ASHRAE's Groundbreaking Environmental Class Changes

Presented by Don Beaty, DLB Associates

Opening Comments

Two concerns of many data center operators are:

1) Did I cause an expensive outage?

2) Did I void a warranty on expensive equipment?

In 2004, ASHRAE TC 9.9 standardized data center temperature and humidity.

Created a common set of vendor neutral environmental guidelines that the IT OEMs would agree did NOT violate their warranties.

In 2008, ASHRAE TC 9.9, 68°F to 77°F range became 64.4°F to 80.6°F while still being within warranty requirements.

In 2011, White Paper provides scenarios for ranges as wide as 41°F to 113°F.

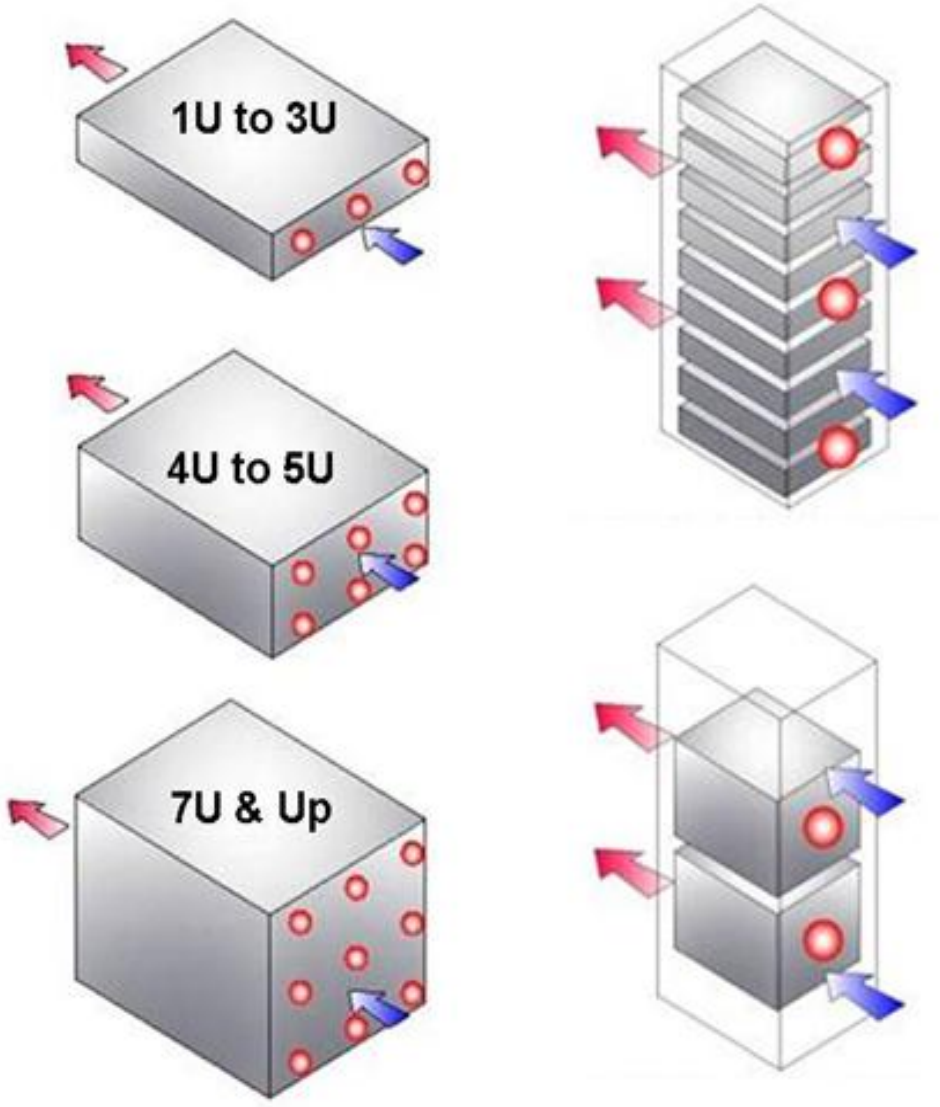
Agenda

Part 1 – ITE Environment (Envelopes, Classes & Specifications)

Part 2 – Use & Application Guidance for New ASHRAE Data Center Classes

Part 1 – ITE Environment

ITE Environment – Measurement Points



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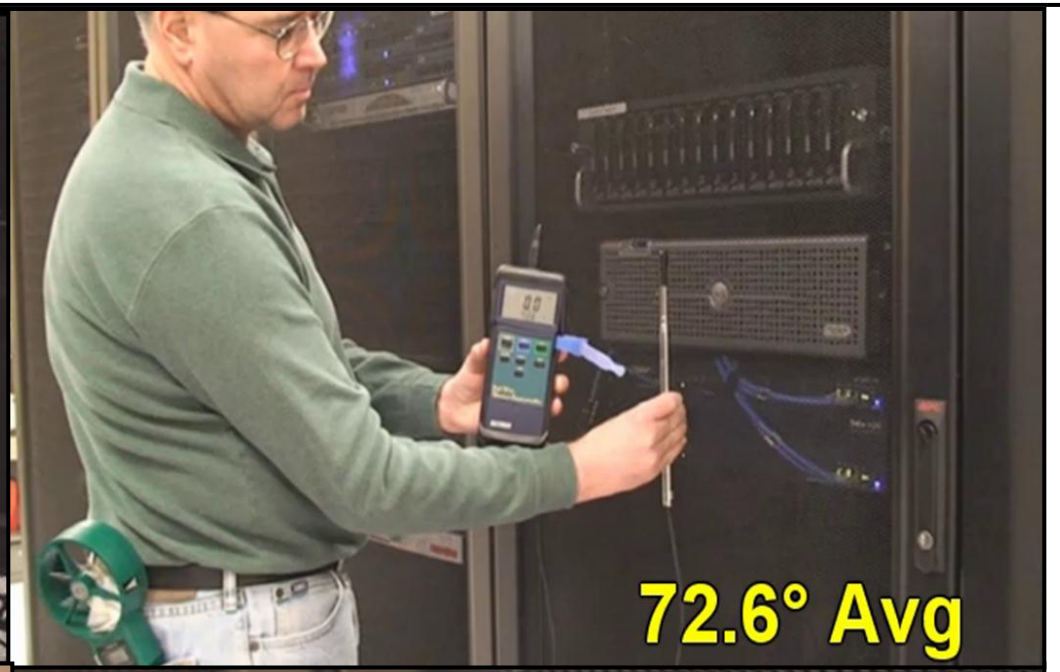
ITE Environment – Measurement Points



ITE Environment – Envelope Definitions

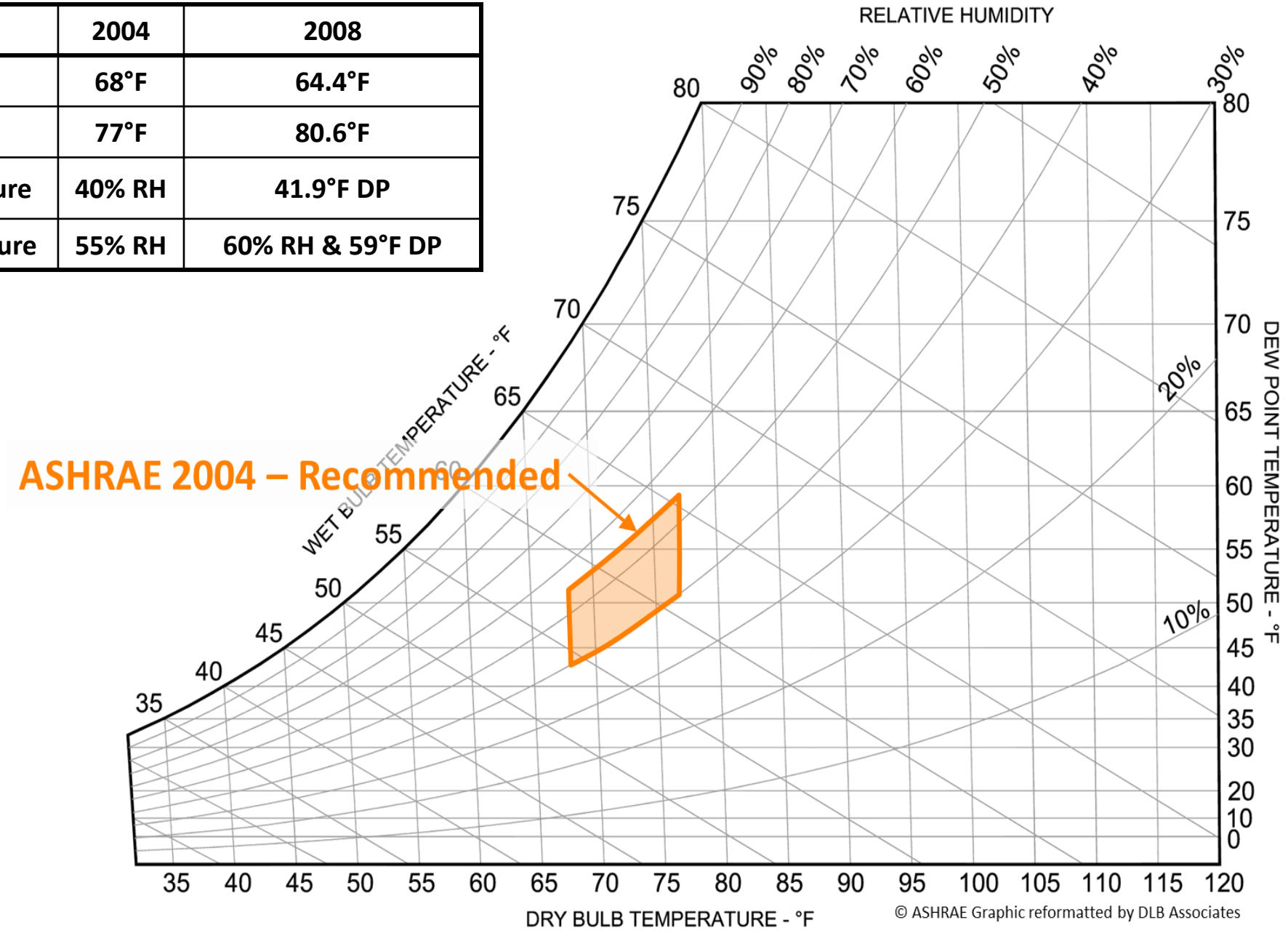
For optimal IT equipment reliability and longevity, conditions should be within the recommended envelope. However, occasional, short-term excursions into the allowable envelope MAY be acceptable.

Recommended – The purpose of the recommended envelope is to give guidance to data center operators on maintaining high reliability and also operating their data centers in the most energy efficient manner.
The recommended envelope is based on IT OEM's expert knowledge of server power consumption, reliability & performance vs. ambient temp.

Allowable – The allowable envelope is where the IT manufacturers test their equipment in order to verify that the equipment will function within those environmental boundaries.

ITE Environment – ASHRAE Psychrometric Chart

Criteria	2004	2008
Low End Temp.	68°F	64.4°F
High End Temp.	77°F	80.6°F
Low End Moisture	40% RH	41.9°F DP
High End Moisture	55% RH	60% RH & 59°F DP



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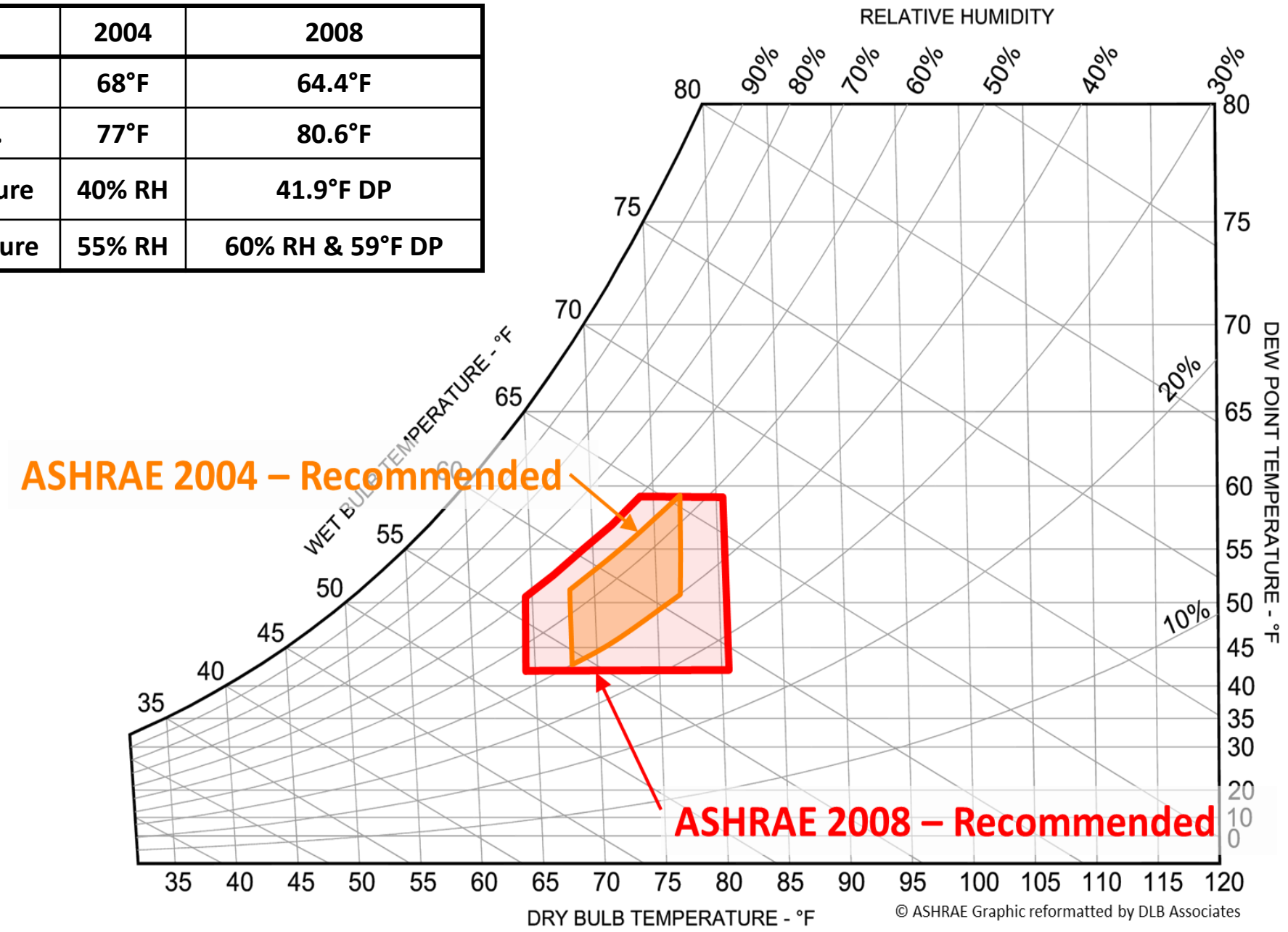

ITE Environment – New Data Center Classes

Previously there were four classes (Class 1 through 4) total.

Two of the old Classes were specifically for data centers (Class 1 & 2).

The naming conventions have now been updated; the old Classes 1, 2, 3 and 4 directly mapped to **A1, A2, B** and **C**.

Two new data center classes have been introduced: **A3 and A4**.

ITE Environment – New Data Center Classes

OPTIONAL READING / SKIPPED DURING PRESENTATION

Previously there were four data center classes (Class 1 through 4). Two of the four classes applied to ITE used in data center applications (Class 1 & 2).

The new environmental guidelines have more data center classes to accommodate different applications and priorities of ITE operation.

This is critical because a single data center class forces a single optimization whereas each data center needs to be optimized based on the operator's own criteria (e.g. fulltime economizer use vs. maximum reliability).

The naming conventions have now been updated to better delineate the types of IT equipment. The old and new classes are now specified differently with the previous Classes 1, 2, 3 and 4 directly mapped to **A1, A2, B** and **C**.

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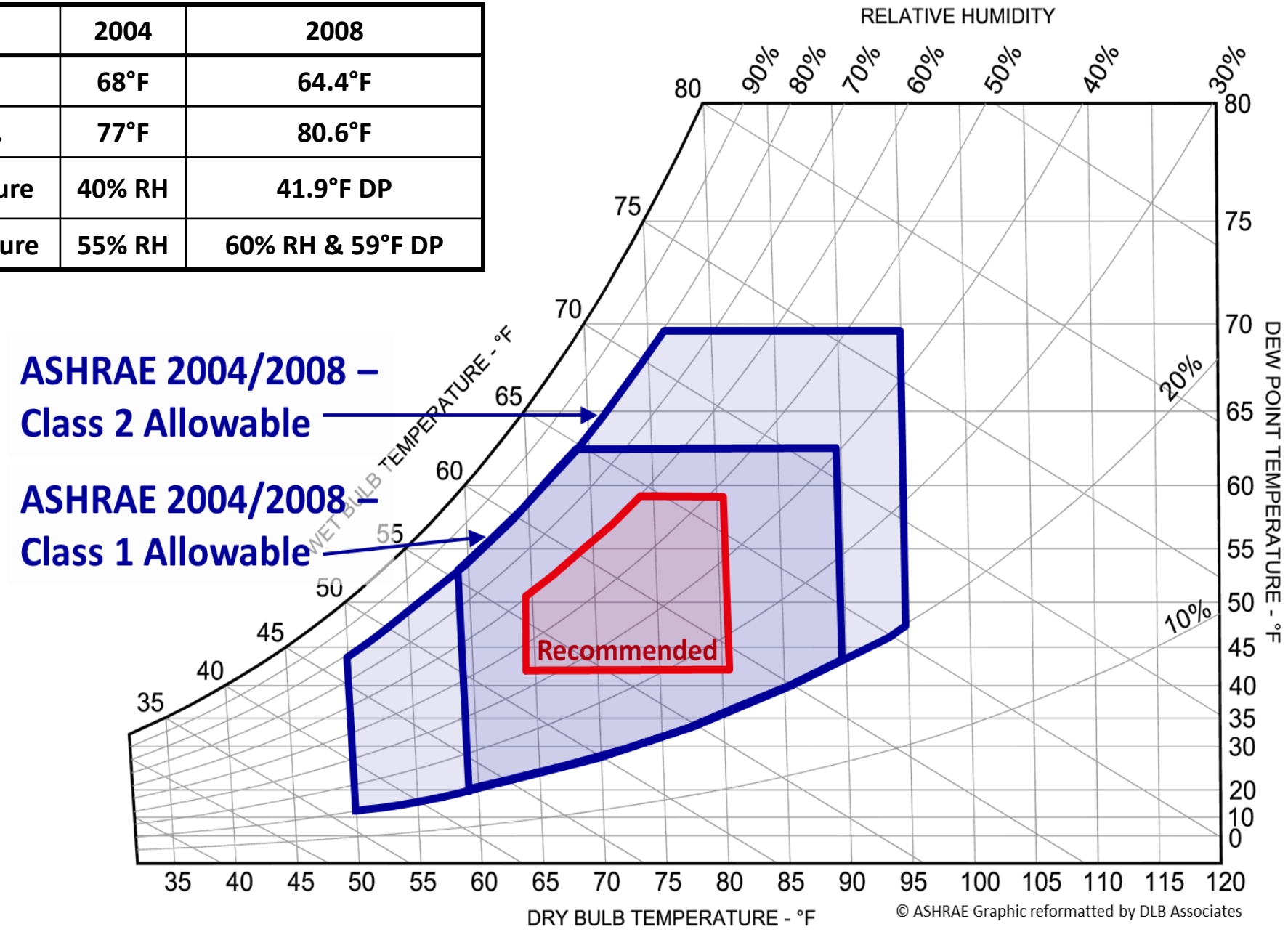
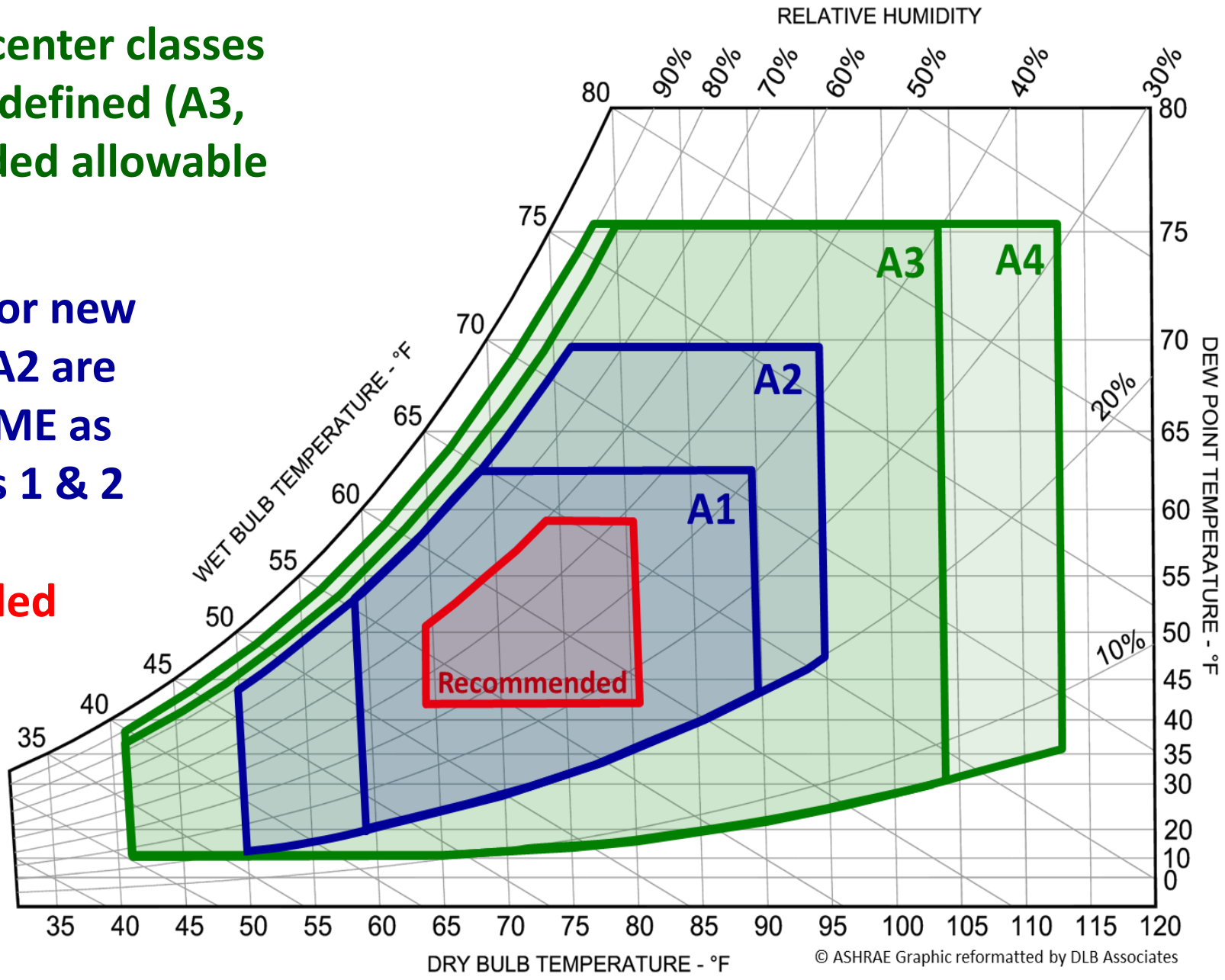


ITE Environment – ASHRAE Psychrometric Chart

Two NEW data center classes have now been defined (A3, A4) with expanded allowable envelopes.

The envelopes for new Classes A1 and A2 are EXACTLY the SAME as previous Classes 1 & 2

The recommended envelope is EXACTLY the SAME.



ITE Environment – New Equip. Environment Specifications Table (Partial)

Class	Dry Bulb (°F)	Humidity Range	Max Dew Point (°F)	Max Elevation (ft)	Max Rate of Change (°F / hr)
Recommended					
A1 to A4	64.4 to 80.6	41.9°F DP to 60% RH & 59°F DP			
Allowable					
A1	59 to 89.6	20% to 80% RH	62.6	10,000	9 / 36
A2	50 to 95	20% to 80% RH	69.8	10,000	9 / 36
A3	41 to 104	10.4°F DP & 8% RH to 85% RH	75.2	10,000	9 / 36
A4	41 to 113	10.4°F DP & 8% RH to 90% RH	75.2	10,000	9 / 36
B	41 to 95	8% to 80% RH	82.4	10,000	N/A
C	41 to 104	8% to 80% RH	82.4	10,000	N/A

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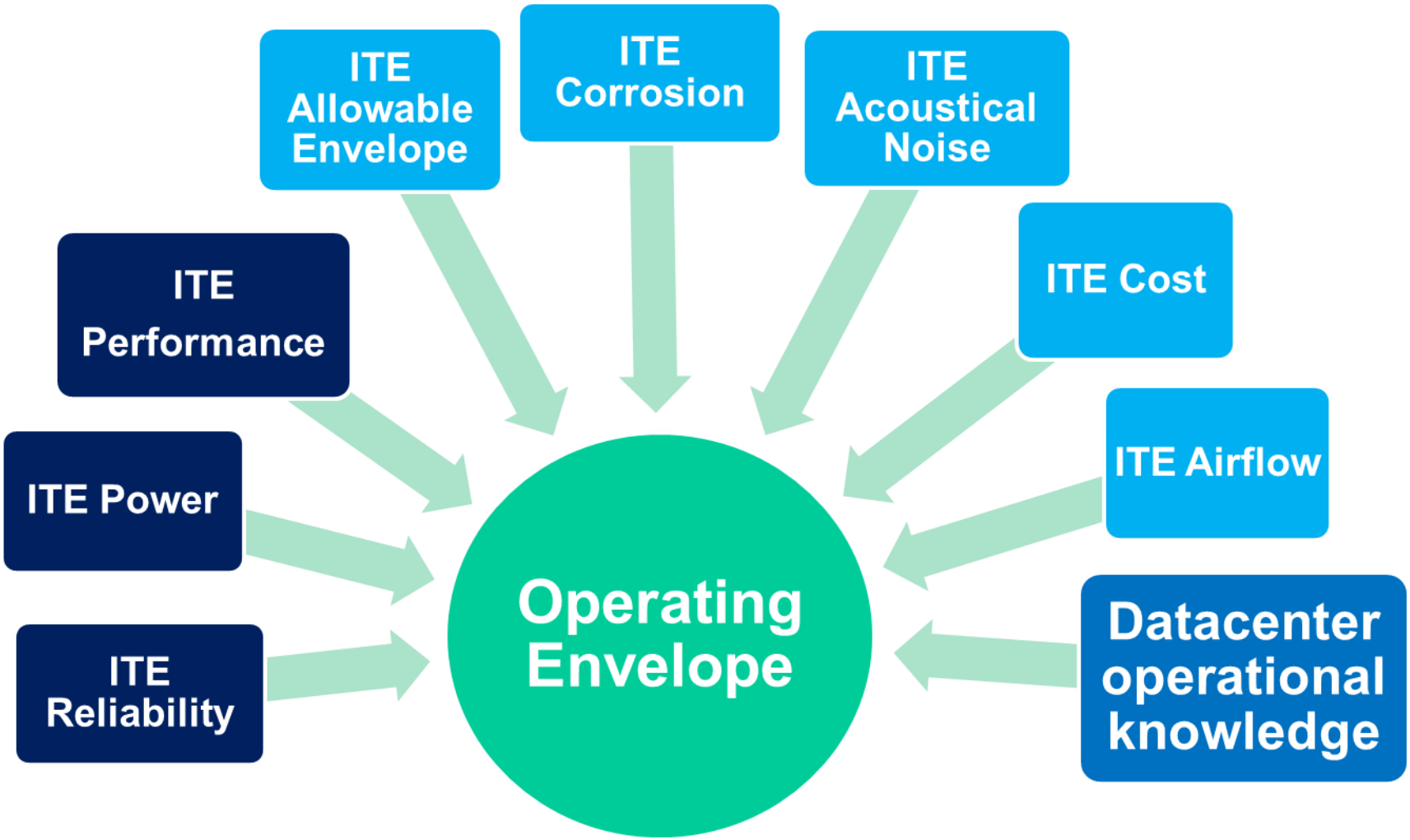
Part 2 – Use and Application Guidance for New ASHRAE Data Center Classes

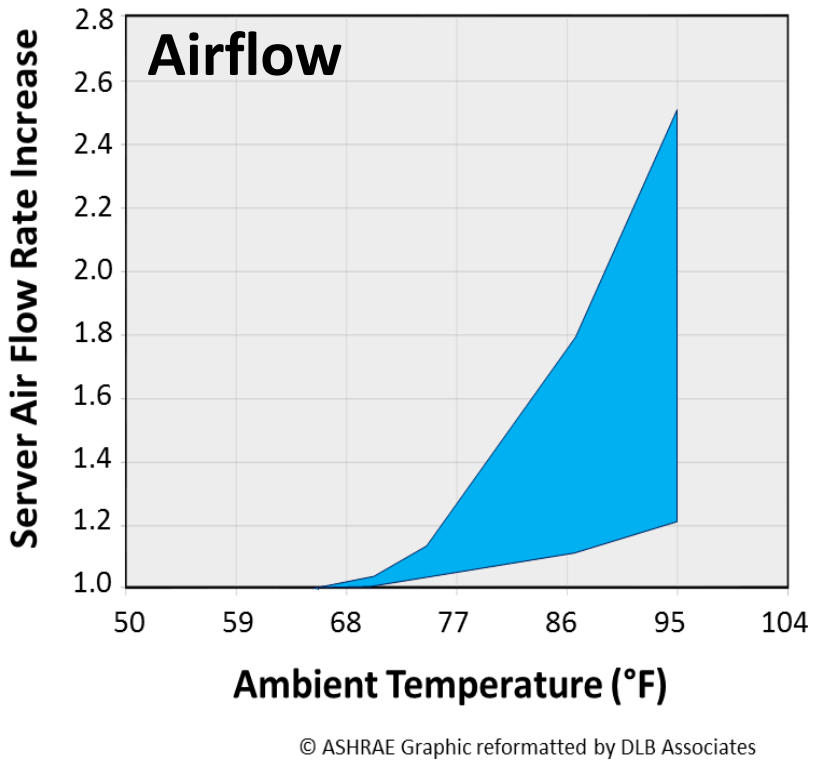
2011 Thermal Guidelines – Operating Envelope

The data center optimization is a complex multi-variable problem and requires a detailed engineering evaluation to be successful.



Server Power Trend vs. Ambient Temperature

Airflow and total power increase with temperature.



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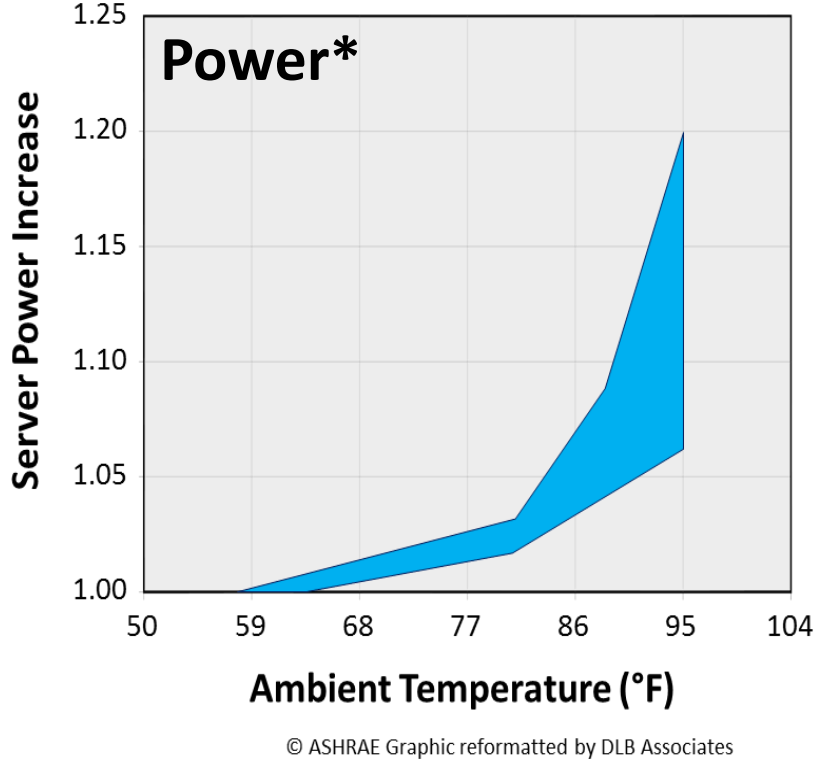

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Fan power required increases to the cube of fan speed (rpm)

* Total power increase includes both fan and component power

Server Reliability Trend vs. Ambient Temperature

The hardware failure rate within a given data center will be determined by:

1) The local climate

2) Type of economization

3) Facility setpoint / operation

For the following example, the data is based on:

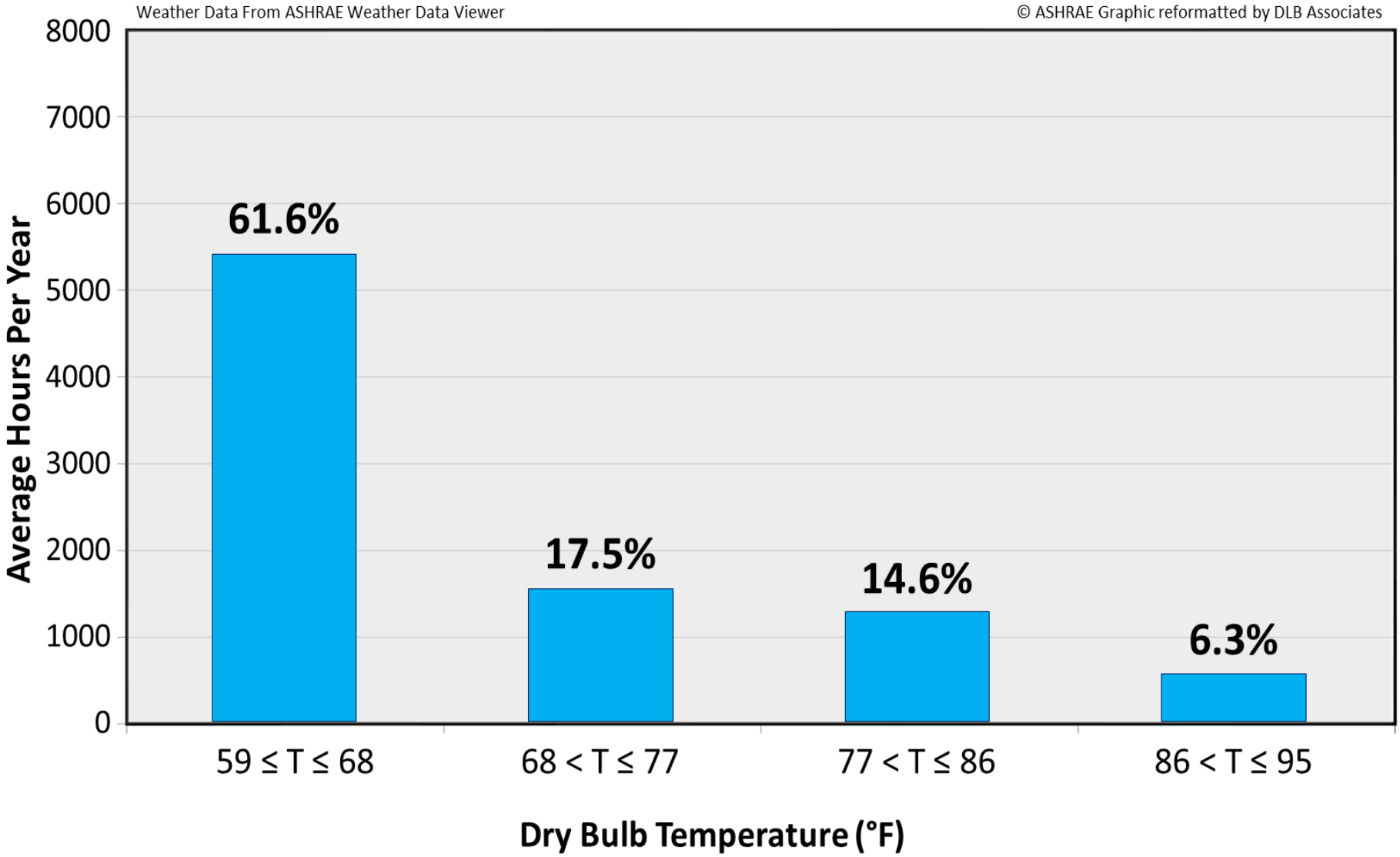
1) Air-side economizer (with an assumed 2.7°F system gain)

2) Internal data center temp. is allowed to vary with ambient temp.

3) Air mixing occurs to maintain a minimum data center temp of 59°F.

Server Reliability Trend vs. Ambient Temperature (cont.)

Avg. yearly dry bulb temp for Washington DC with air mixing to maintain 59°F min.



Server Reliability Trend vs. Ambient Temperature – Relative Failure Rates			
Dry Bulb Temp. (°F)	Hardware Failure Rate for Volume Servers (X-Factor)		
	Average	Lower Bound	Upper Bound
59	0.72	0.72	0.72
63.5	0.87	0.80	0.95
68	1.00 (Baseline)	0.88	1.14
72.5	1.13	0.96	1.31
77	1.24	1.04	1.43
81.5	1.34	1.12	1.54
86	1.42	1.19	1.63
95	1.55	1.35	1.74
104	1.66	1.51	1.81
113	1.76	1.67	1.84

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Assumes continuous (7 x 24 x 365) operation with Dry Bulb Temp. at ITE inlet.

Server Reliability Trend vs. Ambient Temperature (cont.)

Washington DC Net X-Factor across the whole year.

Time-at-Temperature Weighted Failure Rate Calculation for ITE in Wash. DC									
Location	**59 ≤ T ≤ 68°F**		**68 < T ≤ 77°F**		**77 < T ≤ 86°F**		**86 ≤ T ≤ 95°F**		**Net X-factor**
	% hours	**Avg. X-Factor**	% hours	**Avg. X-Factor**	% hours	**Avg. X-Factor**	% hours	**Avg. X-Factor**	
Chicago	72.5	0.865	14.6	1.13	9.5	1.335	3.4	1.482	0.970
Wash. DC	61.6	**0.865**	17.5	**1.13**	14.6	**1.335**	6.3	**1.482**	**1.019**

Weather Data From ASHRAE Weather Data Viewer

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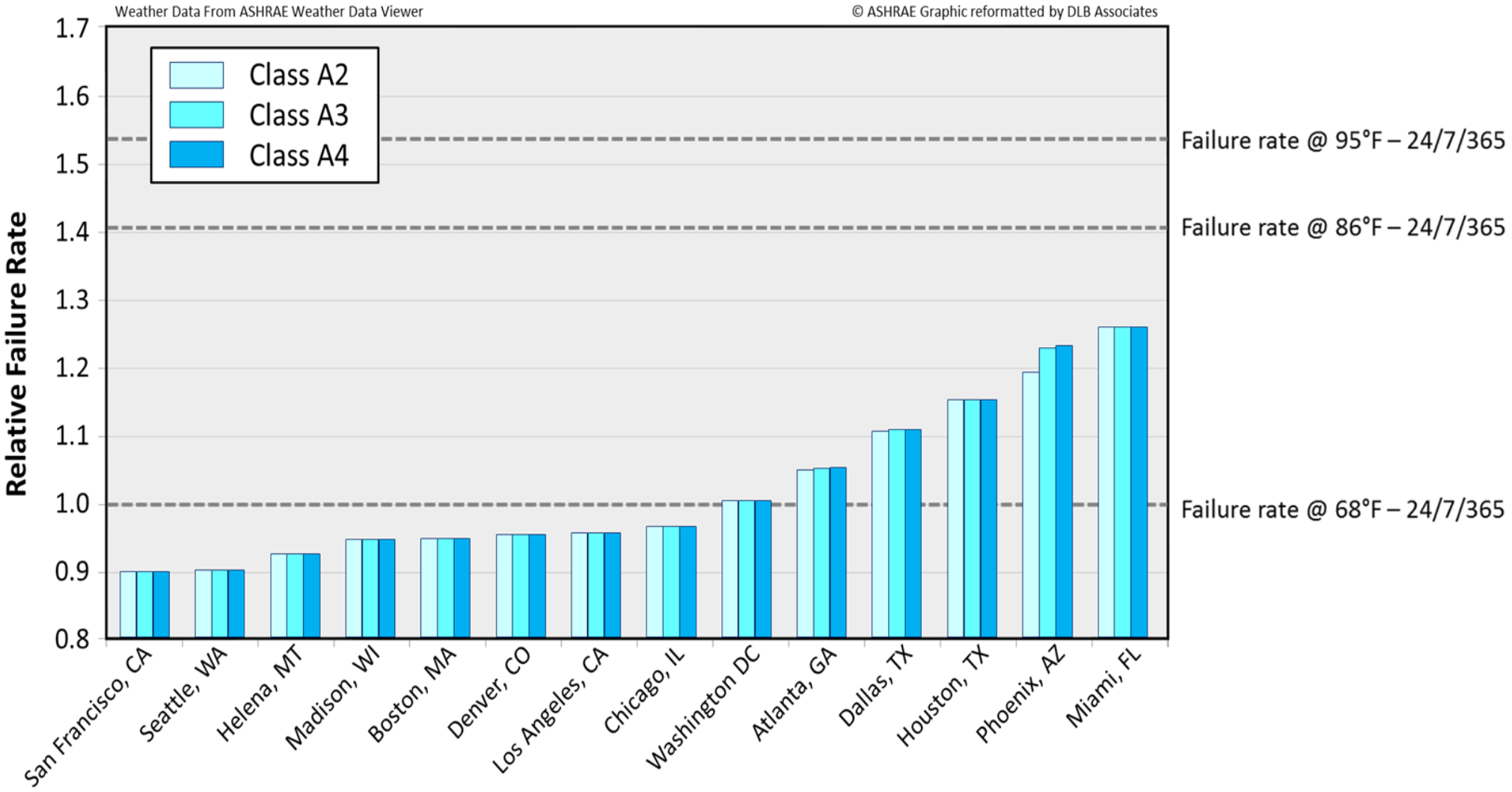
The Net X-Factor in Washington DC IT hardware failure with compressor-less cooling and a variable data center temperature is ONLY 1.9% higher than if the data center was operating at a tightly controlled temperature of 68°F.

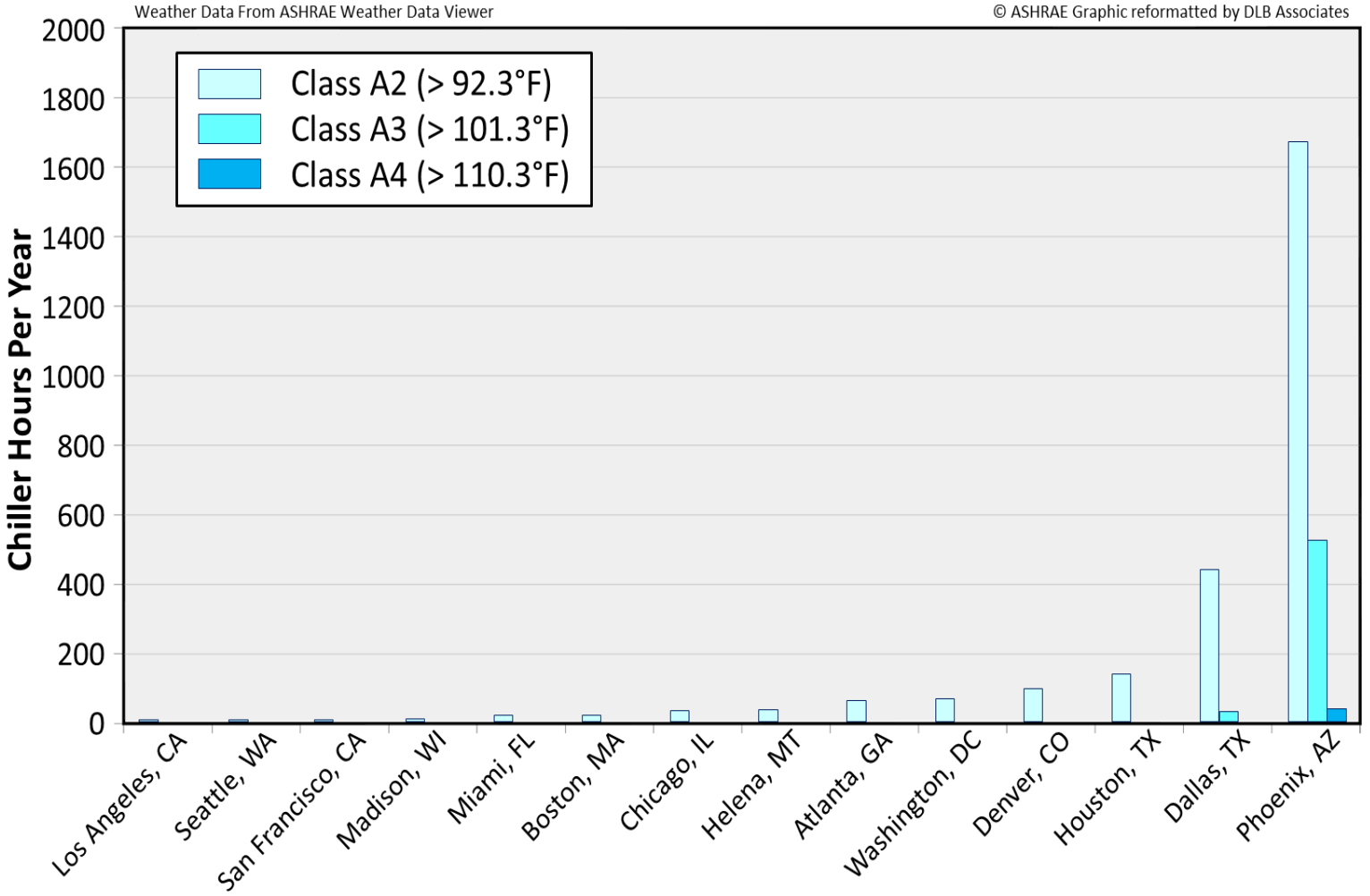
Server Reliability Trend vs. Ambient Temperature (cont.)

Average Net Failure Rate Projections for Air-side Economization (US Cities)



Server Reliability Trend vs. Ambient Temperature (cont.)

Chiller Hours Per Year for Air-side Economization (US Cities)



* Assumes 2.7°F approach between outdoor air dry bulb and supply air due to fan friction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Server Reliability vs. Contamination

Particulate and gaseous contamination becomes a more important consideration when there is an increased use of economizer systems.

The air quality and building materials should be checked carefully for sources of pollution & particulates and additional filtration should be added to remove gaseous pollution and particulates, if needed.

Products of Combustion

Pollen

Dirt

Smoke

Closing Comments

There is a big difference between an Internet Data Center (IDC) and a Financial Services Data Center.

Differences vary greatly even within a company or data center based on the variation of applications and use.

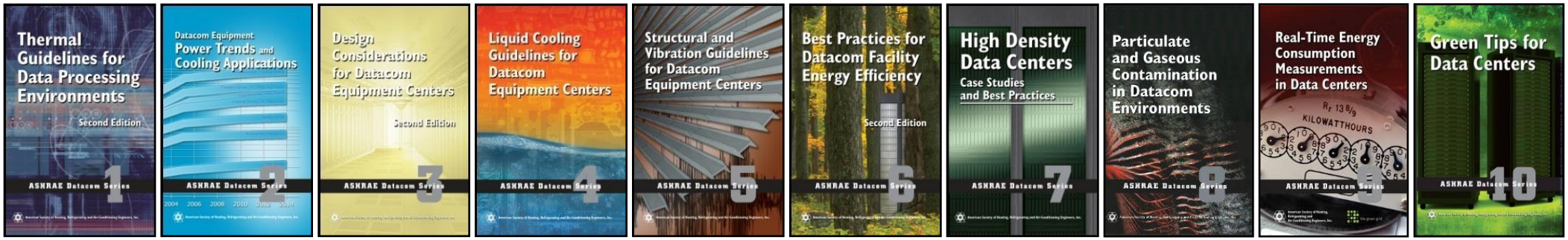
ASHRAE has created the opportunity to optimize on an individual basis to best meet the needs of the user and achieve the best TCO.

To accomplish this requires considering more variables and using an in depth engineering approach.

The payback for using an in depth engineering approach can save NOT only operation expenses but save HUGE capital costs as well.

Experts with in depth ASHRAE experience could save you plenty.

TC 9.9 Datacom Book Series



1. **Thermal Guidelines for Data Processing Environments 3rd Edition (coming soon)**
2. Datacom Equipment Power Trends & Cooling Applications (2005)
3. Design Considerations for Datacom Equipment Centers (2006)
4. Liquid Cooling Guidelines for Datacom Equipment Centers (2006)
5. Structural & Vibration Guidelines for Datacom Equipment Centers (2008)
6. Best Practices for Datacom Facility Energy Efficiency (2008)
7. High Density Data Centers – Case Studies & Best Practices (2008)
8. Particulate & Gaseous Contamination in Datacom Environments (2009)
9. Real-Time Energy Consumption Measurements in Data Centers (2009)
10. Green Tips for Data Centers (2011)

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