PENTAIR

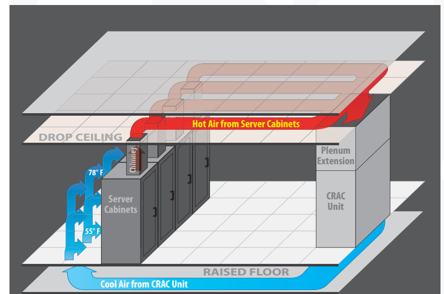
# INSIGHTS

TRENDS IN DATA CENTER DESIGN & OPERATION

# DATA CENTER DESIGN AND DEVELOPMENT—

## TOTAL COST OF OWNERSHIP FOR COOLING SOLUTIONS

Today, data centers contain more powerful electronics in smaller packages, generating more heat and resulting in dramatically higher power consumption. Implementing the proper cooling solution will protect data centers from costly heat damage, but choosing the appropriate cooling strategy consists of more than simply selecting the ideal cabinet configuration. Designers must consider the total cost of ownership (TCO), which includes capital expenses and operational costs.



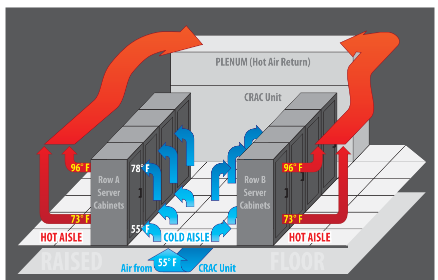
Chimney Cabinet Cooling

## EVOLUTION OF MODERN COOLING SOLUTIONS

Cabinets are configured in many different ways, but the goal of each configuration is the same: help deliver the necessary amount of cool air to each server.

### RANDOM CONFIGURATIONS

Random cooling configurations—still seen in some legacy systems—are not organized to separate cold intake and hot exhaust air. This lack in airflow control means that heat dissipation is achieved by driving the hot airflow above the cabinets to avoid blowing the hot air directly into cabinets containing critical electronic equipment. Their simplicity and minimal set-up cost make them an attractive option for some applications, but random configurations are unable to support many next-generation processing requirements.



Hot Aisle/Cold Aisle

### HOT AISLE/COLD AISLE

Hot aisle/cold aisle cooling systems are designed to separate hot exhaust from cold intake air. Cabinets located on both sides of the cold aisle draw cold air through their front intakes, using it to take heat away from the equipment. Hot exhaust exits through cabinet rears and is directed to CRAC/CRAH units, which remove the heat and redistribute air to the cold aisles. By separating the hot and cold air, the energy and costs required to maintain the optimal data center temperature are minimized. However, hot aisle/cold aisle designs are typically only able to accommodate heat dissipations between 3-5 kW.

### CHIMNEY CABINET COOLING

Chimney cabinet cooling solutions consist of a cabinet with top ductwork, which directs hot exhaust air to an above drop ceiling or additional ductwork that further directs the airflow to the intakes of the CRAC/CRAH unit. Studies have shown that chimney configurations successfully extract heat loads up to 20 kW. By providing a direct airflow path for hot air, chimney cabinets can remove heat from the cabinet or aisle and reduce wasted cold air by 99 percent.

### CONTAINMENT SYSTEMS

Rather than simply separating cold and hot airflow, containment systems erect a barrier to segregated airflows—preventing them from mixing, which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reduces energy costs, minimizes hot spots and improves the data center's carbon footprint. These systems are designed to enclose the hot or cold aisle through the use of aisle-way doors, roof panels and internal sealing within the cabinets. Containment systems offer two cooling options: cold aisle containment or hot aisle containment.

## IN-ROW COOLING

Dedicated cooling units placed between cabinets allow in-row cooling to capture exhaust air and neutralize it before it mixes with cold air. In-row cooling offers a standalone cooling system for some small rooms and can be used in conjunction with hot aisle/cold aisle configurations to accommodate growth. Units provide inherent scalability, which seamlessly allows users to adjust their cooling to accommodate any data center's evolving design requirements.

In-row Cooling

## TOTAL COST OF OWNERSHIP

While simple solutions typically require low capital costs, data center managers must consider the total cost of ownership associated with each cooling solution.

**SAVINGS CHART:**
This chart represents typical savings and is to be used as a guideline. Each data center will present many challenges and the activities shown will vary significantly in their effectiveness and savings.

**PUE (Power Usage Effectiveness)**
**= Total Facility Power/IT Equipment Power**

The total amount of power used by the data center compared to the power used by the IT equipment. A typical data center with Hot Aisle / Cold Aisle cabinet configuration has a PUE number around 2.4. A very efficient data center brings this number down to 2 or even lower. Some purpose-built data centers are claiming PUE numbers 1.75 or even lower.

| Activity | PUE | Annual Power Cost | Cumulative Savings | Individual Savings |
|---|---|---|---|---|
| Data Center Typical (Hot Aisle/Cold Aisle) | 2.40 | $1,055,600 | - | - |
| Blanking Panels (In all open RU locations) | 2.38 | $1,040,000 | $15,600 | $15,600 |
| Floor Brushes (Tile Cutouts) | 2.35 | $1,025,000 | $30,600 | $15,000 |
| Perforated Tile Placement | 2.30 | $1,007,000 | $48,600 | $31,000 |
| CRAC Unit – Duct Work | 2.27 | $994,000 | $61,600 | $13,000 |
| Drop Ceiling Return Duct Work | 2.23 | $976,000 | $79,600 | $18,000 |
| Cabinet Layout Optimized | 2.20 | $964,000 | $91,600 | $26,000 |
| Raised Floor Optimized | 2.15 | $938,000 | $117,600 | $26,000 |
| Containment – Cold Aisle | 2.10 | $920,000 | $135,600 | $18,000 |
| Hot Aisle Containment / Chimney | 2.00 | $880,000 | $175,600 | $40,000 |
| Liquid Cooling (Closed Cabinet System) | 1.75 | $770,000 | $286,600* | $286,600 |

* Note: Liquid Cooling allows for higher density (fewer cabinets and a smaller sized data center) which is not calculated in the savings. Liquid cooling is a stand alone solution not cumulative to the other activities.

## INSTALLATION VS OPERATION

The difference between installation cost factors and operational cost factors can be a deciding factor when selecting the appropriate cooling strategy. For instance, random configurations are relatively affordable and simple to install. However, the energy needed to run these systems may result in excessive utility expenses, create hotspots and lead to costly equipment damage. Conversely, containment systems can be expensive to implement, but due to their low-to-moderate operating costs and high reliability, containment systems can be a cost-effective solution for sophisticated cooling requirements.

## DESIGN FACTORS FOR COST SAVINGS

Additional factors can increase efficiency and contribute to significant annual savings, such as the amount of open space on cabinet front doors and the placement of fans. Companies can also add blanking panels—solid walls installed to prevent cold air from rushing through cabinets and mixing with hot exhaust—or floor brushes, which act as both a plenum for distributing cold air to network equipment and provide cable distribution.

## IN CONCLUSION

By understanding cabinet configurations and additional TCO factors, designers can implement solutions that provide superior protection for networking equipment and energy-efficiency, saving thousands of dollars every year in utility costs.

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