Server Room Airflow Management Overview

Objective

To learn about server-room airflow management (AFM) energy saving opportunities

Almost every business has servers for phone and computer equipment.

Table of Contents

Background

- Servers and server-rooms can be found in most buildings
- Data centers and server-rooms can be 5%+ of utility loads
- Many server-rooms, colocation and multi-tenant data centers
- Airflow management has been an accepted practice since 2007
- Airflow management is being done in most large data centers
- Airflow management is NOT being done in most server-rooms, colocation and multi-tenant data centers

Lots of these

Targeting Server Rooms

Space Type	Example
Server Closet	Small business or school
Small Server Room	Medium sized business with less than 400 staff
Medium Server Room	Large business, hospital or university
Large Server Room	Corporate data center, or medium sized colocation facility
Enterprise-Class Data Center	Internet company server farm, state data center or large colocation facility

What is a Server Room?

Server-rooms are typically:

- Located in a commercial building;
- Are between 200 and 5,000 square feet;
- Have between 4 and 250 servers;
- Need between 10 and 250 tons of cooling capacity;
- Use between 150,000 and 3,750,000 kWh annually.

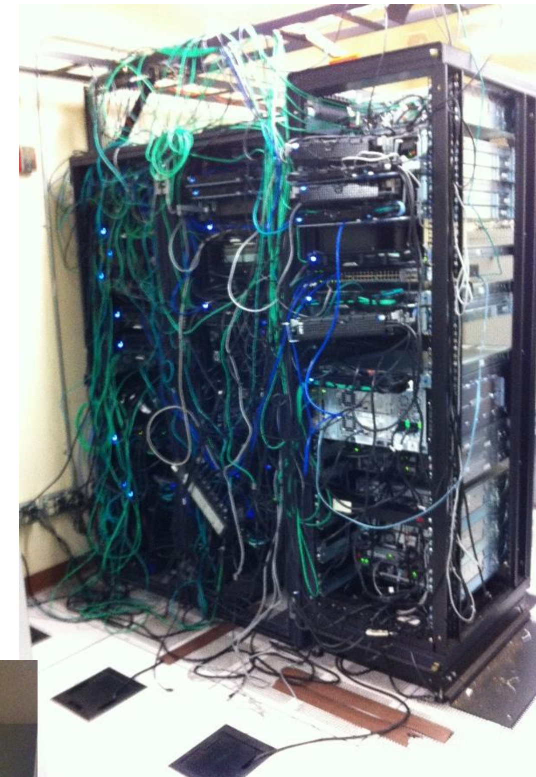
Server Rooms

- Server rooms found in most medium/ large commercial buildings
- **VERY** Energy intensive
- Can’t manage building energy use without managing the server room

Facility Type	% of Data Center in Building	% of Building Electric used by Data Center
Municipal Office Bldg.	0.8%	23.1%
Regional Office Bldg. Software Co.	3.0%	26.7%
Corporate Office Travel Company	1.8%	29.5%
School District Administration Bldg.	1.5%	32.7%

Efficiency Perception

Reality –lots of opportunity



Server Room HVAC Systems

- Computer room air conditioners (CRACs): split-system DX air conditioning units
- Computer room air handlers (CRAHs): air handling units which use cold water from a central chiller plant
- Other: Some small closets use the general building cooling system.

What is Airflow Management?

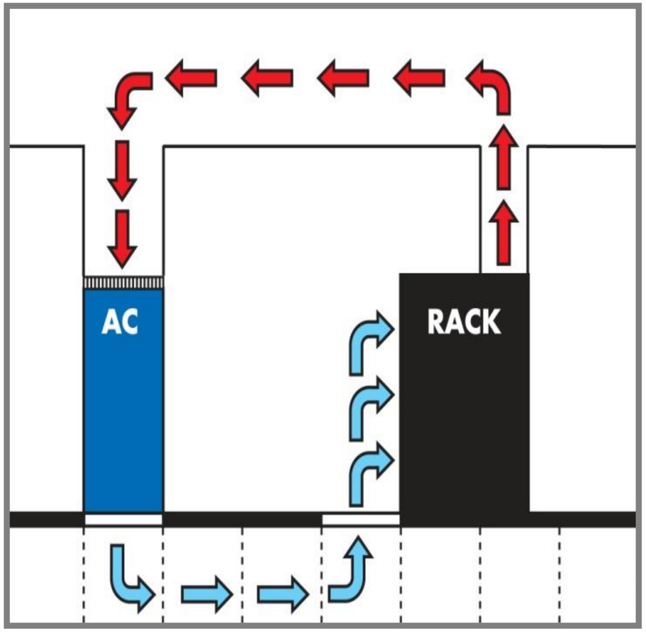
Airflow Management reduces HVAC energy use, while maintaining server cooling

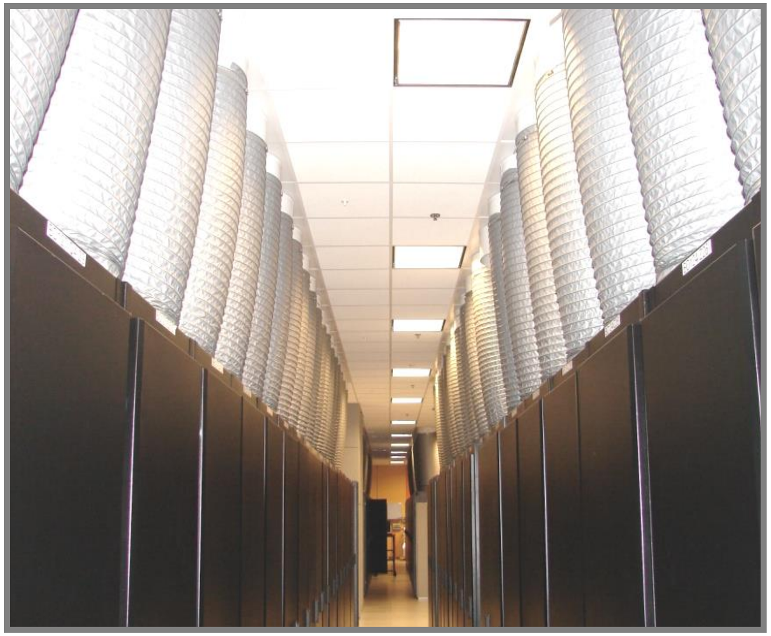
Common strategies include:

- Optimizing under-floor air flow (UAF) systems,
- Adding rack blanking panels,
- Hot or cold isle containment,
- Raising temperature set points, and
- Adding VSDs and controls to CRACs and CRAHs.

What is Airflow Management?

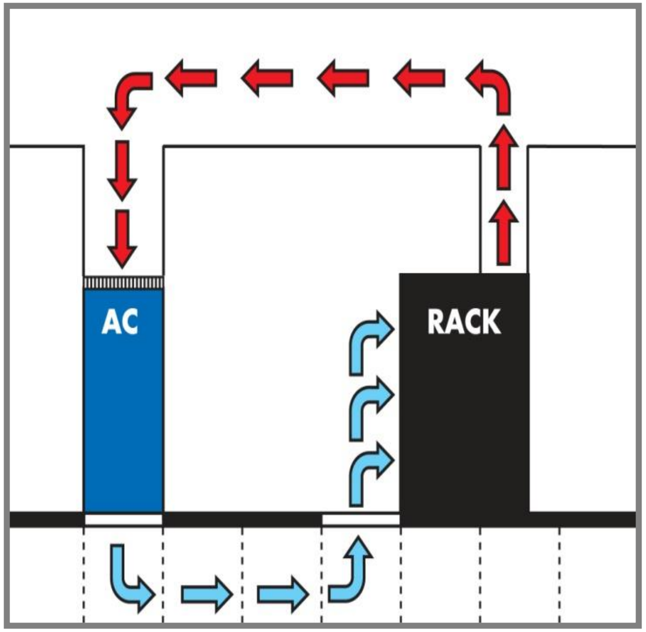
Cold aisle containment

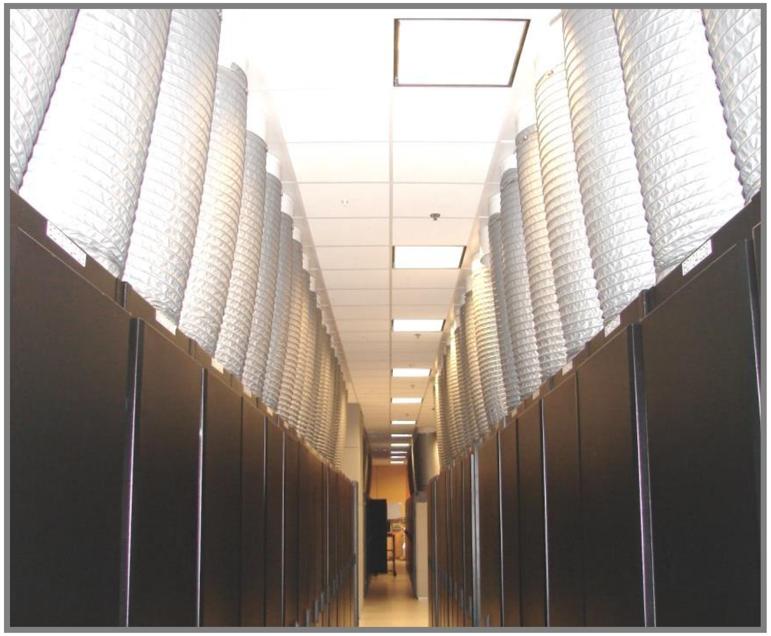




What is Airflow Management?

Cold aisle containment





Why Airflow Management?

For utilities AFM represents energy savings:

- Server rooms represent 261 aMW of potential in the 7th Power Plan.
- Airflow management can save up to 50% of data center HVAC energy use.

For owners AFM represents cost savings and:

- fewer hot spots, better operational visibility, safer and more reliable operation, lower maintenance and increased capacity.

Server-Room Airflow Management Calculator Overview

This calculator is intended to provide a quick, robust estimate of server-room baseline HVAC energy use, energy use with Airflow Management and energy savings, suitable for potential utility incentives

Hurdles for Utility Incentives

- Airflow efficiency measures are well documented and accepted
- Estimating ROI of AFM implementation can be difficult
  - Lack of data about equipment performance
  - Lack of monitoring in many facilities
  - Lack of understanding about savings associated w/ AFM
    - AFM doesn't produce savings it enables changes that produce savings
- Operators are often not experts in energy consumption
- Customized engineering calculations
  - Time consuming & costly
  - Similar effort for small server rooms and large server rooms
- Utility incentive not always enough for implementation

Why develop an airflow tool?

- Significant opportunity for improved efficiency
- Similar measures and HVAC equipment involved
- Custom calculation approach for each project is too expensive and cumbersome to gain traction
- No standardized method available for utilities or trade allies to offer incentives for airflow management

Tool objectives

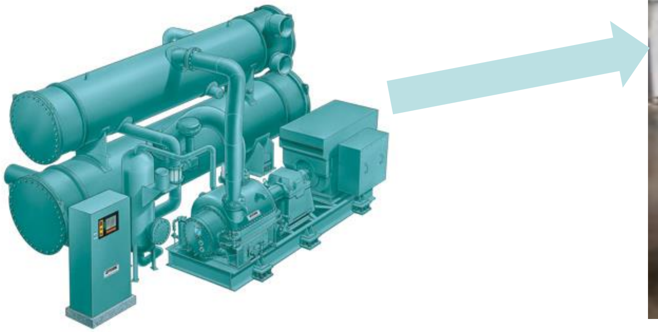
- Cost-effective method to calculate energy savings for small data centers
- Address common improvements to airflows and cooling system operations in smaller data centers – Supply fans, chillers, Dx CRAC units
- Estimate energy savings for potential utility incentive funding
- Document methodology and assumptions for utility program evaluators

Calculator Applicability

- Data centers with 50-750 kW of IT equipment
- Racks with an average power density of 2 – 5 kW per rack
- Maximum power density of 10 kW per rack

Cooling system types

- DX RTU
- DX CRAC
  - Air-cooled
  - Water-cooled
  - Glycol-cooled
- CHW CRAH



What is the airflow calculator tool?

- A spreadsheet tool that calculates annualized energy and peak demand changes resulting from HVAC system changes enabled by measures to improve airflows in a data center.
- ONLY meant to provide reliable estimates of energy savings for common airflow management improvements
- NOT For:
  - Data center design
  - Thermal management

What it does:

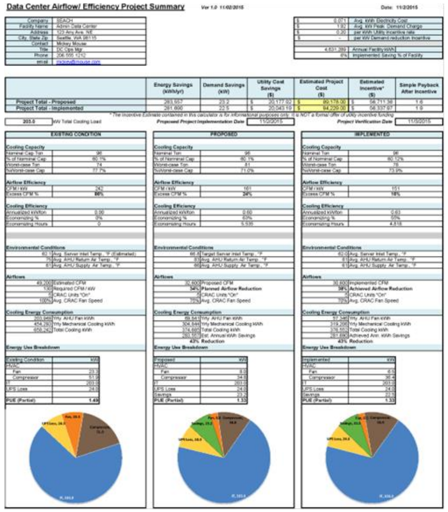
- Tool estimates cooling energy use based on user supplied inputs:
  - Cooling load
  - Operating set points,
  - Inventory of existing cooling equipment
  - TMY3 hourly climate data
- Existing (base line), Proposed, Implemented scenarios compared for potential and actual savings estimates

CALCULATOR

Example

Example use case

- Large admin bldg. server room
  - 4,000 SqFt (5% of Bldg. SqFt)
  - 200 kW IT Equipment
  - >55% of annual bldg. kWh use



- Processed as a custom incentive
  - 20-30 hrs. spent estimating energy use, savings
- Calculator tool applied to project data
  - 25 minutes spent for data entry
  - Tool results: 3% less than actual kWh savings

Cooling Loads, Facility Details

Ver 1.0 11/02/2015

Project # SEACH-Admin Test | Calculator Completed By: T B | Date: 11/2/2015

Facility Information

Company	SEACH
Facility Name	Admin Data Center
Address	123 Any Ave. NE
City, State Zip	Seattle, WA 98115
Contact	Mickey Mouse
Title	DC Ops Mgr.
Phone	206.555.1212
email	mickey@mouse.com

Uninterruptible Power Supply (UPS) Power & Cooling Load Inputs

	UPS kW Capacity	UPS Input kW	UPS Out kW	kW Loss	Load factor	Efficiency
UPS 1	270	114.7	103	11.7	42.5%	89.8%
UPS 2	270	108.3	96	12.3	40.1%	88.6%
UPS 3				0	0.0%	0.0%
UPS 4				0	0.0%	0.0%
TOTALS	540	223	199	24	41.3%	89.2%

Utility Cost / Incentive Inputs

Avg. kWh Electricity Cost	$ 0.071
Avg. kW Peak Demand Charge	$ 1.92
per kWh Utility Incentive rate	$ 0.20
per kW Demand reduction Incentive	
Annual Facility kWh	4,631,289

Data Center Inputs

203	Critical Cooling Load Inside Data Center - kW
3,000	Square Feet
500	Max. Critical Load - kW
8,760	Annual Operating Hours
No	UPS Units in Data Center?
Seattle, WA	Climate City
2%	% Of Misc.Heat Gain (PDU losses, plug loads)
Blade/ High Density	mary IT Equipment Type
24	Primary IT Equipment Delta T (°F)
130	CFM / kW Airflow required for Critical Cooling load (Typical)

Existing (base line) operations

- HVAC system type
- Current operating conditions

EXISTING COOLING SYSTEM INPUTS *Ver 1.0 10/02/2015*

Current Level of Airflow Management — Description

1	Blanking Panels, Dedicated H/C Aisles, Perf tiles cold rows only

Restore Defaults

1. RA Temp and Humidity are required
2. Any changes to inputs need to be recalculated for results to be updated

Total Demand	Total Energy
kW	kWh
83.4	658,242

Calculate

AHU	Type	Economizer?	Nominal Tons	Fan Type	Cooling Load	On /Off	RAT setpoint					Worst Case Capacity
			Tons Capacity		kW	0=Off; 1=On	Return Air Temp Setpoint	Return Air Relative Humidity	Avg Supply Air Temp	Actual Delta T	Glycol %	Tons
CRAC 1	Water-cooled CRAC with DX cooling	No	20	Scroll fan without VFD	42	1	73	50%	67	6		15
CRAC 2	Water-cooled CRAC with DX cooling	No	20	Scroll fan without VFD	42	1	75	50%	55	20		15
CRAC 3	Water-cooled CRAC with DX cooling	No	20	Scroll fan without VFD	42	1	78	50%	61	17		16
CRAC 4	Water-cooled CRAC with DX cooling	No	20	Scroll fan without VFD	42	1	78	50%	52	26		16
CRAC5- Lab	Water-cooled CRAC with DX cooling	No	16	Scroll fan without VFD	34	1	71	50%	68	3		12
Totals			96		203	5						74

Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non-econ
kW	kWh	kW/ton		
12.6	96,208	0.91	0%	100%
12.4	94,564	0.90	0%	100%
12.1	92,471	0.88	0%	100%
12.1	92,471	0.88	0%	100%
10.4	78,579	0.93	0%	100%
59.6	454,293			

Fan Inputs

AHU	Type	Fan								VFD or ON/OFF Cycling				CFM
		HP	Fan Static Pressure (in. H2O)	RPM	Motor Type	Motor Enclosure	Belt Type	Motor Efficiency	Fan Efficiency	Belt Efficiency	Speed% or Cycle ON%	VFD Efficiency	Rec. Speed% or ON%	Affinity Law Exponent	Estimated
CRAC 1	Water-cooled CRAC with DX cooling	7.5	1.97	1,800	Premium	ODP	Standard V-belt	91%	56%	95%					10,200
CRAC 2	Water-cooled CRAC with DX cooling	7.5	1.97	1,800	Premium	ODP	Standard V-belt	91%	56%	95%					10,200
CRAC 3	Water-cooled CRAC with DX cooling	7.5	1.97	1,800	Premium	ODP	Standard V-belt	91%	56%	95%					10,200
CRAC 4	Water-cooled CRAC with DX cooling	7.5	1.97	1,800	Premium	ODP	Standard V-belt	91%	56%	95%					10,200
CRAC5- Lab	Water-cooled CRAC with DX cooling	5	1.97	1,800	Premium	ODP	Standard V-belt	90%	56%	95%					8,400
Totals		35													49,200

Peak Demand	Annual Energy	Avg Demand
kW	kWh	kW
4.9	42,162	4.8
4.9	42,162	4.8
4.9	42,162	4.8
4.9	42,162	4.8
4.1	35,303	4.0
23.8	203,949	23.3

Airflow CFM
Required CFM
26,387
Available CFM
49,200
Excess CFM
86%

Chiller Inputs

Condenser Type	Compressor Type	Chiller Capacity	Chiller Efficiency (full load)	Chilled Water Load	Waterside Economizer?	CHWST setpoint	CWST setpoint	Minimum allowable lift	Design Wetbulb Temp	Design approach (cooling	Design approach (HX)	Eff. Adj. Factor for VFD Centrif.
		Tons	kW/ton	Tons		(F)	(F)	(F)	(F)	(F)	(F)	(%/F)

Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non-econ
kW	kWh	kW/ton		

Proposed operations

– User identified changes to operations
– Modified parameters flagged (orange cell highlight)

PROPOSED COOLING SYSTEM INPUTS *Ver 1.0 11/02/2015*

Current Level of Airflow Management — Description: 2 | Level 1, - Part Containment

Restore Existing

1. RA Temp and Humidity are required (Note: Humidity may need to be updated if RAT is changed from the existing scenario.)
2. Any changes to inputs need to be recalculated for results to be updated

Total Demand (kW)	Total Energy (kWh)
60.2	374,685

Calculate

SAVINGS POTENTIAL

kW	kWh
23.2	283,557

AHU	Type	Economizer?	Nominal Tons (Tons Capacity)	Fan Type	Cooling Load (kW)	On /Off (0=Off; 1= On)	Return Air Temp Setpoint	Return Air Relative Humidity	Avg Supply Air Temp	Recom'd Delta T	Glycol %	Worst Case Capacity (Tons)
CRAC 1	Water-cooled CRAC with DX cooling	Yes	20	Scroll fan with VFD	42	1	83	35%	66	15		17
CRAC 2	Water-cooled CRAC with DX cooling	Yes	20	Scroll fan with VFD	42	1	83	35%	66	20		17
CRAC 3	Water-cooled CRAC with DX cooling	Yes	20	Scroll fan with VFD	0	0	83	35%	66	17		0
CRAC 4	Water-cooled CRAC with DX cooling	Yes	20	Scroll fan with VFD	42	1	83	35%	66	26		17
CRAC5- Lab	Water-cooled CRAC with DX cooling	Yes	16	Scroll fan with VFD	34	1	83	35%	66	15		14
CRAC 6	Water-cooled CRAC with DX cooling	Yes	20	Scroll fan with VFD	42	1	83	35%	66	15		17
Totals			96		203	5						81

AHU	Peak Demand (kW)	Annual Energy (kWh)	Efficiency (annualized) (kW/ton)	% Econ	% Non-econ	Demand Saving (kW)	Energy Savings (kWh)
CRAC 1	10.8	63,476	0.60	63%	37%	1.8	32,732
CRAC 2	10.8	63,476	0.60	63%	37%	1.6	31,088
CRAC 3	0.0	0	-	-	-	12.1	92,471
CRAC 4	10.8	63,476	0.60	63%	37%	1.3	28,394
CRAC5- Lab	8.7	50,938	0.60	63%	37%	1.7	27,641
CRAC 6	10.8	63,476	0.60	63%	37%	-10.8	-63,476
Totals	52.0	304,844				7.5	149,449

Fan Inputs

AHU	Type	HP	Fan Static Pressure (in. H2O)	RPM	Motor Type	Motor Enclosure	Belt Type	Motor Efficiency	Fan Efficiency	Belt Efficiency
CRAC 1	Water-cooled CRAC with DX cooling	7.5	1.97	1,800	Premium	ODP	Standard V-belt	91%	56%	95%
CRAC 2	Water-cooled CRAC with DX cooling	7.5	1.97	1,800	Premium	ODP	Standard V-belt	91%	56%	95%
CRAC 3	Water-cooled CRAC with DX cooling	7.5	1.97	1,800	Premium	ODP	Standard V-belt	91%	56%	95%
CRAC 4	Water-cooled CRAC with DX cooling	7.5	1.97	1,800	Premium	ODP	Standard V-belt	91%	56%	95%
CRAC5- Lab	Water-cooled CRAC with DX cooling	5	1.97	1,800	Premium	ODP	Standard V-belt	90%	56%	95%
CRAC 6	Water-cooled CRAC with DX cooling	7.5	1.97	1,800	Premium	ODP	Standard V-belt	91%	56%	95%
Totals		42.5								

AHU	VFD or ON/OFF Cycling: Speed% or Cycle ON%	VFD Efficiency	Rec. Speed% or ON%	Affinity Law Exponent	CFM (Estimated)	Peak Demand (kW)	Annual Energy (kWh)	Avg Demand (kW)	Demand Savings (kW)	Energy Savings (kWh)
CRAC 1	75%	97%	60%	2.4	6,800	1.7	14,528	1.7	3.2	27,634
CRAC 2	75%	97%	60%	2.4	6,800	1.7	14,528	1.7	3.2	27,634
CRAC 3	75%	97%	60%	2.4	0	0.0	0	0.0	4.9	42,162
CRAC 4	75%	97%	60%	2.4	6,800	1.7	14,528	1.7	3.2	27,634
CRAC5- Lab	75%	97%	60%	2.4	5,400	1.4	11,730	1.3	2.7	23,673
CRAC 6	75%	97%	60%	2.4	6,800	1.7	14,528	1.7	-1.7	-14,528
Totals					32,600	8.1	69,841	8.0	15.6	134,108

Airflow CFM	
Required CFM	26,387
Available CFM	32,600
Excess CFM	24%

Chiller Inputs

Condenser Type	Compressor Type	Chiller Capacity	Chiller Efficiency (full load)	Chilled Water Load	Waterside Economizer?	CHWST setpoint	CWST setpoint	Minimum allowable lift	Design Wetbulb Temp	Design approach (cooling)	Design approach (HX)	Eff. Adj. Factor for VFD Centrif.	Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non-econ	Demand Savings	Energy Savings
		Tons	kW/ton	Tons		(F)	(F)	(F)	(F)	(F)	(F)	(%/F)	kW	kWh	kW/ton			kW	kWh

Summary data

Base Line

Total Demand	Total Energy
kW	kWh
83.4	658,242

Calculate

Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non-econ
kW	kWh	kW/ton		
12.6	96,208	0.91	0%	100%
12.4	94,564	0.90	0%	100%
12.1	92,471	0.88	0%	100%
12.1	92,471	0.88	0%	100%
10.4	78,579	0.93	0%	100%
59.6	454,293			

Peak Demand	Annual Energy	Avg Demand
kW	kWh	kW
4.9	42,162	4.8
4.9	42,162	4.8
4.9	42,162	4.8
4.9	42,162	4.8
4.1	35,303	4.0
23.8	203,949	23.3

Airflow CFM
Required CFM
26,387
Available CFM
49,200
Excess CFM
86%

Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non-econ
kW	kWh	kW/ton		

Proposed

Total Demand	Total Energy
kW	kWh
60.2	374,685

Calculate

SAVINGS POTENTIAL

kW	kWh
23.2	283,557

Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non-econ
kW	kWh	kW/ton		
10.8	63,476	0.60	63%	37%
10.8	63,476	0.60	63%	37%
0.0	0	-	-	-
10.8	63,476	0.60	63%	37%
8.7	50,938	0.60	63%	37%
10.8	63,476	0.60	63%	37%
52.0	304,844			

Demand Savings	Energy Savings
kW	kWh
1.8	32,732
1.6	31,088
12.1	92,471
1.3	28,994
1.7	27,641
-10.8	-63,476
7.5	149,449

Peak Demand	Annual Energy	Avg Demand
kW	kWh	kW
1.7	14,528	1.7
1.7	14,528	1.7
0.0	0	0.0
1.7	14,528	1.7
1.4	11,730	1.3
1.7	14,528	1.7
8.1	69,841	8.0

Airflow CFM
Required CFM
26,387
Available CFM
32,600
Excess CFM
24%

Demand Savings	Energy Savings
kW	kWh
3.2	27,634
3.2	27,634
4.9	42,162
3.2	27,634
2.7	23,573
-1.7	-14,528
15.6	134,108

Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non-econ
kW	kWh	kW/ton		

Demand Savings	Energy Savings
kW	kWh

Implemented

Total Demand	Total Energy
kW	kWh
60.9	376,552

Calculate

SAVINGS ACHIEVED

kW	kWh
22.5	281,690

Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non-econ
kW	kWh	kW/ton		
11.0	64,355	0.61	60%	40%
11.1	65,162	0.62	60%	40%
0.0	0	-	-	-
11.3	67,109	0.64	45%	55%
9.5	56,720	0.67	45%	55%
11.2	65,861	0.63	63%	37%
54.2	319,206			

Demand Savings	Energy Savings
kW	kWh
1.7	31,854
1.3	29,402
12.1	92,471
0.8	25,362
0.8	21,859
-11.2	-65,861
5.4	135,086

Peak Demand	Annual Energy	Avg Demand
kW	kWh	kW
1.6	13,860	1.6
1.5	12,591	1.4
0.0	0	0.0
1.6	13,860	1.6
0.7	6,190	0.7
1.3	10,844	1.2
6.7	57,346	6.5

Airflow CFM
Required CFM
26,387
Available CFM
30,600
Excess CFM
16%

Demand Savings	Energy Savings
kW	kWh
3.3	28,301
3.4	29,571
4.9	42,162
3.3	28,301
3.4	29,113
-1.3	-10,844
17.1	146,604

Peak Demand	Annual Energy	Efficiency (annualized)	% Econ	% Non-econ
kW	kWh	kW/ton		

Demand Savings	Energy Savings
kW	kWh

Calculator summary metrics

Data Center Airflow/ Efficiency Project Summary

Ver 1.0 11/02/2015

Date: 11/2/2015

Company	SEACH
Facility Name	Admin Data Center
Address	123 Any Ave. NE
City, State Zip	Seattle, WA 98115
Contact	Mickey Mouse
Title	DC Ops Mgr.
Phone	206.555.1212
email	mickey@mouse.com

$	0.071	Avg. kWh Electricity Cost
$	1.92	Avg. kW Peak Demand Charge
$	0.20	per kWh Utility Incentive rate
$	-	per kW Demand reduction Incentive
	4,631,289	Annual Facility kWh
	6%	Implemented Saving % of Facility

	Energy Savings (kWh/yr)	Demand Savings (kW)	Utility Cost Savings ($)	Estimated Project Cost ($)	Estimated Incentive* ($)	Simple Payback After Incentive
Project Total - Proposed	291,185	24.0	$ 20,720.22	$ 89,178.00	$ 58,237.07	1.5
Project Total - Implemented	281,690	22.5	$ 20,043.19	$ 94,229.00	$ 56,337.97	1.9

** The Incentive Estimate contained in this calculator is for informational purposes only. It is NOT a formal offer of utility incentive funding*

203.0	kW Total Cooling Load	*Proposed Project Implementation Date*	11/2/2015	*Project Verification Date*	11/3/2015

EXISTING CONDITION	
Cooling Capacity	
Nominal Cap Ton	96
% of Nominal Cap	60.1%
Worst-case Ton	74
%Worst-case Cap	77.7%
Airflow Efficiency	
CFM / kW	242
Excess CFM %	**86%**
Cooling Efficiency	
Annualized kW/ton	0.90
Economizing %	0%
Economizing Hours	0

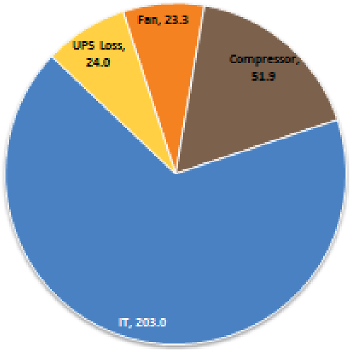
PROPOSED	
Cooling Capacity	
Nominal Ton	96
% of Nominal Cap	60.1%
Worst-case Ton	81
%Worst-case Cap	70.9%
Airflow Efficiency	
CFM / kW	154
Excess CFM %	**18%**
Cooling Efficiency	
Annualized kW/ton	0.61
Economizing %	70%
Economizing Hours	6,167

IMPLEMENTED	
Cooling Capacity	
Nominal Ton	96
% of Nominal Cap	60.12%
Worst-case Ton	78
%Worst-case Cap	73.9%
Airflow Efficiency	
CFM / kW	151
Excess CFM %	**16%**
Cooling Efficiency	
Annualized kW/ton	0.63
Economizing %	55%
Economizing Hours	4,818

Calculator summary metrics

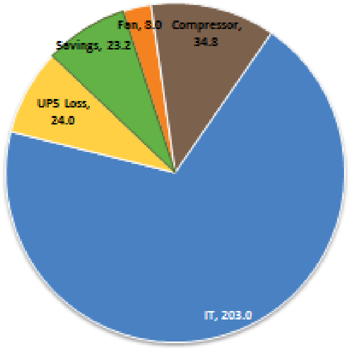
Environmental Conditions	
62.1	Avg. Server Inlet Temp., °F (Estimated)
75	Avg. AHU Return Air Temp., °F
61	Avg. AHU Supply Air Temp., °F
Airflows	
49,200	Estimated CFM
130	Required CFM / kW
5	CRAC Units "On"
100%	Avg, CRAC Fan Speed
Cooling Energy Consumption	
203,949	Yrly. AHU Fan kWh
454,293	Yrly.Mechanical Cooling kWh
658,242	Total Cooling kWh
Energy Use Breakdown	

Existing Condition	kW
HVAC	
Fan	23.3
Compressor	51.9
IT	203.0
UPS Loss	24.0
PUE (Partial)	**1.49**



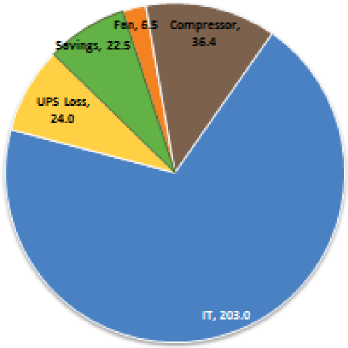
Environmental Conditions	
66.8	Target Server Inlet Temp., °F
83	Avg. AHU Return Air Temp., °F
66	Avg. AHU Supply Air Temp., °F
Airflows	
32,600	Proposed CFM
34%	**Planned Airflow Reduction**
5	CRAC Units "On"
75%	Avg, CRAC Fan Speed
Cooling Energy Consumption	
69,841	Yrly. AHU Fan kWh
304,844	Yrly.Mechanical Cooling kWh
374,685	Total Cooling kWh
283,557	Est. Annual kWh Savings
43%	**Reduction**
Energy Use Breakdown	

Proposed	kW
HVAC	
Fan	8.0
Compressor	34.8
IT	203.0
UPS Loss	24.0
Savings	23.2
PUE (Partial)	**1.33**



Environmental Conditions	
62.0	Avg. Server Inlet Temp., °F
81	Avg. AHU Return Air Temp., °F
61	Avg. AHU Supply Air Temp., °F
Airflows	
30,600	Implemented CFM
38%	**Achieved Airflow Reduction**
5	CRAC Units "On"
70%	Avg, CRAC Fan Speed
Cooling Energy Consumption	
57,346	Yrly. AHU Fan kWh
319,206	Yrly.Mechanical Cooling kWh
376,552	Total Cooling kWh
281,690	Achieved Ann. kWh Savings
43%	**Reduction**
Energy Use Breakdown	

Implemented	kW
HVAC	
Fan	6.5
Compressor	36.4
IT	203.0
UPS Loss	24.0
Savings	22.5
PUE (Partial)	**1.33**



PROS

- Relatively quick estimate of energy savings
  - ~30 min for an 800 kW data center with 13 AHU's
- Accommodates common cooling designs
- Default assumptions can be overwritten w/ measured values
  - Formatting flags modified inputs in orange
- Based on transparent documented engineering principles, equipment performance data

Trade-offs

- Use of macros “Manual” calculation button to facilitate hourly calculations
  - 8,760 calcs for each AHU
- Only intended to model key “buckets” of savings from AFM improvements
  - Reduced fan energy
  - Reduced mechanical cooling energy
  - Increased hours of economizer use
- User must have some knowledge of server-room operation

Server-Room AFM Walk-Thru Audits

BPA will assist utilities to providing walk-thru assessments to identify energy efficiency opportunities, including AFM projects.

A request form and other resources, including a link to the calculator can be found at: https://www.bpa.gov/EE/Technology/EE-emerging-technologies/Projects-Reports-Archives/Pages/Air-Flow-Management.aspx

AFM Calculator Resources

The following resources are posted at:
http://rtf.nwcouncil.org/subcommittees/it/

- AFM Calculator
- User Guide
- Technical Guide

Server-Room AFM Audit Process

1. Airflow and temperatures will be measured, and equipment info gathered;
2. Baseline and potential AFM strategy info entered in the calculator;
3. Potential AFM energy savings will be sent to the serving utility, as the basis for a streamlined custom project; and
4. After AFM implementation, actual AFM energy savings will be verified.

Questions?

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