WHITE PAPER

AisleLok® Modular Containment vs. Legacy Containment: A Comparative CFD Study of IT Inlet Temperatures and Fan Energy Savings

By
Bruce Long, Upsite Technologies, Inc.
Lars Strong, P.E., Upsite Technologies, Inc.

Synopsis
Airflow management is one of the most important parameters for optimizing operations and utilization of the data center. This white paper presents and compares the effectiveness of two types of airflow containment systems, the resultant impact on IT temperatures, the energy consumption and associated operational costs for the data center, and the projected return on investment (ROI) for implementing the containment systems.

upsite technologies®
+1.888.982.7800
upsite.com

Table of Contents

AisleLok® Modular Containment vs. Legacy Containment: A Comparative CFD Study of IT Inlet Temperatures and Fan Energy Savings

1. Executive Summary

1.1. Background

Airflow Management (AFM) is a mature and proven method for reducing IT equipment inlet temperatures, increasing cabinet, row and physical infrastructure utilization, improving cooling efficiency, and other important physical and operational parameters within the computer room space. There are various strategies and implementations for AFM, many of which are influenced by the existing conditions within the data center. Common AFM practices include, but are not limited to: sealing raised floor openings; installing blanking panels in unused cabinet u-space; sealing gaps in equipment rows; sealing the cabinet top, bottom and side rails; and installing hot aisle/cold aisle containment. Cold aisle containment, being the most simplistic and commonly implemented form of containment, is the subject of this white paper. The effectiveness of two different types of cold aisle containment, AisleLok® Modular Containment and legacy 'full' containment, as they relate to IT inlet temperatures and data center air conditioning efficiency, are analyzed with their corresponding results presented.

A Computational Fluid Dynamics (CFD) model of a 5,280 $ft.^2$ (490 m^2) theoretical raised floor data center was created to study the effects of Upsite's AisleLok® Modular Containment solution and a legacy containment solution with respect to IT equipment inlet temperature, air conditioning centrifugal blower airflows, air distribution effectiveness, and air conditioning operational costs. The data center represents a typical raised floor design with various cabinet and row densities. In the baseline model, most of the IT equipment falls within the ASHRAE recommended temperature range, with a few cabinets and pieces of IT equipment exceeding the ASHRAE recommended range but still falling within the ASHRAE *accepted* range. The baseline model was built with cabinet airflow management and no aisle containment. It is used as the control configuration for comparisons against the two different containment options. While theoretical, the baseline model was constructed to accurately represent a typical data center based on actual field data.

The baseline CFD model established the IT equipment inlet temperatures and the minimum conditioned airflow requirements for the data center. AisleLok® Modular Containment and a legacy containment solution were then implemented to quantify the improvements to IT equipment inlet temperatures, and determine the extent to which the total conditioned airflow rate to the data center could be reduced without IT equipment inlet temperatures exceeding the ASHRAE maximum recommended 80.6° F (27° C). Finally, the operational cost savings from the reduced airflow requirements to the data center were determined, and a return on investment (ROI) for the implementation of these containment systems was calculated.

1.2. Summary Results

This white paper offers comparative analysis of legacy containment to the new AisleLok® Modular Containment solution, installed on the same non-contained data center. Legacy "full" containment is a constructed enclosure encompassing selected cabinet rows or a section of the data center space. AisleLok® Modular Containment is an aisle containment solution applied to individual IT cabinets and is made up of two components: Rack Top Baffles and Bi-Directional Doors. The Rack Top Baffles are applied magnetically to the top of individual IT cabinets, blocking exhaust air recirculation. The Bi-Directional Doors are applied magnetically to end-of-row cabinets, blocking the end of the aisle.

Both approaches showed significant improvement to IT inlet temperatures and ability to reduce CRAH centrifugal blower speeds without exceeding ASHRAE maximum recommended 80.6° F (27° C) IT inlet temperatures. The results show both solutions had improved performance, but AisleLok® Modular Containment shows a faster ROI and a lower total cost of ownership.

		Base Model (no Containment)	AisleLok® Modular Containment	Legacy Containment
Maximum IT Inlet Temperature	End of Row	83.1° F (28.4° C)	66.7° F (19.3° C) *16.4° F Lower than base*	63.2° F (17.3° C) *19.9° F Lower than base*
	Middle of Row	85.9° F (29.9° C)	67.3° F (19.6° C) *18.6° F Lower than base*	63.3° F (17.4° C) *22.6° F Lower than base*
Raised Floor Air Flow Supply		124,000 CFM (58,521 L/s)	86,800 CFM (40,965 L/s) *30% Lower than base*	80,600 CFM (38,039 L/s) *35% Lower than base*
Computer Room Air Handler (CRAH) Power		55.9 kW	19.2 kW *66% Lower than base*	15.4 kW *72% Lower than base*
Annual Energy Savings*		—	$32,171	$35,320
Cost to Deploy (Fully Installed)		—	$36,180	$70,993
Return on Investment		—	13.5 months	24 months

**based on 24 hours/day, 365 days/year cooling system usage, and $.10/kWh energy cost rate*

2. Data Center Model Configuration

2.1. Background

A baseline CFD model was constructed to accurately represent a typical data center based on actual field data. The baseline model physical layout, IT load, and CRAH operational settings, were optimized for IT equipment intake air temperatures within the ASHRAE TC9.9 recommended range of 64.4° F (18° C) to 80.6° F (27° C). The model was designed to push the limits of IT equipment density without containment, and establish IT inlet temperatures and energy consumption comparisons between the baseline, modular and legacy containment scenarios.

The baseline model utilizes both grates and standard perforated tiles. This depicts a typical real-world scenario where grates are installed to address hot spot locations. The grate and perforated tile locations remained the same for all 3 models so as not to introduce an additional variable into the model comparisons. However, it may be possible to achieve better results by utilizing all perforated tiles or grates throughout the room, depending on the data center configuration.

With the baseline established, the three different configuration scenarios were modeled in the CFD software:

1. No containment:
   a. Top and side cabinet rails sealed with 25% air leakage.
   b. Blanking panels installed with 5% air leakage.
2. AisleLok® Modular Containment and legacy containment:
   a. Top, side and bottom cabinet rails sealed with 5% air leakage.
   b. Blanking panels installed and .03% air leakage.
   c. Bottom front edge of cabinet sealed to the floor.

The results from the three different scenarios was analyzed and compared for ASHRAE temperature compliance and energy consumption.

With the baseline, modular and legacy containment scenario analysis complete, the CRAH blower speeds were reduced for the AisleLok® Modular Containment and legacy containment scenarios until the maximum IT inlet temperatures were close to, but not exceeding, the ASHRAE TC9.9 recommended maximum of 80.6° F (27° C). Energy savings resulting from the reduced CRAH blower speeds was calculated based on the manufacturer's data sheet for the CRAH units. This data was then used to analyze the ROI for an installed AisleLok® Modular Containment and legacy containment system in the data center.

For the sake of simplicity and meaningful comparative data, all other data center parameters (variables), except CRAH blower speeds, were held constant. Further optimization of IT load distribution, CRAH temperature settings, optimized tile placement, and many other variables, could be performed as a more complex optimization strategy for the data center. These other variables were not considered as part of this white paper.

2.2. Data Center Design

A representative data center configuration was created for all three models, as shown in figure 2.3.1.

Data Center Configuration

- The data center model is a 5,280 ft.^{2} (490 m^2) rectangle. It is 60 ft. (18.3 m) W x 88 ft. (26.8 m) L.
- Equipment rows arranged in a Hot Aisle/Cold Aisle configuration.
- Raised floor height is 2 ft. (0.6 m).
- There is a hard ceiling in the data center.
- The ceiling height above the raised floor is 9 ft. 3.6 in. (2.8 m).
- The cooling system is a raised floor supply/flooded return. Down flow perimeter chill water CRAH units supply the conditioned air to the raised floor plenum.
- Conditioned air supplied to the IT cabinets through perforated tiles and grates. All tiles and grates are located within the cold aisles.
- The raised floor space contains chill water supply and return pipes for the CRAH units (dark blue for supply and light blue for return), and cable conduits for power and data (shown in red). These are the only under-floor obstructions. There are no overhead obstructions in the data center.
- Total data center heat load is 488 kW.
- Total IT load is 433 kW. The IT load is constant for all three models.
- Total number of IT cabinets 138.
- Cable conduit penetrations along the walls sealed with brushes.
- Cable penetrations beneath each cabinet are sealed with brushes. Leakage past the brushes is modeled at 20%.

2.2.1. IT Cabinets

- 42U.
- 78 inches (2 m) high.
- 2 feet (0.6 m) wide.
- 3 feet (0.9 m) deep.
- Average cabinet density - 3.3 kW.
- Maximum cabinet density - 12 kW.
- Minimum cabinet density - 0.75 kW.
- The cabinets are constructed with solid sides and a solid top.
- 64% perforated front and rear doors on each cabinet.
- Cabinet leveling feet extended 1.5 inches (3.8 cm).

2.2.2. Cooling System

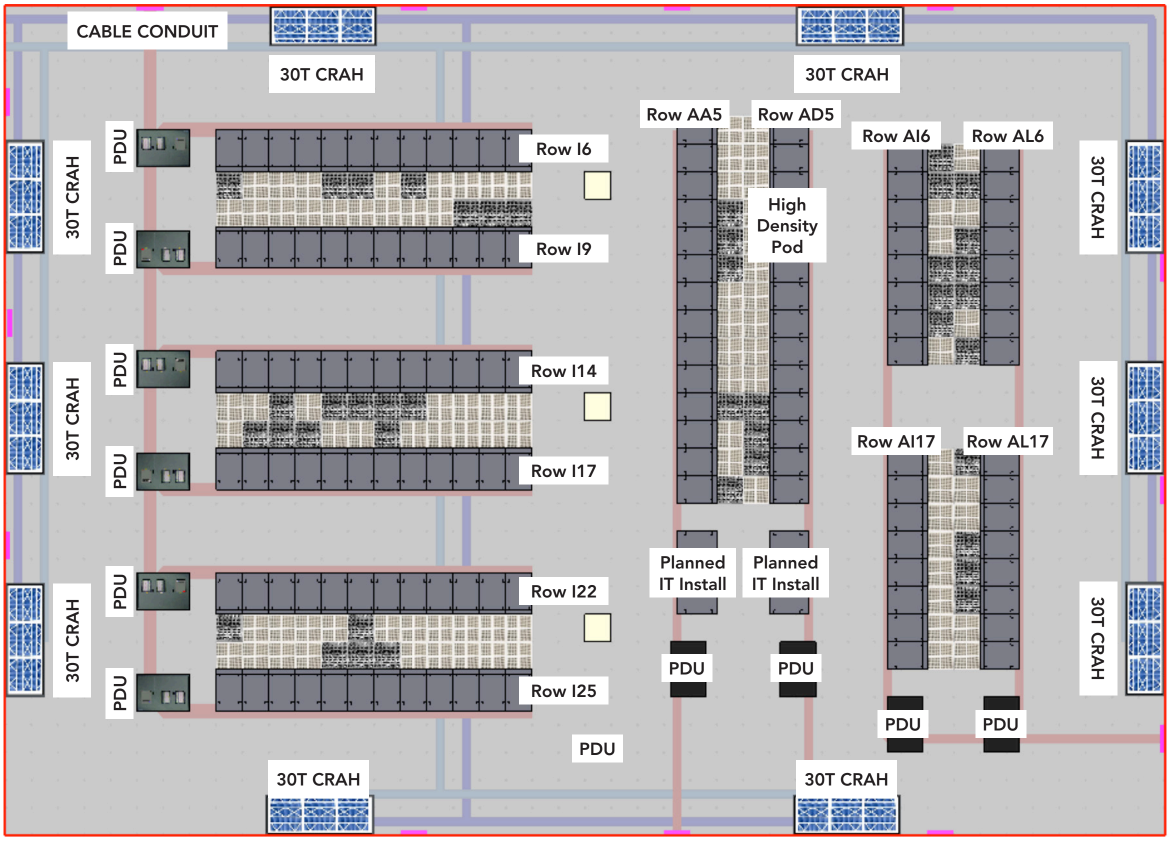
- Ten 30 Ton Liebert CW084DCS down flow CRAH units.
- Raised floor supply through floor tiles and grates, flooded return.
- Total nominal cooling capacity: 1,027 kW.
- Perforated tiles are Tate Perforated Steel 2 ft. square (610 mm square) non-damper units with 25% open area.
- Grates are Tate GrateAire 2 ft. square (610 mm square) non-directional/non-damper units with 56% open area.

2.2.3. Modeling Software and General Parameters

- Software used to generate models is Future Facilities' 6SigmaRoom, Release 8-SP2.
- Heat removal for all IT equipment modeled at 120 CFM/kW (57 L/s/kW).

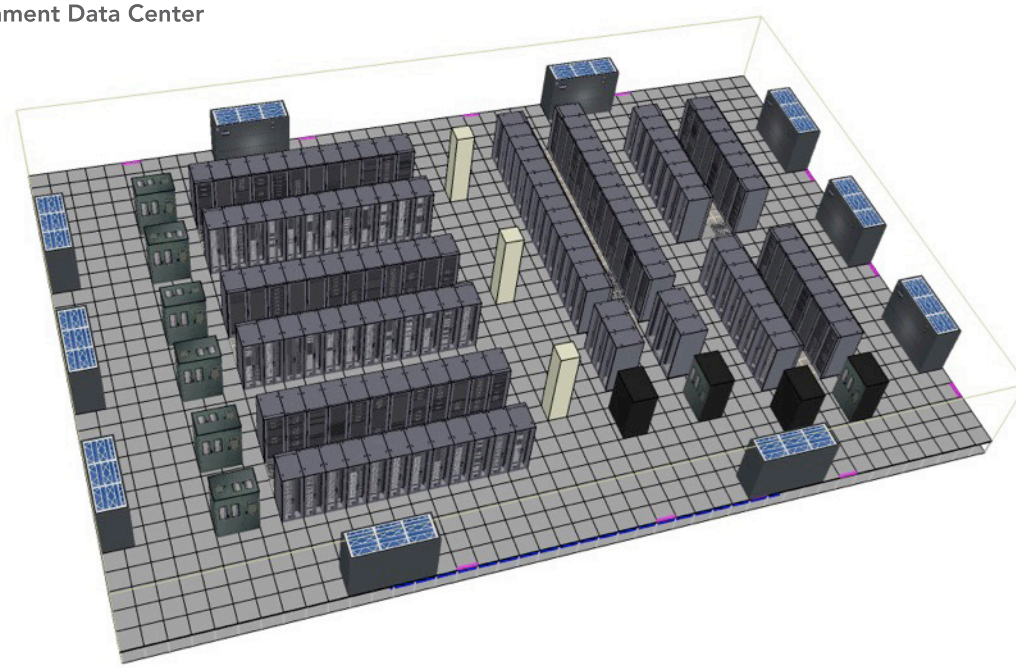
2.3. Data Center Plan View

Figure 2.3.1



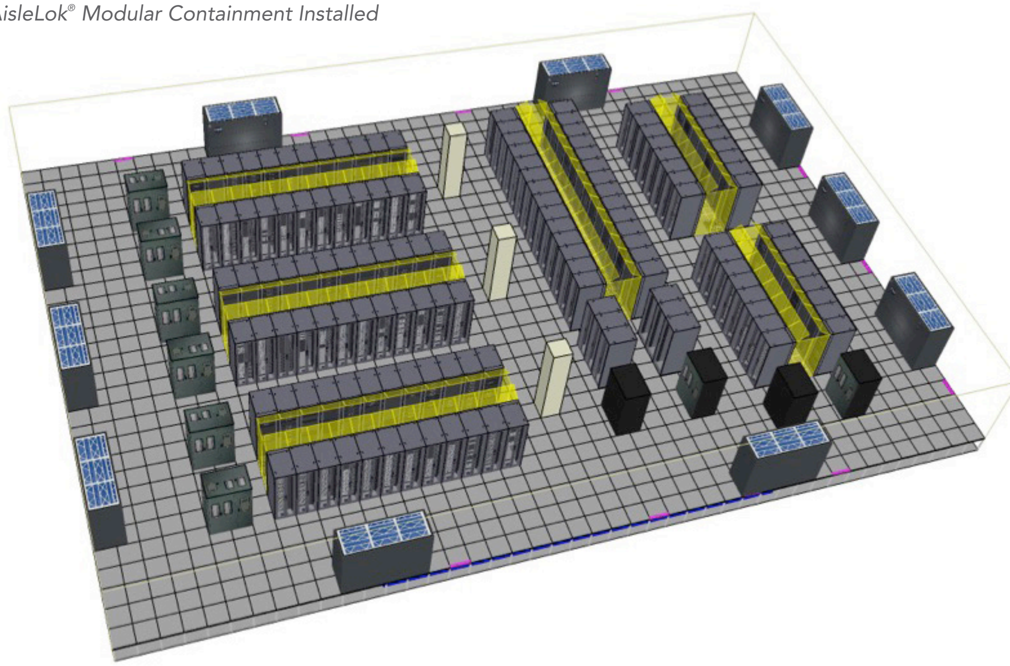
2.4. No Containment Data Center

Figure 2.4.1



2.5. AisleLok® Modular Containment Data Center

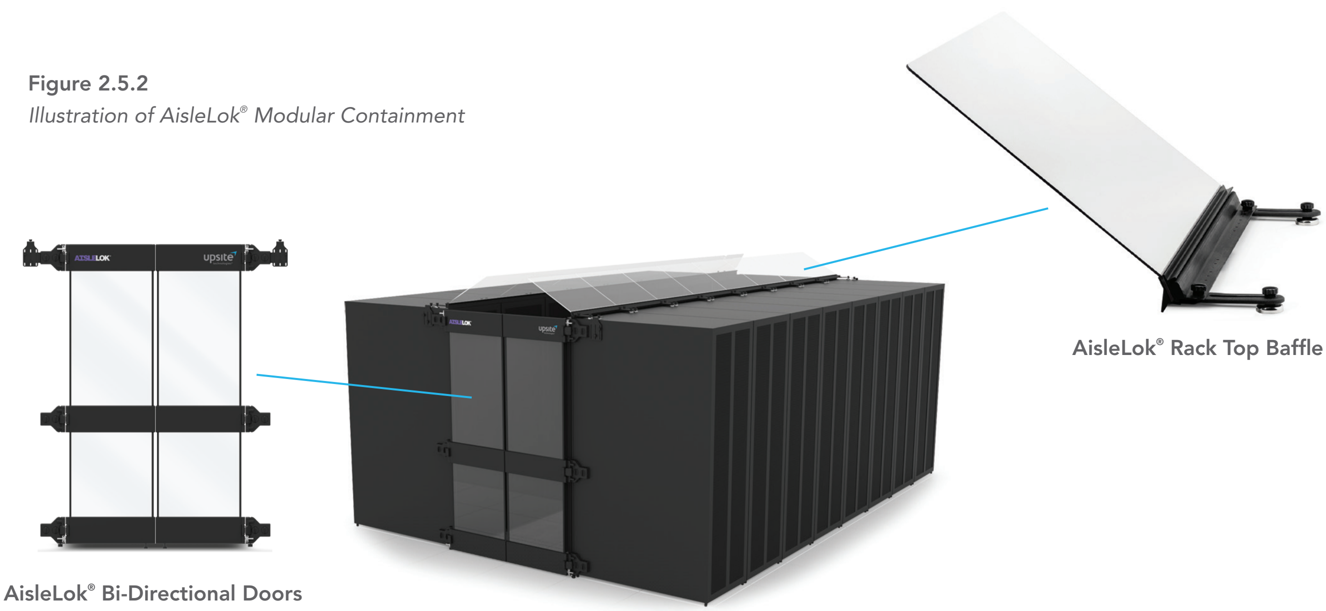
Figure 2.5.1
CFD Model With AisleLok® Modular Containment Installed



Configuration

- AisleLok® Modular Containment 30° Angled Rack Top Baffles installed in cold aisles.
- AisleLok® Modular Containment Bi-Directional Doors installed at both ends of cold aisle.

Figure 2.5.2
Illustration of AisleLok® Modular Containment



2.6. Legacy Containment Data Center

Figure 2.6.1

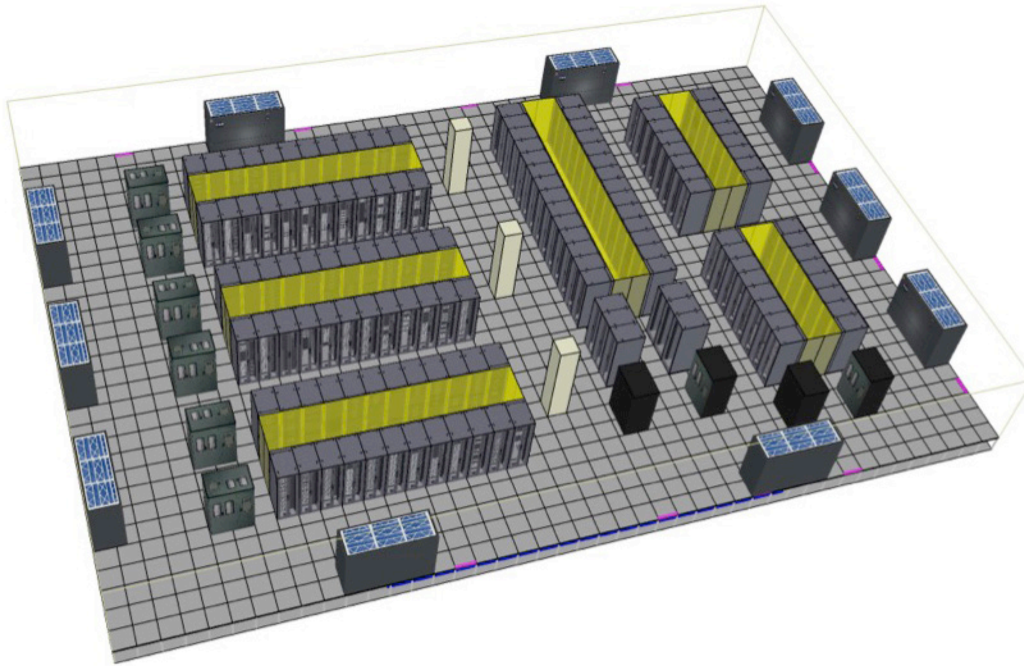
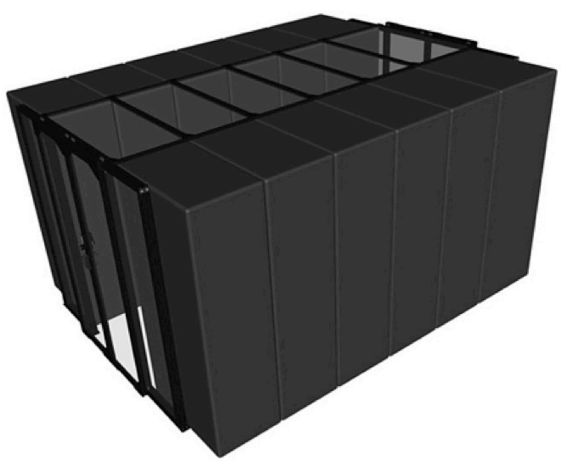


Figure 2.6.2

Illustration of Typical Legacy Containment Solution



3. Detailed Analysis and Recommendations

In the subsequent sections, a no containment data center is compared to two subsequent data centers: a data center with all cold aisles contained with AisleLok® Modular Containment and a data center with all cold aisles contained with legacy containment. The configuration of the data center, and the operational parameters of the CRAH units, are kept constant between these three scenarios so that no variables are introduced that would skew the results. The summary of the data center baseline configuration is shown below.

Baseline CRAH and Airflow Settings

- Supply temperature set point 62° F (16.7° C).
- ± 2° F (1.1° C) sensitivity.
- Total airflow supply from the CRAH units is 124,000 CFM (58,521 L/s).
- Supply air through floor grills 93,744 CFM (44,242 L/s), (75.6% of total).
- Supply air through cable penetrations 29,636 CFM (13,986 L/s), (23.9% of total).
- Leakage through raised floor 682 CFM (322 L/s), (0.55% of total).

Data Center Loads

- Total data center heat load is 488 kW.
- Total IT load is 433 kW.
- Total number of IT cabinets is 138.
- Average cabinet density - 3.3 kW.
- Maximum cabinet density - 12 kW.
- Minimum cabinet density - 0.75 kW.

3.1. Computational Fluid Dynamics Model Results

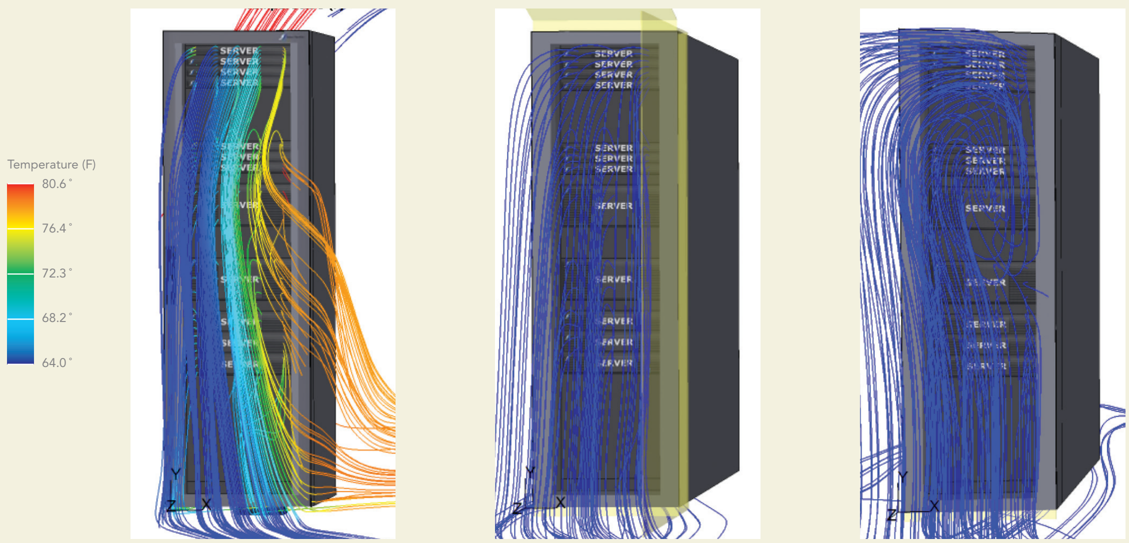
3.1.1. End of Row Cabinets

In this section the air recirculation, IT inlet temperatures and cabinet inflow temperatures are shown for a typical end of row cabinet.

3.1.1.1. Air Recirculation

Figure 3.1.1.1.1
Air Recirculation – End of Row Cabinet

No Containment | **AisleLok® Modular Containment** | **Legacy Containment**



No Containment: *Significant recirculation to the IT equipment in the cabinet. Hot exhaust air pulled around the side of the cabinet is mixing with the cold air and entering the IT equipment.*

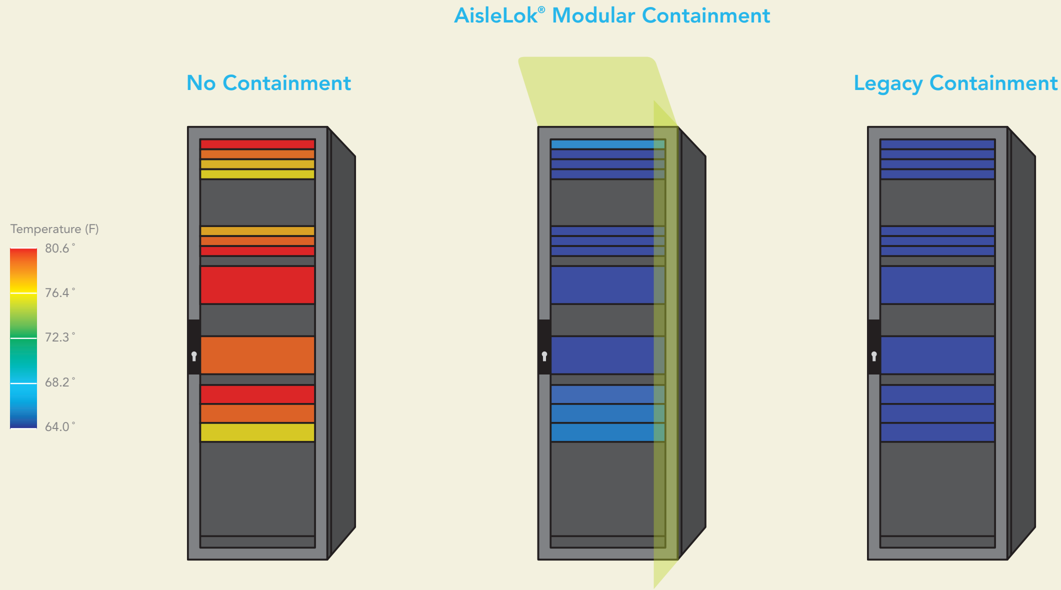
AisleLok® Modular Containment: *Minimal air recirculation to the IT equipment in the cabinet. Significant improvement over no containment.*

Legacy Containment: *Minimal air recirculation to the IT equipment in the cabinet. Significant improvement over no containment.*

3.1.1.2. IT Equipment Inlet Temperatures

Figure 3.1.1.2.1

IT Equipment Inlet Temperatures – End of Row Cabinet

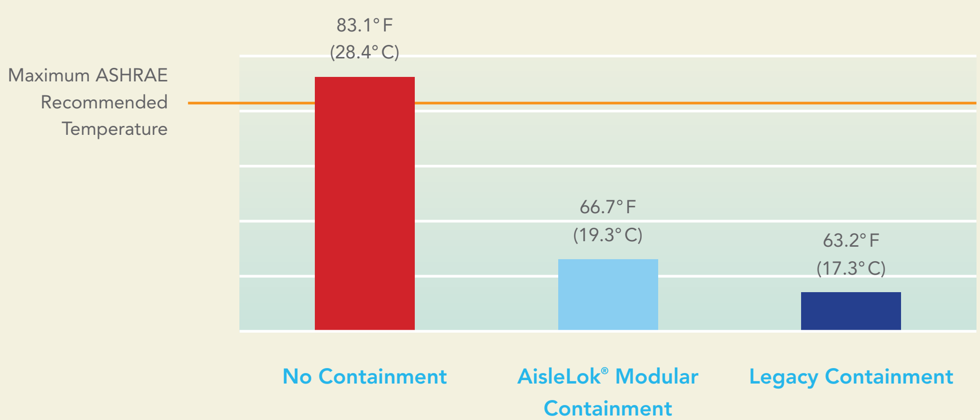


No Containment	AisleLok® Modular Containment	Legacy Containment
Maximum IT inlet temperature 83.1° F (28.4° C)	*Maximum IT inlet temperature 66.7° F (19.3° C)*	*Maximum IT inlet temperature 63.2° F (17.3° C)*

Summary

Figure 3.1.1.2.2

Maximum IT Temperature – End of Row Cabinet

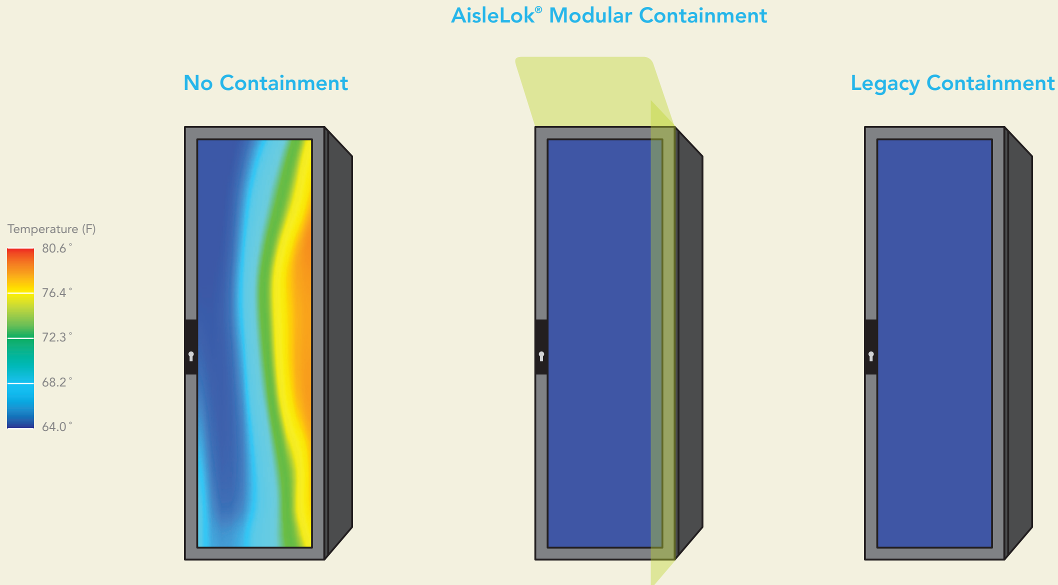


Conclusions

- The IT equipment temperatures at the end of the equipment rows are significantly impacted by back-to-front recirculation of the IT exhaust air around the side of the cabinet. This is seen in Figure 3.1.1.1.1. There is some influence from air recirculation back to front over the top as well but the side wrap around predominates. AisleLok® Modular Containment mitigates most of the recirculation, reducing maximum IT inlet temperatures by 16.4° F (9.1° C).

3.1.1.3. Cabinet Inflow Air Temperatures

Figure 3.1.1.3.1
Temperatures – End of Row Cabinet



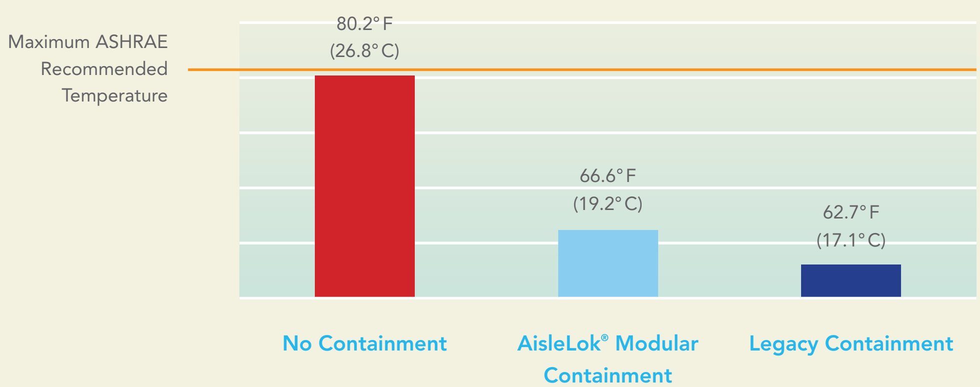
Maximum cabinet inflow temperature 80.2° F (26.8°C)

Maximum cabinet inflow temperature 66.6°F (19.2°C)

Maximum cabinet inflow temperature 62.7°F (17.1°C)

Summary

Figure 3.1.1.3.2
Maximum Cabinet Inflow Temperature – End of Row Cabinet



Conclusions

- Both AisleLok® Modular Containment and legacy containment reduce the cabinet inlet air temperatures due to reduced hot and cold air mixing. In this case AisleLok® Modular Containment shows a 13.6°F (7.6°C) reduction in maximum cabinet inlet air temperatures and legacy containment shows an additional 3.9°F (2.1°C) reduction in maximum cabinet inlet temperatures.

3.1.2. Middle of Row Cabinets

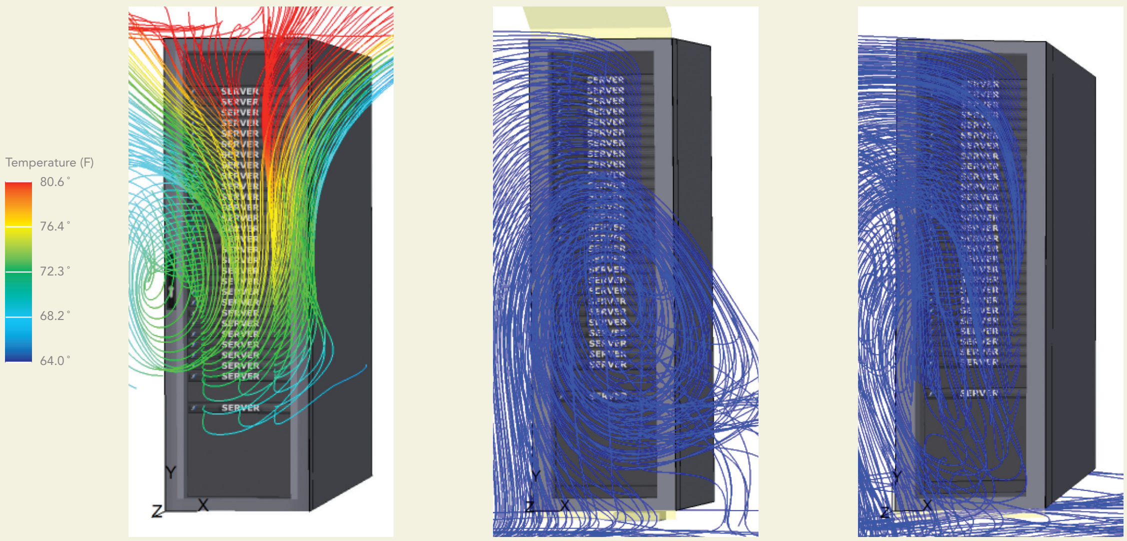
In this section the air recirculation, IT inlet temperatures and cabinet inflow temperatures are shown for a typical middle of row cabinet.

3.1.2.1. Air Recirculation

Figure 3.1.2.1

Air Recirculation – Middle of Row Cabinet

No Containment | **AisleLok® Modular Containment** | **Legacy Containment**



Significant recirculation to the IT equipment in the cabinet. Hot exhaust air is being pulled over the top of the cabinet, and being recirculated into the inlet of the IT equipment. This recirculated air is causing the IT equipment in the cabinet to overheat.

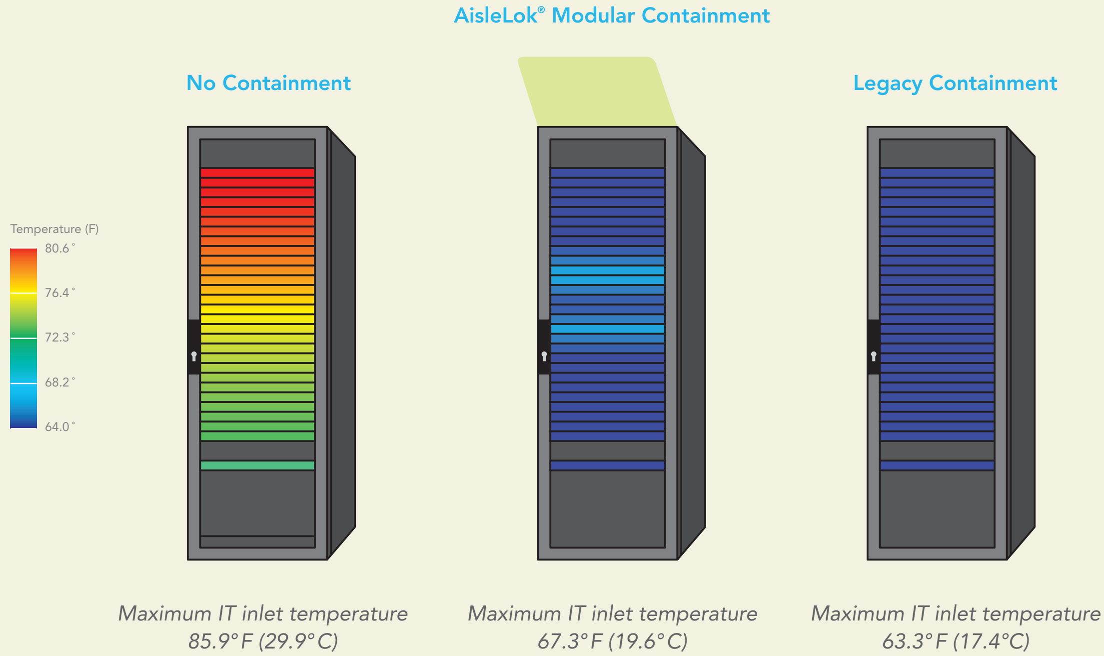
Minimal air recirculation to the IT equipment in the cabinet. Significant improvement over no containment.

Minimal air recirculation to the IT equipment in the cabinet. Significant improvement over no containment.

3.1.2.2. IT Equipment Inlet Temperatures

Figure 3.1.2.2.1

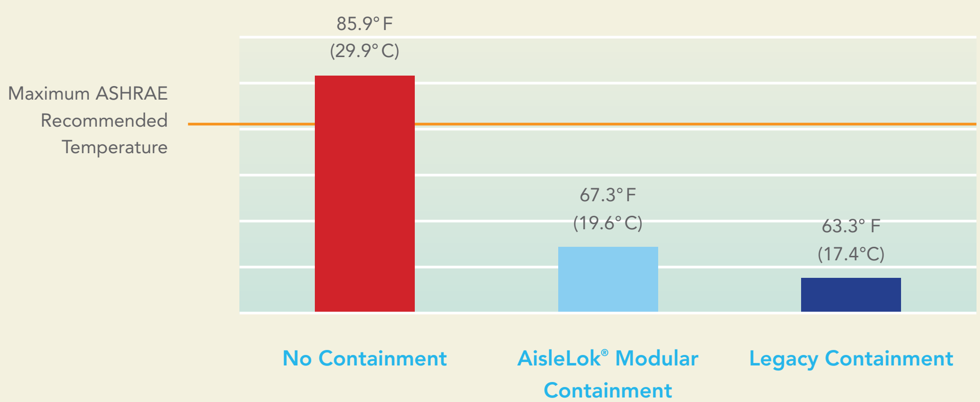
IT Equipment Inlet Temperatures – Middle of Row Cabinet



Summary

Figure 3.1.2.2.2

Maximum IT Inlet Temperature – Middle of Row Cabinet

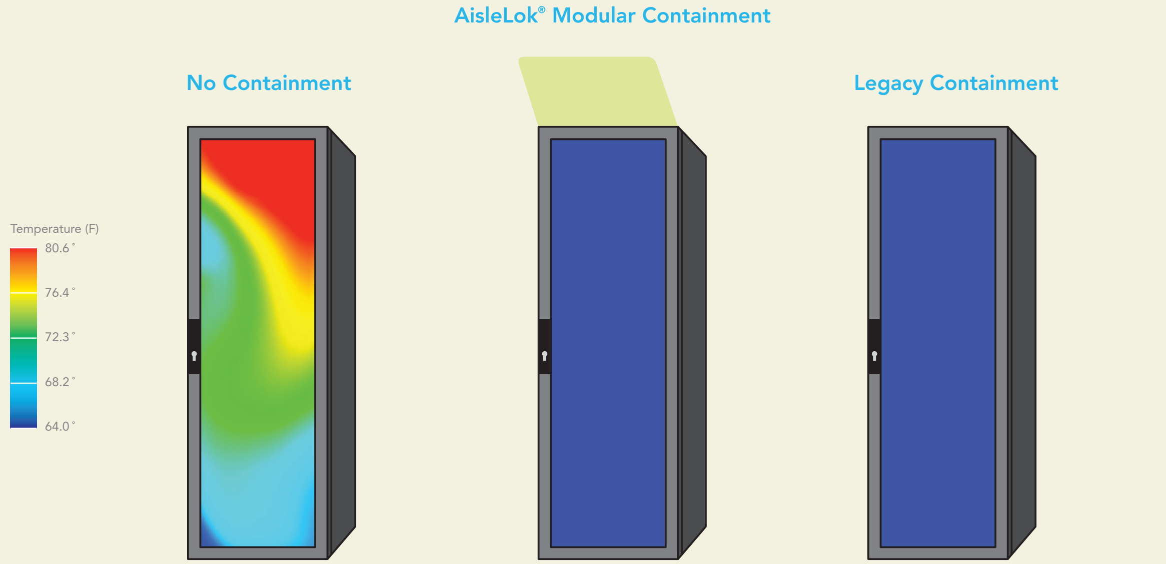


Conclusions

- The elevated IT equipment inlet temperatures in the middle of the equipment rows are predominantly influenced by the back to front recirculation of the IT exhaust over the top of the cabinet. The recirculation impact is most significant at the top of the cabinet. As one progresses to the bottom of the cabinet the back to front recirculation becomes negligible and has virtually no influence on IT equipment inlet temperatures.

3.1.2.3. Inflow Air Temperatures

Figure 3.1.2.3.1
Inflow Air Temperatures–Middle of Row Cabinet



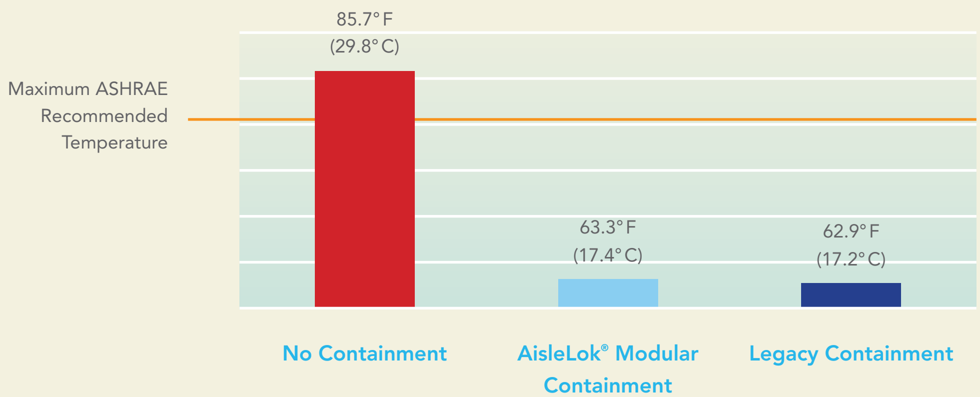
Maximum cabinet inflow temperature 85.7° F (29.8° C)

Maximum cabinet inflow temperature 63.3° F (17.4° C)

Maximum cabinet inflow temperature 62.9° F (17.2° C)

Summary

Figure 3.1.2.3.2
Maximum Cabinet Temperature–Middle of Row Cabinet



Conclusions

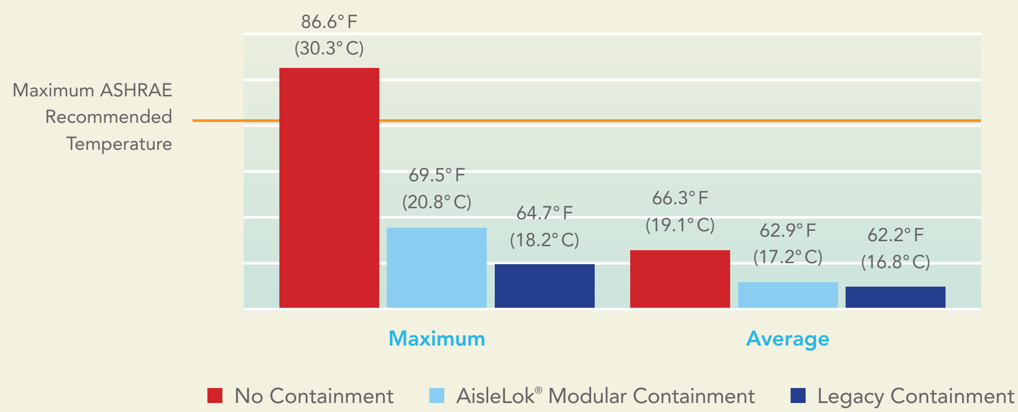
- Both AisleLok® Modular Containment and legacy containment reduce the cabinet inflow air temperatures by reducing hot and cold air mixing.
- For the typical middle of the row cabinet in this CFD model, AisleLok® Modular Containment reduces the maximum cabinet inflow temperature by 22.4° F (12.4° C). Legacy containment shows a fractional 0.4° F (0.2° C) additional reduction in maximum the cabinet inflow air temperatures.

3.2. Inlet Temperature Analysis and Conclusions

The inlet temperatures shown in the figure below are the temperature of the air entering the IT equipment. The maximum temperature is defined as the highest temperature of any of the air entering a piece of IT equipment. It could be a single point on the intake of the piece of IT equipment. The average temperature is the flow rate weighted average temperature of all the air entering a piece of IT equipment.

Figure 3.2.1

Maximum and Average IT Equipment Inlet Temperatures



Analysis

- The AisleLok® Modular Containment solution lowers the maximum inlet temperature from 86.6°F (30.3°C) to 69.5°F (20.8°C) with no changes to CRAH supply temperatures or supply air volume. This is a 17.1°F (9.5°C) reduction in the maximum IT inlet temperature.
- The legacy containment solution lowers the maximum inlet temperature from 86.6°F (30.3°C) to 64.7°F (18.2°C) with no changes to CRAH supply temperatures or supply air volume. This is a 21.9°F (12.1°C) reduction in the maximum mean IT inlet temperature.

Conclusions

- With no changes to the data center configuration or operational settings, both AisleLok® Modular Containment and legacy containment solutions bring all IT equipment inlet temperatures down below ASHRAE recommended 80.6°F (27°C). This provides the opportunity to increase the CRAH supply temperature set points to decrease energy usage and of the air conditioning system.
  - With AisleLok® Modular Containment, the CRAH supply temperature could be increased by 11.1°F (6.2°C) while still maintaining ASHRAE maximum recommended temperature compliance.
  - With legacy containment, the CRAH supply temperature could be increased by 15.9°F (8.8°C) while still maintaining ASHRAE maximum recommended temperature compliance.
- AisleLok® Modular Containment and legacy containment both create a more even IT inlet temperature distribution within the cabinet. Containment enables reducing conditioned air energy usage or increasing cabinet densities.

4. Containment Solutions and Energy Savings

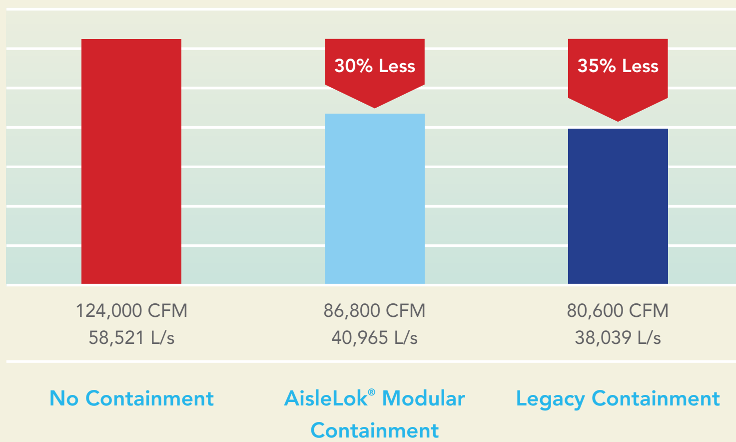
4.1. AisleLok® Modular Containment Energy Savings

4.1.1. CRAH Centrifugal Blower Speed Reduction

With baseline models for no containment, AisleLok® Modular Containment, and legacy containment established it is now possible to determine the effect of reducing the CRAH centrifugal blower speeds. Figure 4.1.1.1 below shows the total CRAH supply required for no containment, AisleLok® Modular Containment, and legacy containment while keeping the maximum IT inlet temperatures at or below the ASHRAE recommended maximum of 80.6° F (27° C)

Figure 4.1.1.1

Total CRAH Supply



Analysis

- Containment allows for reduced CRAH centrifugal blower flow rates while still maintaining the IT equipment inlet temperatures below ASHRAE recommended maximum of 80.6° F (27° C). The total minimum airflow to the raised floor, without exceeding the ASHRAE recommended maximum IT equipment inlet temperature of 80.6° F (27° C), is shown in the Figure 4.1.1.1 above. The resulting power reduction due to the total decreased CRAH supply is calculated using the Affinity Laws for centrifugal blower speeds and airflow (Note 1). Energy reduction and savings in the chilled water plant, due to chill water pump speed reduction and/or increase chill water supply temperature, are not taken into consideration for the energy reduction estimates that follow.

Conclusions

- AisleLok® Modular Containment reduces CRAH energy usage by 30%. Legacy containment provides an additional 5% energy savings. Both measurements assume the CRAH unit set point temperatures of 62° F (16.7° C) remain unchanged between the baseline, AisleLok® Modular Containment, and legacy containment scenarios.

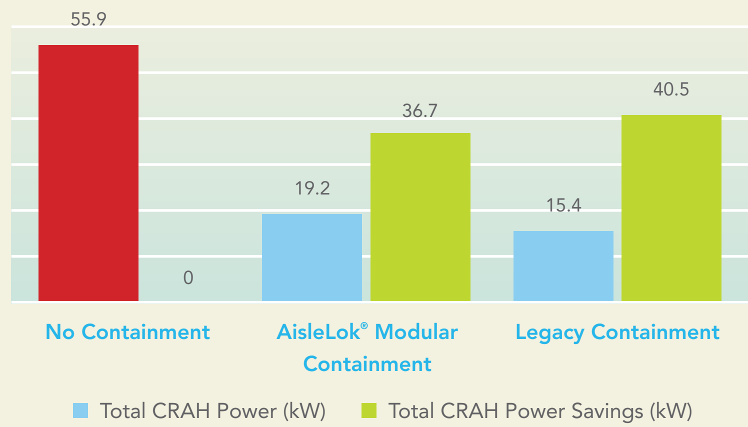
Note 1: The Affinity Law states that power reduction is proportional to the cube of the difference between the flow rates of the centrifugal blowers. Therefore, small changes in total CRAH supply flow rates result in significant CRAH power and energy savings.

4.1.2. CRAH Power Usage Reduction

With no changes to the data center other than the reduction in the CRAH centrifugal blower speeds, the potential power savings for AisleLok® Modular Containment and Legacy Containment are shown in the Figure 4.1.2.1 below

Figure 4.1.2.1

Total CRAH Power and Power Reduction (kW)



Analysis

- Significant CRAH energy usage reduction can be realized by implementing containment in the data center.
- With AisleLok® Modular Containment, the 30% reduction in the CRAH centrifugal blower flow rates results in CRAH centrifugal blower power dropping by 65.7% or 36.7 kW.
- With legacy containment an additional 5% CRAH centrifugal blower power reduction is possible. This results in the CRAH centrifugal blower power dropping by 72.5% or 40.5 kW.

Conclusions

- Containment provides the opportunity to reduce CRAH power and energy usage.
- Legacy containment provides a projected 6.8% improvement over AisleLok® Modular Containment in reducing CRAH power requirements. The cost to implement legacy containment, though, is significantly higher, as shown in Section 4.1.4.

4.1.3. CRAH Energy Savings

Assuming 24 hours/day, 365 days/year cooling unit fan operation, the potential energy savings for AisleLok® Modular Containment and legacy containment are shown in Table 4.1.3.1.

- AisleLok® Modular Containment saves 321,722 kWh/year.
- Full containment saves 355,205 kWh/year.

Table 4.1.3.1

	Yearly Energy Savings	
Energy Cost ($/kWh)*	AisleLok® Modular Containment	Legacy Containment
$0.08	$25,738	$28,416
$0.10	$32,172	$35,520
$0.12	$39,572	$43,690
$0.14	$45,041	$49,729

Analysis

- From the data center CFD model, AisleLok® Modular Containment lowers maximum IT inlet temperatures, and allows for significant reduction in cooling costs.
- Legacy containment shows more improvements to IT equipment intake air temperatures then AisleLok® Modular Containment. However, the fan energy reductions made possible by legacy containment are only slightly better than the fan energy reductions made possible by AisleLok® Modular Containment

Conclusions

- The CFD model used for this white paper considered only CRAH centrifugal blower flow rate reductions for potential energy savings. Additional savings can be realized by increasing CRAH temperature set points and chill water temperatures. Other operational cost savings could be realized from increased economization hours if economization methods are utilized at a site.
- Containment enables the reduction in centrifugal blower flow rates. This reduction in the CRAH utilization frees up stranded capacity in the data center air conditioning system. There are many benefits of releasing stranded capacity: the ability to install more IT load, deferring capital expenditure for cooling system improvements, and potentially even deferring the capital expenditure of building a new site.

**Source: US Energy Information Administration*
http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a

4.1.4. Return on Investment

The ROI for implementing AisleLok® Modular Containment and legacy containment based on the energy savings from Section 4.1.3 can be estimated using the average installed cost for each system. For this calculation, an industry average energy cost of $.10/kWh was used.

Table 4.1.4.1

	Installed Costs ($)	Energy Savings ($/yr)	ROI (months)
AisleLok® Modular Containment System by Upsite Technologies	$36,180	$32,172	13.5
Legacy Containment System	$70,993	$35,520	24.0

Cost estimates are based on full installation of the computer room configuration in section 2.2. The model features 138 IT cabinets and measures 5,280 ft² (490m²).

Analysis

- The ROI for AisleLok® Modular Containment is 13.5 months. This is significantly less than 24 months for legacy containment. AisleLok® Modular Containment payback time is 56% that of legacy containment.

Conclusions

AisleLok® Modular Containment has many benefits over legacy containment, in addition to the significantly lower ROI.

- No specialized skills required. Data center personnel can be used to install the system without the need of outside 3rd party installation resources.
- Easy and fast initial deployment. There is no need to incur the burden of logistics planning and scheduling for implementation.
- Simple and fast modifications or additions to the installation as the data center evolves. Adapting AisleLok® Modular Containment to reconfigured equipment rows, addition of new cabinets, power density/expansion within the cabinets, air flow changes within the data center, etc., can be done quickly without the need for specialized installation personnel or services.
- Minimal risk to the data center. There are no construction activities that require shutting down part or all of the data center. It can be done during normal operating hours or during scheduled maintenance periods.
- Depending on the design of the data center, and the deployment of AisleLok® Modular Containment, it may not require the added costs and disruptions to the data center for fire suppression system modifications.

4.1.5. AisleLok® and Legacy Containment Comparison

In addition to the ROI of product costs, there are additional considerations worth evaluating, including adjustments to the data center that may be required, depending upon the layout. Table 4.1.5.1 shows a comparison of this additional evaluation criteria, both in terms of costs and time associated with these two categories of containment.

Table 4.1.5.1

	Internal Labor Costs	External Labor Costs	Installation Time	Time from product order to deployment	Ease of expanding containment	Level of Risk
AisleLok® Modular Containment	$200	$0	3 Staff Hours	1 Week	Easy. Only internal resources required to add additional modules to new cabinets.	Low. No tools required. Only internal resources used.
Legacy Containment	$2,400	$6,000	80 Staff Hours	Weeks to months	Difficult. Requires planning cycle, measurement, and 3rd party construction.	Moderate. Requires 3rd party construction.

Cost estimates are based on full installation of the computer room configuration in section 2.2. The model features 138 IT cabinets and measures 5,280 ft² (490m²).

5. Summary Conclusions

Airflow management in the data center is critical for optimizing data center utilization, increasing IT loads, reducing IT equipment temperatures and overall operational excellence. Containing the cold conditioned air, delivering it directly to the IT loads, and preventing mixing of hot exhaust air with cold inlet air are basic principles of airflow management. Implementing AisleLok® Modular Containment in a data center provides significant airflow management improvement, reduces equipment inlet temperatures, increases the efficiency of the cooling system while freeing up stranded capacity, reduces energy costs, and does this in a flexible manner that can grow and adapt with the evolution of the data center.

Implementing AisleLok® Modular Containment in a data center is a low cost solution to airflow management and improved data center performance. The upfront cost to install is low. There is no need for specialized 3rd planning and installation services. It can be installed utilizing in-house IT support personnel with little disruption and virtually no risk to the data center. It is also fast to install; the components are a tool less design and attach directly to the cabinets without additional hardware or modifications to the cabinet. AisleLok® Modular Containment also has significantly lower overall costs due to the modularity of the system. Cabinets, aisles and rows can be reconfigured as the data center needs change. The modular containment system can adapt without disrupting data center operations of incurring the cost of specialized planning and installation services.

Legacy containment does provide marginal improvements in airflow and energy savings benefits over modular containment. These benefits come at a cost though. Legacy containment is a fixed inflexible solution and cannot easily grow or adapt as the data center needs change. Modifications and/or additions to legacy containment systems are expensive, time consuming, and disruptive to the operations of the data center.

In many data centers AisleLok® Modular Containment can provide most of the benefits of legacy containment, at a lower initial and overall cost, while maintaining the flexibility to grow and change as the data center configuration and requirements evolve.

6. About the Authors

Lars Strong, P.E.

Lars is a thought leader and recognized expert on data center optimization. He leads Upsite Technologies' EnergyLok Cooling Science Services, which originated in 2001, to optimize data center operations. He is a certified U.S. Department of Energy Data Center Energy Practitioner (DCEP) HVAC Specialist. Lars has delivered and continues to deliver value-added services to domestic and international Fortune 100 companies through the identification and remediation of dilemmas associated with the fluid mechanics and thermodynamics of their data center cooling infrastructure. Lars brings his knowledge and ability to teach the fundamentals of cooling science to numerous U.S. and international private and public speaking events annually.

Bruce Long

Bruce has over 15 years of experience in the design and development of new products, from concept to production, of uninterruptible power supply products for both the IT and commercial markets. He also spent seven years in the design, development and launch of data center assessment services and tools. These services were focused on improving data center efficiency, reducing energy consumption, optimizing cooling systems and improving operational excellence. He is a certified U.S. Department of Energy Data Center Energy Practitioner (DCEP). Bruce is also a past member of the Green Grid where he led the development of the EPA data center efficiency assessment service.