



A PRACTICAL GUIDE TO DATA CENTER CONTAINMENT

WHY CONTROLLING AIRFLOW IS THE FASTEST PATH TOWARD
HIGH-DENSITY COOLING

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SCALING SMART: CONTAINMENT SHOULD BE YOUR DATA CENTER'S NEXT MOVE

Data center demands are accelerating fast. Rack densities are jumping from 10 kW or 15 kW into the 50 kW range and beyond as AI workloads drive unprecedented heat loads. For most data centers, this means the traditional open-air cooling that once worked reliably is quickly running out of headroom.

But most operators aren't ready to make the leap from air cooling to liquid cooling. It's also not a very realistic or cost-effective strategy. Why? Because liquid systems can require changes that most teams aren't ready to absorb all at once, including:

- Major capital investments
- Facility retrofits
- Operational disruptions



THE SMARTER PATH FORWARD IS CONTAINMENT.

By physically separating hot and cold air, containment helps you get more capacity and efficiency out of the cooling infrastructure your data center already has in place. It stabilizes temperatures, cuts energy consumption, and creates room for higher rack densities, all without forcing an immediate transition to full liquid cooling.



WHAT CONTAINMENT ACTUALLY DOES FOR DATA CENTERS

In a typical air-cooled data center, cold supply air and hot exhaust air mix. When this happens, cooling units have no choice but to work harder to keep equipment operating within safe temperatures. This drives up energy use and costs, as data center spaces are often overcooled to protect the hottest racks.

Containment changes that dynamic by separating hot and cold air with simple, low-disruption physical barriers like:

- Doors
- Panels
- Overhead or end-of-row barriers

The impact of containment is significant. It makes airflow predictable, reduces temperature fluctuations, and makes cooling performance easier to control.

Improves cooling efficiency

Because cooling units receive hotter, drier return air, they can operate at their most efficient point (closer to their design temperature and airflow conditions).

Reduces energy use

CRAC (computer room air conditioner) and CRAH (computer room air handler) units get to run at lower speeds, cycle less frequently, and even be taken offline in some cases, which reduces energy expenses.

Extends equipment life

With more consistent inlet temperatures, hot spots are reduced, and less thermal stress is placed on sensitive electronics.

Boosts reliability

Creating a stable thermal environment reduces the risk of unexpected shutdowns and service interruptions, supporting higher uptime and more predictable performance as densities climb.

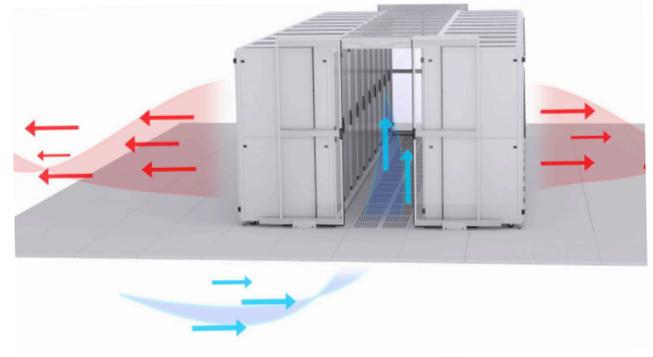
TWO WAYS TO DEPLOY CONTAINMENT

There are two containment strategies for data centers to consider. Both can adapt to a wide range of cabinet types, ceiling heights, and legacy environments, making containment a viable option for new and existing sites.



HOT AISLE CONTAINMENT (HAC)

1. Hot aisle containment encloses the aisles behind the servers where exhaust air leaves the racks. The hot air is captured and directed back to the cooling units without mixing with the cold air in the room, keeping temperatures comfortable for technicians.



COLD AISLE CONTAINMENT (CAC)

2. Cold aisle containment encloses the aisles in front of the servers where cold air is supplied to the equipment. Only cold air enters the racks, and the rest of the room becomes the return path for hot air.

WHICH IS THE BEST CHOICE? THAT DEPENDS ON YOUR DATA CENTER'S:

- Layout
- Current cooling design
- Density targets
- Sustainability goals
- Operational patterns and how people use the space

CONTAINMENT IS A KEY STEP IN THE COOLING EVOLUTION

As computing demand grows, most data centers follow a predictable cooling journey. Here's how that progression typically looks.



Stage 1: Traditional open-air cooling (< 15 kW)

Room-level air conditioning manages heat in low-density environments. This approach is simple and inexpensive, but it has limits in terms of capacity. As loads increase, it can also create hot spots and temperature swings.



Stage 2: Containment (10 kW to 30 kW)

Adding containment to an air-cooled environment delivers immediate efficiency gains and helps eliminate hot spots. Containment extends the useful life of existing air-cooled systems and allows you to support higher densities without major upgrades.



Stage 3: Rear door heat exchangers (25 kW to 80 kW)

By mounting liquid-cooled coils on the back of racks, rear door heat exchangers move cooling closer to the heat source. They can be highly efficient and space-conscious, but they also introduce additional maintenance and complexity considerations.



Stage 4: Direct-to-chip liquid cooling (50 kW to 100+ kW)

Coolant is delivered directly to CPUs and GPUs, removing heat at the source and enabling very high rack densities. These systems are powerful but require careful design, integration, and leak management.



Stage 5: Immersion cooling (100-250+ kW)

Servers are immersed in dielectric fluid for virtually complete heat removal, a strategy most often seen in AI and high-performance computing environments where extreme density justifies the higher capital and operating costs.

PREPARING FOR TRANSITION

At some point, all data centers enter the "transition zone," where rack densities rise to between 20 kW and 40 kW. This is when traditional air cooling struggles to keep up on its own, but full liquid cooling may still be out of reach from budget or readiness standpoints.

Containment bridges that gap. It maximizes the value of air cooling, creates a stable starting point for liquid-assisted solutions, and reduces risk when it's time to move on to more advanced approaches.

WHY SKIPPING CONTAINMENT ISN'T A SMART IDEA

It can be tempting to view containment as optional, especially if liquid cooling is in your future. But it's not an add-on. It's the foundation that allows air and liquid cooling investments to deliver on their full potential. Skipping it can introduce problems that undermine data center performance and efficiency, including:



Residual heat

Liquid cooling often focuses on high-power components, such as CPUs and GPUs. Meanwhile, other hardware continues to reject heat into the room. Without containment, that residual heat circulates freely, creating hot spots and forcing cooling systems to work harder.



Uncontrolled airflow

When hot and cold air mix, temperatures become difficult to predict and control. Even advanced liquid systems may end up compensating for poor airflow, which increases energy use and erodes return on investment.



Higher equipment stress and risk

Persistent hot spots and thermal swings shorten equipment lifespan and increase the possibility of failure. The costs associated with unplanned downtime and accelerated hardware replacement can easily outweigh the perceived savings of bypassing containment.



Limits on cooling capacity

Without containment, effective cooling capacity is lower, no matter which technologies you deploy. Containment enables higher rack densities and provides a "safety net" if active systems experience issues.



WHY CONTAINMENT DELIVERS FAST WINS

Containment can deliver a strong combination of impact, flexibility, and speed. Key advantages include:

- **Rapid payback** due to better airflow management that reduces cooling energy demand
- **Phased deployment** that allows implementation in stages (by row, room, or site) so you can align spending with growth and business priorities
- **A future-ready foundation** that makes it simple to introduce liquid-cooled technologies when the time is right later
- **Operational resilience** supported by a more predictable thermal environment, which ensures consistent performance

HOW TO GET CONTAINMENT RIGHT

Following these best practices can go a long way in making sure your containment systems perform the way you expect.

- **Plan for tomorrow's workloads.** Design containment with future density targets and AI-driven growth in mind. Build in extra headroom now to avoid expensive, disruptive rework later.
- **Choose the right containment strategy.** Consider airflow design, flooring, ceiling height, cable routing, and occupancy to select the approach that fits your facility and operating model.
- **Think about hybrid cooling.** Containment can be used alongside rear door heat exchangers or targeted liquid-assisted solutions to support high-density zones without overhauling the entire data center at once.
- **Align facilities, IT, and operations.** Bring all stakeholders to the table early. Sharing goals and clarifying responsibilities reduces friction and speeds deployment.
- **Monitor, measure, and fine-tune.** After containment goes live, use temperature and airflow data to validate performance and identify opportunities for refinement. Small adjustments in setpoints, balancing, and/or sealing can offer additional efficiency.



ABOUT LEGRAND CONTAINMENT SOLUTIONS

Legrand's hot aisle and cold aisle containment systems are engineered to improve cooling efficiency and equipment reliability, letting your data center evolve on its own terms. Modular, adaptable designs support a wide variety of layouts, ceiling heights, and operational requirements to minimize air mixing at normal operating pressures.

With in-house engineering and nationwide project management, Legrand supports you from initial design through installation and performance validation. The goal is simple: to create a stable, efficient thermal environment that keeps your data center ready for what comes next.

Learn more:

<https://www.legrand.us/critical-power-and-infrastructure/aisle-containment>



To learn more visit

[legrand.us/containment](https://www.legrand.us/containment)

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