ASHRAE Technical Committee (TC) 9.9

Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

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ASHRAE Overview

- What is ASHRAE?
  - A nonprofit technical society formed in 1894 specializing in HVAC
  - With over **50,000** members and **2,000** technical committee members within almost 100 technical committees
  - Focused on maintaining an unbiased role within the industry
  - Actively writes standards, guidelines, model codes, etc.
  - A creator of more than **125** standards and guidelines

Ice Cooled System
(Circa 1890)

General Electric Room Cooler
(Circa 1932)

Computer Room Air Conditioner
(Circa 1980)

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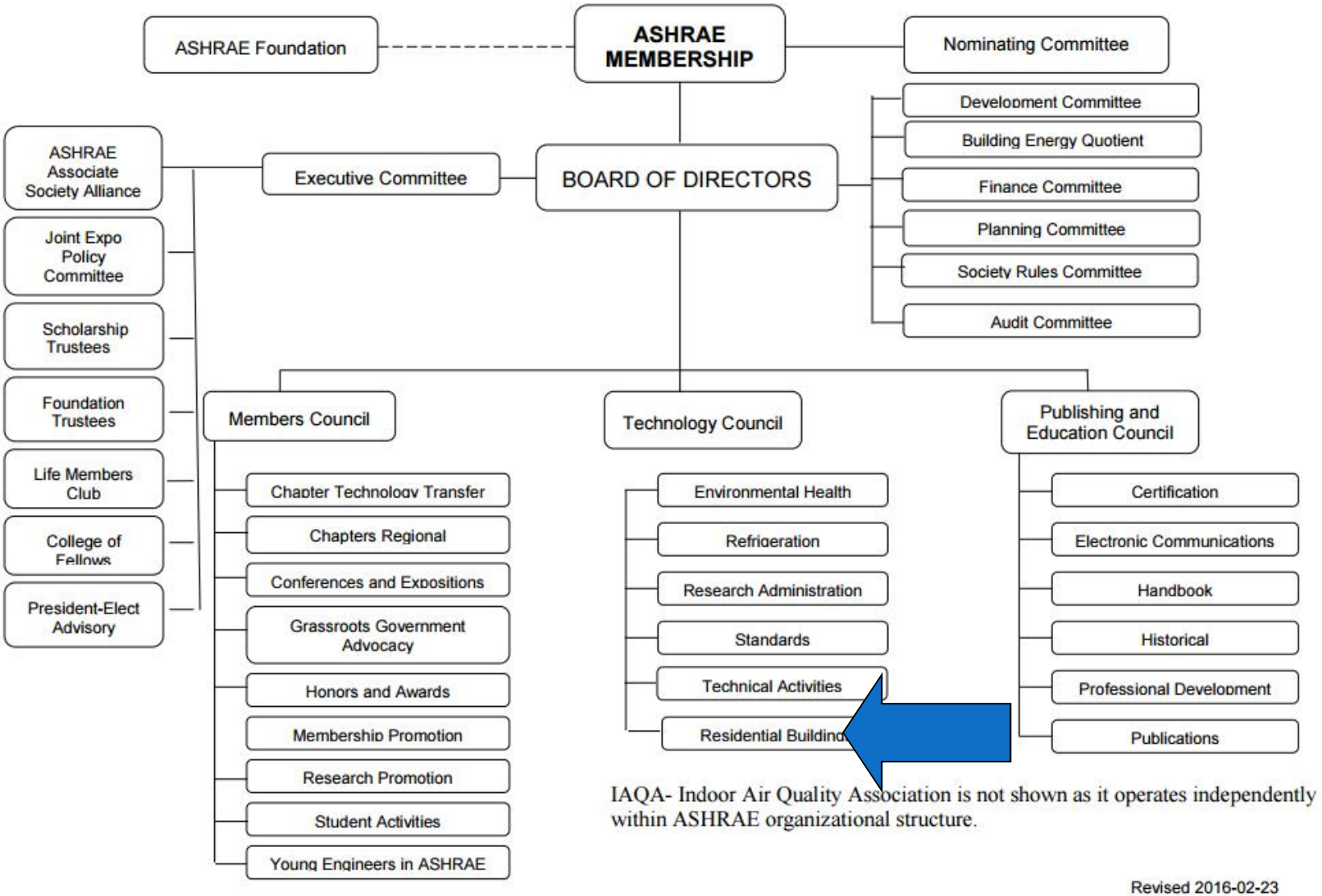
ASHRAE Overview



IAQA- Indoor Air Quality Association is not shown as it operates independently within ASHRAE organizational structure.

Revised 2016-02-23

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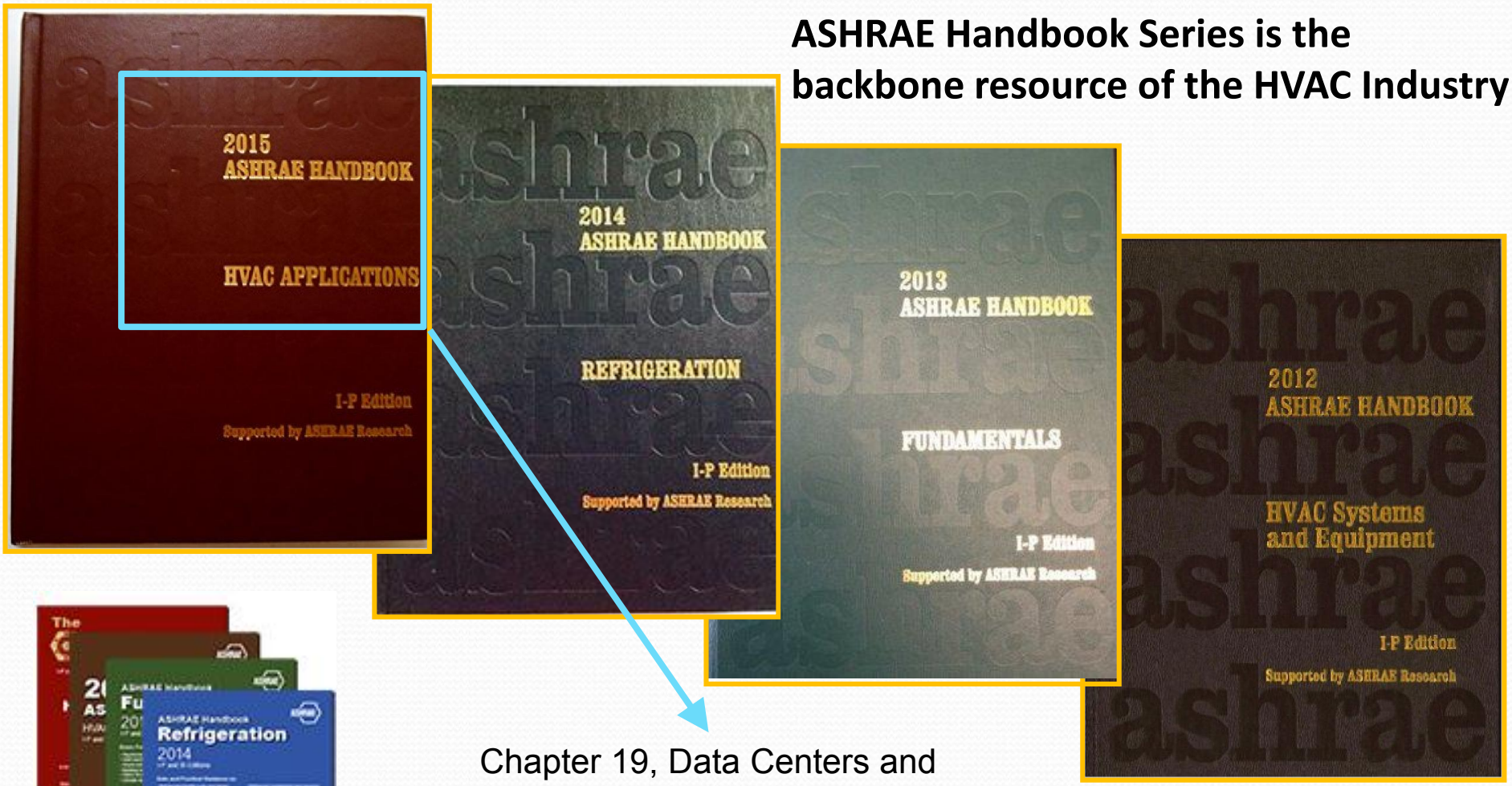
ASHRAE Handbook

ASHRAE Handbook Series is the backbone resource of the HVAC Industry



Chapter 19, Data Centers and Telecommunication Facilities

www.ashrae.org

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ASHRAE TC 9.9 Overview

Title:

- Mission Critical Facilities, Data Centers, Technology Spaces, & Electronic Equipment

Objective:

- To be recognized by ALL areas of the datacom industry as the UNBIASED engineering leader in HVAC and an effective provider of technical datacom information.

Scope:

- All datacom facilities: datacom refers to data processing and communication facilities. It includes rooms or closets used for communication, computers, or electronic equipment

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ASHRAE TC 9.9 Membership

Participants:

- TC 9.9 is the largest and most active TC with over 250 members.

Representatives:

- Producers of Datacom Equipment – computing hardware, software and services
- Producers of Facility Equipment – HVAC, software, DCIM, rack solutions
- Users of Datacom Equipment – facility owners, operators, managers
- General Interest – government agencies, utilities, consultants, academia, testing laboratories

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ASHRAE TC 9.9 Activities

Volunteers Provide the Expertise:

- Manufacturers, Consultants, Researchers, Universities, Utilities, Regulators, Contractors, and Government

Areas of Influence:

- Standards
- Research
- Handbook
- Programs (including paper reviews)
- Technical Activities – Books, whitepapers, education, etc.

TC 9.9 Members:

- Advise ASHRAE on Datacom industry technical matters

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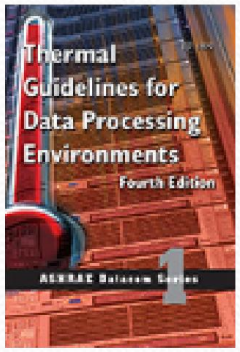
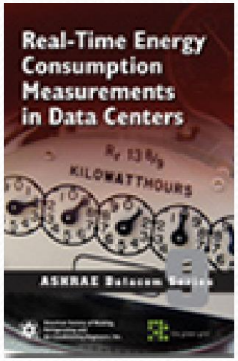
TC 9.9 Datacom Book Publications/Roadmap

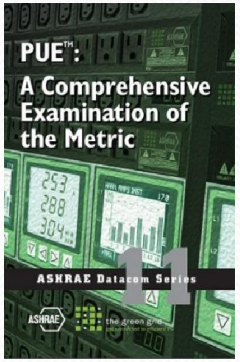
Environments

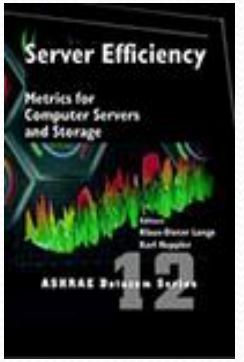


Forecasts and Trends

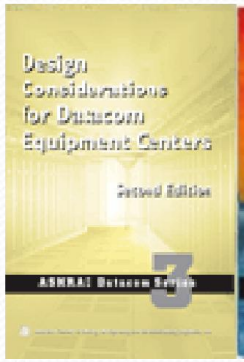
Key Metrics

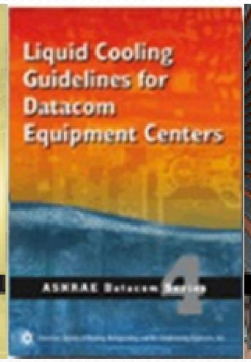


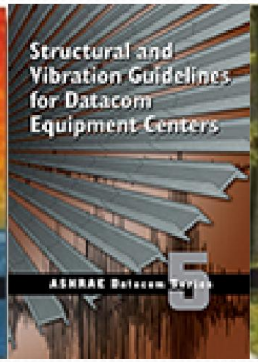


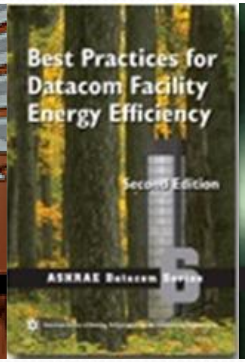


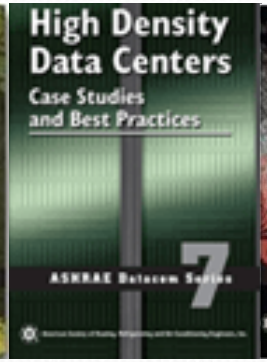
Practical Applications

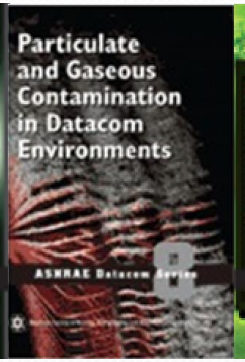


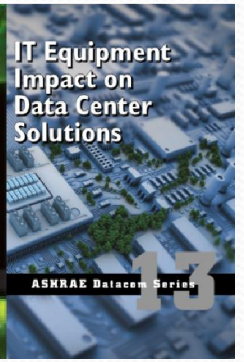












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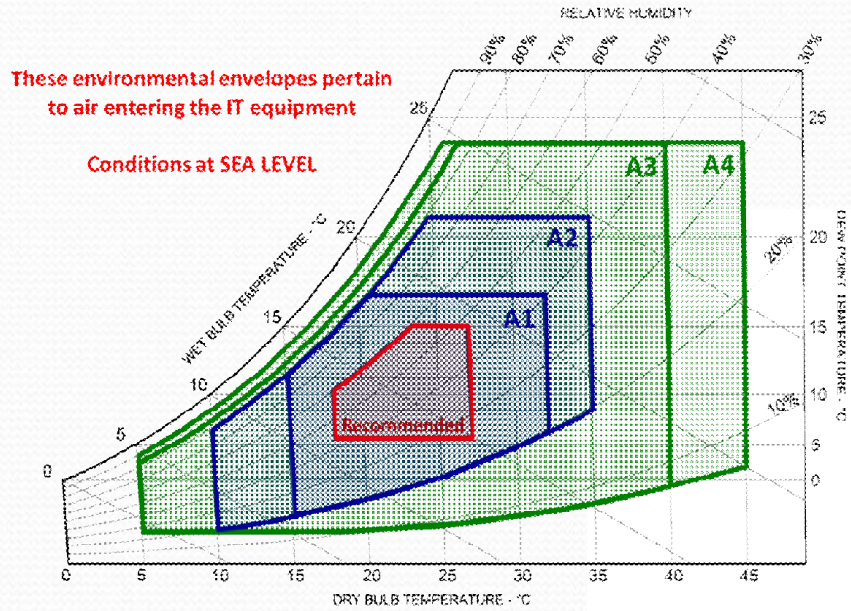
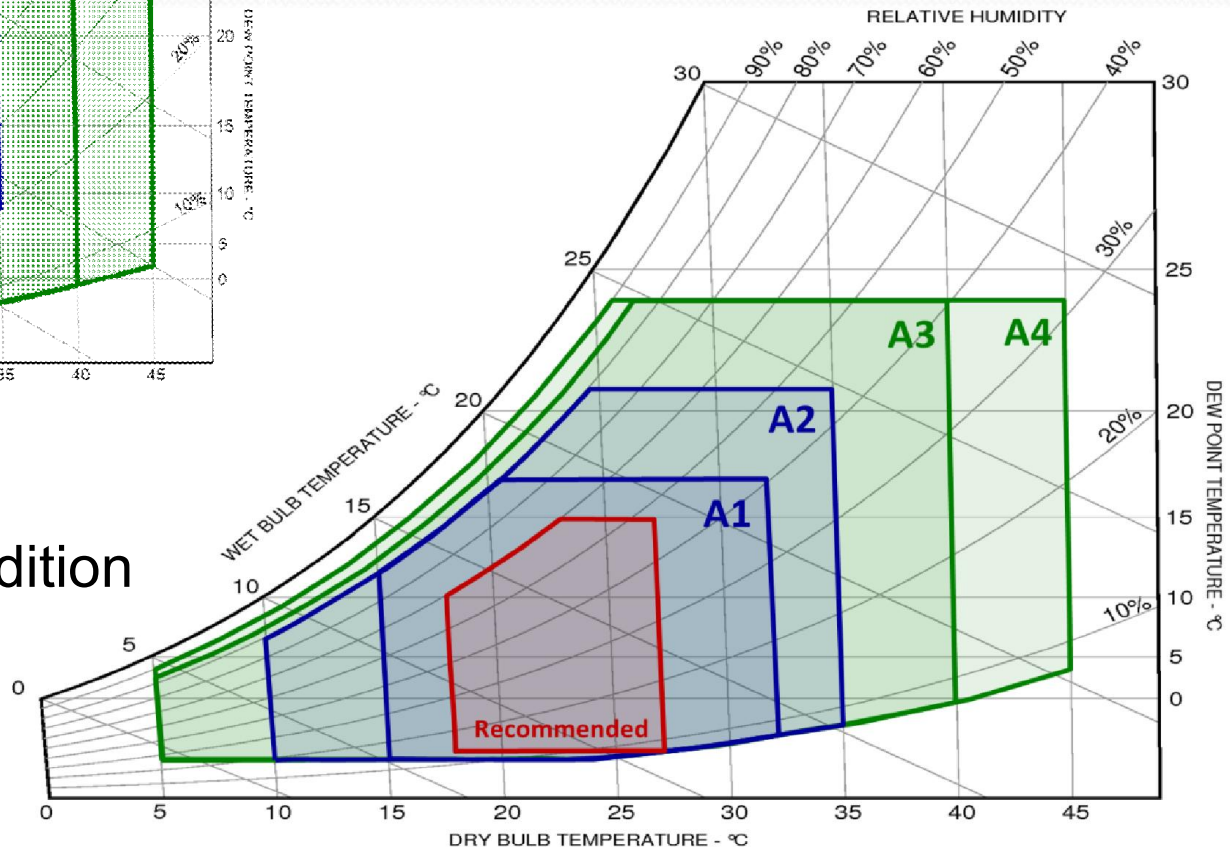
Book 1 – Thermal Guidelines – 3rd vs. 4th Edition (SI)



2011 3rd Edition

2015 4th Edition



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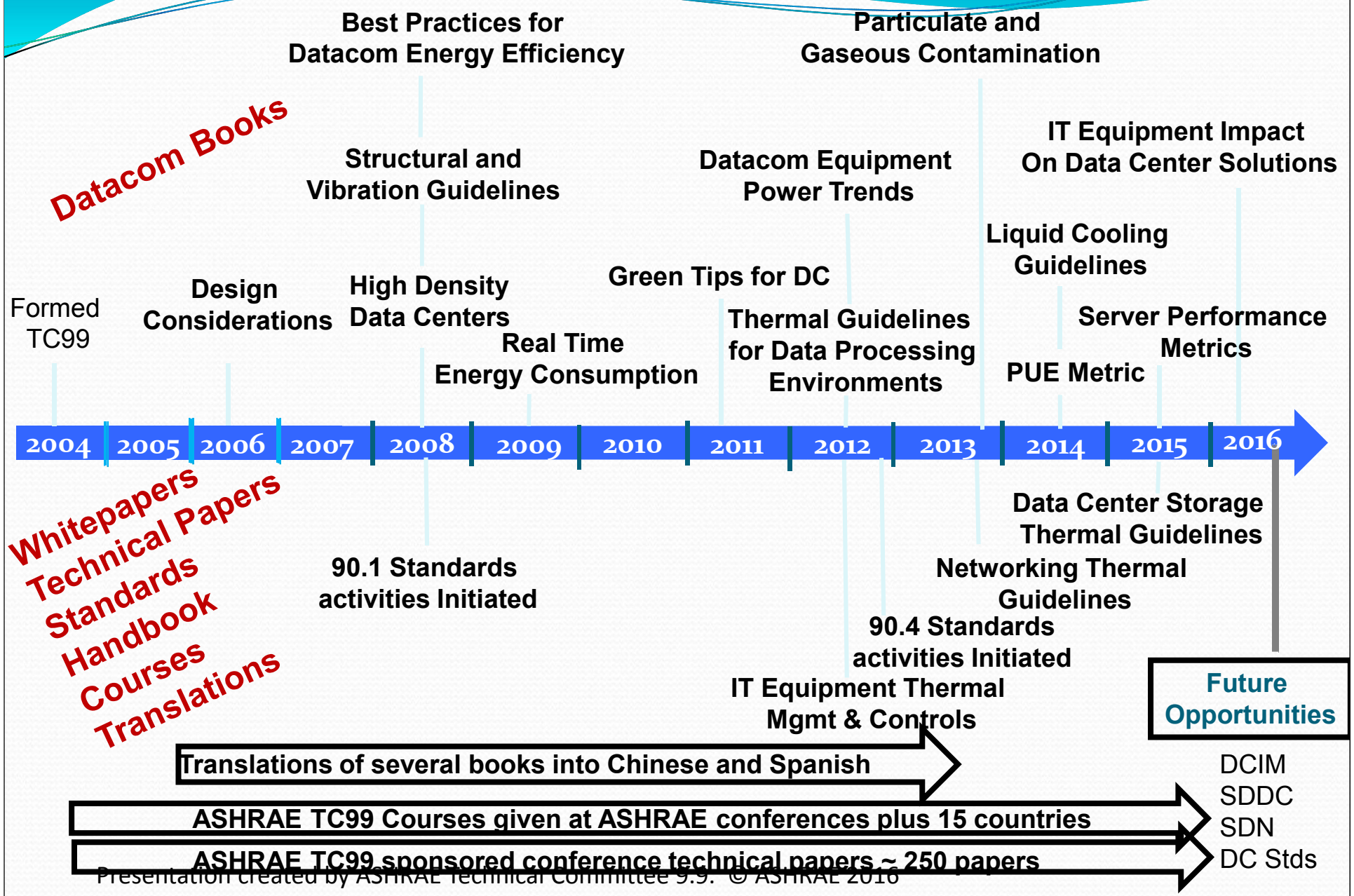
Time Line of ASHRAE TC9.9 Published Results



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We Need You!

- STANDARDS
  - Provide your comments during publicized 90.1 and 90.4P comment periods: relatively few people provide comments, all comments are important
    - Standard 90.1 – Data Centers were included starting with 90.1-2010 (see the TC 9.9 website)
    - Standard 90.4P – Energy Standard for Data Centers and Telecommunications Buildings
- HANDBOOK
  - Write and/or review handbook updates
- PUBLICATIONS
  - Provide feedback on TC9.9 publications and activities
  - Write or create white papers, books, papers and presentations for annual meetings
  - Review technical papers
- RESEARCH
  - Write and/or review RTAR's, work statements
  - Serve on advisory subcommittees for approved research topics

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THANK YOU

tc0909.ashraetcs.org

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Supplemental Material

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Current TC9.9 Work Activities(3/2016)

- ✓ 90.4 Energy Standard for Data Centers
- ✓ SPC 127 – Method of Testing for Rating Computer and Data Processing Room Unitary Air Conditioners
- ✓ Server Power Trend Datacom Book Update
- ✓ Power Equipment Thermal Guidelines WP
- ✓ DCIM WP – starting 1/2016
- ✓ Liquid Cooling Common Rack Components WP
- ✓ Research on IT Equipment Corrosion at high humidity and gaseous pollutants – starting in 7/2016

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ASHRAE – Technical Committee 9.9 Definitions

Data Center:

- A room or building, or portions thereof, with one or more ITE enclosures greater than 2 KW

Information Technology Equipment (ITE):

- Computers, data storage, servers and network / communication equipment.

Information Enclosure:

- A rack, cabinet, or chassis that is designed to mount ITE.

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ASHRAE Research Strategic Plan Goals 2010-2015(extended to 2018)

1. Maximize the actual operational energy performance of buildings and facilities.....5

2. Progress toward Advanced Energy Design Guide (AEDG) and cost-effective net-zero-energy (NZE) buildings.....7

3. To reduce significantly the energy consumption for HVAC&R, water heating and lighting in existing homes.....9

4. Significantly advance our understanding of the impact of indoor environmental quality (IEQ) on work performance, health symptoms and perceived environmental quality in offices, providing a basis for improvements in ASHRAE standards, guidelines, HVAC&R designs and operation practices.....11

5. Support the development of ASHRAE energy standards and reduce effort required to demonstrate compliance.....13

6. Building Information Modeling (BIM) of energy efficient, high-performing buildings.....15

7. Support development of tools, procedures and methods suitable for designing low energy buildings.....16

8. Facilitate use of natural and low global warming potential (GWP) synthetic refrigerants and seek methods to reduce refrigerant charge.....18

9. Support the development of improved HVAC&R components ranging from residential through commercial to provide improved system efficiency, affordability, reliability and safety.....19

10. Significantly increase the understanding of energy efficiency, environmental quality and the design of buildings in engineering and architectural education.....21

11. Understand influences of HVAC&R on airborne pathogen transmission in public spaces and develop effective control strategies.....23

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Environmental Envelopes

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IT Equipment Environment – Measurement at Inlet

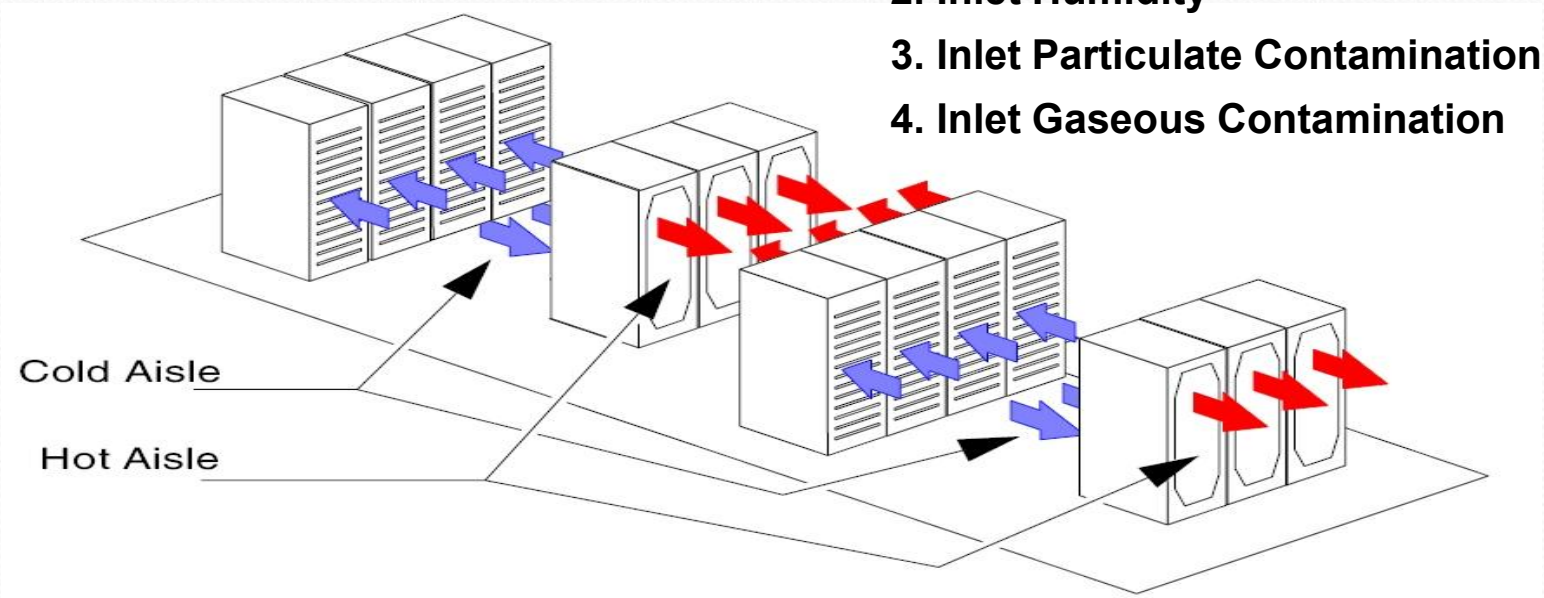
Four Key Environmental Requirements

1. Inlet Air Temperature

2. Inlet Humidity

3. Inlet Particulate Contamination

4. Inlet Gaseous Contamination



- **AIR INLET** to datacom equipment **IS** the important specification to meet.
- **OUTLET** temperature is **NOT** of concern to the datacom equipment (but is limited by safety and other concerns).

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IT Equipment Environment – Envelope Definitions

- **Recommended** – The purpose of the recommended envelope is to give guidance to data center operators on the optimal range from the perspective of the datacom equipment for optimal performance, high reliability and lowest power consumption. The recommended envelope is based on IT manufacturer's knowledge of the design and capability of their equipment.
- **Allowable** – The allowable envelope defines the limits within which the IT manufacturers test their equipment to verify that the equipment will function within the relevant environmental envelopes.
- **Practical Application** – Prolonged exposure of operating equipment to conditions outside its recommended range, especially approaching the extremes of the allowable operating environment, can result in decreased equipment reliability and longevity. Occasional, short-term excursions into the allowable envelope is generally acceptable but MAY result in performance implications and higher power consumption.

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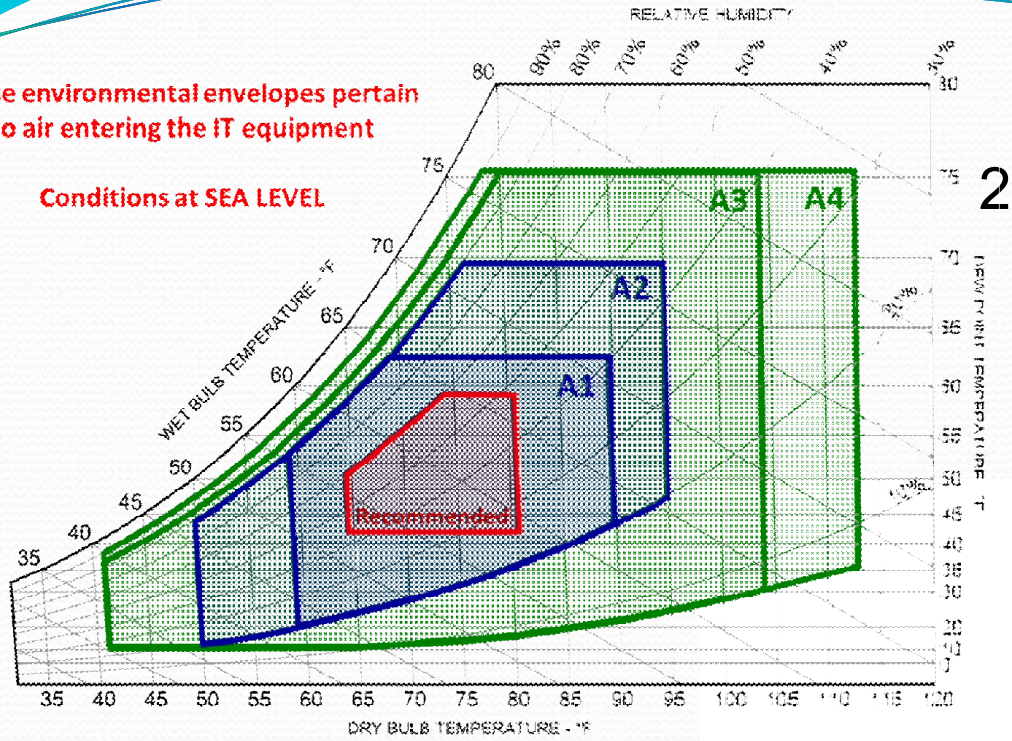
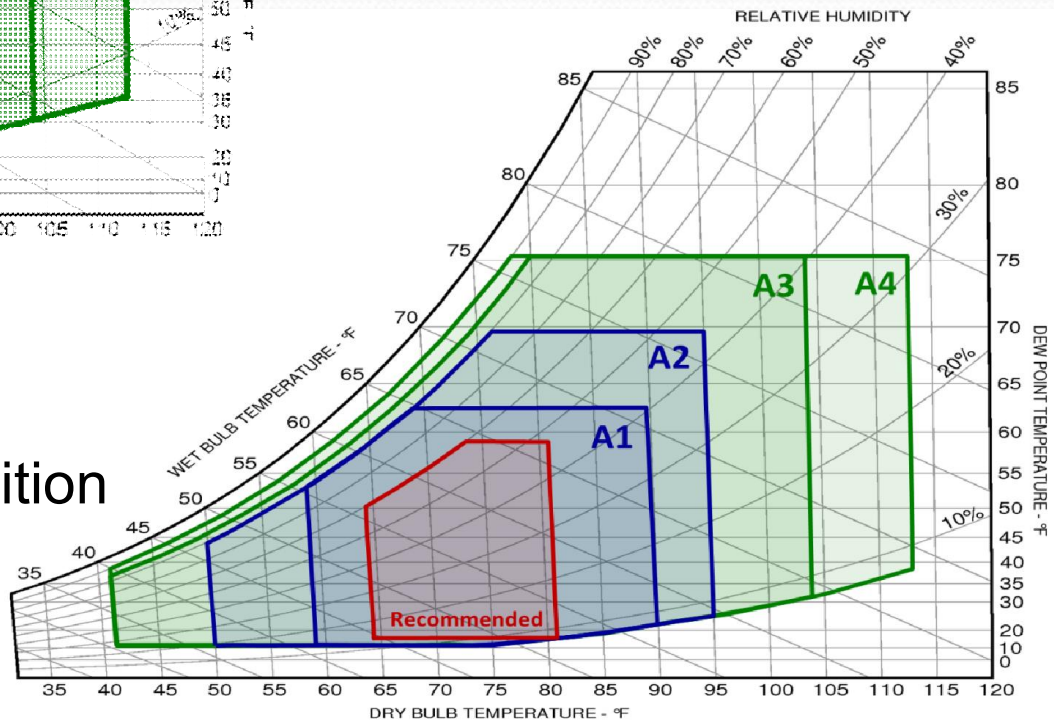
Thermal Guidelines – 3rd vs. 4th Edition (I-P)

These environmental envelopes pertain to air entering the IT equipment

Conditions at SEA LEVEL



2011 3rd Edition



2015 4th Edition

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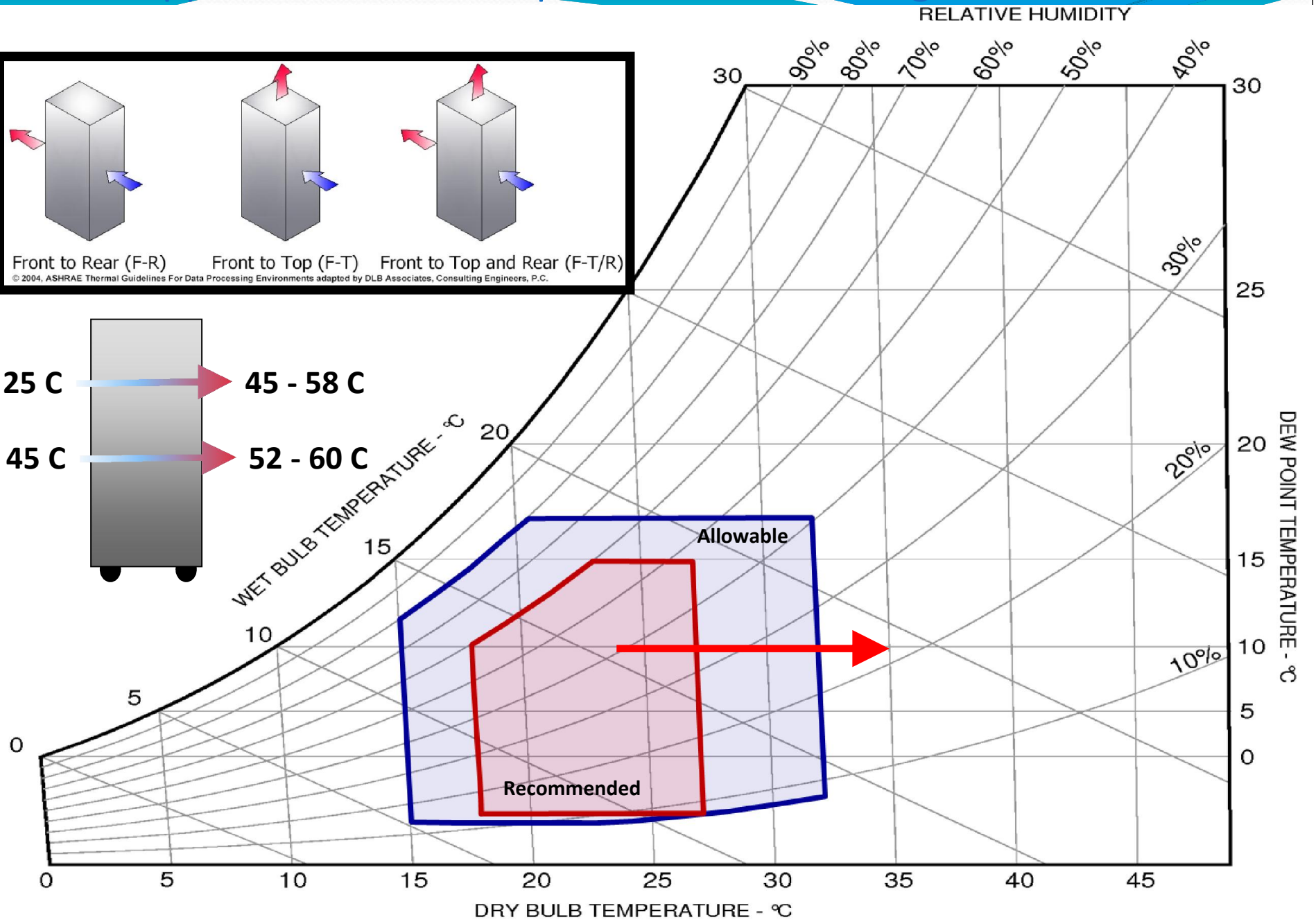
What Happens to the Air Temperature & RH Through a Server Rack?



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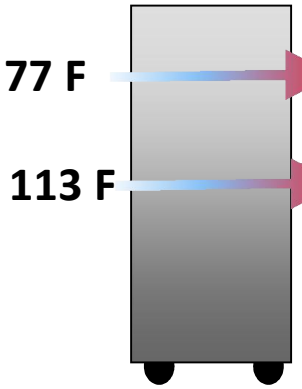
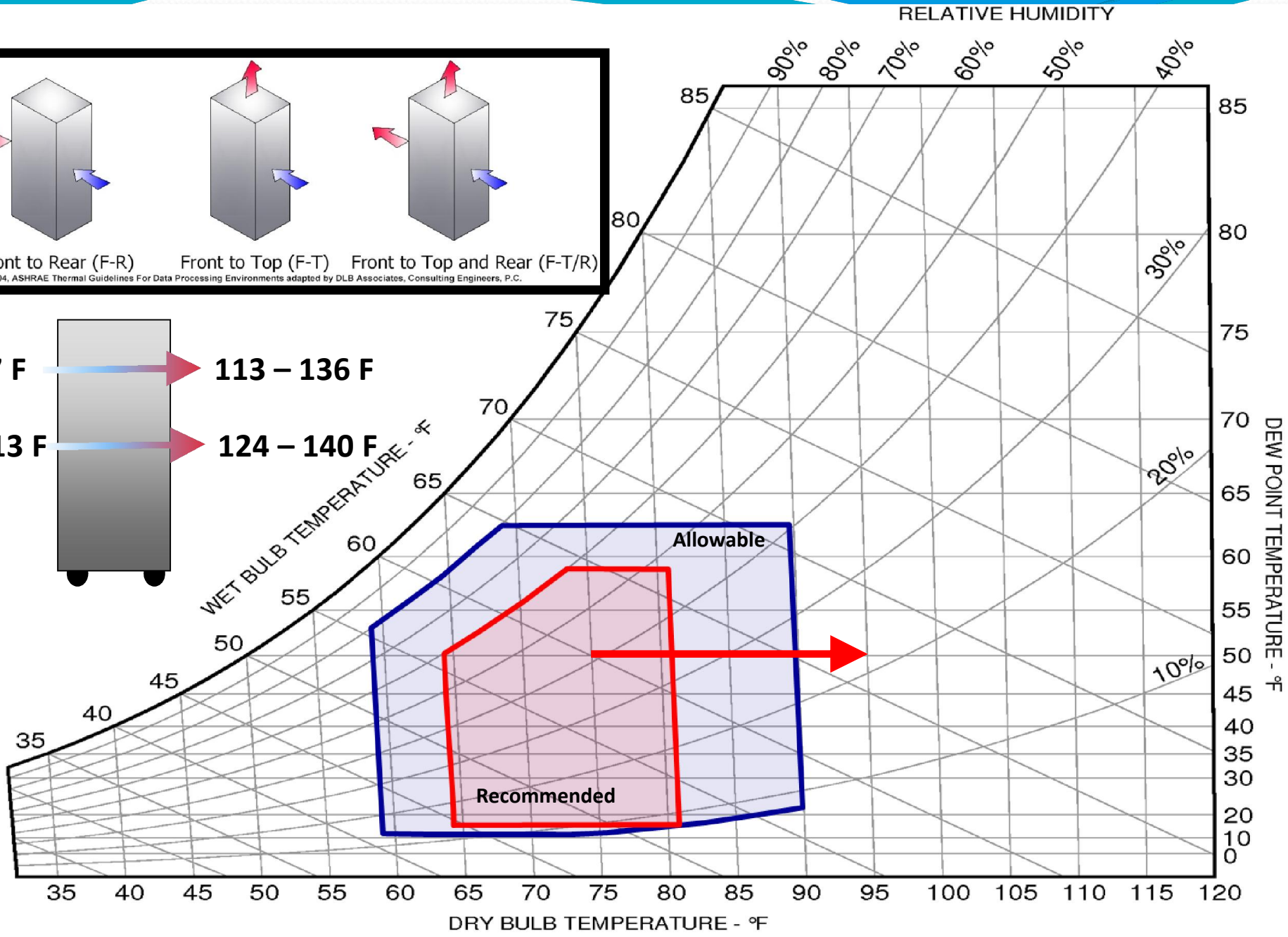


113 – 136 F

124 – 140 F



Liquid Cooling

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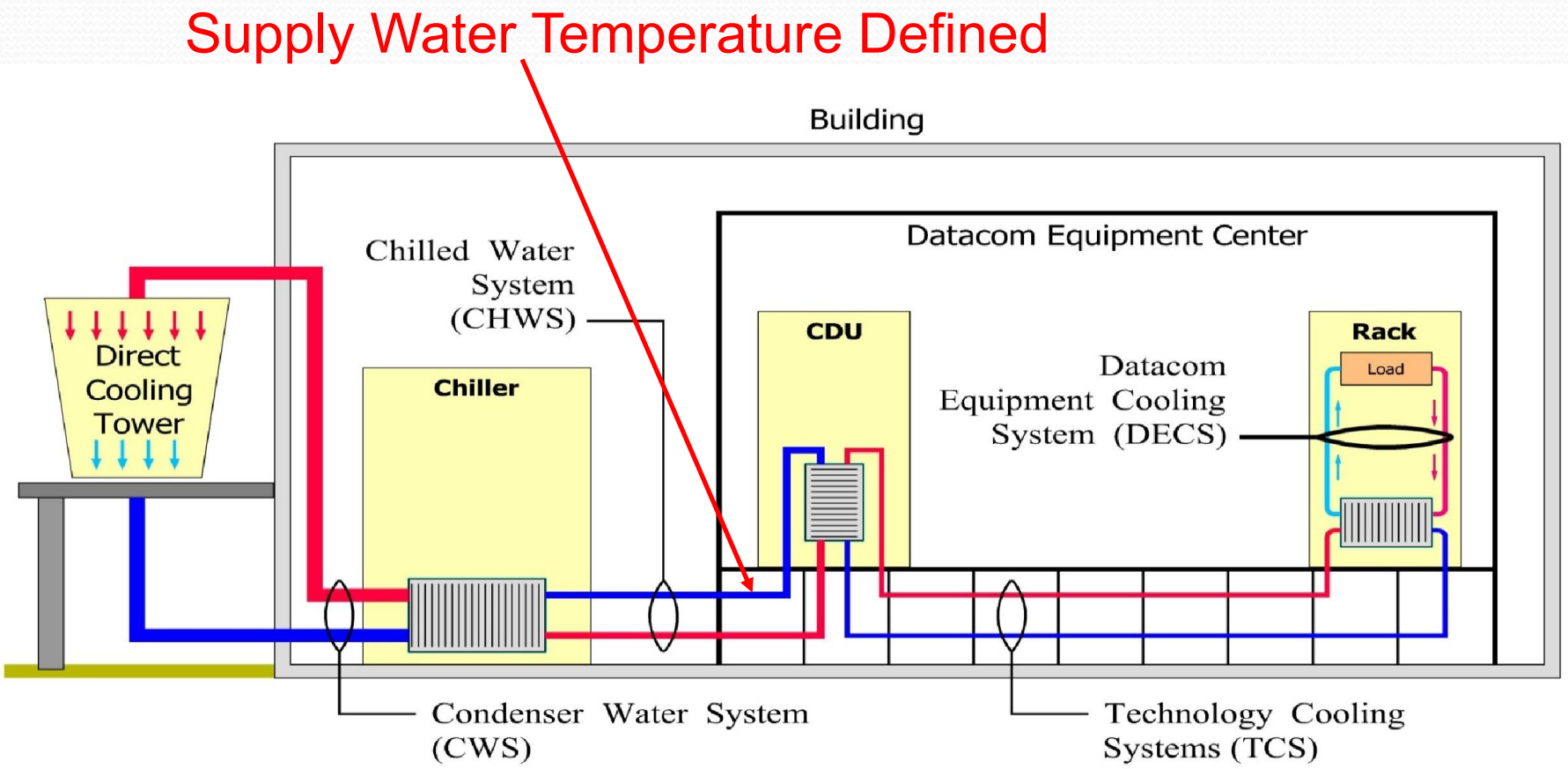
Liquid Cooling – Systems / Loops



ASHRAE 2006 Publication : Liquid Cooling Guidelines for Datacom Equipment Centers

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Liquid Cooling – ASHRAE 2011 Guidelines

Liquid Cooling Classes	Typical Infrastructure Design		Facility Supply Water Temp.
	Main Cooling Equipment	Supplemental Cooling Equipment	
W1	Chiller / Cooling Tower	Water-side Economizer (cooling tower or drycooler)	36 – 63°F (2 – 17°C)
W2			36 – 81°F (2 – 27°C)
W3	Cooling Tower	Chiller	36 – 90°F (2 – 32°C)
W4	Water-side Economizer (cooling tower or drycooler)	N/A	36 – 113°F (2 – 45°C)
W5	Building Heating System	Cooling Tower	> 113°F (> 45°C)

ASHRAE Whitepaper: 2011 Thermal Guidelines for Liquid Cooled Data Center Processing Environments

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Book 2 – Datacom Equipment Power Trends – Volume Server Power Projections

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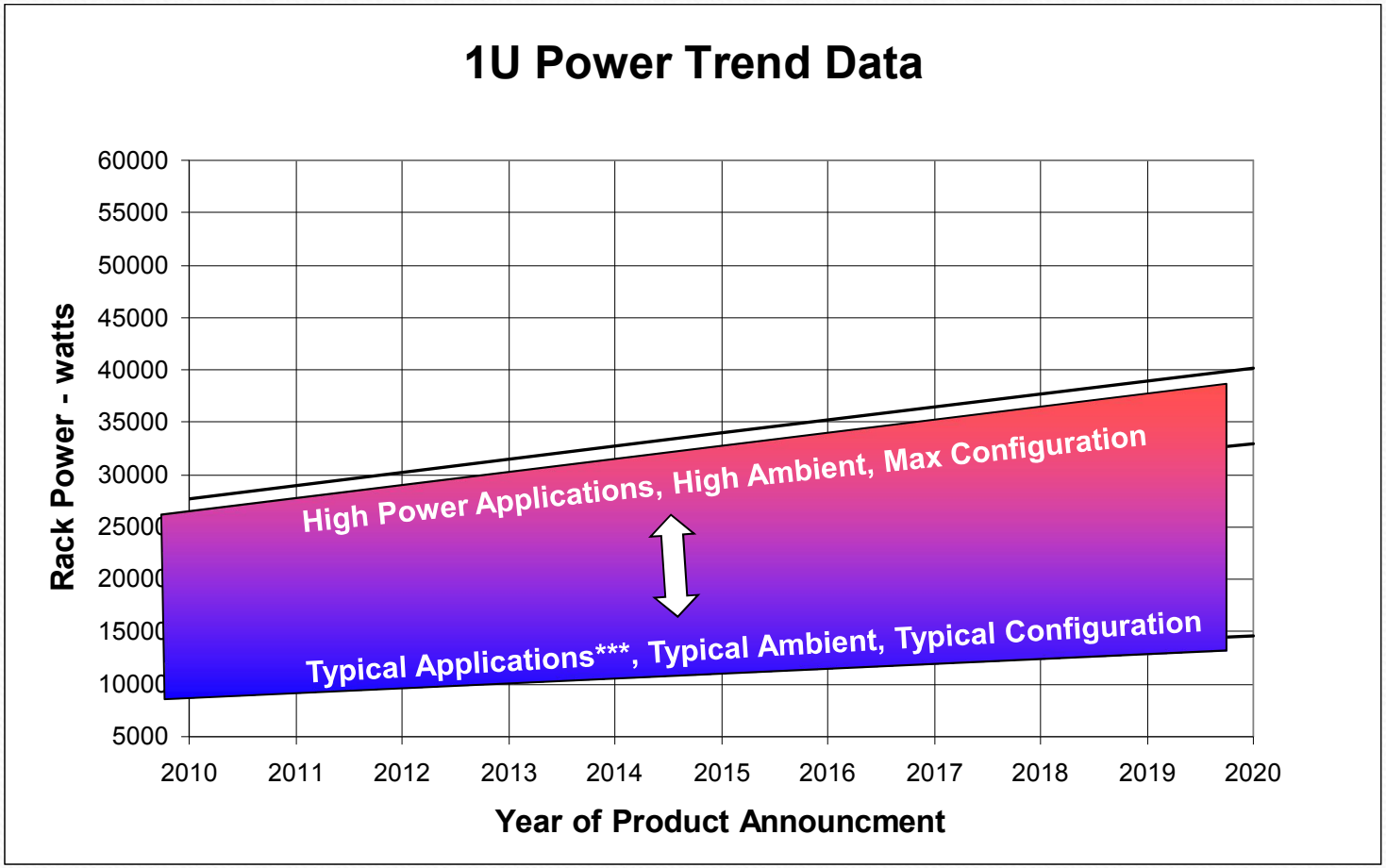
1U 2S – Rack Level Data



Source – ASHRAE Datacom Series 2 handbook - Datacom Equipment Power Trends and Cooling Applications, Second Edition. Figure 4.4 on page 41

These rack heat loads will result in increased focus on improving data center ventilation solutions and localized liquid cooling solutions

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Datacom Series Books

1. Thermal Guidelines for Data Processing Environments 4th Edition (2015)
2. Datacom Equipment Power Trends & Cooling Applications 2nd Edition (2012)
3. Design Considerations for Datacom Equipment Centers (2006)
4. Liquid Cooling Guidelines for Datacom Equipment Centers 2nd Edition (2014)
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)
11. PUE: A Comprehensive Examination of the Metric (2014)
12. Server Efficiency: Metrics for Servers and Storage (2015)
13. IT Equipment Impact on Data Center Solutions (2016)

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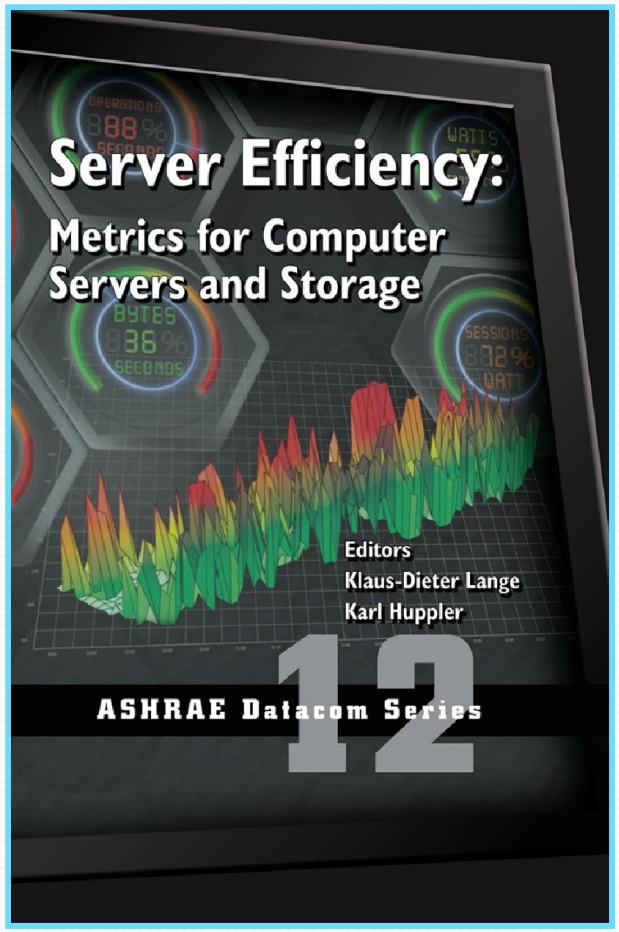
Datacom Series Book 12 – Server Efficiency: Metrics for Computers Servers and Storage



First publication containing all the server benchmarks in one book to allow ease in comparisons.

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A Performance Benchmark Requires

- ✓ An application or specification representing an application, usually satisfying a particular business model.
- ✓ A method for driving the applicaton in a consistent way, including ways to ensure that the system under test is in a similar state at the start of eah benchmark run.
- ✓ A definition of the metrics of the benchmark and how they are derived.
- ✓ A set of rules that provide for reasonable and fair comparison between results and how information from the benchmark may be used in public comparisons.

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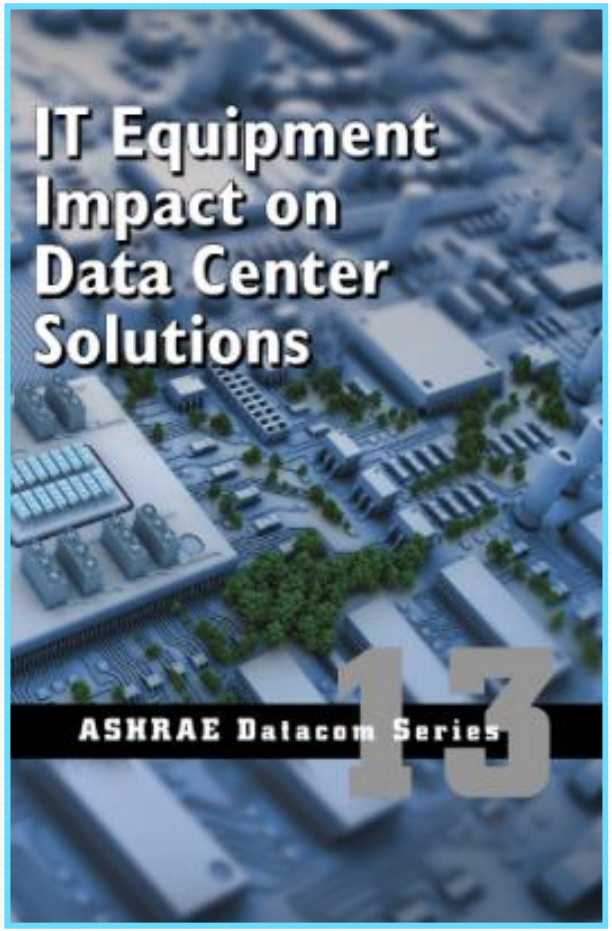
Summary of Benchmarks and Tools and their Metrics

Benchmark / Tool	Components Measured	Application Focus	Primary Performance Measures	Primary Energy Efficiency Measures
SPECpower_ssj2008	Lightly configured server	Lightweight Server Java operations	Java ops/sec	Ops/watt at various loads
SPECvirt_sc2010	Moderately configured server	Mixed light to moderate virtualized operations	Fraction of theoretical maximum operations	Average performance/power
SPECvirt_sc2013	Moderately configured server	Mixed moderate virtualized operations	Fraction of theoretical maximum operations	Average performance/power
SPEComp2012	High Performance Computing nest of servers	High Performance Computing Suite	Normalized to reference machine	Normalized power/performance
SPECweb2009	Moderately configured server and associated storage	Mixed web serving operations	Simultaneous user sessions managed	User sessions per watt
TPC-C and TPC-E with TPC-Energy	Strongly configured server with large storage and moderate middle tier nest	Online Transaction Processing	Transactions per minute	Watts per transaction per minute
TPC-H and TPC-DS with TPC-Energy	Strongly configured server with moderate storage	Decision Support	(complex calculation of) queries per hour at specific DB size	Watts per queries per hour
TPC-VMS with TPC-Energy	(relates to one of the four benchmarks, above)	(uses one of above TPC benchmarks)	Per base benchmark chosen	Per base benchmark chosen
VMmark 2.5	Moderately configured server	Mixed moderate virtualized operations	Geometric mean of normalized scores from mixed workloads	Performance score per kilowatt
SAP Server Power Benchmark	Strongly configured server	Enterprise Resource Planning	Throughput measure called SAPs	Watts per kSAPs at various loads
SAP System Power Benchmark	Strongly configured server with moderate storage	Enterprise Resource Planning	Throughput measure called SAPs	Watts per kSAPs at various loads
SNIA Emerald	Storage system	Storage I/O	IOs per second and bytes per second under various loads	Performance metrics per watt
SPC-1E and SPC-1CE	Storage system or Storage component	Storage I/O	IOs per second	IOs per second per watt at various loads
SPC-2E and SPC-2CE	Storage system or Storage component	Storage I/O	Bytes per second	Bytes per second per watt
SERT	Servers with range of configurations	Mixed CPU, Memory and I/O operations	Measures reported, Metrics determined in future release	Measures reported, Metrics determined in future release

Datacom Series Book 13 – IT Equipment Impact on Data Center Solutions



Book 13 describes the design and design process for ITE and how ITE interacts with the environments in which it is used.

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SPC 90.4P – Proposed ASHRAE Standard: Energy Standard for Data Centers & Telecommunications Buildings

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ASHRAE Standard 90.4P, Energy Standard for Data Centers

Purpose:

To establish the minimum energy efficiency requirements of Data Centers for:

1) design, construction, and a plan for operation and maintenance, and
2) utilization of on-site, renewable energy resources

Scope:

1) Minimum energy-efficient requirements for the design, construction, and a plan for operation and maintenance of:
   - New Data Centers or portions thereof and their systems
   - New portions of Data Centers or portions thereof and their systems
   - New systems and equipment in existing Data Centers or portions thereof
2) Criteria for determining compliance with these requirements

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