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Cold Aisle Containment & Hot Aisle Containment

Executive Summary of Aisle Containment

This article examines cold aisle containment and hot aisle containment (also known as cold or hot air containment) from a neutral perspective. Cross-Guard, as a manufacturer and installer of both aisle containment solutions, has over a decade of experience working alongside many of the best-known data centre companies.

In this report, we take a pragmatic look at the drivers for data centre operators, beyond the veneer of efficiency figures. We also share the findings of a live data centre study of cold aisle containment (CAC) from one of the world's largest hosting companies, and offer up some of the reasons why cold aisle still remains the dominant strategy for the majority of data centre owners in the UK and, in fact, worldwide.

Contents

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Introduction to Aisle Containment

High energy costs, coupled with the desire to optimise reliability and efficiency, have increasingly focussed customers' minds on cooling in data centres. Data centre cooling and power efficiency is a vast topic, with the pros and cons of different methods continually being debated as chiller and Data Centre Infrastructure Monitoring (DCIM) technology evolves, and new facilities come online.

One principle universally accepted is that preventing the mixing of hot (exhaust) and cold (inlet) air in any form of data room through aisle containment is highly desirable, and a key part of cooling strategies in data centres. Indeed, it is essential in data centres aiming to achieve high reliability and minimal energy costs or power utilisation effectiveness (PUE).

Fig. 1: Cold aisle containment

The construction design of the building fabric, and means of supplying chilled air, will both have a large influence on the method used to prevent hot and cold air mixing. New data centre facilities may have the latest free air adiabatic chillers or advanced water-cooled chillers, but they still need to ensure segregation of hot and cold air in the same way that the more traditional cooling via edge Computer Room Air Handling (CRAH) units do.

However, in the constant pursuit for a balance between energy efficiency and saving money, it can be difficult to decide on the product most suitable to your needs. This is a common dilemma facing modern data centres: how best to combat the ever-present problem of data centre cooling in a dynamically changing environment, in order to achieve maximum efficiency.

A popular and cost-effective choice for data centre cooling is Cold Aisle Containment Systems (CACS); however, studies have shown that Hot Aisle Containment Systems (HACS) are more efficient, so why aren't HACS the most popular choice? Firstly, let us consider what CACS and HACS are, and how they work.

Fig. 2: Cold aisle containment system in-situ

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What is Cold Aisle Containment?

Cold Aisle Containment Systems (CACS) are one of the most widely-recognised data centre cooling solutions. By managing air flow, CACS restrict the loss of cold air, and prevent the mixing of cold and hot air. Cold aisle systems are designed for server and network cabinets, and other computing equipment in data centres, server rooms, or office environments, to maximize cooling predictability, capacity and efficiency.

How does Cold Aisle Containment Work?

Aisle containment is set up by lining server and network cabinets in alternating rows, with cold air intakes and hot air exhausts facing opposite directions. The rows in which cold air flows are called cold aisles, and the rows in which hot air flows are called hot aisles. A containment system is used to isolate hot and cold aisles from each other to prevent hot and cold air from mixing, thus forming a 'pod.'

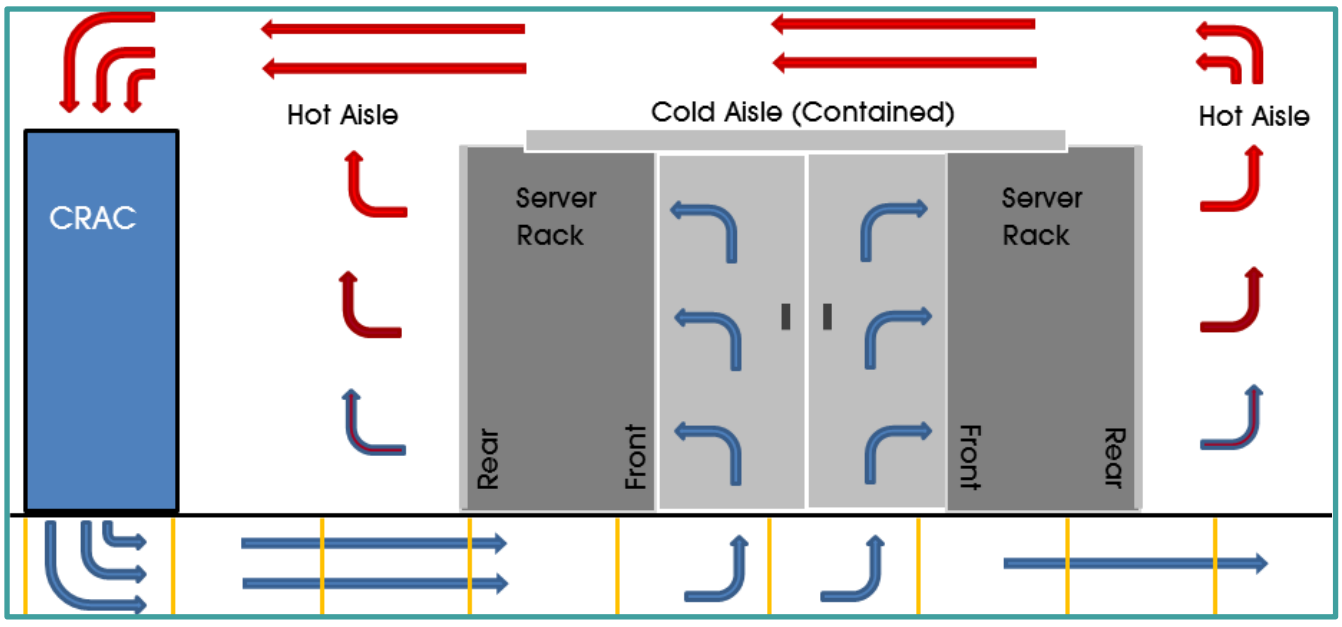

Fig. 3: illustration of how cold aisle containment works

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What is Hot Aisle Containment?

Hot aisle containment has gained increasing popularity as denser computing and power loads have evolved—through blade servers, for example. The hot aisle ensures that hot exhaust air from the racks is contained within the aisle, enabling the rest of the data centre to become a large reservoir of cold air. HACS are similar to CACS, in that the racks are normally lined up in rows to form pods.

How does Hot Aisle Containment Work?

The hot air is ducted away either via a plenum space in the ceiling, or using large ducts connected to the CRAH unit. This set up can lend itself well to very large, purpose-built data centres employing adiabatic cooling, for example. The aisle containment will typically need to be extended upwards to connect with the overhead plenum/ducting, or 'chimney' cabinets can be used.

One popular alternative to this approach is known as in-row cooling, where CRAC units are built into the cabinet rows. The hot aisle will then typically look identical to a cold aisle with a flat aisle roof, and there is no requirement for a hot air plenum. This provides a more granular cooling approach as in-row CRAC fan speeds are controlled individually.

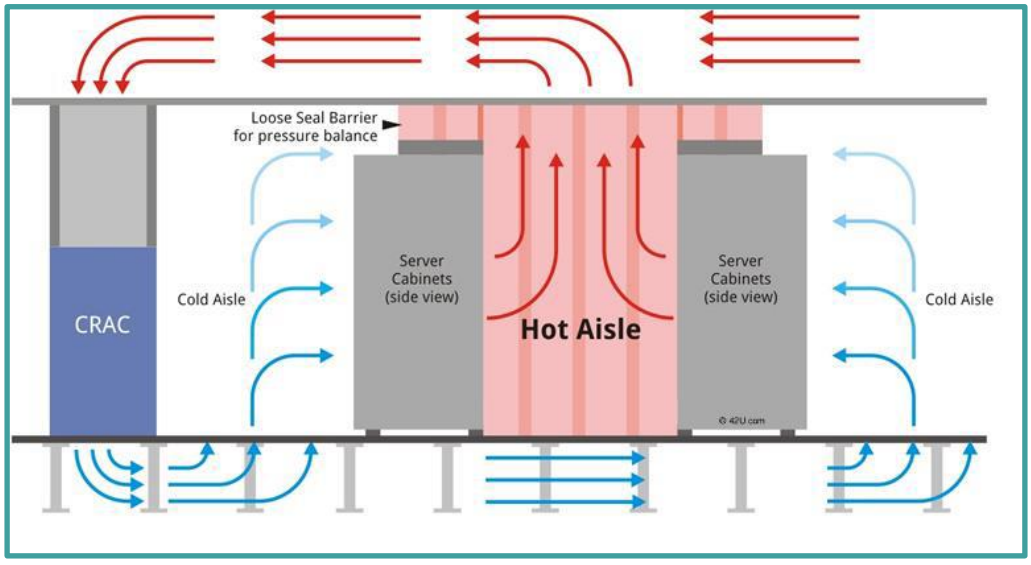

Fig. 4: illustration of how hot aisle containment works

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Fire Suppression for Aisle Containment

One consideration when designing an aisle containment system is fire suppression. When an aisle is created, it can present a barrier to overhead fire sprinklers if used. There are several ways to overcome this. The sprinklers can be re-located to within the aisle. However, this can be problematic if future changes are envisaged. The most popular and cost-effective solution is to use temperature fusible links, which enable lightweight canopy panels to drop into the aisle in the event of fire and allow the sprinklers to do their job. Another method is to link the panels into the fire control system via actuators which will raise the panels in the event of a fire, known as active control. This system would be used in a situation where glass panels are preferred due to the weight compared to polycarbonate or 'Lexan' lightweight panels.

Fig. 5: example of CAC roofing with fire suppression system

Best Practice for Aisle Containment

The best practices for aisle containment (both hot and cold aisle containment) include:

- Having a raised floor 'plenum' of at least 500mm so that air being pushed by air conditioning equipment can pass through
- Use cabinets rather than open racks, which cannot easily be sealed, to prevent cool air escaping from the aisle
- Deploy high Cubic Feet per Minute (CFM) rack grills that have outputs in the range of 600 CFM
- Locating devices with side or top exhausts in their own part of the data centre or using deflectors within the cabinet
- Installing self-closing doors in the data centre and at the ends of the cold aisle
- Ensuring any openings within the cabinet or where cables come through the floor into the cabinets are sealed using blanking panels and brush strips
- Ensuring floor tiles are seated and only removed when necessary

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Benefits of Aisle Containment

Cold aisle containment and hot aisle containment both have many benefits, including:

- Maintaining temperatures between 24°C and 27°C
- Reducing hot spots
- Extending IT equipment life
- Improving data centre efficiency
- Improving the power usage effectiveness (PUE)
- Reducing power consumption
- Reducing energy costs
- Increasing savings if power consumption continues to grow
- Providing a favourable return on investment
- Minimising Opex costs
- Minimising incremental cost of extending aisle
- Optimising real estate costs
- Providing a more flexible/re-usable solution than
- other methods
- Reducing carbon footprint

Fig. 6: image of aisle containment

Fig. 7: image of roofing system for aisle containment

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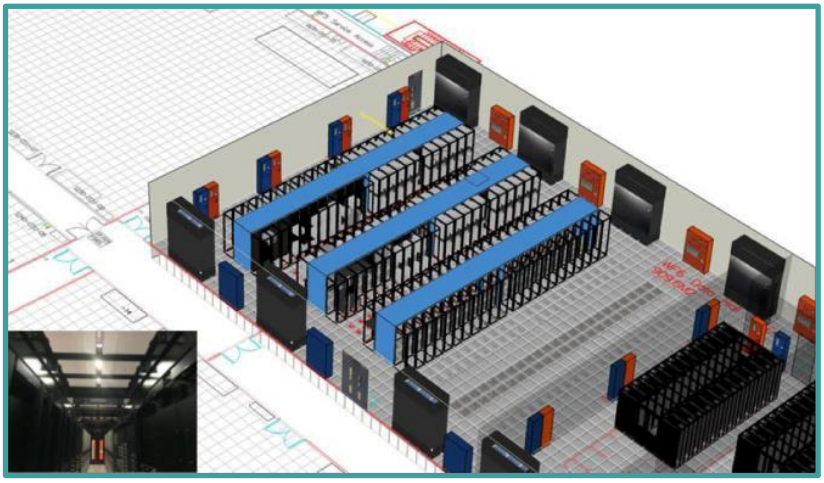
Case Study and 'Real Life' Results



In 2015, Digital Realty, one of Cross-Guard's long-standing customers, produced a case study on the outcome of implementing a CACS in one of their large data halls. They took measured data from the legacy facility before Cross-Guard installed three cold aisle containment systems. Further measurements were then taken to determine the improvements, as follows:

Fig. 8: image of cold aisle layout for Digital Realty's data centre hall

- "The containment system has contributed to a significant improvement in the PUE (from 1.85 to 1.55)."
- "Return on investment will be achieved in approximately 5 months."
- "The containment system is predicted to save more than £118,500 per year. Savings will increase further if power consumption continues to grow."
- "The IT load within the suite grew from circa 350kW to circa 550kW during the period of the assessment. The total suite load (including ancillary loads) rose from 650kW to 850kW during the same period."
- "The containment system maintains cold aisle temperatures between 24°C (75.2°F) and 27°C (80.6°F). A setting of 30-32°C (86-89°F) is recommended for sensor alarm threshold."
- "Data centre owner/operators often struggle to realise the full potential of their facilities. As hot-spots occur the data centre is considered 'full' prematurely even though power remains available. Arguably, the greatest benefit of the containment system is its ability to prevent those hot-spots and in so doing allow more equipment to be installed. Across a large data centre estate this 'asset sweating' benefit will be considerable."
- "The use of aisle containment systems are recommended in all customer deployments and should ideally be installed prior to the installation of IT equipment so as to eliminate risk to operation."

Read the full case study on Digital Realty, or check out our other case studies on cold and hot aisle containment.

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Hot vs. Cold Aisle Containment

Data centres are agile environments, frequently changing with business needs. Consequently, heat load distribution changes, as does the physical infrastructure, with cabinets and associated hardware being replaced or moved. This is particularly true of co-location facilities, which form the majority of data centre space in the UK, where multiple companies may be hosted. It is also true to say that the majority of existing facilities are traditional raised floor data halls with edge CRAH units.

A raised floor is not only very practical to route power and data to cabinets but also provides a natural plenum for cold air to be pushed by the CRAH units under the data centre floor. Grills are then placed within the cold aisle through which the cold air can pass to be drawn into the intake side of the cabinets.

As computing power becomes denser, space becomes less of an issue, so the need for new data centres has reduced in recent years, but cooling has increased in importance as the power consumed per rack space goes up. This means our existing UK facilities are not going to be replaced any time soon and, without an overhead plenum, cold aisle containment is a logical choice. Most importantly for data centre operators, it is much easier to re-configure a cold aisle.

This leaves water cooling to the rack level via in-row cooling, which has gained popularity and is undoubtedly a more efficient way to remove heat. Typically, it is used in a hot aisle containment configuration. However, it does not lend itself so well to these agile facilities where cabinets may need to be added or moved, but the data centre as a whole needs to keep running.

These systems also generally represent more points of failure, and the incremental capital cost of adding computer load in new cabinets is increased. However, where space is at a premium and with very high computing densities, in-row cooled hot aisles can be the right solution. Another point worth mentioning about the hot and cold aisle is that people generally need to work in the aisle. Working in an aisle where the hot air is concentrated into a small area is more uncomfortable than working in an aisle where cool air is concentrated.

Making changes of any sort in a data centre without meticulous planning can have major consequences. Intelligent Computational Fluid Dynamics (CFD) modelling from the likes of Future Facilities has ensured that simulations can be carried out prior to making changes with relative ease, testing fault tolerance in the event of any failure scenarios, which is essential for resilience, predicting the effect on PUE and, consequently, energy costs. Any necessary baffling can be integrated with variable damper tiles coupled to CRAH fan speeds, reducing the potential for hot spots. However, data centres tend to be populated over a period of time so there is a tendency to defer the aisle until the pod is fully populated.

Cross-Guard can provide a solution to this, by utilising low-cost, vertical infill panels in the place of unpopulated cabinet positions, which can easily be removed, and the cabinet inserted, which means the benefits of the aisle are obtained from day one. There is no drilling required, as the cold aisle roof is secured to the top of the cabinet using existing holes. Roof panels can easily be removed to facilitate access above the canopy, should modifications to lighting or other overhead services be required.

Cross-Guard

Cross-Guard has over 20 years of experience in designing and manufacturing caging and aisle containment for data centres worldwide. We offer a number of bespoke cold and hot aisle containment solutions, combining the requirements for energy savings, security, and fire safety, with optimum data centre efficiency. These systems are highly versatile, built to last, and represent an excellent return on investment.

Cross-Guard has a highly experienced installation team, which means we can support our customers when they implement changes to their installation. With design and manufacturing taking place in the UK, we turn around most orders in 2-3 weeks, which is just one of the reasons why Cross-Guard are the number one supplier of data centre caging and aisle containment systems in the UK.
For more information, please call +44 (0)20 8108 9327 or email sales@cross-guard.com.