Opengate data systems

ORACLE

High Density Heat Containment System

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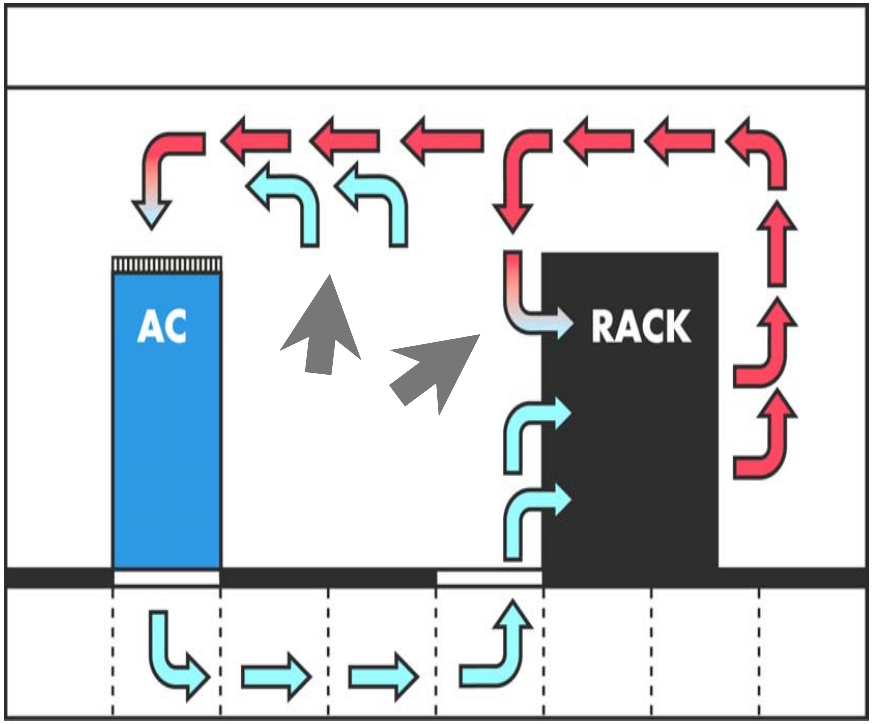
Oracle Austin Data Center

- 130,000 sq ft building
- Total data floor sq ft 82,000
- Redundant medium voltage (12.47 kV) utility feeds
- UPS capacity 7.8 MW parallel redundant (15.6 MW total).
- Generator capacity is 14 MW (N+1)
- Electrical system is designed to have multiple diverse paths and cross over paths from utility to PDUs and servers
- Chiller capacity is 3600 tons (N+1)

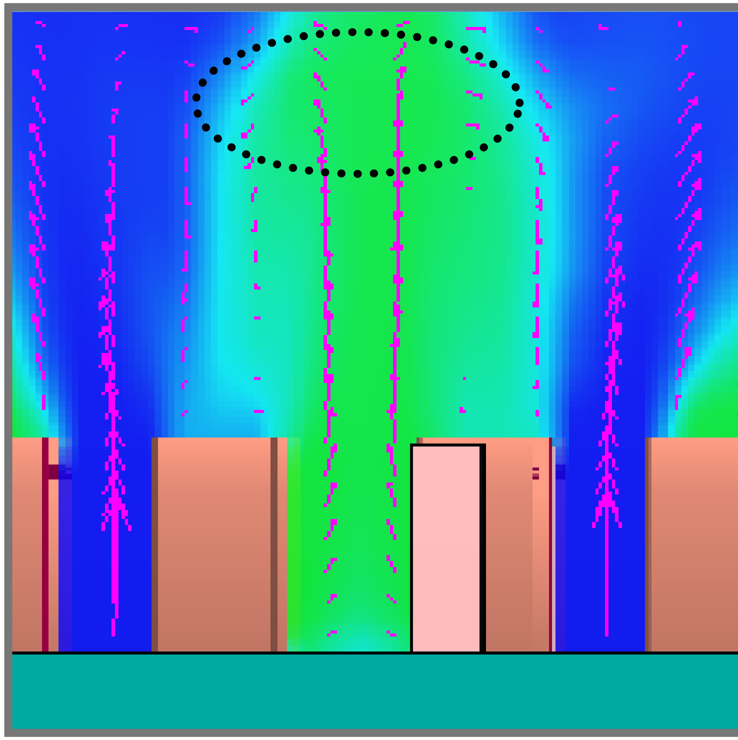
- 22,500 operational servers
- 4.5 petabytes (4,500 terabytes) of disk storage
- 355 servers on average installed each month
- Largest Dell/Linux and NetApp installation

Conventional Cooling Issues at High Density Heat Loads

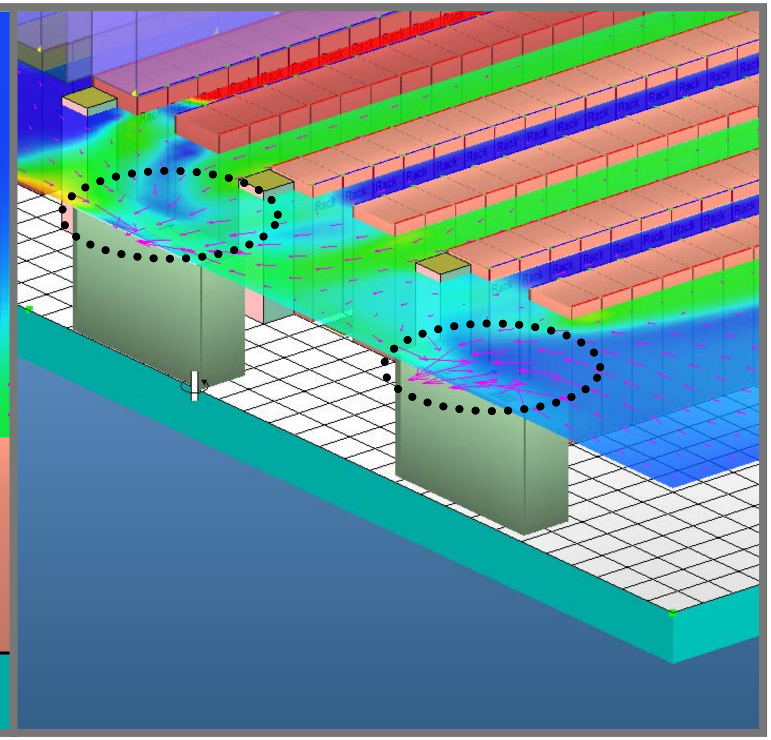


- Heat discharged by IT equipment is getting drawn back into the front of the equipment
- Excessive cool air, generated by the cooling unit is bypassing the IT equipment before returning to the cooling unit
- Airflow distribution in the data center is not easy to predict during facility design

Bypass Air With Conventional Cooling



Typical hot-aisle / cold-aisle configuration shows cool air mixing with heated exhaust air high into the ceiling



Section through CRAC unit return shows similar supply/return temperatures

Conventional Cooling – Grab The Available Capacity

- Cool air is exiting through perforated floor tiles and floor cable cut-outs and is returning to the cooling unit unused

- 72% of the cool air that is generated by data center cooling units is not getting to the intakes of the IT equipment but rather is short cycling back to the cooling unit

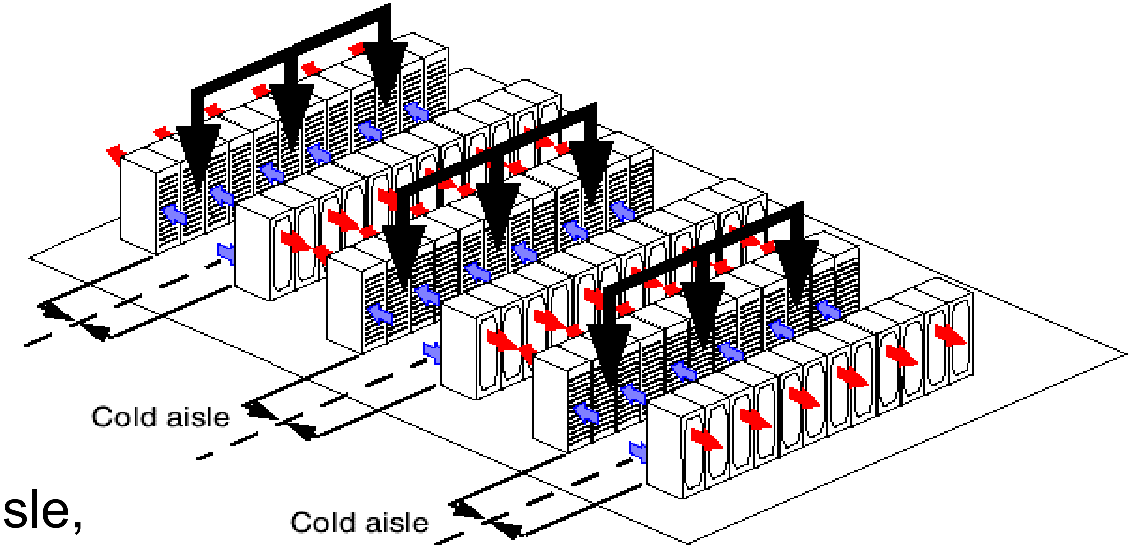
- 2.6 times more cooling is being delivered than is required by the IT equipment load

Information provided at Uptime Institute's Data Center Efficiency EPA Conference January 2005 and is based on detailed measurements from 19 facilities totaling 204k sq-ft

ASHRAE Class 1 Design Standards

Recommended Conditions for ASHRAE class 1

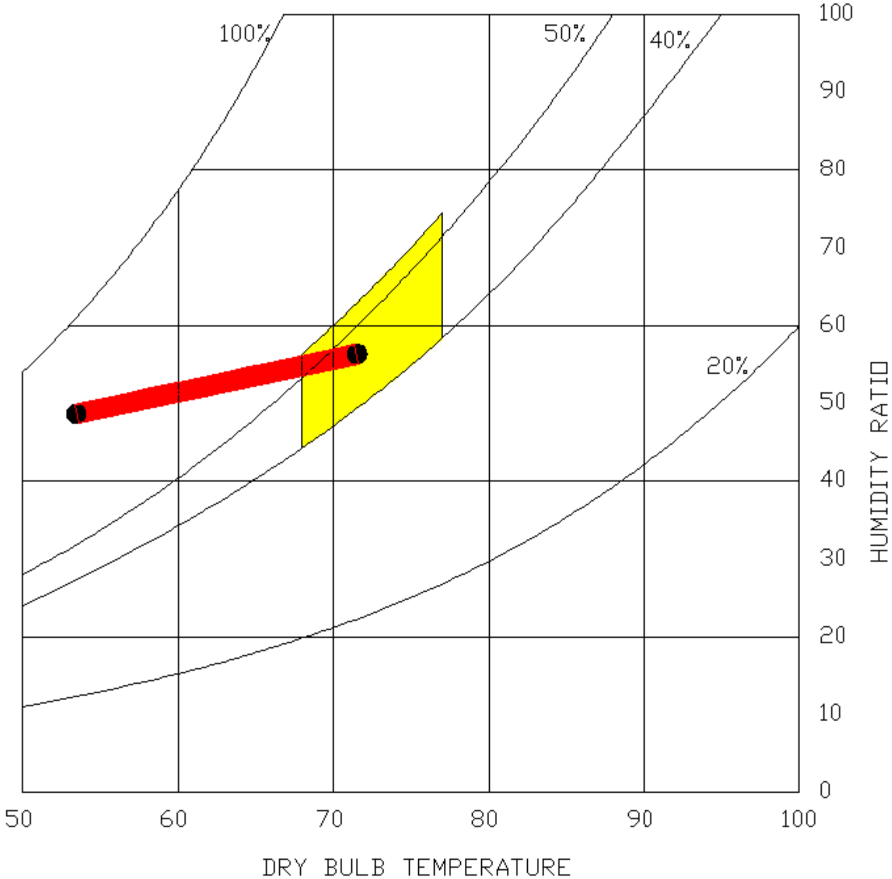
- 68-77 °F supply air temp
- 9 °F per hour rate of change
- 40-55% RH



Measure in center of aisle,
1.5 m (59”) above floor

Reference ASHRAE Design Considerations for Datacom Equipment Centers, 2005

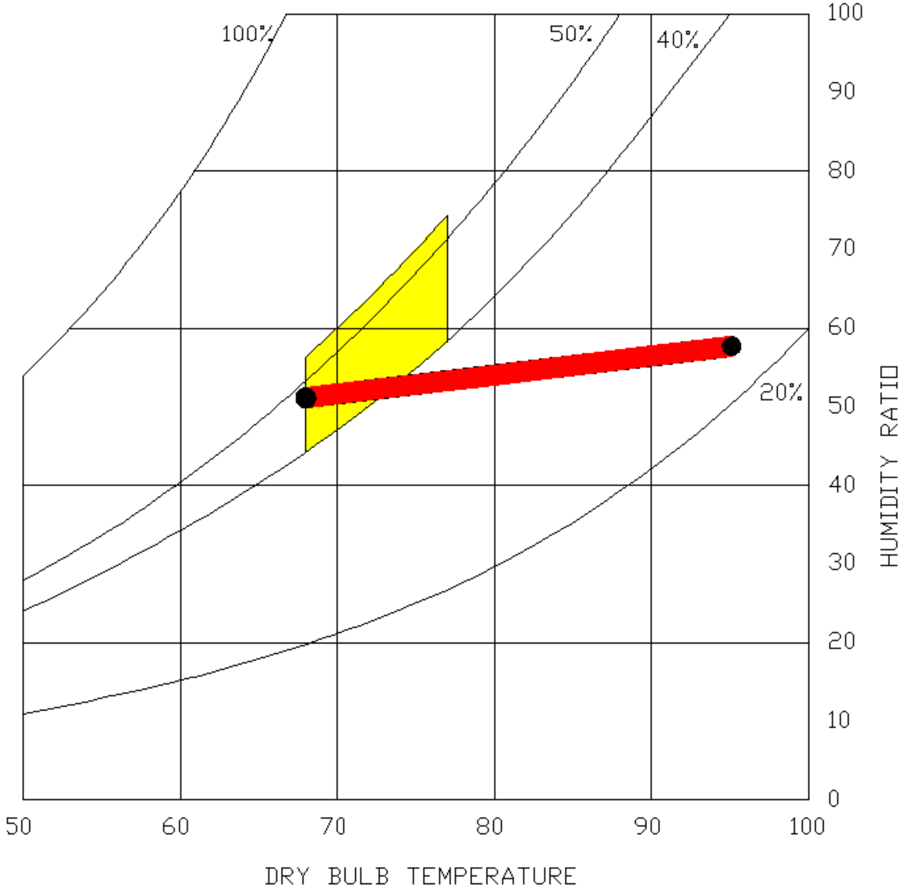
Comparing Cooling Strategies



Conventional Cooling

CRAC Return Air Control

72 degree and RH <u>return</u> is constant



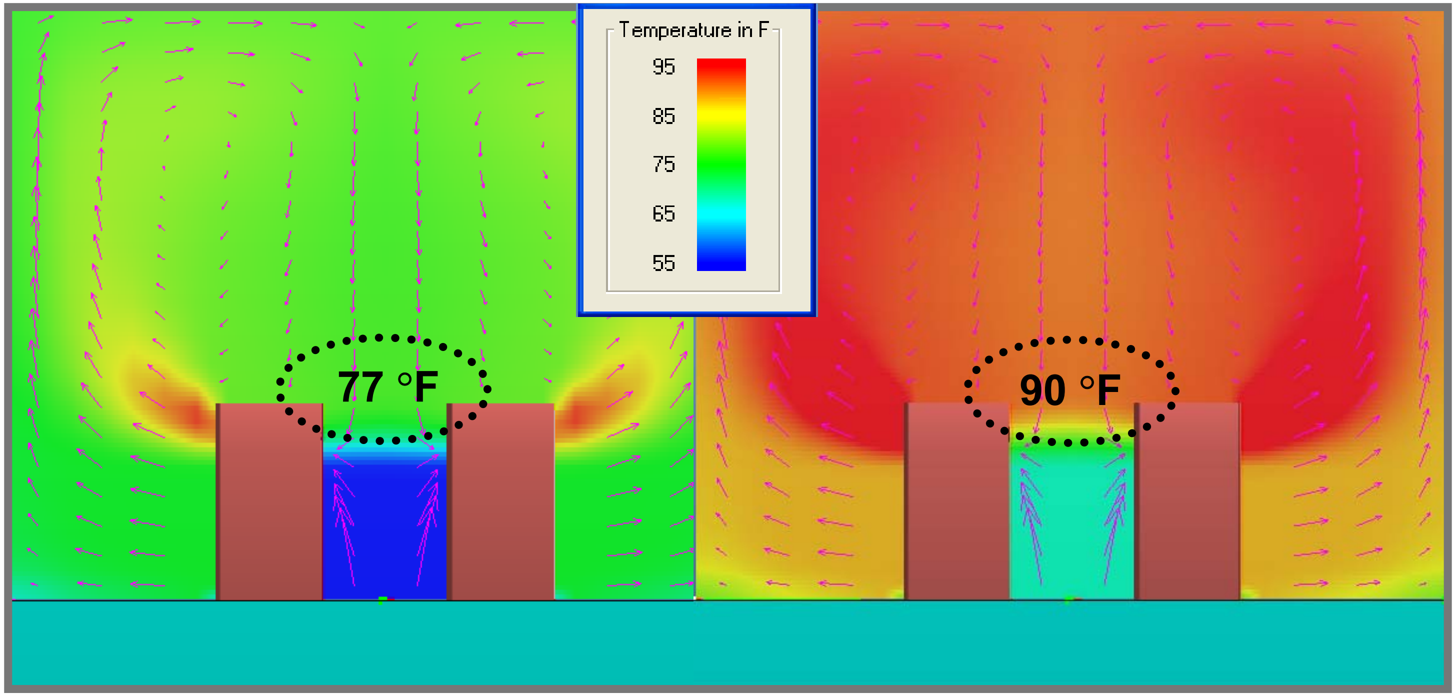
Oracle's ASHRAE based Cooling

CRAC Supply Air Control

68 degree and RH <u>supply</u> is constant

Supply Air Temperature CFD

Section taken from racks in the middle of the row.



Insufficient volume of 55 °F air still allows equipment inlet temperatures to be within ASHRAE class 1 limits

Insufficient volume of 68 °F air shows equipment inlet temperatures exceeding ASHRAE class 1 limits

Conditions deteriorate as you move out towards the end of the rows.

Svante Arrhenius

1859-1927

Nobel Prize for Chemistry 1903

"When the temperature increases, the rate of a chemical reaction increases also. Iron rusts, food spoils, or bread rises more rapidly when conditions are warm than when they are cool. One result of this similarity is the useful generalization that for many reactions which occur near room temperature, a temperature increase of 10 °C approximately doubles the rate of the reaction."

25 °C = 77 °F → 35 °C = 95 °F → 45 °C = 113 °F

New Design

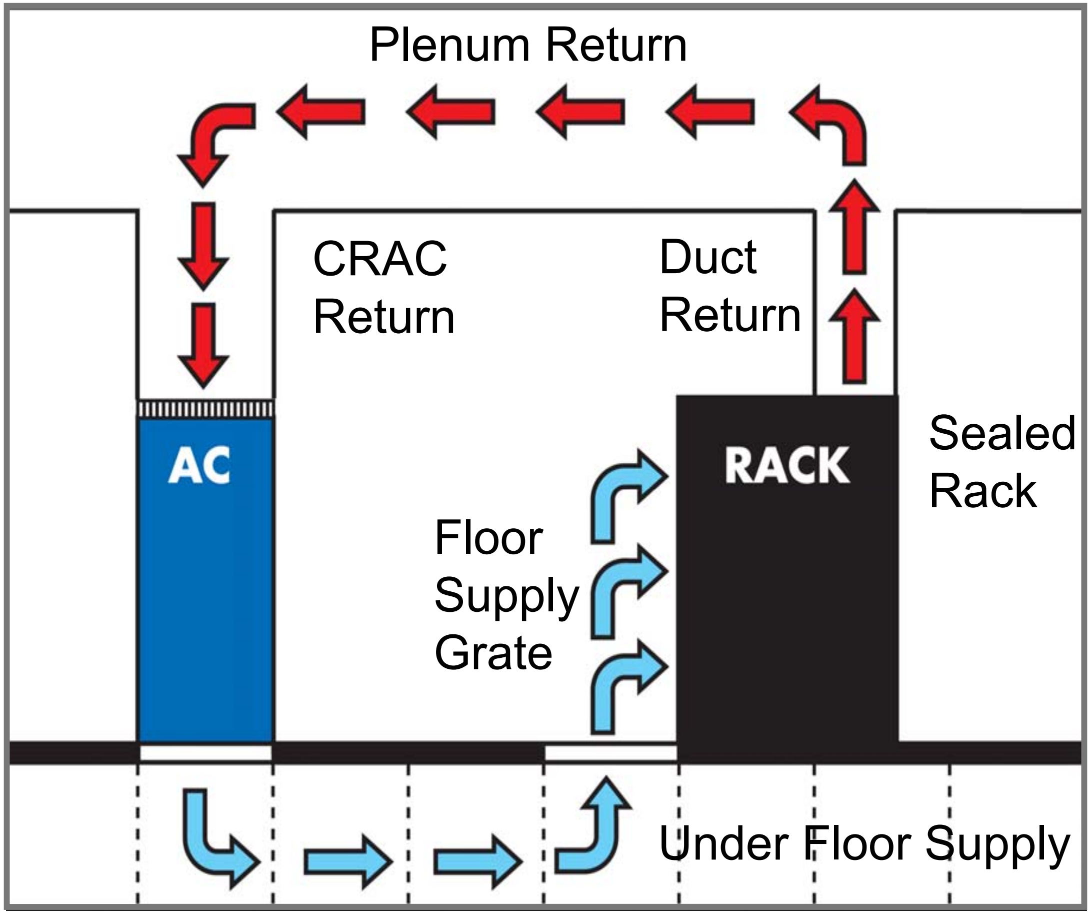
- Add 40,000 sq ft of raised floor space for standard density and high density applications up to 170 watts/sq ft or 12kW/rack
- Maintain ASHRAE class 1 standards
- Provide sufficient airflow to have consistent temperature from the bottom to the top of the rack.
- Monitor environmental and electrical conditions
- Improve efficiencies
- Complete the above with optimal equipment to maximize uptime and minimize costs

High Density Heat Containment (HDHC) System

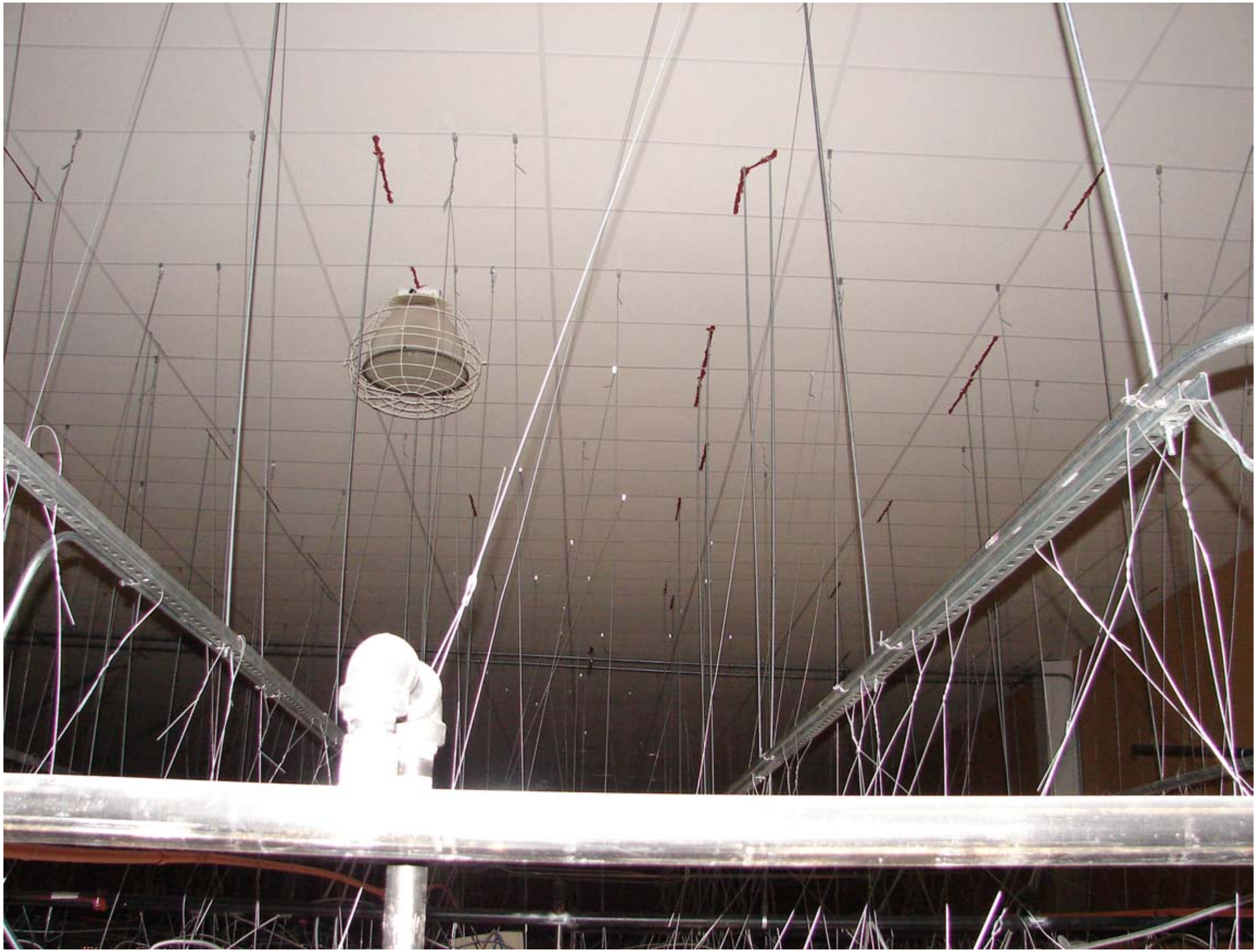
"A key factor in maximizing the cooling capacity is the ability to isolate the cold supply air and the hot exhaust air. It creates an environment that is both effective and efficient."

Dr. Robert Sullivan, Principle Uptime Institute

High Density Heat Containment (HDHC) System Components



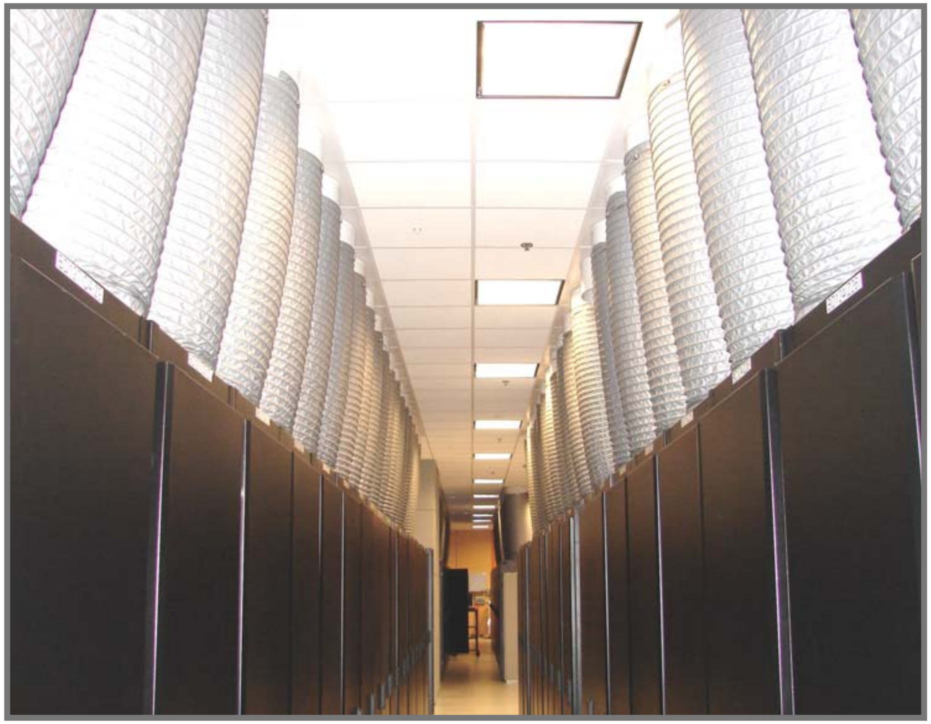
Plenum Construction



Plenum Construction

Plenum Construction

Standard HDHC Rack System



HDHC Components

System uses an energy efficient high flow fan to minimize power loads in the data center.

Required power: 70 watts

Airflow rate: 1700 CFM

Rack Cooling Capacity	Equipment Delta T
20 kW	37 Deg F
17 kW	32 Deg F
15 kW	28 Deg F

• Sealing grommets allow cable pass through without degrading under floor air pressure. A significant improvement in data canter efficiency can be achieved when the cable cut-out is blocked by the use of a sealing grommet.

• Tool-less blanking panels eliminate recirculation of hot air through open spaces between IT equipment

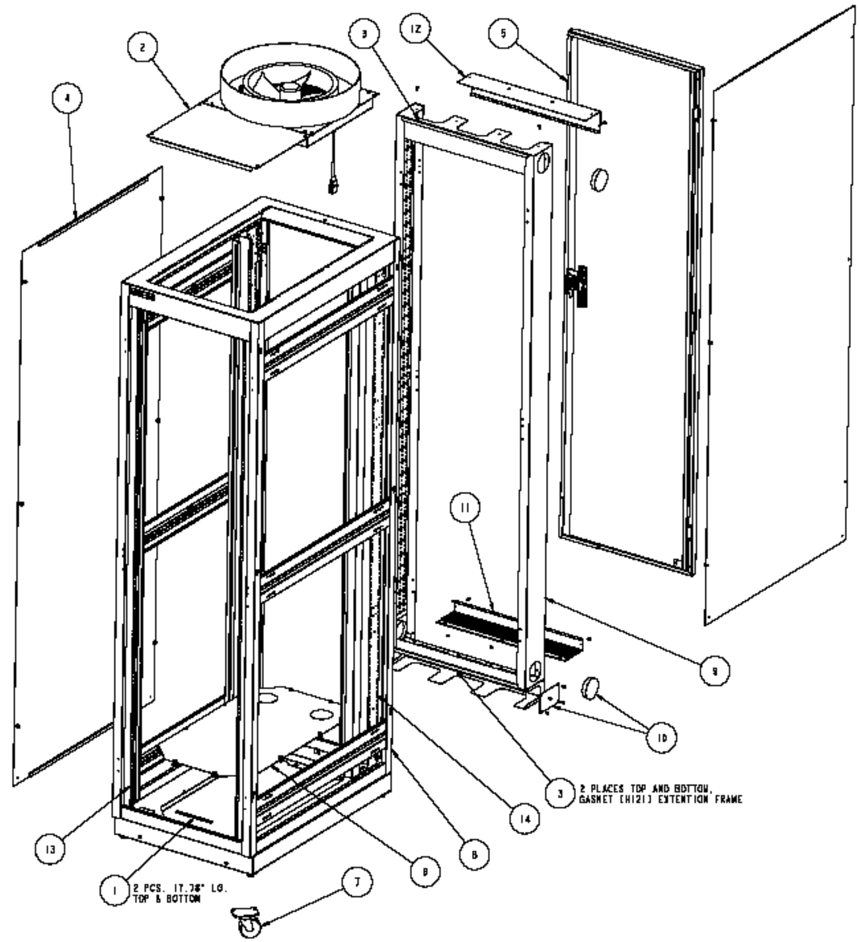
HDHC Components

HDHC Rack
System Upgrade

640 HDHC Rack Enclosures

45U Rack Enclosure Upgrade Includes:

Side divider panels
Solid bottom panel with brush strip
Solid rear door with gasket
High airflow – Low power fan system



Benefits of a High Density Heat Containment System

- Consistent temp at server intakes at all rack heights
- Hot air predictably contained in return duct with no possible pathway for hot air to contaminate cold aisle
- Increases CRAC cooling capacity plus save energy by raising supply air temperature and by eliminating cool air oversupply
- Actively controlling supply temperature and relative humidity (Rh) results in a more stable and reliable environment which also allows predictability when deploying new applications
- Significantly increase the available runtime during full cooling failure due to heated air mixing in return plenum before returning to the IT load

Increased CRAC Performance

Greater temperature differential from chilled water and return air, improves coil performance. Impossible to get 90% SHR cooling unless raise chilled water set point above dew point.

Increase SHR 6% by increasing supply air temperature to 68 degrees

45 degree entering water temperature and <u>control valve full open</u>

Return Dry Bulb (°F)	% Rh	Leaving Chilled Water (°F)	Total Cooling (kW)	Sensible Cooling (kW)	Sensible Heat Ratio (SHR)	Supply Dry Bulb (°F)
72	50.0	58.5	128	107	83%	51.1
80	38.3	62.0	164	144	88%	51.4
90	27.8	66.5	210	188	90%	52.1
100	20.4	71.0	255	228	89%	53.2

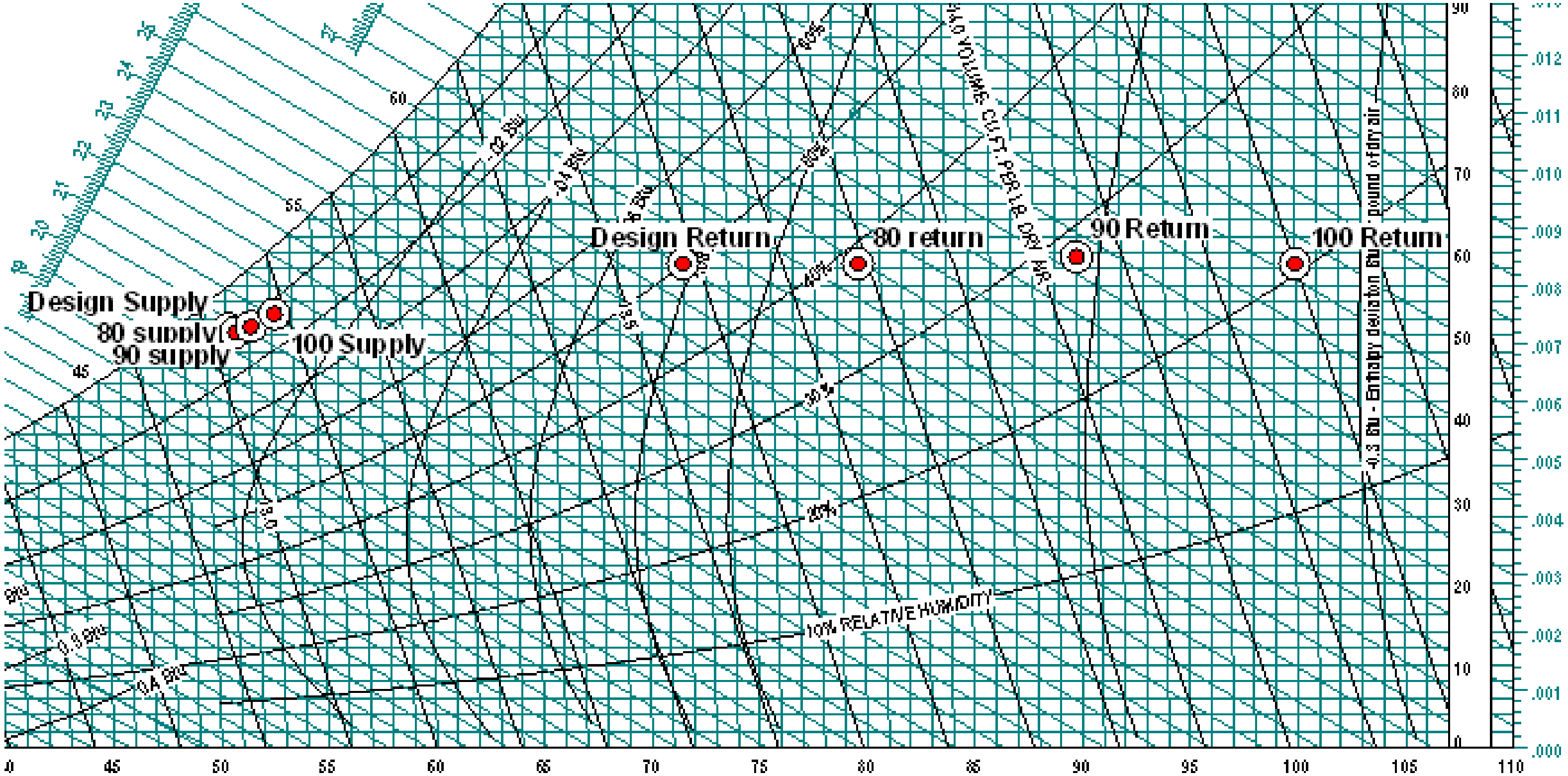
45 degree entering water temperature and <u>control valve throttled</u>

Return Dry Bulb (°F)	% Rh	Leaving Chilled Water (°F)	Total Cooling (kW)	Sensible Cooling (kW)	Sensible Heat Ratio (SHR)	Supply Dry Bulb (°F)
80	38.3	76.0	203.7	192.1	94%	68.2
90	27.8	85.2	371.2	354.7	96%	68.3
100	20.4	93.1	544.5	516.4	95%	68.1

3.4 kW = 1 Ton Refrig.

Increased CRAC Performance

Greater temperature differential from chilled water and return air, improves coil performance



Improved Cooling System Performance

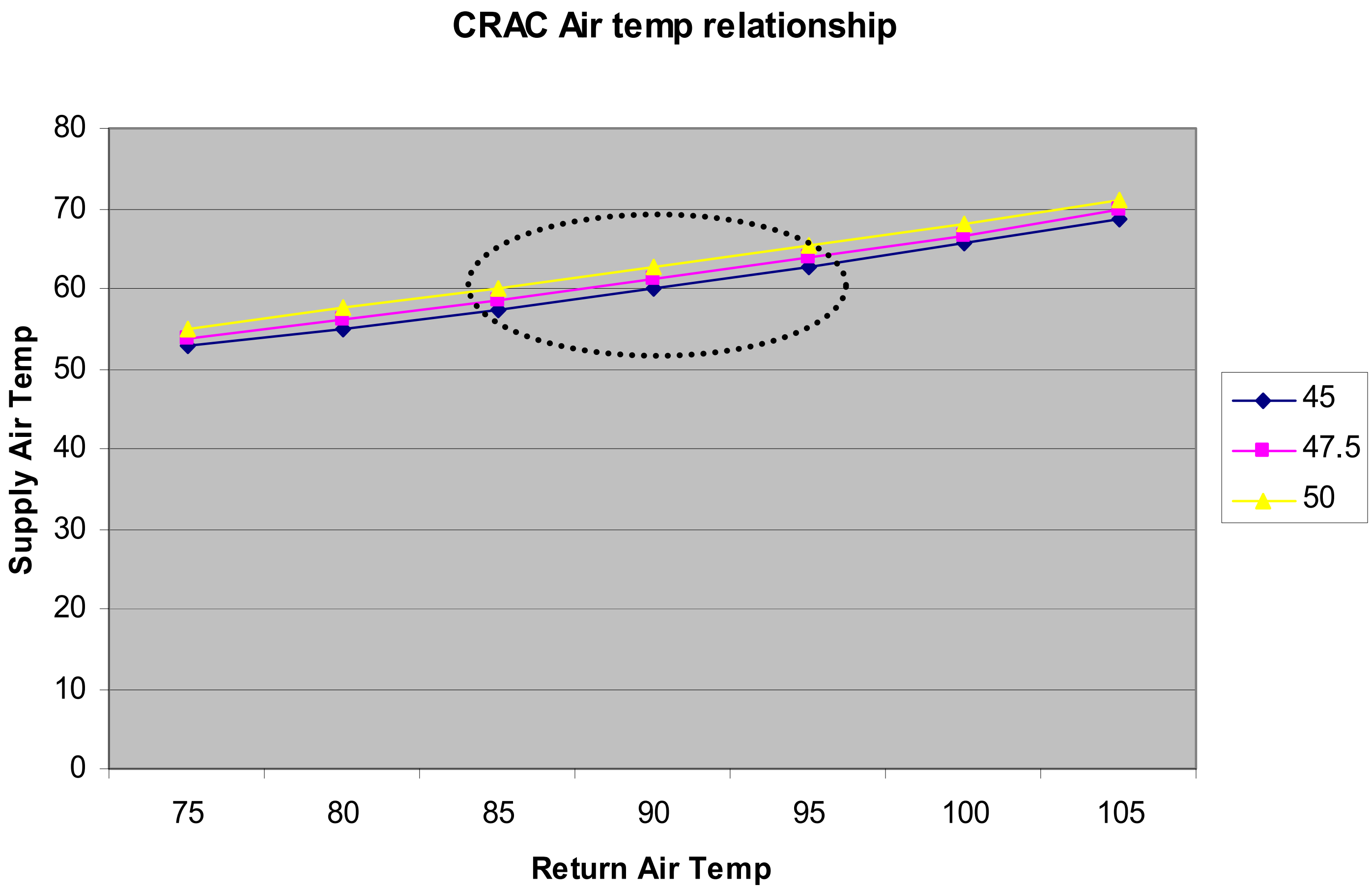
R123 Low Pressure VFD Chiller
3.4% capacity increase per 1 degree/chiller
2.4% energy savings for 1 degree/chiller
$4,555 dollars saved per 1 degree/chiller/year

R134-A High Pressure Chiller
1.8% capacity increase per 1 degree/chiller
1.2% energy savings for 1 degree/chiller
$2,277 dollars saved per 1 degree/chiller/year

45 to 50 saves $76,869/year

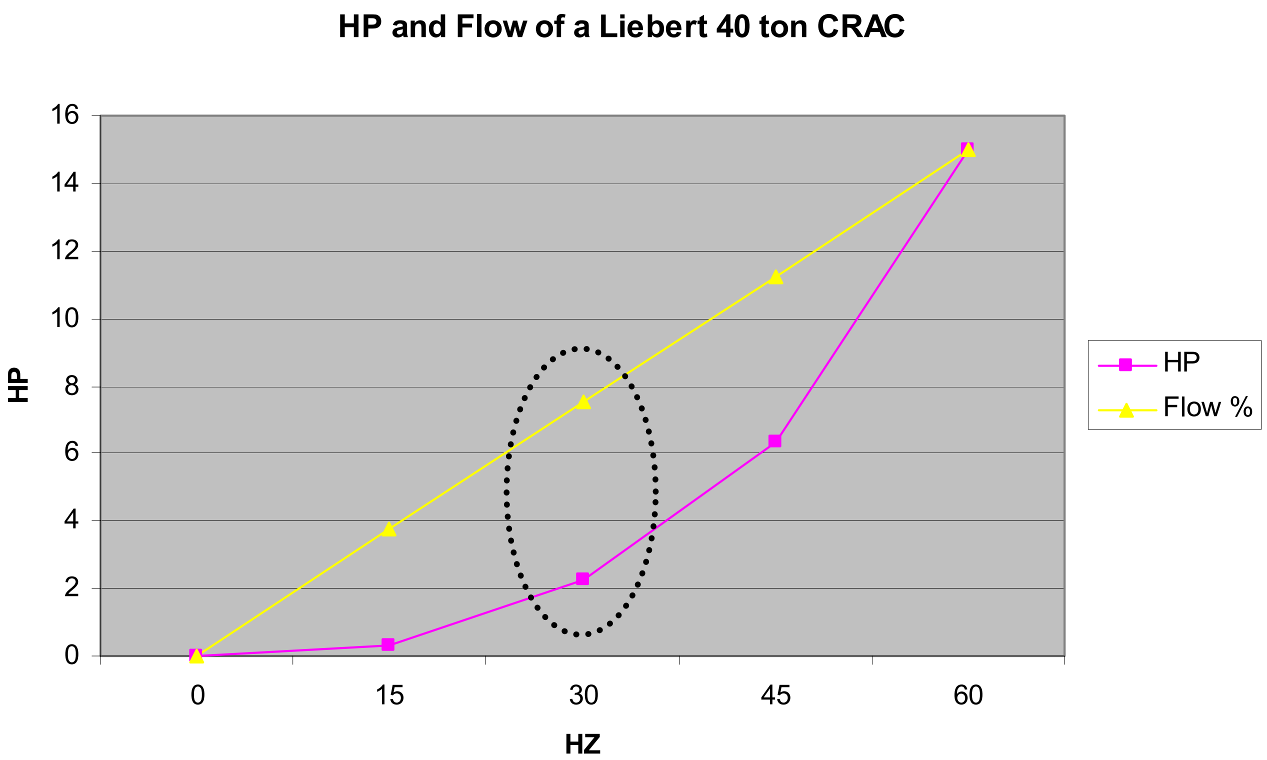
Your mileage may vary!

Improved Cooling System Performance



Raising Chilled water temp 1 degree raises Supply air temp ½ degree

Improved Cooling System Performance



CRACs utilizing VFD Benefits:

- Electrical Cost Savings
- Redundant CRAC is already running
- Increase MTBF running at slower speed
- Soft start
- Under floor pressure is maintained, even with multiple floor tiles removed
- Under floor pressure is adjustable

Improved Cooling System Performance

High Density area has 27 40 ton CRACs with Variable Speed Drives

27 CRACs at Full Speed	$145,306 Annual Cost
27 CRACs at ½ Speed	$ 21,854 Annual Cost

Currently running at ~ ½ speed (.05 in w.g. set point)

This is equivalent to running ~6.5 CRACs at ½ speed providing ~3.25 CRACs air capacity for the same cost of one CRAC at full speed

Energy costs at 5.5 cents/kWatt HR

Payback Analysis

Capital Investment	
Plenum Construction	$ 583,400
HDHC rack options	$ 595,200
CRAC VFD	$ 137,942
	$1,316,542
Annual Cost	
Rack fan power	$ 23,126
Annual Savings	
Chilled water temp reset to 50	$ 76,869
CRAC VFD savings	$ 123,452
SCWP power savings	$ 24,992
	$ 225,313

Payback 6.5 years

Summary

- Because typical heat loads per rack enclosure are now exceeding 8 kW, the traditional hot-aisle/cold-aisle configuration for these loads is outdated
- Heat Containment Systems eliminate cold row contamination from the hot row
- Rack load capacities can be increased since all cold air generated by the cooling system is available for the IT equipment
- Depending on the cost of electricity, efficiency gains can be significant

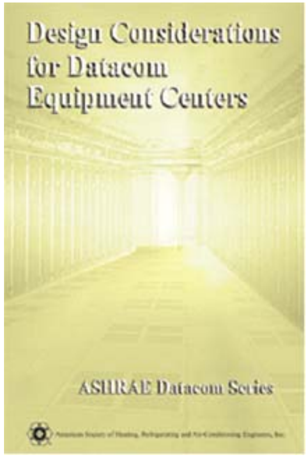
Summary

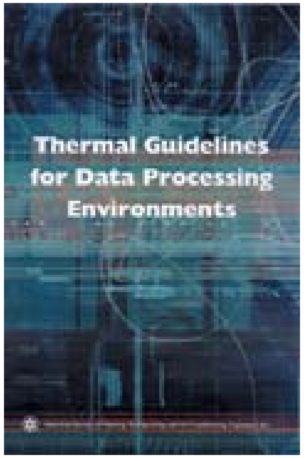
- HDHC systems provide the necessary environmental conditions for high density IT equipment loads while improving energy efficiency
- Payback of mechanical systems is within the lifetime of operation of the equipment
- Able to maintain high reliability using standard time tested cooling systems and components
- Additional efficiency gains are now possible using the next generation HDHC systems

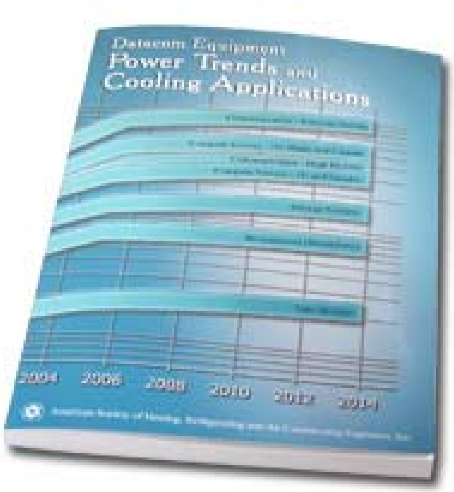
For More Information

ASHRAE Datacom Series

http://resourcecenter.ashrae.org/store/







Psychometric Chart Software

http://www.handsdownsoftware.com/Downloads.htm

THANK YOU!

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