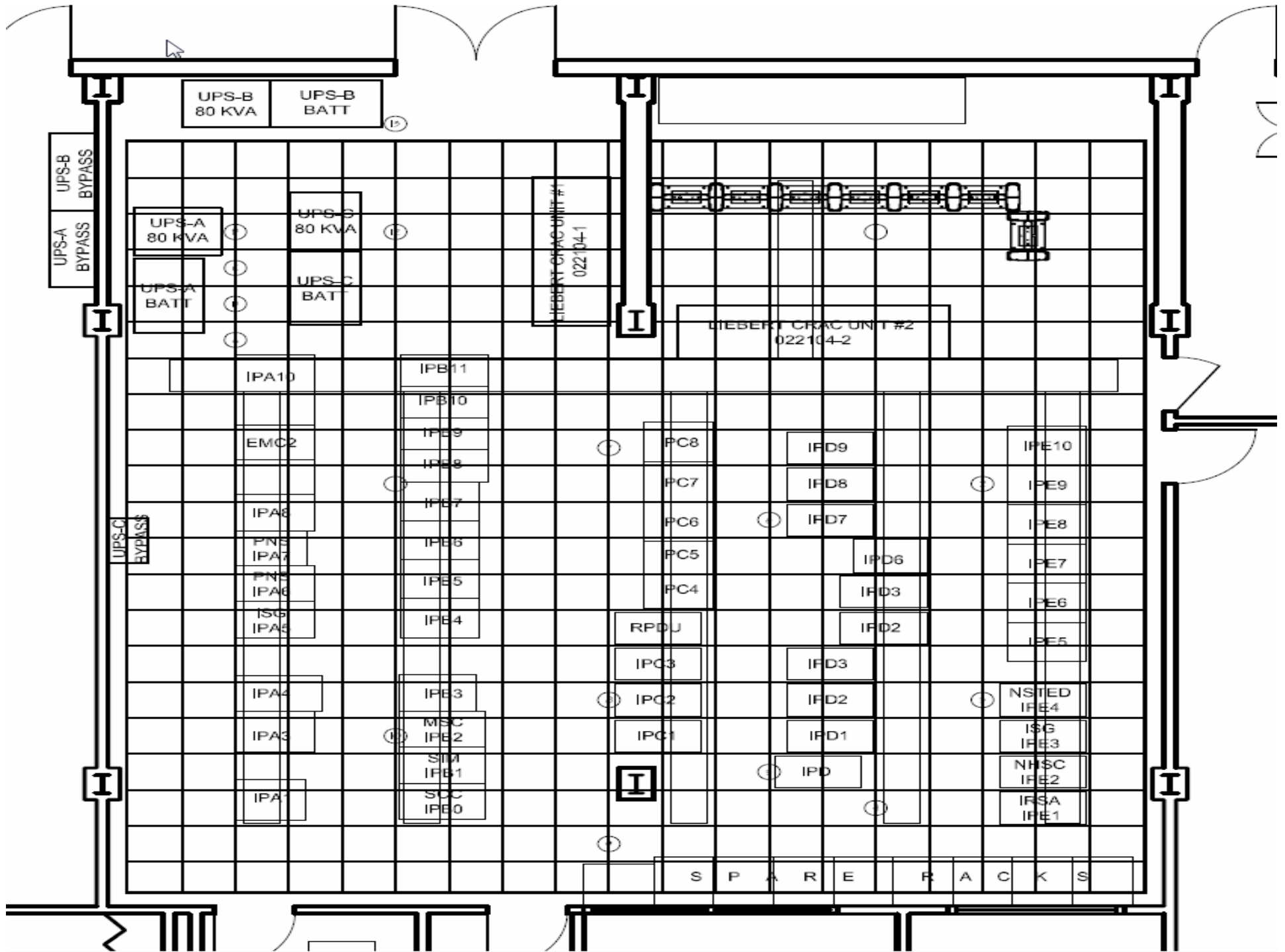


IPAC Energy Efficient Data Centers and Management Tools

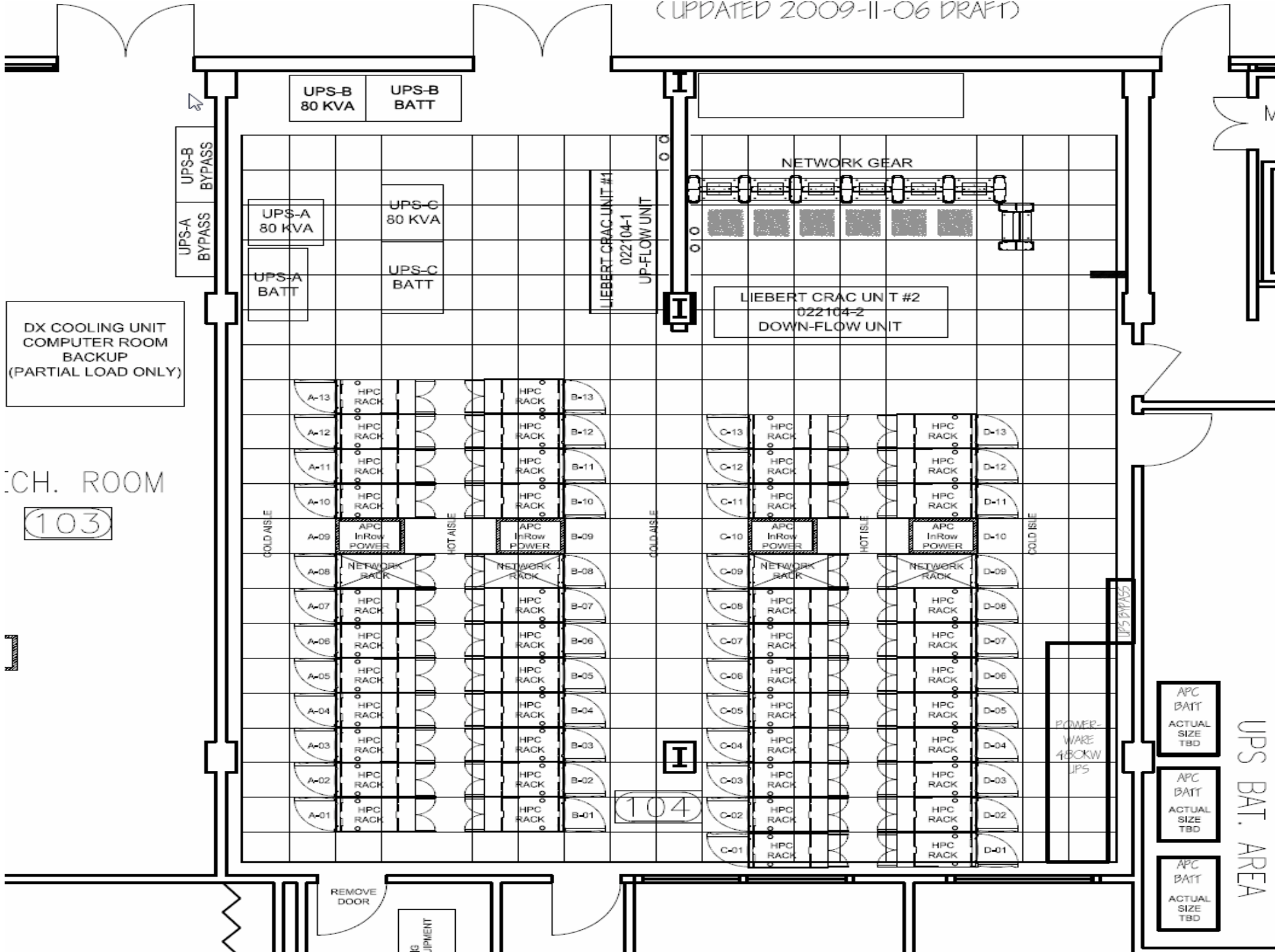
The background of the slide is a green-tinted image. On the left side, there is a wireframe representation of a human head in profile, facing right. The head is composed of a grid of lines. On the right side, there is a detailed pattern of a circuit board, showing various traces, pads, and components. The overall color scheme is a monochromatic green.

Implement Data Center Best Practices

- Why Standardize?
 - Necessary for HACS or CACS
- Jigsaw Puzzle
 - Racks need to be same
 - Racks were different sizes and shapes
 - Close off hot isle with containment system.
 - Easy to expand or add additional rack space.
 - Managing Power Distribution
 - 2 each power strips per rack
 - A/C Placement
 - APC units fit within layout.



(UPDATED 2009-11-06 DRAFT)

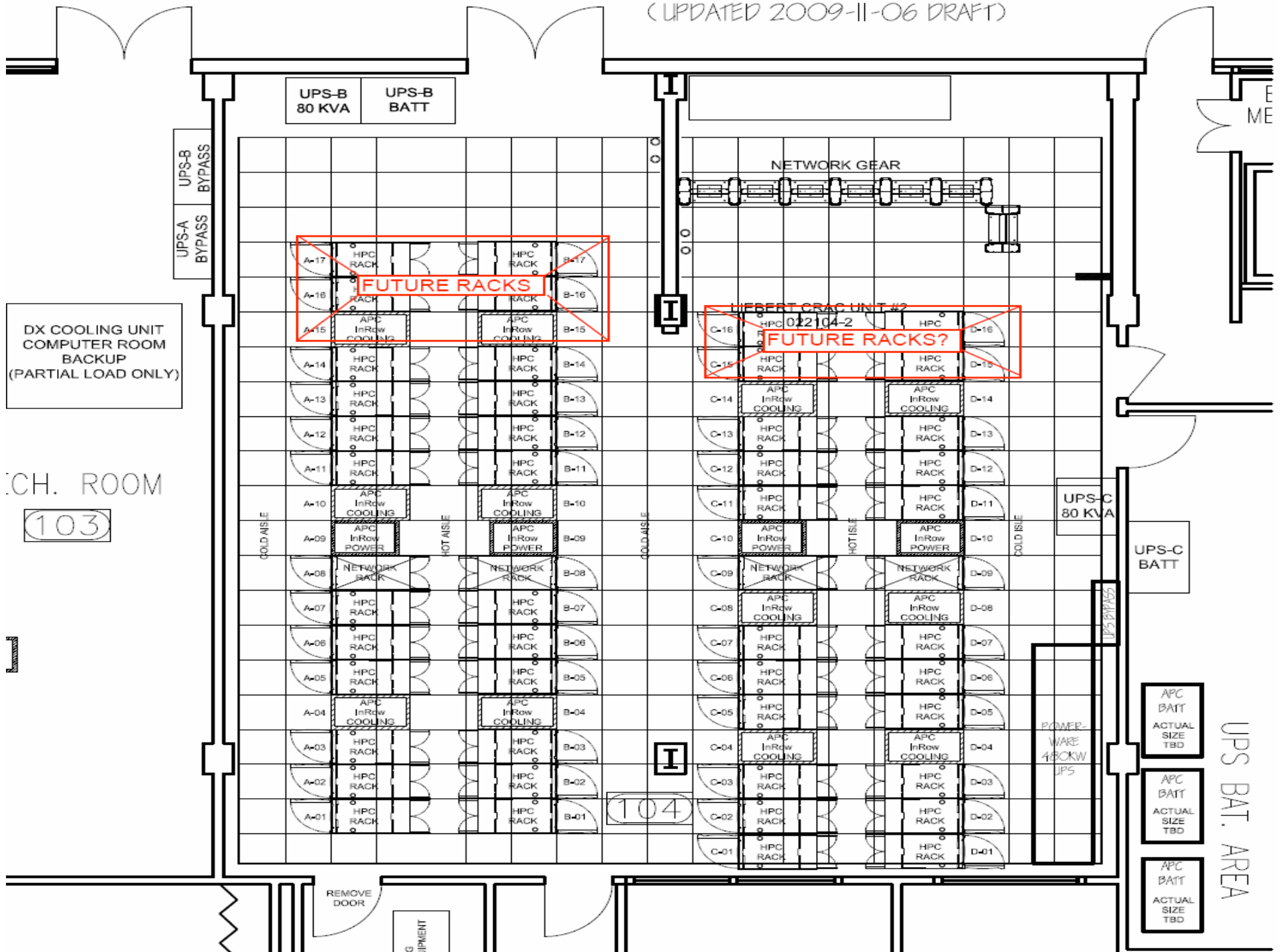


CH. ROOM
103

104

UPS BAIT AREA

(UPDATED 2009-11-06 DRAFT)

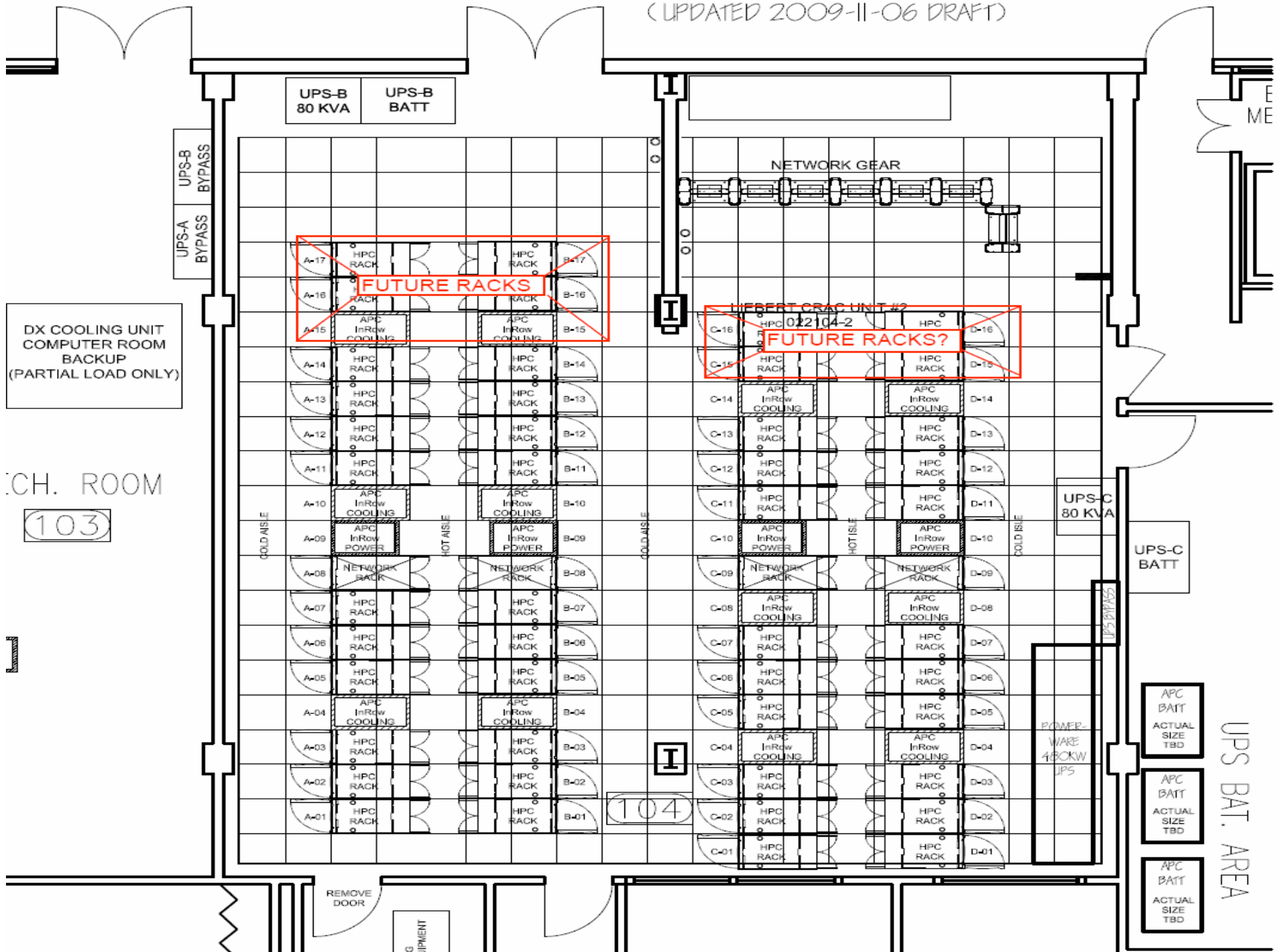


HACS vs. CACS

What's remaining to be done?

- Install ceiling fans in HACS
 - Why?
- Relocate UPS “C”
 - Why?

(UPDATED 2009-11-06 DRAFT)



Centralized Management Tools

- Who needs them and why?
- Remote Monitoring
 - Alerting
 - SMS “Paging”,
 - MMS
 - Email
 - Archive
- Many Managed Devices:
 - 5 each UPS Units 4 are 80 KVA 1 a 450 KVA unit
 - 17 each 10 Ton A/C Units
 - 6 each PDU 80 KVA each
 - 9 each Environmental Monitoring Devices
 - 108 each RPDU 2 in each rack 5 KVA
 - 28 each RPDU 2 in each rack 10 KVA

Device Groups

- All Devices
 - Unassigned
 - IPAC
 - 104 Computer Room
 - 257 Computer Room
 - 330 Computer Room
 - Keith Spaulding Building
 - KS & MR Computer Rooms
 - Morrisroe Building
 - Network Closets

Device View | Map View | *Device Sensor Repo | *Device Sensor Repo | *Device Sensor Repo | *Device Sensor Repo

Search Clear 193 of 193 devices shown

Type	Status	Parent Device	Model	Serial Number
A/C	Normal	ISXCentral (InfraStruXure Central)	InRow Full-Rack	YK0849110017
A/C	Normal	ISXCentral (InfraStruXure Central)	InRow Full-Rack	UK0950211599
A/C	Normal	ISXCentral (InfraStruXure Central)	InRow Full-Rack	YK0849110026
A/C	Normal	ISXCentral (InfraStruXure Central)	InRow Full-Rack	YK0846110085
UPS	Normal	ISXCentral (InfraStruXure Central)	Silcon DP380E	QE0121150003
UPS	Normal	ISXCentral (InfraStruXure Central)	Silcon DP380E	SE0124000238
A/C	Normal	ISXCentral (InfraStruXure Central)	Npower	
UPS	Normal	ISXCentral (InfraStruXure Central)	POWERWARE 9395	
SNMP Device	Normal	ISXCentral (InfraStruXure Central)		
SNMP Device	Normal	ISXCentral (InfraStruXure Central)		
PDU	Normal	ISXCentral (InfraStruXure Central)	0M-5103	PI0835330836
PDU	Normal	ISXCentral (InfraStruXure Central)	0M-5103	PI0833130692
PDU	Normal	ISXCentral (InfraStruXure Central)	0M-5103	PI0833130708
PDU	Normal	ISXCentral (InfraStruXure Central)	0M-5103	PI0833130699
PDU	Normal	ISXCentral (InfraStruXure Central)	0M-5103	PI0840330021
PDU	Normal	ISXCentral (InfraStruXure Central)	0M-5103	PI0910131694
WallBotz	Normal	mrb13-netbotz.ipac.caltech.edu	WallBotz 500	00:02:D3:02:F9:9
Camera Pod	Normal	mrb13-netbotz.ipac.caltech.edu	Camera Pod 120	NB007107020050
Sensor Pod	Normal	mrb13-netbotz.ipac.caltech.edu	Sensor Pod 120	NB007206160172
WallBotz	Normal	mrb13-netbotz.ipac.caltech.edu	WallBotz 500	00:02:D3:02:F9:9
Sensor Pod	Normal	mrb13-netbotz.ipac.caltech.edu	Sensor Pod 120	NB007206160192
Sensor Pod	Normal	mrb13-netbotz.ipac.caltech.edu	Sensor Pod 120	NB007206320023
Camera Pod	Normal	mrb13-netbotz.ipac.caltech.edu	Camera Pod 120	NB007106130987
Camera Pod	Normal	mrb13-netbotz.ipac.caltech.edu	Camera Pod 120	NB007106500030

Active Alarms

Search Clear 0 of 0 alarms shown [Alarm Details](#)

- PDU Monitoring**
 - panel output
 - main input
 - alarm setup
- PDU Breakers**
 - input breakers
 - bypass status
- PDU Info**

Panel Output

Output Measurements				
	L1-2	L2-3	L3-1	
Voltage:	206 V	206 V	208 V	
	L1	L2	L3	N
Voltage:	120 V	119 V	120 V	
Current:	152 A	155 A	124 A	005 A
	L1	L2	L3	Total
Power:	16.5 kW	17.8 kW	14.3 kW	48.7 kW
Apparent Power:	18.1 kVA	18.4 kVA	14.8 kVA	51.3 kVA
Power Factor:	0.90	0.96	0.95	0.94
Frequency:	60.0 Hz			

- ! Alerting Sensors
- MRB13-NETBOTZ
 - MRB13-NETBOTZ Camera South Door (docked)
 - MRB13-NETBOTZ Sensor North Wall (docked)
 - MRB13-NETBOTZ Camera East Door
 - MRB13-NETBOTZ Camera West Door
 - MRB13-NETBOTZ Hot Isle A&B
 - MRB13-NETBOTZ Liebert1 Return Air

MRB13-NETBOTZ:

Sensor	Reading	Status
Temperature:	66.6 °F	OK
Humidity:	38 %	OK
Dew Point:	40.3 °F	OK
Air Flow:	75 ft/min	OK
Audio:	15	---
Door Switch:	Closed	OK
Fluid Detector (Wet Sensor #1):	Dry	OK
Fluid Detector (Wet Sensor #2):	Dry	OK
Fluid Detector (Wet Sensor #3):	Dry	OK
Camera Motion:	Motion Detected	---
Ethernet Link Status:	Up	OK
External Mic:	Connected	OK
Speakers:	Not connected	---

05/11/2010 02:19:48 PM

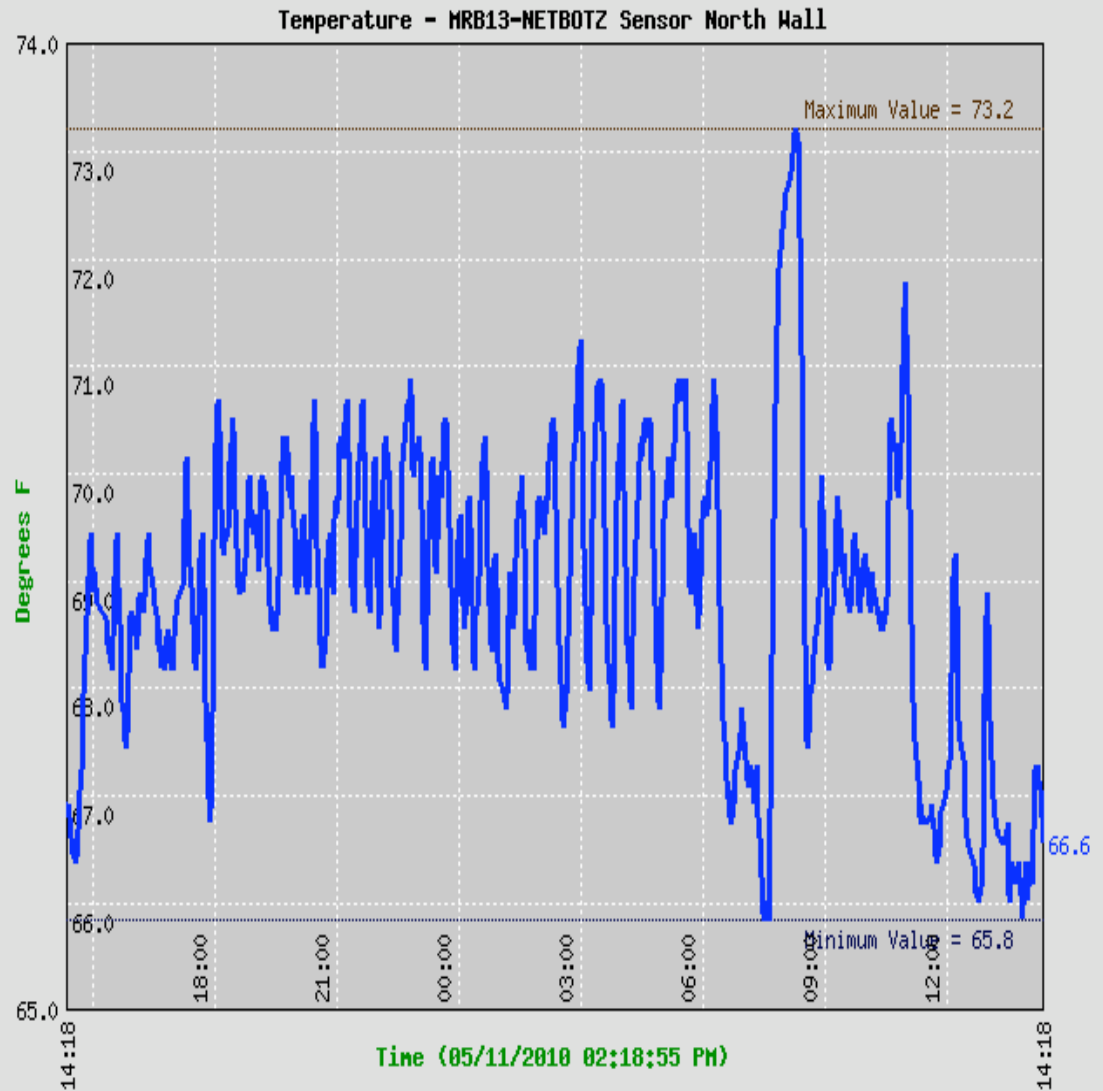
[View Camera](#)

[Launch Advanced View](#)

- [Cameras](#)
- [Alerts](#)
- [Maps](#)
- Graphs**
- [Setup](#)
- [About](#)

Pods: MRB13-NETBOTZ Start Time: 24 Hours Refresh

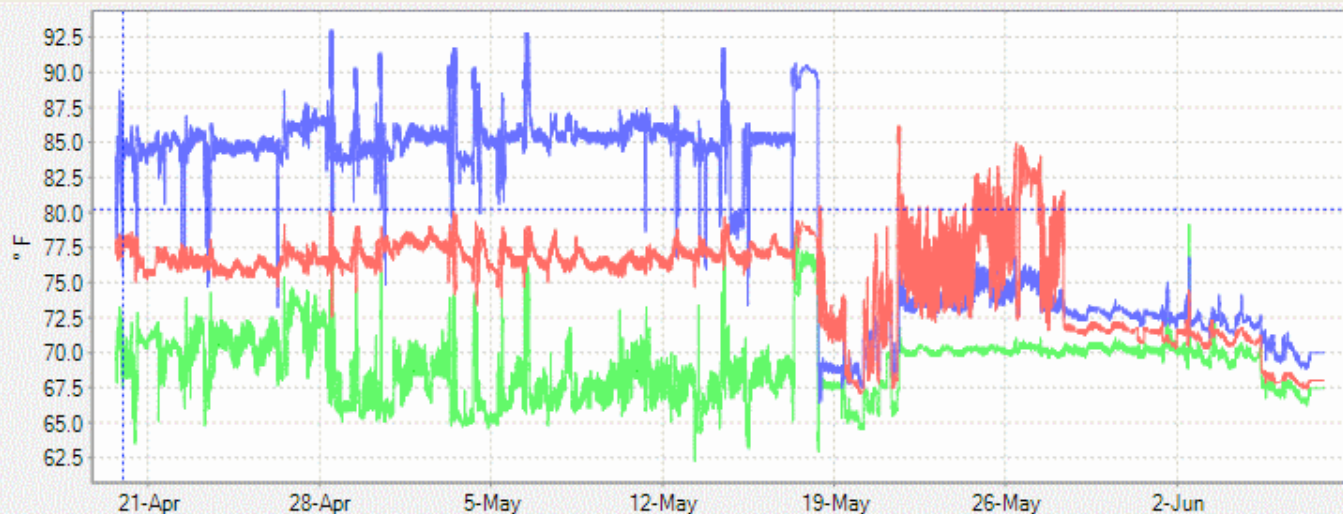
Sensors: Temperature End Time: Present



- All Devices
 - Unassigned
 - IPAC
 - 104 Computer Room
 - 257 Computer Room
 - 330 Computer Room
 - Keith Spaulding Building
 - KS & MR Computer Rooms
 - Morrisroe Building
 - Network Closets

Device Sensor Report

1/7/09 12:00 AM to 6/7/10 11:59 PM



Note: Maximum of 50 sensors shown at a time.

Color	Parent Device	Monitored Device	Sensor
Green	mrb13-netbotz.ipac.caltech.edu	MRB13-NETBOTZ Sensor North Wall	Temperature
Blue	mrb13-netbotz.ipac.caltech.edu	MRB13-NETBOTZ Hot Isle A&B	Temperature
Red	mrb13-netbotz.ipac.caltech.edu	MRB13-NETBOTZ Liebert1 Return Air	Temperature

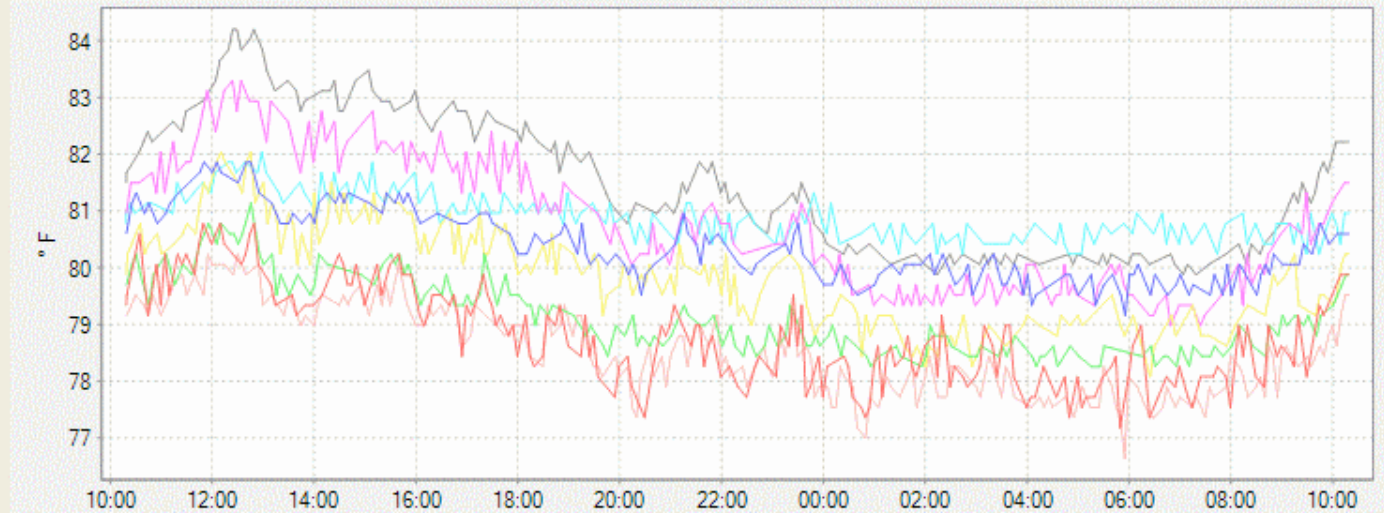
Search Clear 0 of 0 alarms shown

Alarm Details

- All Devices
 - Unassigned
 - IPAC
 - 104 Computer Room
 - 257 Computer Room
 - 330 Computer Room
 - Keith Spaulding Building
 - KS & MR Computer Rooms
 - Morrisroe Building
 - Network Closets

Device Sensor Report

6/6/10 10:18 AM to 6/7/10 10:18 AM



Note: Maximum of 50 sensors shown at a time.

Device	Sensor	Units	Low	High	Aver...
t-apc-ac18(134.4.89.48)	Unit Return Air Temperature	°F	77.18	80.78	78.777
l-apc-ac17(134.4.89.47)	Unit Return Air Temperature	°F	78.26	81.14	79.147
t-apc-ac16(134.4.89.46)	Unit Return Air Temperature	°F	78.08	82.04	79.8
l-apc-ac14(134.4.89.44)	Unit Return Air Temperature	°F	79.16	81.86	80.381
l-apc-ac11(134.4.89.41)	Unit Return Air Temperature	°F	78.98	83.3	80.781
t-apc-ac10(134.4.89.40)	Unit Return Air Temperature	°F	80.24	82.04	80.898
t-apc-ac6(134.4.89.37)	Unit Return Air Temperature	°F	79.88	84.2	81.443

Search Clear 0 of 0 alarms shown

Alarm Details

- All Devices
 - Unassigned
 - IPAC
 - 104 Computer Room
 - 257 Computer Room
 - 330 Computer Room
 - Keith Spaulding Building
 - KS & MR Computer Rooms
 - Morrisroe Building
 - Network Closets

Search Clear 10 of 10 cameras shown



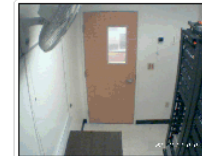
Label: MRB13-NETBOTZ Ca...
Hostname: mrb13-netbotz.i...
Location:
Status: Online
Licensed: Yes
Model: 500 series
Device Groups: 104 Comput...
Description:



Label: MRB13-NETBOTZ Ca...
Hostname: mrb13-netbotz.i...
Location:
Status: Online
Licensed: Yes
Model: 500 series
Device Groups: 104 Comput...
Description:



Label: MRB13-NETBOTZ Ca...
Hostname: mrb13-netbotz.i...
Location:
Status: Online
Licensed: Yes
Model: 500 series
Device Groups: 104 Comput...
Description:



Label: Camera
Hostname: ks231-netbotz.ip...
Location:
Status: Online
Licensed: Yes
Model: 320 series
Device Groups: KS 2nd Floor,...
Description:



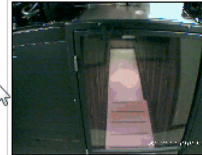
Label: Camera
Hostname: ks330a-netbotz.i...
Location:
Status: Online
Licensed: Yes
Model: 320 series
Device Groups: KS 3rd Floor,...
Description:



Label: Camera
Hostname: ks330-netbotz.ip...
Location:
Status: Online
Licensed: Yes
Model: 320 series
Device Groups: KS 3rd Floor,...
Description:



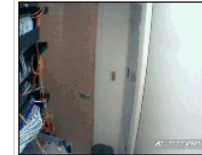
Label: KSC03-NETBOTZ Ca...
Hostname: ksc03-netbotz.ip...
Location:
Status: Online
Licensed: Yes
Model: 500 series
Device Groups: KS 3rd Floor,...
Description:



Label: Camera
Hostname: mr257s-netbotz.i...
Location:
Status: Online
Licensed: Yes
Model: 320 series
Device Groups: MR 2nd Floo...
Description:



Label: Camera
Hostname: mr257n-netbotz...
Location:
Status: Online
Licensed: Yes
Model: 320 series
Device Groups: MR 2nd Floo...
Description:



Label: Camera
Hostname: ks412-netbotz.ip...
Location:
Status: Online
Licensed: Yes
Model: 320 series
Device Groups: Network Clo...
Description:



IPAC - PUE Calculation and Chilled Water Usage Study

10/11/2009

PUE Calculation	IPAC - 104 (Existing)	Beowulf (Pre-Capip)	S. Mudd 250
Time Stamp:	8/10/2009	Sep-09	01/29/2009 - 10:00 AM
Sever Load	NA	62.32%	NA
IT Load One (kW)	92	126	14.6
IT Load Two (kW)	0	49	0
CRAC Units (kW)	19.7	9	2
Chilled Water (kW)	66	188	5
Lighting (kW)	1.7	3.2	0.75
PUE	1.95	2.14	1.53
(+/- 5% for Losses)	0.10	0.11	0.08

RATES		
Electric	\$0.1500	\$/ kWh
Plant Utility Cost	\$0.0720	\$/ 1000 BTUs

IPAC 104 Annual Operating Cost		
Electrical, IPAC-104	\$120,888	
IPAC - 104 Chilled Water Utility	\$69,379	(estimated)
Total	\$190,267	

IPAC Bldg Annual Electric Cost \$242,608

	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2017	FY2018	FY2019-BEP	FY2020
Project Cost	(\$130,000)									
Energy Savings	\$13,553	\$14,230.56	\$14,042.08	\$15,699.19	\$16,473.65	\$17,297.33	\$18,162.20	\$19,070.31	\$20,023.82	
Project Economics	(\$130,000)	(\$116,447)	(\$102,217)	(\$87,274)	(\$71,586)	(\$55,112)	(\$37,814)	(\$19,852)	(\$682)	\$19,442

* Assumes 5% Annual Increase in Electric Rates

ENERGY CALCULATION Methodology

Feasibility Analysis - Methodology utilizes PUE improvement for CHW reduction

PUE Improvement from based on observed performance in S Mudd Rm 250 with Hot/Cold Aisle Configuration

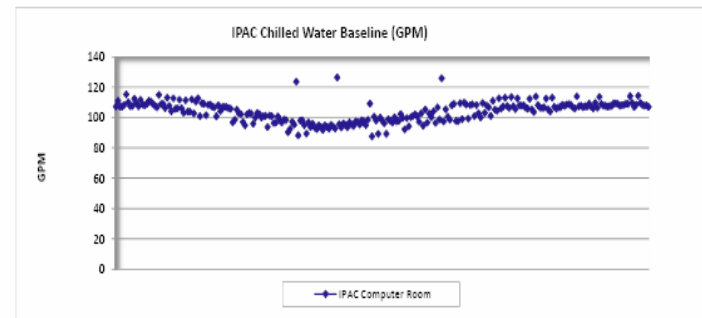
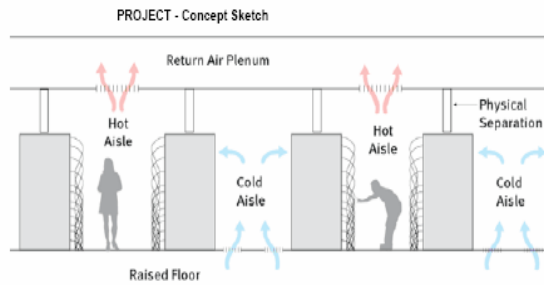
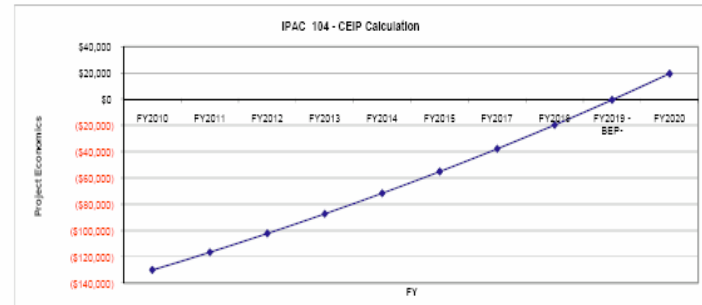
PUE Proposed	1.53	
CHW Proposed	X	
PUE Existing	1.95	
IT Existing (kW)	92	
CRAC Existing (kW)	19.7	
Lighting Existing (kW)	1.7	
CHW Proposed (kW)	42	(Hold PUE value constant - solve for CHW kW)

Chilled Water Flow Improvement

CHW (kW) @ PUE 1.95	66	
CHW (kW) @ PUE 1.53	51	(CHW kW Improvement is in-line with Case-Studies on Efficiency Improvements from Hot/Cold Separation Projects)
CHW Annual (\$) @ PUE 1.95	\$69,379	
CHW Proposed Annual (\$) @ PUE 1.53	\$53,435	
Annual Operating Savings	\$13,553	

Project Cost (\$)	\$130,000
SPB	9.6

DRAFT



Data Center Cooling Challenges