Current HVAC Design Issues in Data Centers

Presented to 7x24 Exchange Northwest Chapter

February 8, 2005

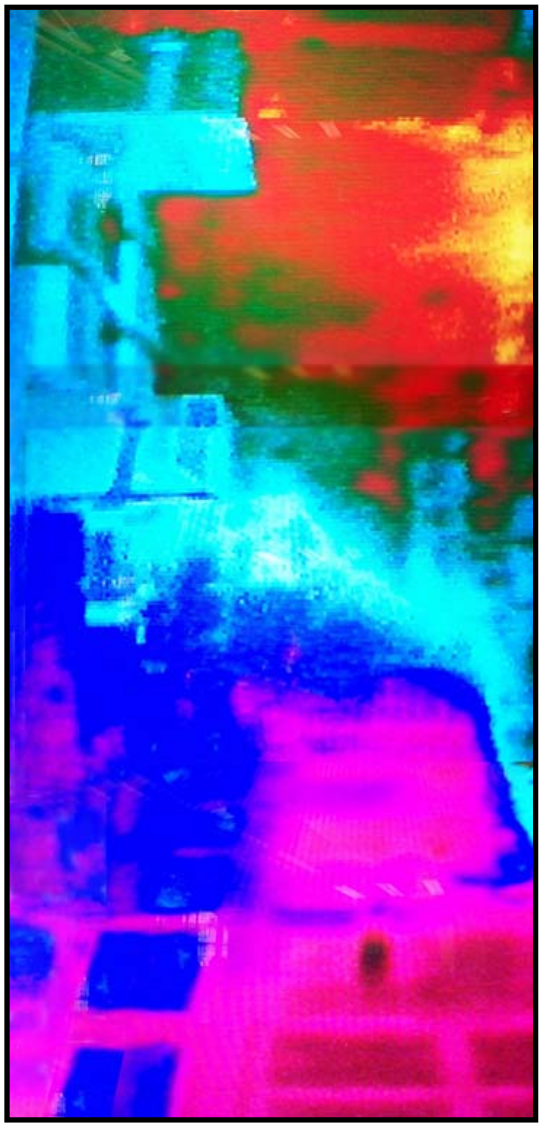
Presentation Goals & Outline

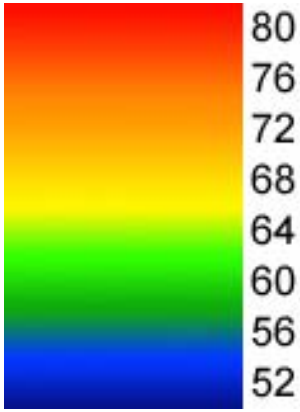
- *Power Density – Where we have been, where we are now and where we are going*
- *Limitations of Air Cooling – Air Distribution, Effectiveness and Heat Removal*
- *What Does ASHRAE Say?*
- *Unified System Solutions*
- *Energy Efficiency*

Common Data Center Scene

Have you seen data centers that look like this?

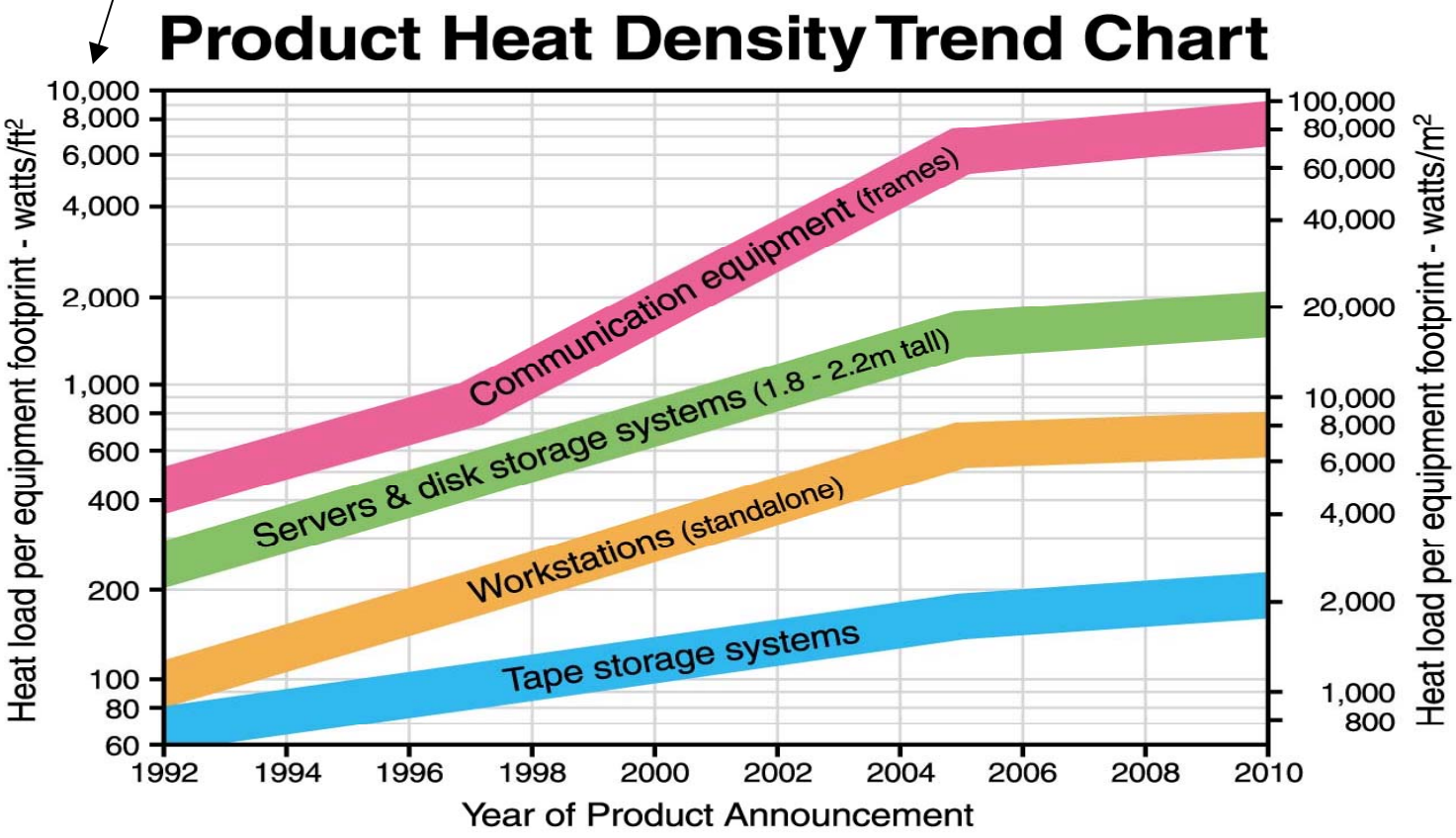
Thermophoto Analysis





IT Equipment Trends

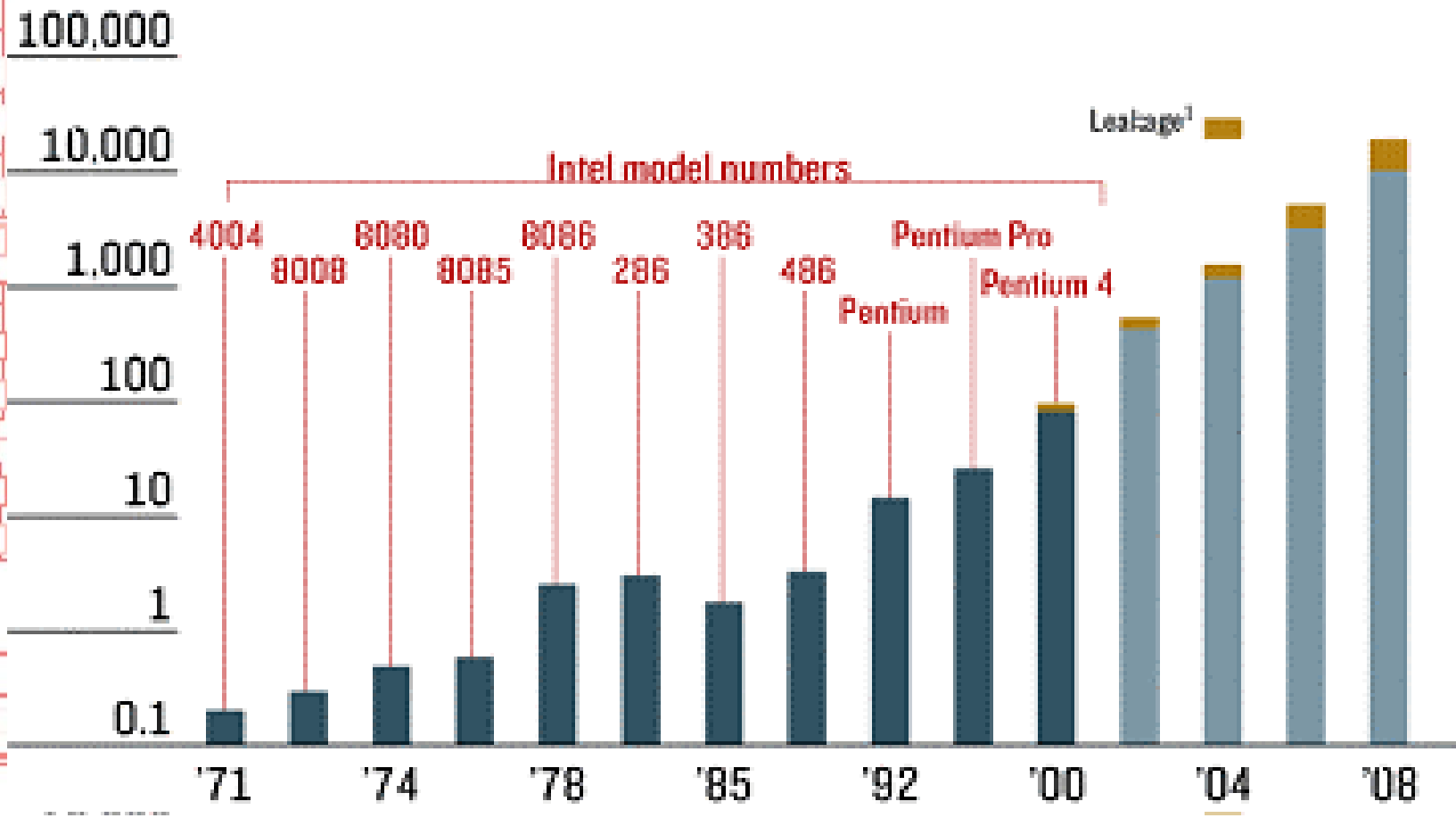
This area is for the equipment footprint only! Power density is diluted when the entire data center area is added.



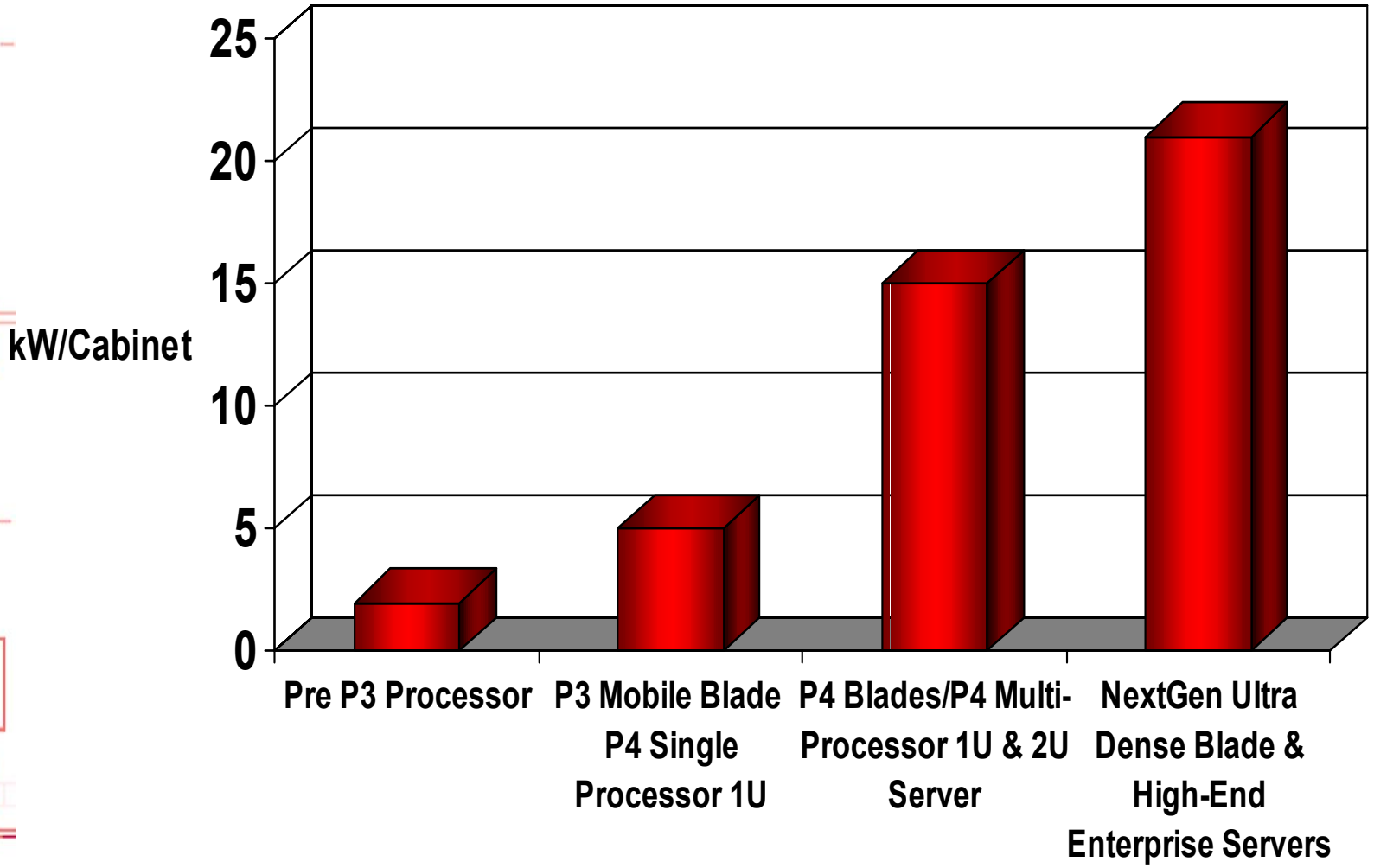
*from The Uptime Institute (http://207.201.136.39/TUIpages/whitepapers/tuiheat1.0.html)

Issues in the Data Center

The rise of heat densities at the microprocessor level (watts)



Blade Servers



How Do We Remove the Heat?

Water

- ***Water has 3500 times more heat capacity than air by volume***

Air

- ***Overhead***
- ***Underfloor***

Are We Hitting the Wall?

- ***"The failure rate at the top third of the rack is three times greater than at the bottom."***

  –Mr. Kenneth Brill, Executive Director: The Uptime Institute, March 2003 DataCenter Dynamics Conference)

- ***The wall is at 3.5 KW/Cabinet (with raised floor)***
- ***Without raised floor, 2.5 KW/Cabinet max.***

  –Steve Spinazzola, RTKL, Oct. 2004, 7x24

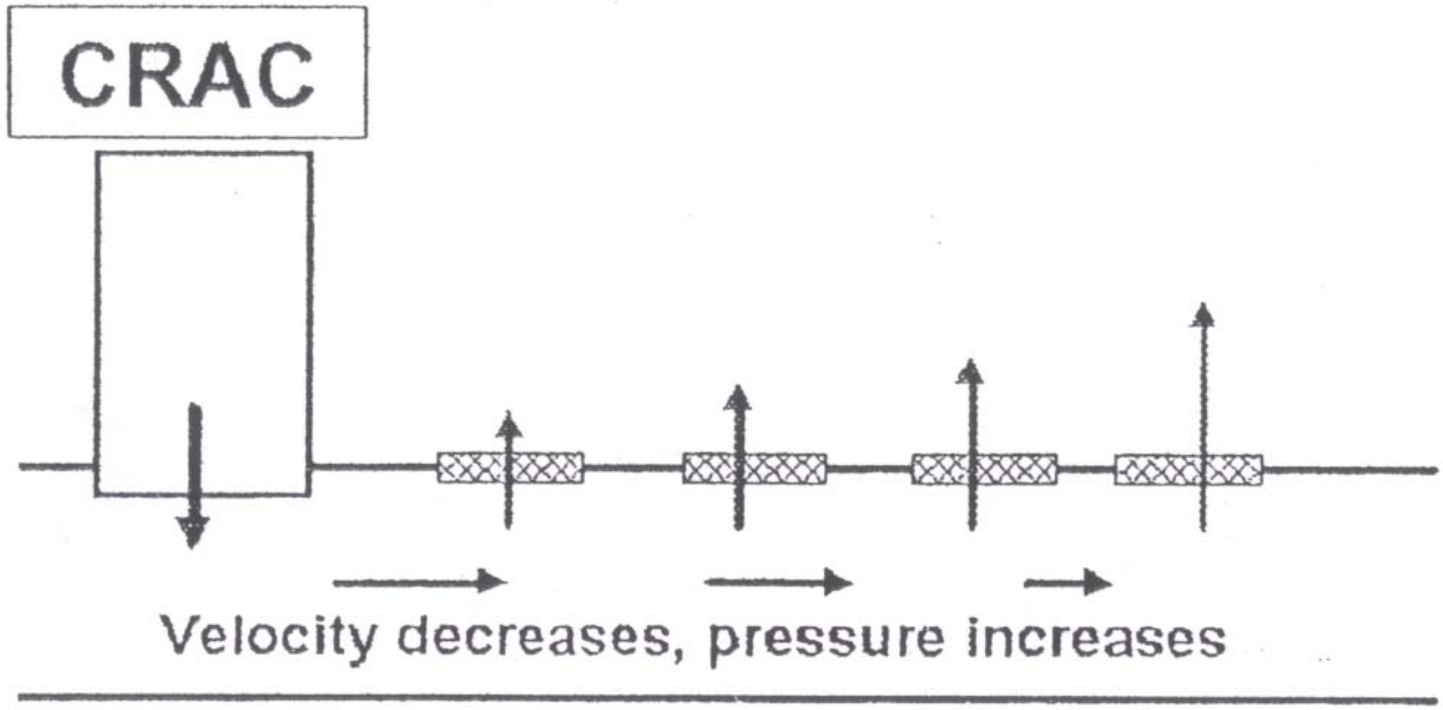
Overhead Air Distribution

- *Limitations to capacity due to duct size / space constraints*
- *Higher cost for ductwork versus underfloor system*

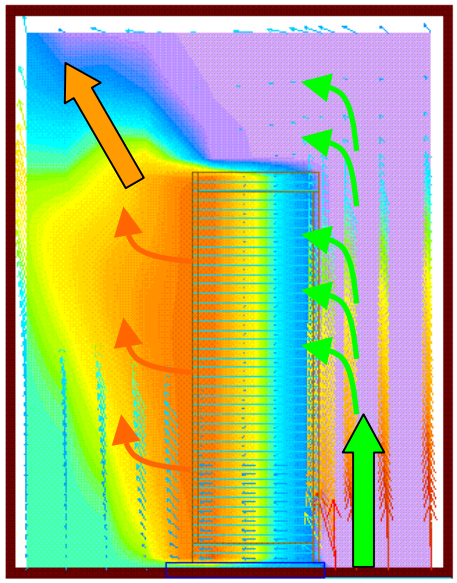
Underfloor Air Distribution

- *Increased floor depth for higher flows*
- *Limitation of perf tiles (400 cfm = +-2.5 kW/rack)*
- *UF obstructions*
- *Air Maldistribution – underfloor velocity/static pressure*
- *Air plumes*

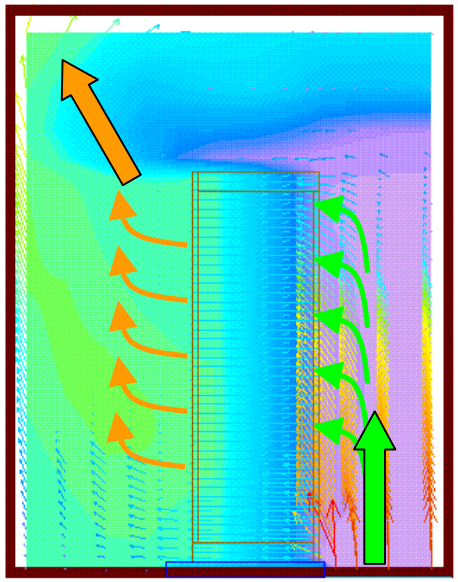
The Cause of Flow Maldistribution



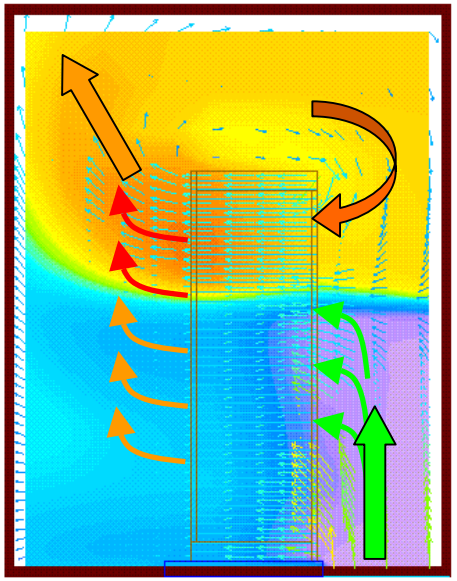
Abovefloor Plumes



Rack total airflow: 350cfm
Max inlet temp: **16□C/61□F**



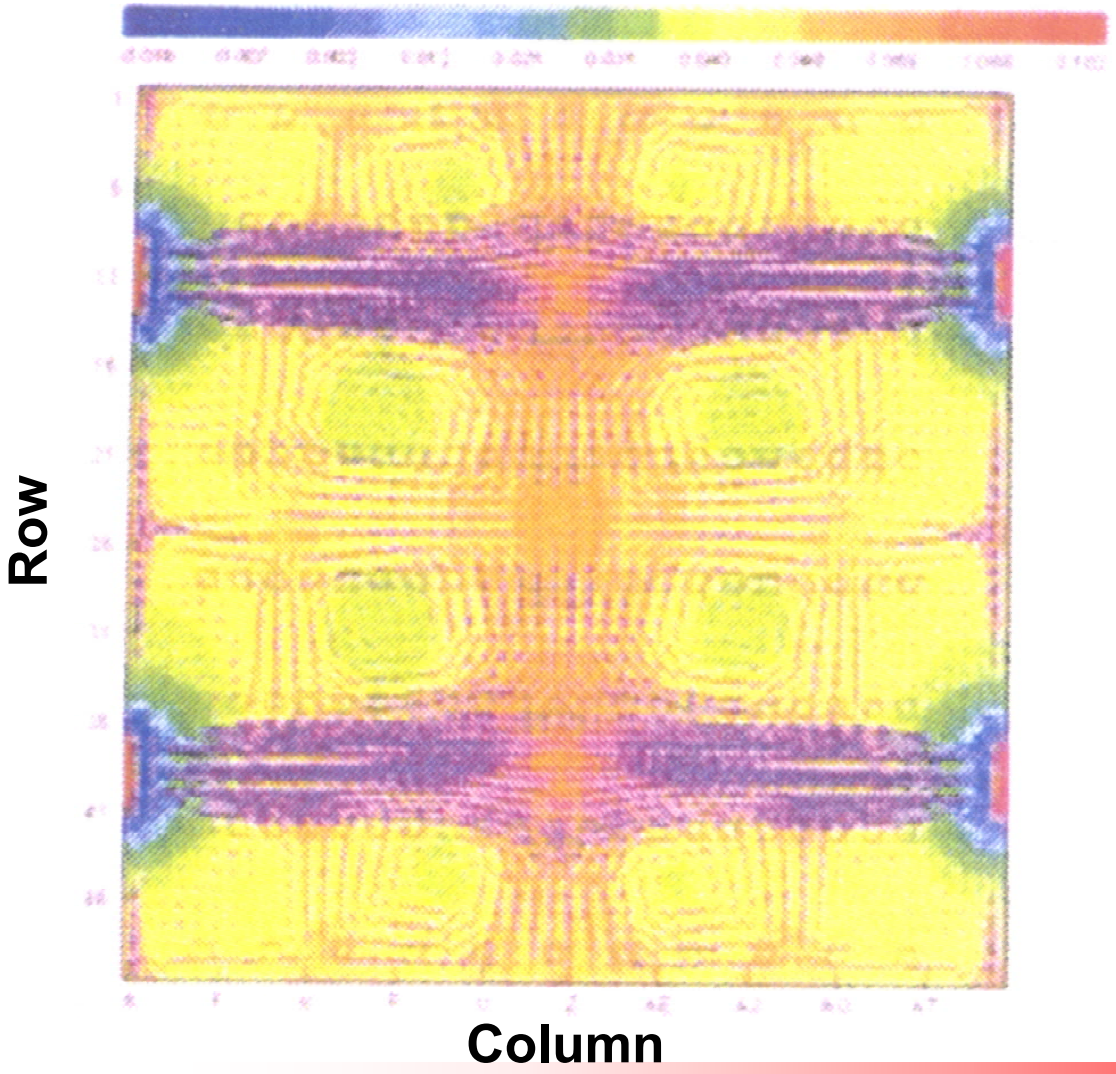
Rack total airflow: 700cfm
Max inlet temp: **18□C/64□F**



Rack total airflow: 1400cfm
Max inlet temp: **28□C/82□F**

Underfloor Plumes

1 kW / Cabinet – 24” Raised Floor



Velocity vectors & pressure (inch wg) under the raised floor

HVAC Effectiveness

- ***Bypass Airflow***
- ***Air Distribution Efficiency***
  - *70% of cooling supply air is wasted and bypasses back to return system.*

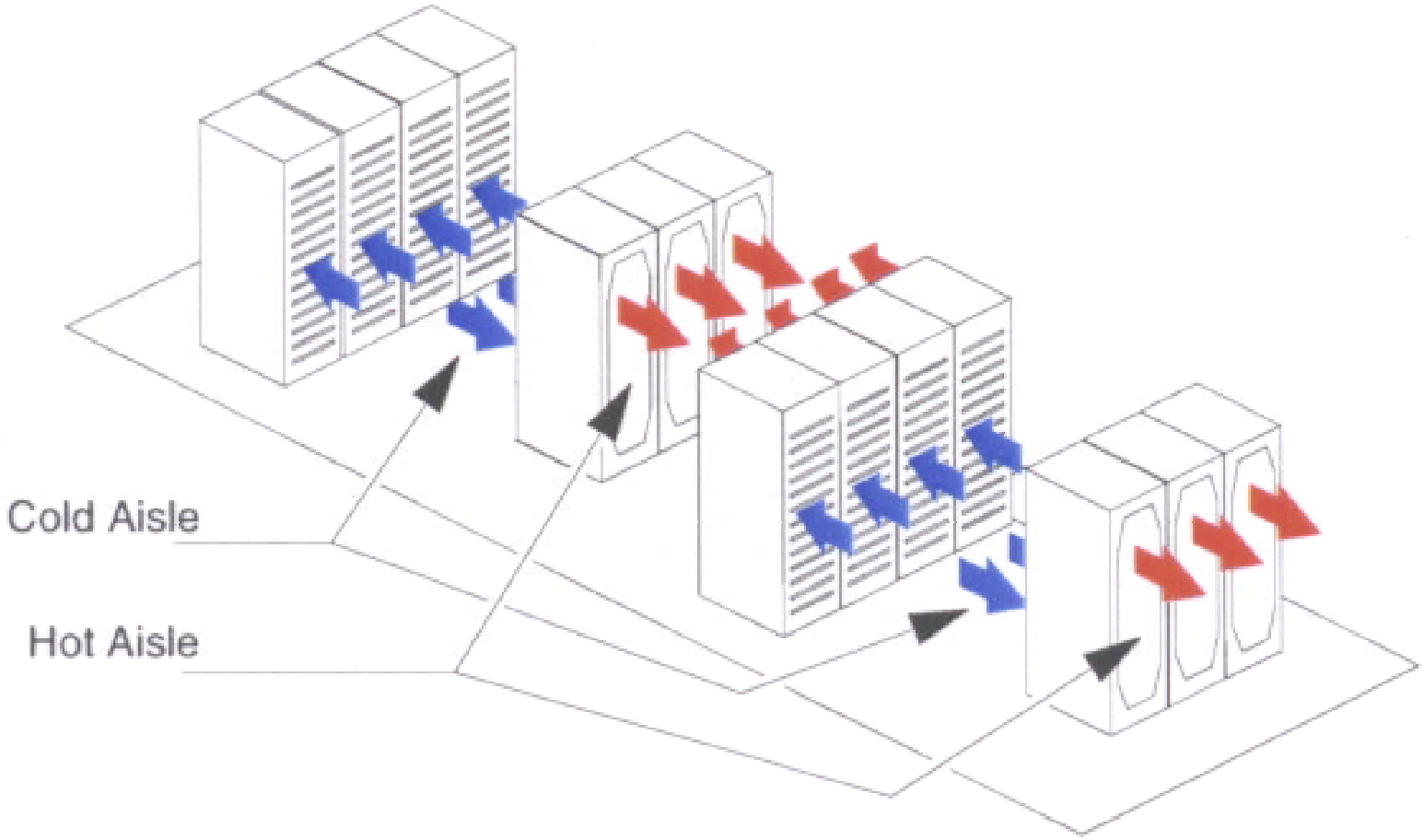
Key Points to ASHRAE TC9.9

- *Equipment Environmental Specifications*
- *Equipment Room Airflow*
- *Standardize Measuring / Monitoring Points*
- *Equipment Airflow Protocol Syntax*
- *Equipment Manufacturer's Heat Reporting*

Table 2.1 Equipment Environment Specifications

Class	Equipment Environment Specifications									
	Product Operation [a,b]							Product Power Off [b,c]		
	Dry-Bulb Temperature (ºF)		Relative Humidity (%) Non-Condensing		Max. Dew Point (ºF)	Max. Elevation (m)	Max Rate of	Dry-Bulb Temperature (ºF)	Relative Humidity (%)	Max. Dew Point (ºF)
	Allowable	Recommended	Allowable	Recommended						
1	59 to 90 [d]	68 to 77	20 to 80	40 to 55	63	3050	5	41 to 113	8 to 80	81
2	50 to 90 [d]	68 to 77	20 to 80	40 to 55	70	3050	5	41 to 113	8 to 80	81
3	41 to 95 [d,e]	N/A	8 to 80	N/A	82	3050	N/A	41 to 113	8 to 80	84
4	41 to 104 [d,e]	N/A	8 to 80	N/A	82	3050	N/A	41 to 113	8 to 80	84

Equipment Room Airflow

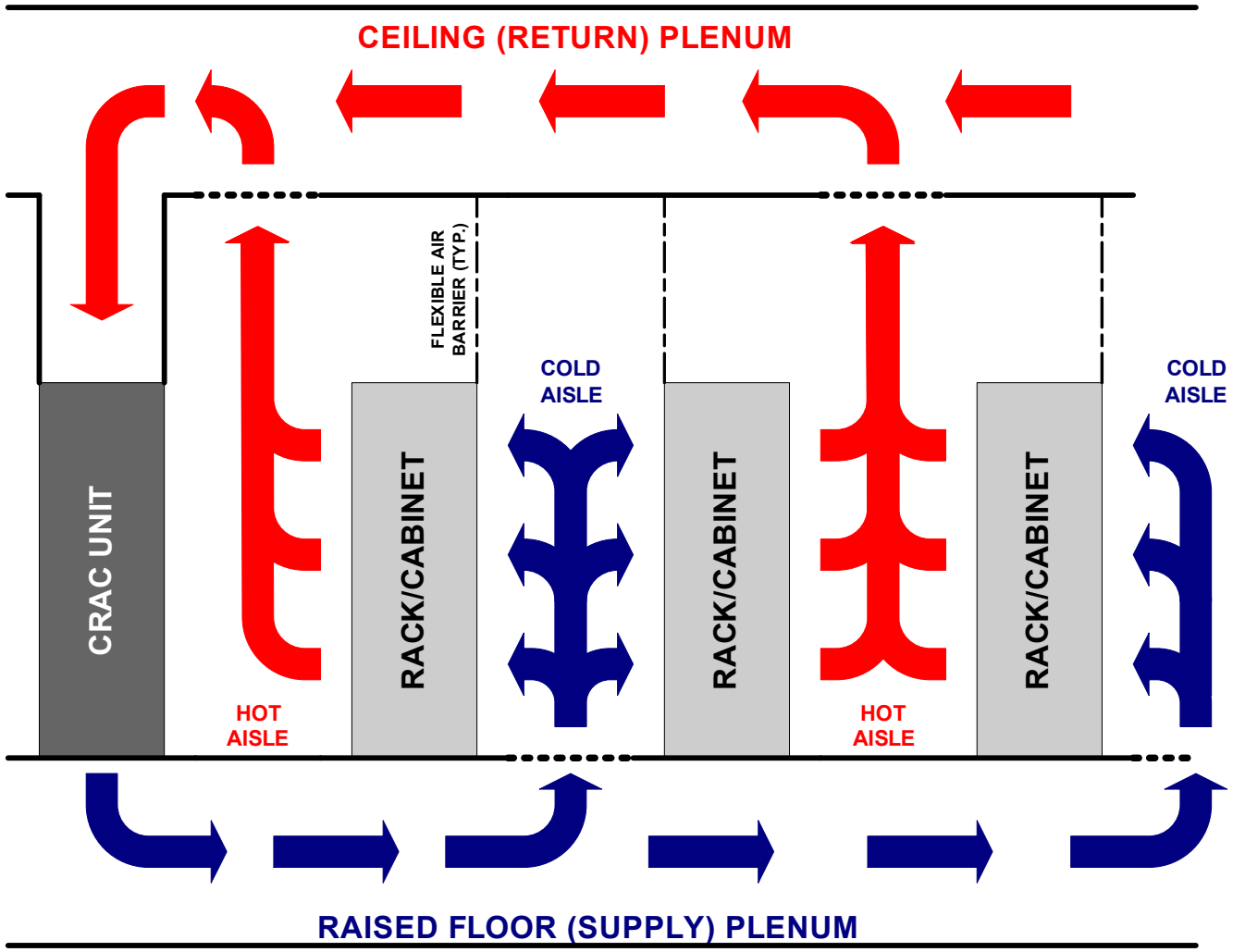


Key Points to ASHRAE TC9.9 (continued)

- *Standardize Measuring / Monitoring Points*
- *Equipment Airflow Protocol Syntax*
- *Equipment Manufacturer's Heat Reporting*

Extraction Versus Dilution

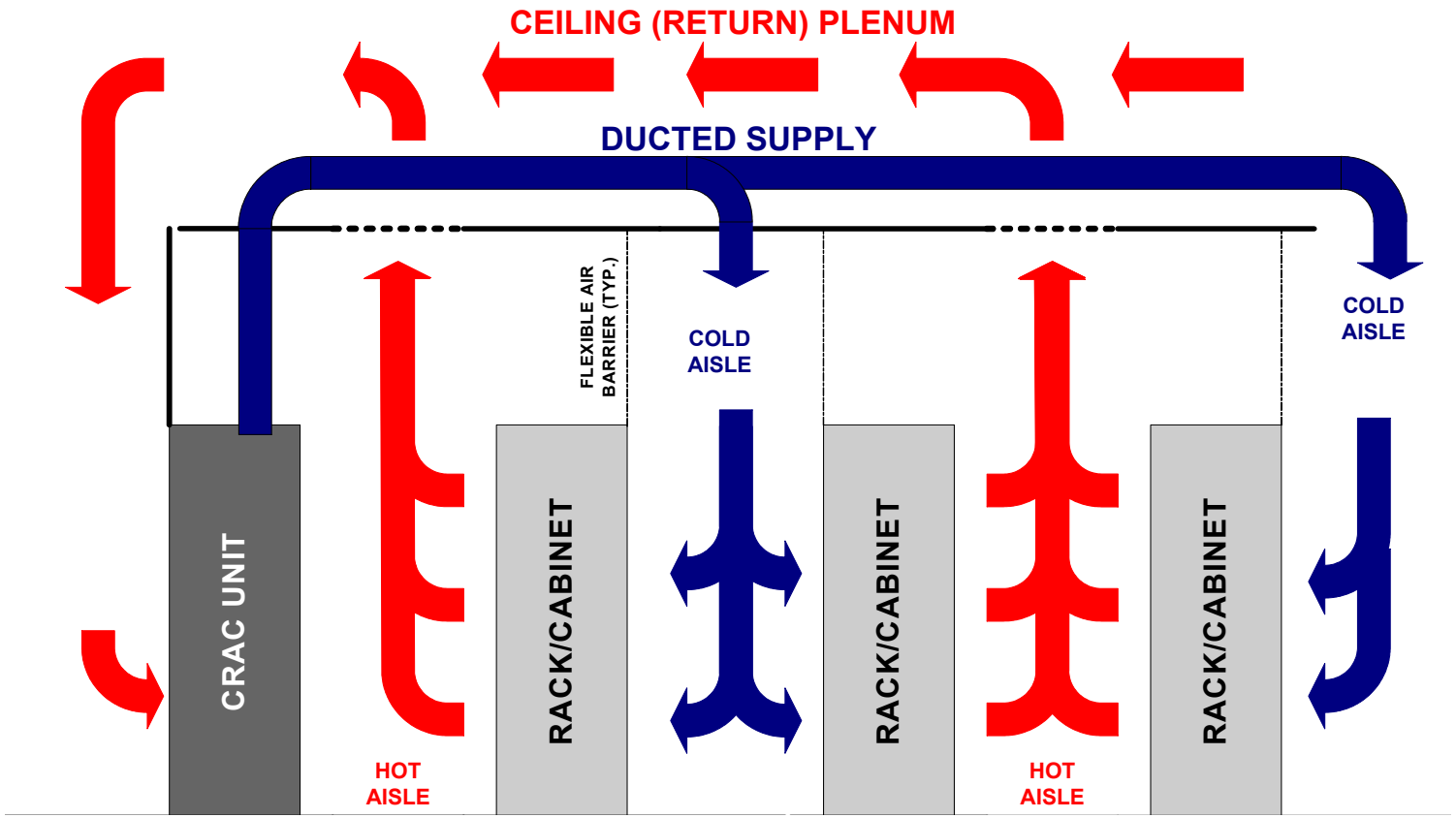
Hot & Cold Aisle - Plenum



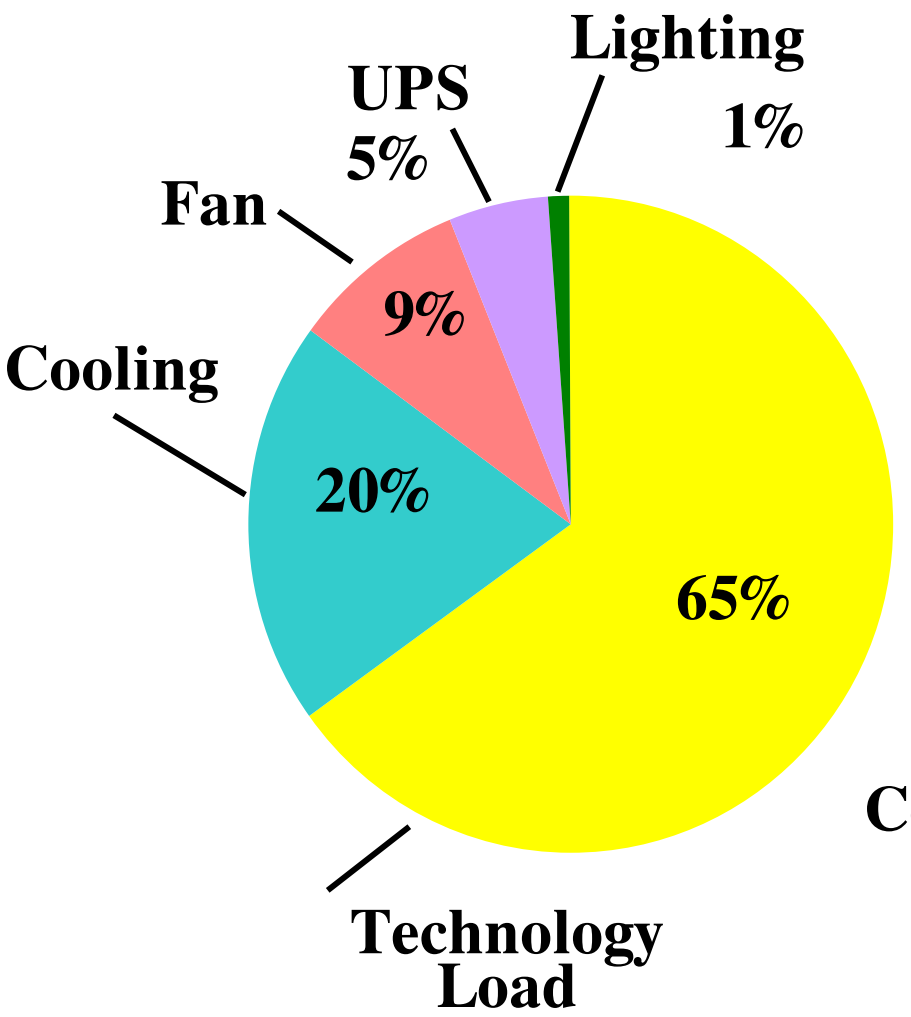
General Ideas and Points

- **No cabinet doors.**
- **Cable management behind servers in "hot" aisle.**
- **Limit air bypass – use rack blanking panels and seal all floor cutouts.**
- **Limit mixing between hot and cold aisles.**
  - *Lexan panels above racks and doors at aisle ends.*
  - *Sprinklers / FP piping in each aisle.*

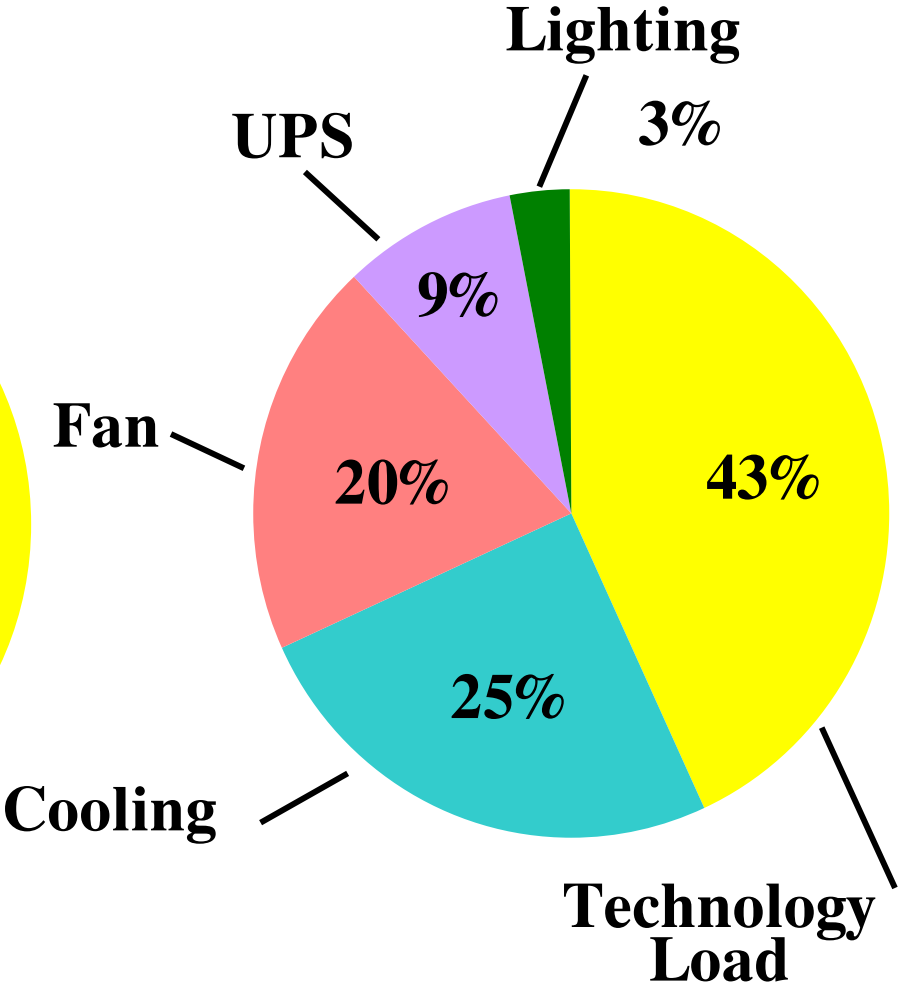
Hot & Cold Aisles – All Overhead



Power Use in Tech Spaces



Full Load



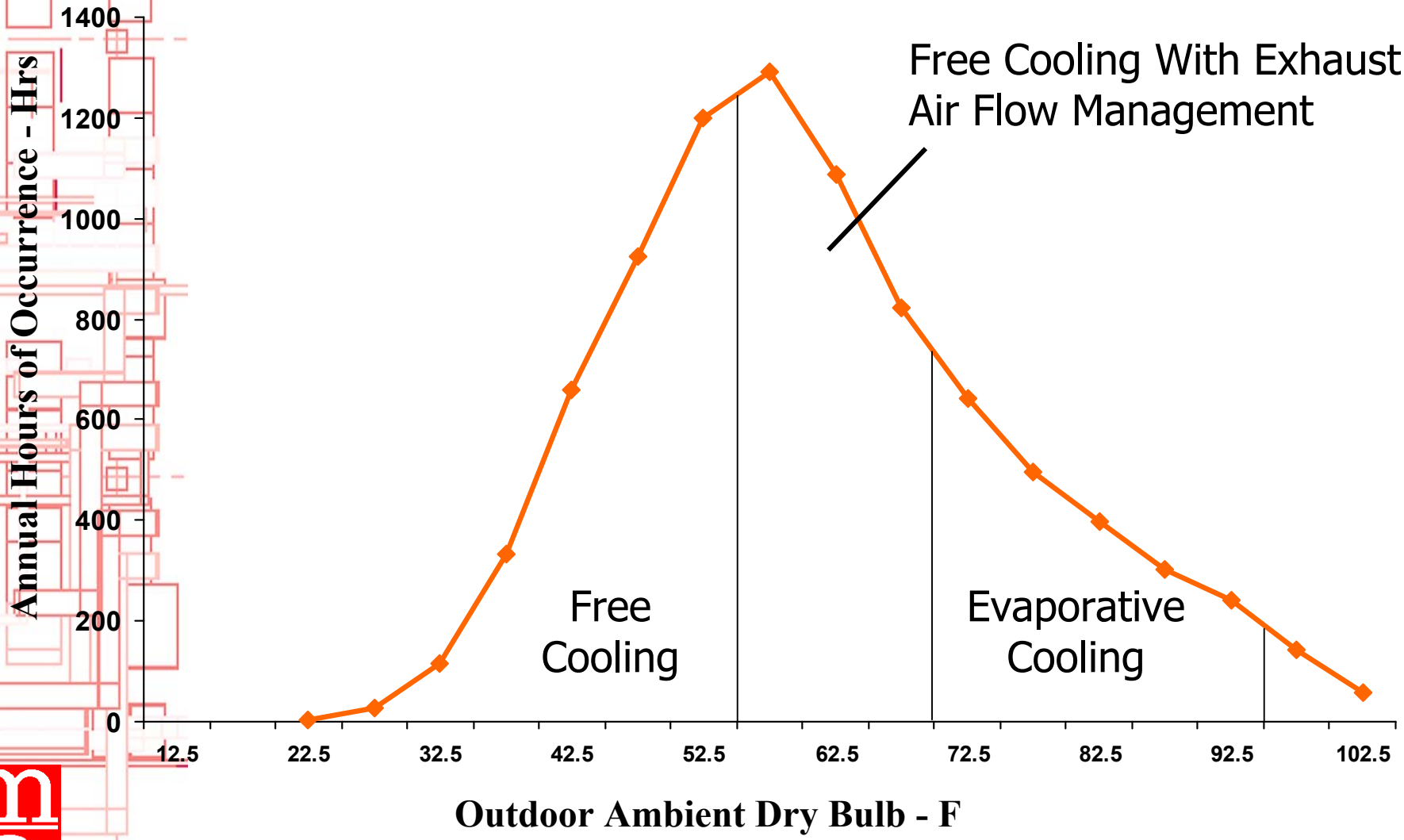
Actual Part Load

Energy Conservation

- More efficient equipment power supplies
- Water-cooled vs. air-cooled
- Variable speed drives
- Plenum fan vs. housed fan
- Minimize operating redundant equipment
- Air-side economizers
- Water-side economizers
- Tightly controlled air flow
- Split circuited coils for humidity

Sacramento Weather Profile

(Dry Bulb Data)



Summary

- *Understand the limitations of air cooling*
- *Focus on heat removal*
- *Understand part load operating conditions*
- *Look for energy efficiency opportunities*

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