Bill Tschudi, P.E.
(510) 495-2417
wftschudi@lbl.gov

Should utilities give away supercomputers with purchase of a long term power contract?

Mark Bramfitt (PG&E):

"No, but they might give incentives to remove some"

Microsoft's data center in a tent

http://www.datacenterknowledge.com/archives/2008/09/22/new-from-microsoft-data-centers-in-tents/

"Inside the tent, we had five HP DL585s running Sandra from November 2007 to June 2008 and we had **ZERO failures** or 100% uptime. In the meantime, there have been a few anecdotal incidents:
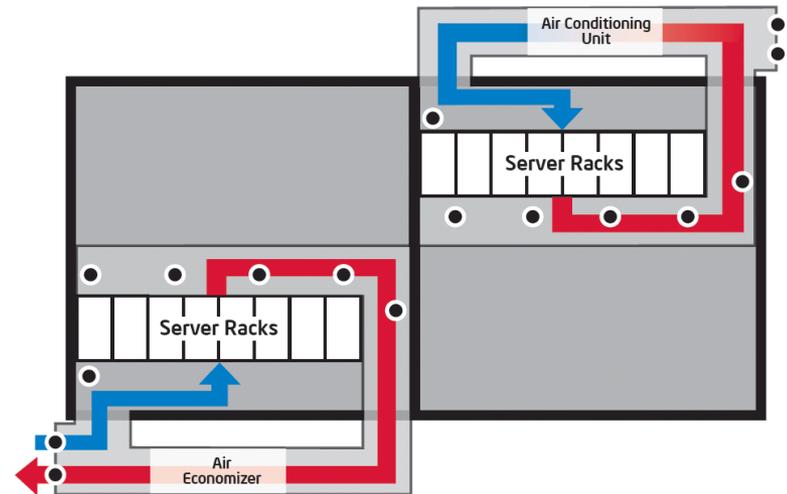
– Water dripped from the tent onto the rack. The server continued to run without incident.

– A windstorm blew a section of the fence onto the rack. Again, the servers continued to run.

– An itinerant leaf was sucked onto the server fascia. The server still ran without incident."

And from Intel a side-by-side comparison

Intel conducted a 10-month test to evaluate the impact of using only outside air to cool a high-density data center, even as temperatures ranged between 64 and 92 degrees and the servers were covered with dust.

– Intel's result: "We observed no consistent increase in server failure rates as a result of the greater variation in temperature and humidity, and the decrease in air quality. This suggests that existing assumptions about the need to closely regulate these factors bear further scrutiny."
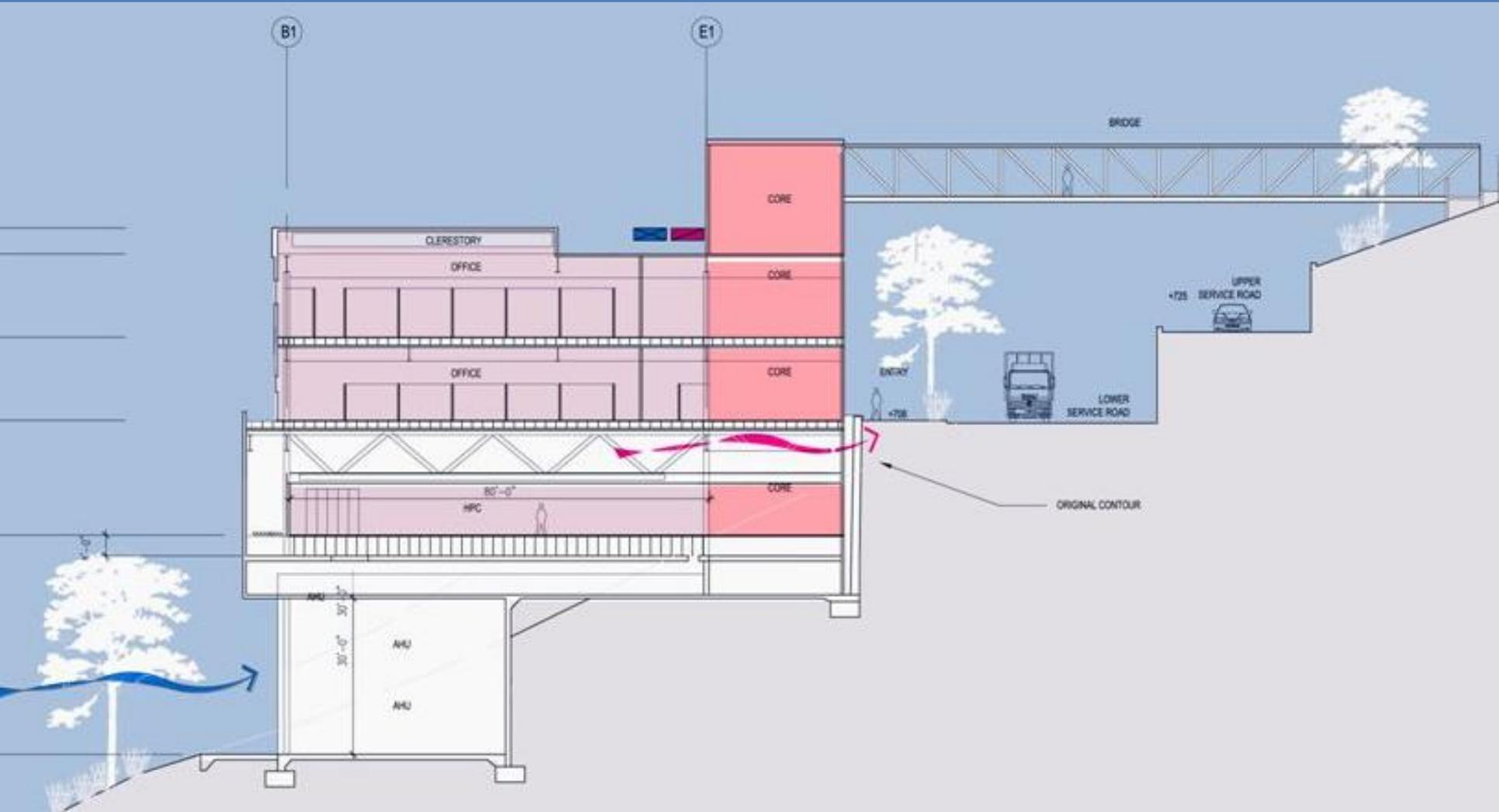

See http://www.datacenterknowledge.com/archives/2008/09/18/intel-servers-do-fine-with-outside-air/
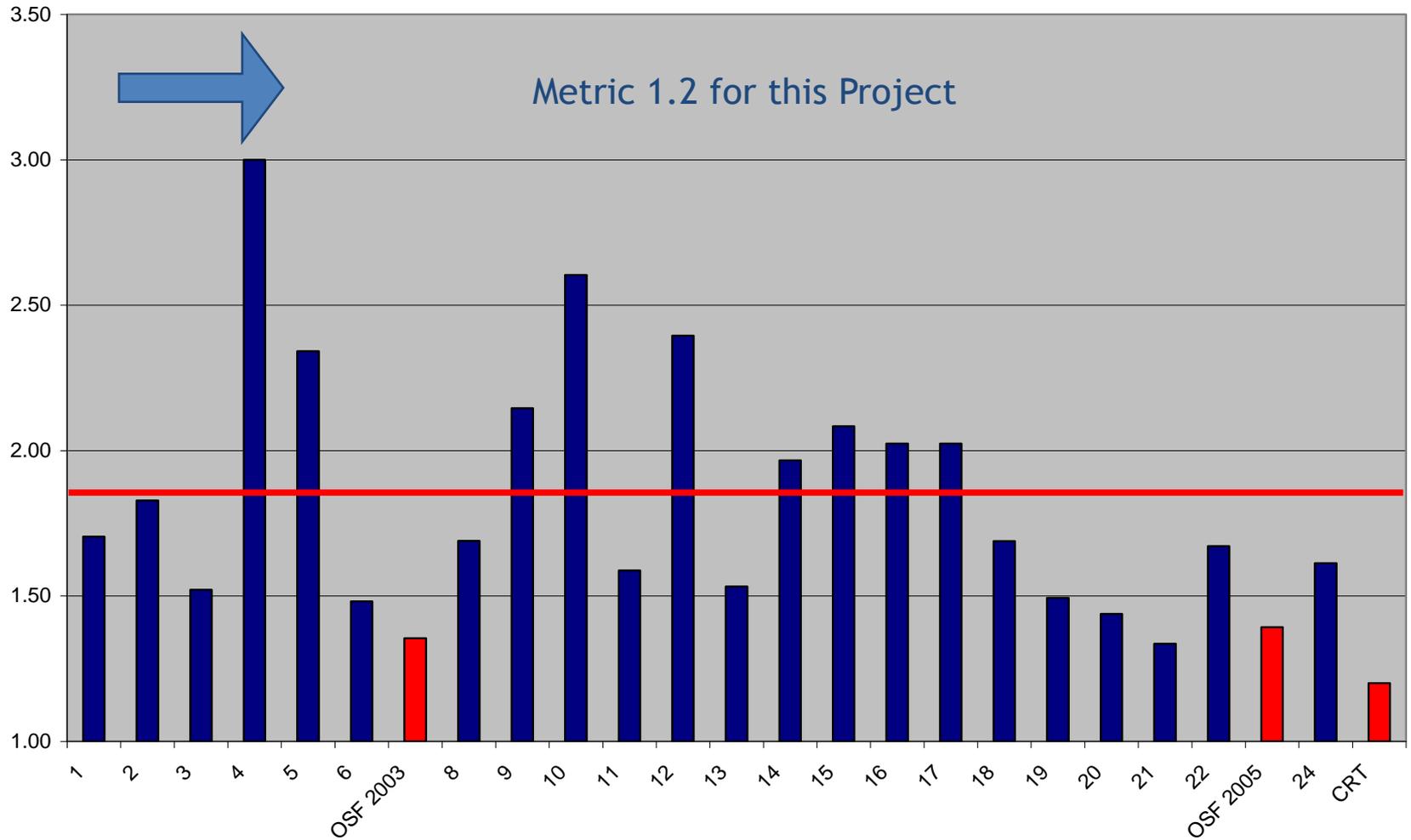
Computational Research and Theory (CRT) Facility

South-West View

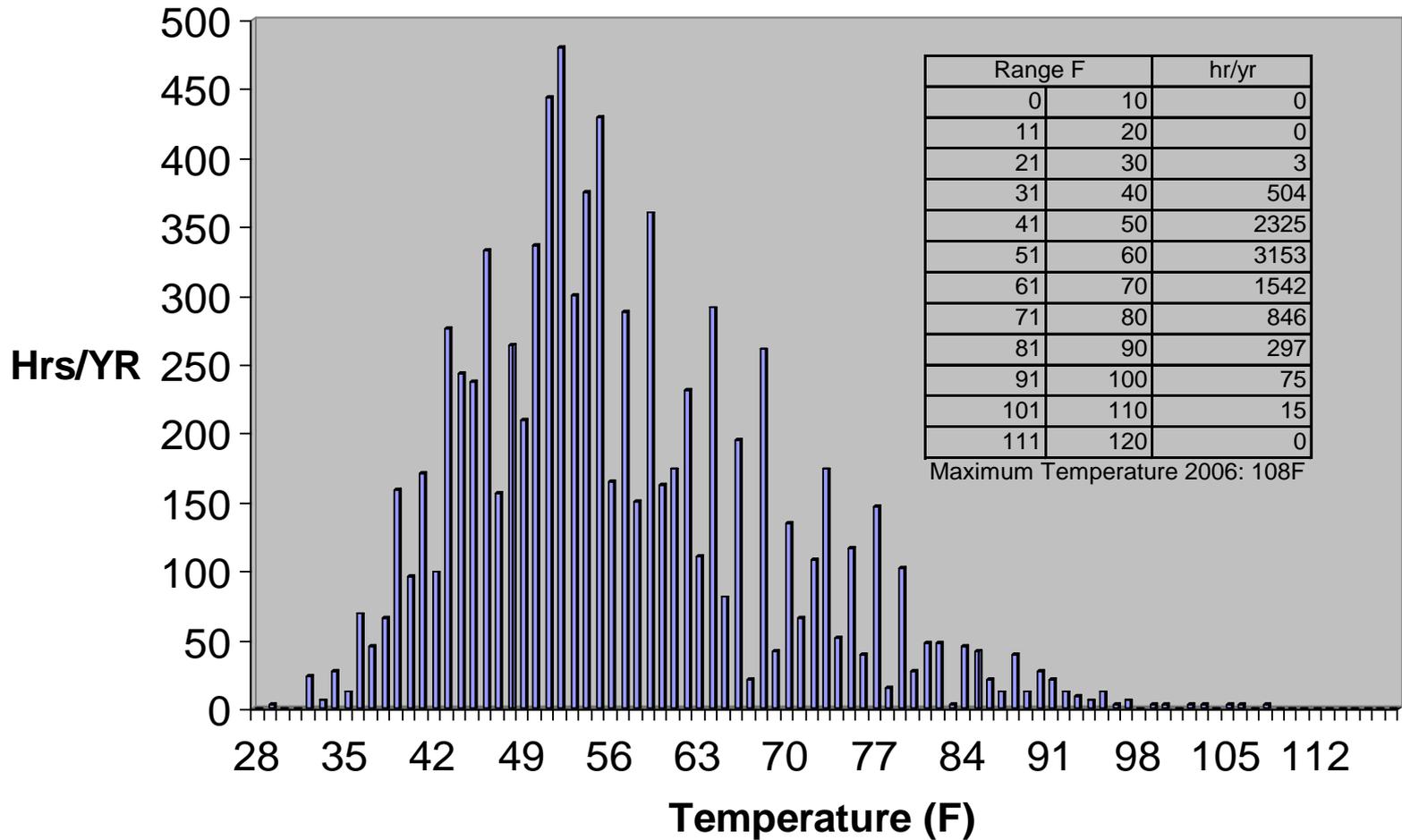B1   E1

BRIDGE

CORE

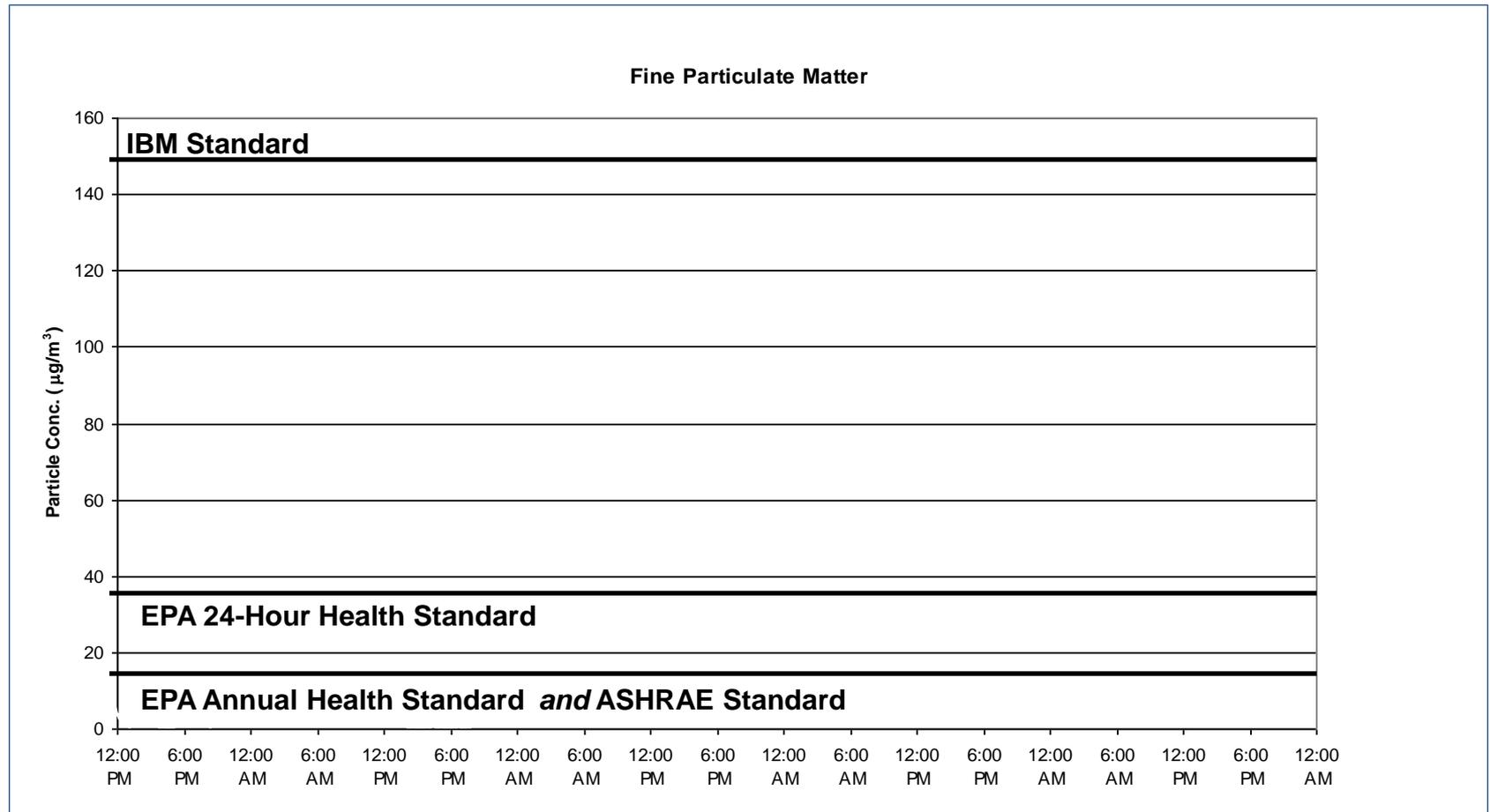CLERESTORY

OFFICE

CORE

OFFICE

CORE

UPPER
SERVICE ROAD

+725

ENTRY

+708

LOWER
SERVICE ROAD

CORE

ORIGINAL CONTOUR

80'-0"

HPC

AHU

30'-0"

AHU

AHU

Total Data Center Power/IT Power

Metric 1.2 for this Project

Berkeley Weather

Range F		hr/yr
0	10	0
11	20	0
21	30	3
31	40	504
41	50	2325
51	60	3153
61	70	1542
71	80	846
81	90	297
91	100	75
101	110	15
111	120	0

Maximum Temperature 2006: 108F

Hrs/YR

Temperature (F)

What about contamination? "My center must be closed."

Fine Particulate Matter

Particle Conc. ($\mu g/m^3$)

- IBM Standard (~150)
- EPA 24-Hour Health Standard (~35)
- EPA Annual Health Standard *and* ASHRAE Standard (~15)

Time axis: 12:00 PM, 6:00 PM, 12:00 AM, 6:00 AM, 12:00 PM, 6:00 PM, 12:00 AM, 6:00 AM, 12:00 PM, 6:00 PM, 12:00 AM, 6:00 AM, 12:00 PM, 6:00 PM, 12:00 AM, 6:00 AM, 12:00 PM, 6:00 PM, 12:00 AM

Outdoor measurements

Outdoor Measurments
Fine Particulate Matter

Indoor measurements

Indoor Measurments
Fine Particulate Matter

IBM Standard

EPA 24-Hour Health Standard

EPA Annual Health Standard *and* ASHRAE Standard

Legend: LBNL, NERSC, Center 3, Center 4, Center 5, Center 6, Center 7, Center 8

Indoor measurements

Indoor Measurments
Fine Particulate Matter
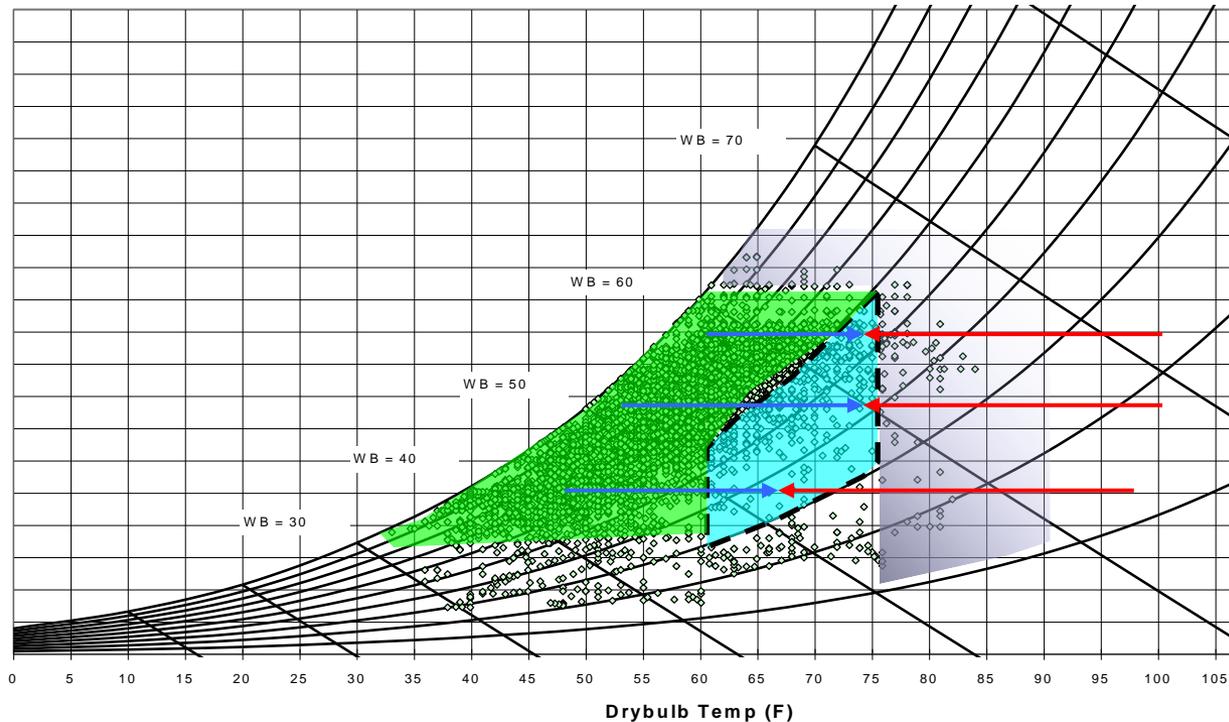
Server specs exceed ASHRAE ranges
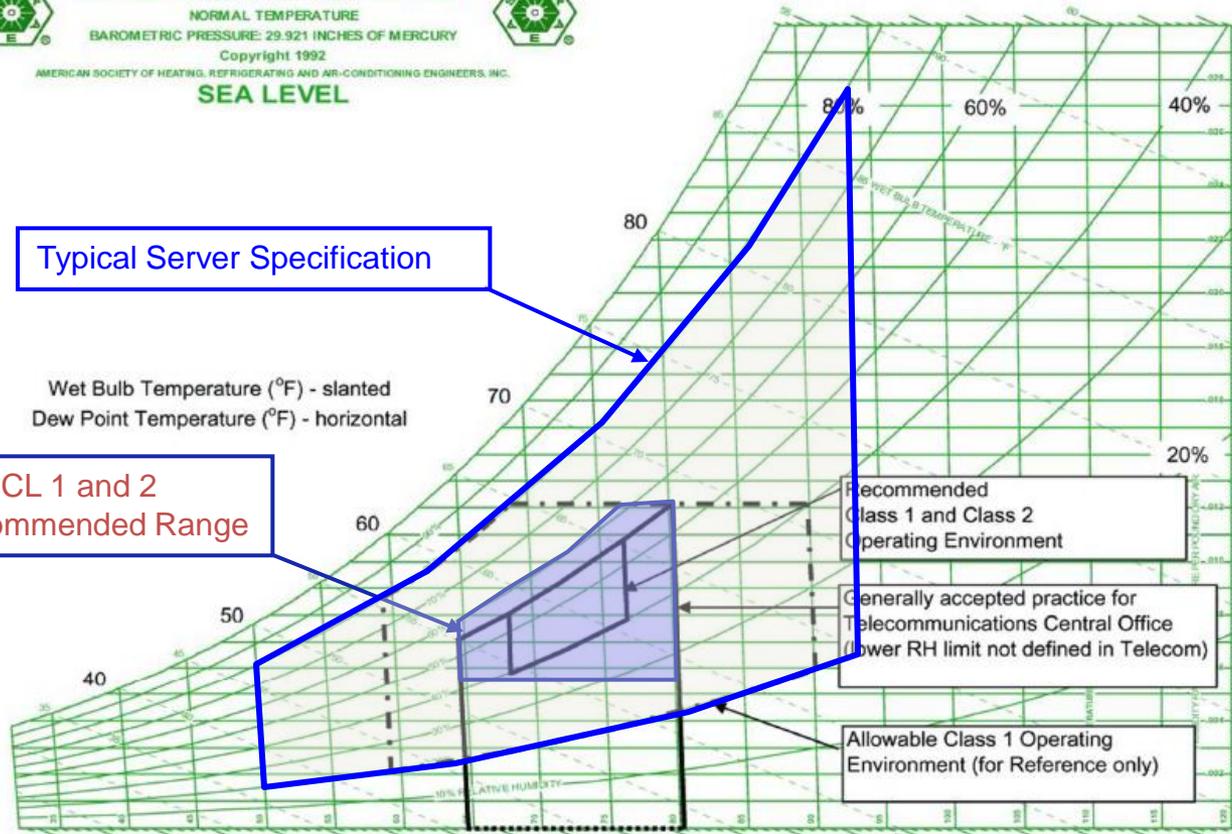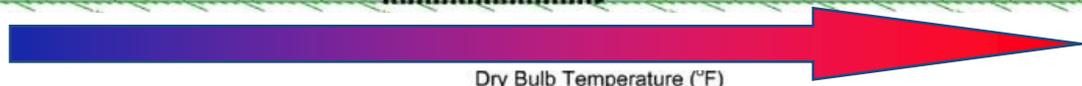
Basis of design

Design Conditions:
Summer 100F DB/ 65 MWB; Winter 37.5F (99.5% Oakland ASHRAE)
CRT design : 68 to 75F DB; 30-60% RH

Annual Psychrometric Chart of Oakland, CA
(relative humidity lines are stepped by 10%,
wetbulb lines by 10 degrees F)

WB = 70
WB = 60
WB = 50
WB = 40
WB = 30

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105

Drybulb Temp (F)

Mechanical design challenges

- **Many generations of supercomputers over several decades**
- **High computing load densities**
  20- 30 kW/rack; 500 W/sft – 1100 W/sft
- **Unknown mix of air, water, or hybrid cooling**
- **Potential independent temperature and humidity requirements**
- **Life Cycle Cost effective**

Need to design for maximum **flexibility**

Design opportunities for efficiency

- **Minimal requirements for Uninterruptible Power Supplies (scientific computing)**

- **Mild climate suitable for economizer cooling**

- **Eventual move to liquid cooling**

- **Use of full ASHRAE TC 9.9 recommended range for temperature and expanded humidity range**

- **In the future with even wider environmental conditions – more use of free cooling**

Predicted HPC performance

- **DCIE of 0.95 based on annual energy**

- **DCIE of 0.88 based on peak**

   (inverse of PUE)