliminate hot air recycling through the cabinet to achieve 2-4 kW of cooling.

### Data Center Myth Busters

**Myth** - Network switches with side-to-side airflow should not be used in a hot aisle/cold aisle layout.

**Fact** - With proper airflow management you can use network switches in a hot aisle/cold aisle layout.

### Do Network Switches With Side-To-Side Airflow Compromise Your Hot Aisle/Cold Aisle Layout?

The new N-Series TeraFrame™ Network Cabinet, engineered to combat thermal challenges and manage large amounts of cable in a hot aisle/cold aisle layout.

#### Thermal Management

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- Maximize energy efficiency and decrease total cost of ownership
- Support Hot Aisle/Cold Aisle Layout allowing switches and servers to be next to one another.



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tively create a front-to-rear barrier to airflow and will lower the temperature of air entering the top half of the cabinet.

### Increase the Amount Of Cold Air Entering The Cabinet

Cold air available to a cabinet is often limited to the amount of cold air entering the room through the perforated access floor tile located in front of the cabinet. You can achieve a medium heat density passive cooling solution (4-7 kW) by increasing the amount of cold air entering your cabinet.

Cable openings in access floors can cause as much as 50 percent of the cold air under access floors to bypass equipment. If you block airflow through open RMU spaces with filler panels and seal cable holes in access floors, the amount of cold air entering the cabinet will increase. To deliver more cold air to the top half of the cabinet use an internal ducted device to channel cold air up the sides of the cabinet into the front of equipment. This cold air will reduce the negative effects of hot air traveling over the cabinet into the cold aisle. It is important to use a perforated front and back door and solid side panels with a medium heat density passive cooling solution.

### Isolate Hot Air from the Room

Hot air isolation can be used to achieve desired cooling results as heat loads rise and the demand for cold air increases. In high density situations hot air re-circulates over the cabinet, back through the front of equipment, causing temperatures near the top half of the cabinet to increase. In order to manage these extreme heat loads and reach a high heat density passive cooling solution (7-20+ kW) you must isolate hot air from the room.

This is accomplished using a ducted hot air return to remove hot air from the cabinet, blocking airflow through open RMU spaces with filler panels, preventing hot air re-circulation with an air dam or equivalent structure and sealing cable holes. Use a perforated front door, solid back door and solid side panels to allow for front airflow intake and exhaust channeling through the duct.

This simple approach allows equipment intakes to draw the required volume of cool air, resulting in more efficient use of available cool air and better overall heat transfer away from equipment. By attaching to the top of the cabinet, the ducted hot air return isolates hot air from the room, returning it to the primary cooling system through the drop ceiling plenum or ducted return positioned high above the cabinet. Because hot air is now isolated in the duct, you can place perforated access floor tiles anywhere in the room to deliver additional cold air to equipment and the need for a hot aisle/cold aisle layout is no longer required. The resulting lower

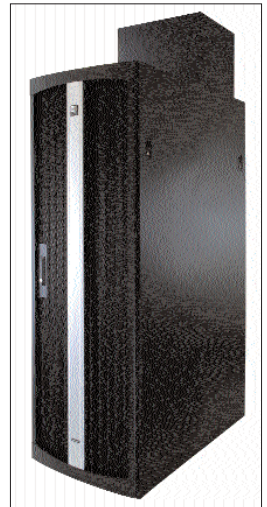
room temperature eliminates the need for supplemental liquid or active cooling solutions. In addition, a ducted exhaust cabinet avoids fan dependency and qualifies for Tier IV critical applications.

Passive cooling achieves the ultimate thermal management solution and provides flexibility, scalability, Tier IV capabilities and minimizes total cost of ownership. Since passive cooling does not involve liquid or active cooling components, backup is not needed when changes are performed, maintaining critical uptime. In addition, service and maintenance is not an issue with passive cooling and redundancy is never compromised because no additional power or plumbing is required to cool equipment. Passive cooling is a safe and effective technique to solve thermal management issues, eliminating the risks to equipment associated with supplemental liquid or active cooling systems and does not bring another level of complexity into your data center.

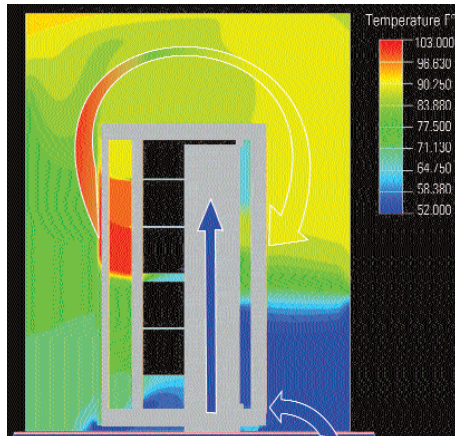
*CPI uses a systems approach to product development to solve the ongoing need for companies to organize, store and secure technology equipment. CPI's lines of structural support solutions, including racks, cabinets, and cable management and pathway support products, are offered through an international network of distributors and prime contractors. CPI, a 100 percent employee-owned company, has manufacturing facilities in Chatsworth, Calif.; Georgetown, Texas; and New Bern, N.C. For more information, visit [www.chatsworth.com](http://www.chatsworth.com).*

*In addition, CPI is listed with the General Services Administration (GSA) under Federal Supply Schedule IT 70. Products are also available through GSA Advantage and through Government Wide Acquisition Contracts (GWACs), including GSA Connections and NITAAC-ECS III.*

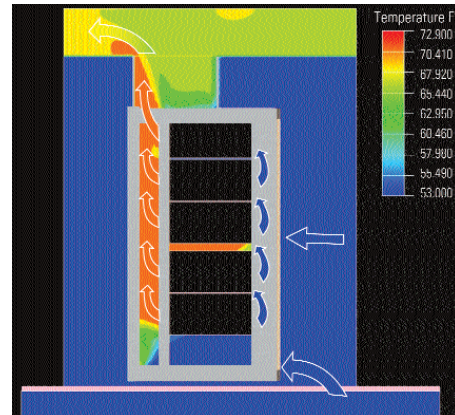
<sup>1</sup>CFD modeling provided by Fluent, Inc. ([www.fluent.com](http://www.fluent.com)) using Fluent AirPak software. CFD modeling is used to show airflow and temperature patterns in a high-density data center environment based on testing conducted by CPI. CFD models (Figure 1-3) are based on a standard data center server cabinet with perforated front and rear doors and various combinations of thermal management accessories. The cabinet (Figure 4) has a solid rear door and a top-mount Vertical Exhaust Duct. Equipment produces 9.467 kW of heat and consumes 1580 CFM (2689 CMH) of air. The perforated access floor tile in front of the cabinet provides 515 CFM (875 CMH) of air at 53°F (12°C). In Fig. 4, additional make-up air is provided into the room. The computational mesh of 700,000 cells assures the CFD model accurately models the empirical test condition.



**TeraFrame Cabinet System equipped with CPI Passive Cooling Solutions offered by Chatsworth Products, Inc. This system shows the Vertical Exhaust Duct, CPI's version of a ducted hot air return positioned above the cabinet to isolate hot air from the cabinet and room.**



**Figure 3. This CFD model shows a server cabinet with filler panels, sealed cable holes and an internal ducted device to increase the amount of cold air entering the cabinet to achieve 4-7 kW of cooling.**



**Figure 4. This CFD model shows a server cabinet with a ducted hot air return, filler panels, air dam and sealed cable holes to isolate hot air from the room using a ducted hot air return.**

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