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

2026 ASHRAE Annual Conference

Austin, Texas

Working Session Meeting

Sunday June 28, 2026

6:00 pm – 8:00 pm CDT

Hybrid In-Person

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Welcome

ASHRAE TC 9.9

Working Session Meeting

High Level Agenda

- Welcome
- Working Session Track Primers
- Working Sessions

Meeting Organizers

Meeting Host: Mark Steinke - *Chair*

- Organize the meeting content
- Introduce topics
- Moderate discussions
- Manage screen-sharing and in-person presentation

Virtual Host: John Gross - *Vice Chair*

- Monitor the chat for questions and comments
- Mute and Unmute Virtual Participants
- Manage discussions and voting

Virtual Co-Host: Chris Campbell - *Secretary*

- Monitor time and keep the meeting on schedule
- Record the event
- Produce meeting minutes
- Respond to audio problems
- Add the attendance link to the chat

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Agenda – Working Session Meeting

Section	Topic	Time	Presenter
Welcome	Welcome & Agenda	10	Mark Steinke
Publications Subcommittee	Working Session Primer	5	Dustin Demetriou
Programs Subcommittee	Working Session Primer	5	Eric Yang
Research Subcommittee	Working Session Primer	5	Brad Cochran
Working Sessions	Track 1: Encyclopedia / Tech Briefs Track 2: Programs Track 3: Research Track 4: Handbook	95	Dustin Demetriou Eric Yang Brad Cochran Bob McFarlane/Jonell Watson
	Total Time:	120	Minutes

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Housekeeping & Meeting Etiquette

General Meeting Etiquette

- Individuals should state their name & affiliation prior to speaking
- Speak into a microphone
- In-room projection is being shared virtually as well
- There are audio speakers in the room, but unmuted virtual commentators may not be immediately connected. Please be patient.
- In-person participants are discouraged from joining the virtual meeting due to wireless bandwidth constraints

Virtual Attendees

- Audio
  - Virtual attendees are muted upon entry
  - Do not un-mute your line unless acknowledged by the hosts to do so
  - If you need to speak, please use the Raise Hand button and the moderator will enable your microphone
  - Un-mute to present your topic
- Video
  - We encourage you to keep your video off due to the high number of virtual participants.
  - If you do enable your video, be mindful that you are on display
  - If you are a speaker for a topic, video sharing is acceptable
- Miscellaneous
  - Please do not attempt to share your screen without being asked to do so by the Hosts
  - Use the chat function to ask questions
  - Our moderator will share questions throughout the presentation with the speaker to answer.
  - Be aware that chat comments sent to the Host may be seen by those in-person in addition to general chat comments.

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Meeting Attendance - Sunday

Meeting Attendance is tracked via a Google form. Please complete the attendance form for each meeting…

Sunday Meeting Attendance

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ASHRAE Code of Ethics

ASHRAE Value Statement

In ASHRAE meetings, we will act with honesty, fairness, courtesy, competence, inclusiveness and respect for others, which exemplify our core values of excellence, commitment, integrity, collaboration, volunteerism and diversity, and shall avoid all real or perceived conflicts of interest. Our culture is one of inclusiveness, acknowledging the inherent value and dignity of each individual. We celebrate diverse and inclusive communities, understanding that doing so fuels better, more creative and more thoughtful ideas, solutions and strategies for the Society and the communities our Society serves. We respect and welcome all.

Code of Ethics - https://www.ashrae.org/about/governance/code-of-ethics

Core Values - https://www.ashrae.org/about/ashrae-s-core-values

Diversity Statement - https://www.ashrae.org/about/diversity-equity-and-inclusion-dei

Antitrust Policy - https://youtu.be/ykisOzjHyZM

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Workshops Meeting

- New meeting format for Sunday Continues…
  - Dedicate time for face-to-face discussions & group work on Sunday
  - Well received and productive
    - Encyclopedia updates, Tech Brief ideas, Program topics, & Research topics were generated and submitted
- Start with some working group “primers”
- Break into parallel tracks
  - **Track 1: Datacom Encyclopedia**
  - **Track 2: Programs**
  - **Track 3: Research**
  - **Track 4: Handbook**
- If your track ends early, please feel free to join another track

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Track 1a: Datacom Encyclopedia

Dustin Demetriou

- Goal of today's workshop is to solicit volunteers who want to be ***content developers***.
- A pre-defined listing of topics that need to be created and/or edited based on the Encyclopedia work done since the Winter
- Volunteers will be writing the content using what ever software they prefer.
- To sign up for a topic add your name in the **Volunteer** column and mark **Status** as **In Progress**
- **EXPECTATION**: If you volunteer, you will send a draft of the content at the end of the session
- Send to tc99publications@gmail.com

Table1

Topic	What's Needed	Volunteer	Status	Notes
Energy Star for Servers	Update			Need to reflect current version and st
ASHRAE Standard 90.1	Update			Need to reflect current version. In **Sta**
ASHRAE Standard 90.4	Update			Need to reflect current version. In **Sta**

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Track 1b: Tech Briefs

Dustin Demetriou

- Tech Brief has been valuable and well received but we need to accelerate their publication to at least 2x every 6 months to have a real impact
- IT Subcommittee has been meeting monthly to focus on Tech Brief publication acceleration via asynchronous collaboration.
- Goal of today's workshop is to support the development of one of these Tech Briefs with a goal to have a draft and possibly a brief for review.

Topic	Lead
L2A CDU trends	Jason Matteson
Demystifying biostatic vs. biocide vs. biofilm	Matt Hatley
Fluid quality	Tanya Hutter
Fluid testing and maintenance	Lauren Huffman
TCS commissioning	John Gross

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Track 2: Programs

Eric Yang

- 11 programs accepted in Austin
- First time Data Center Track
- plan for a dedicated conference paper session on data center at Chicago 2027 Winter Conference.
  - For those who are submitting a conference paper for Chicago, please drop me a note
- Sub- session for program ideas
  - Welcome to join and discuss
  - Good ways to be involved in TC9.9
  - Reduced registration rate
  - Due date: 8/3/2026

- **Contact me at ericyangcem@gmail.com**
  - **If you need to co-sponsorship from other TCs**
  - **If you need an ASHRAE speaker submission template or understand the process of submitting a session**

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Track 3: Research

Brad Cochran

Since 1960, ASHRAE has sponsored almost 1000 research studies at universities and research firms for a total cost of almost $90M.

The results of these studies have been used to prepare chapters in the ASHRAE Handbook series; as foundational material in special publications; in the formulation of standards; to train university students as they prepare for service in the HVAC&R industry; and to spread the knowledge gained through presentation at Society Conferences and publication in ASHRAE Transactions or conference proceedings.

ASHRAE currently has 42 active research projects

- Total value of active research - $7.5M
- Average contract - $180K

TC9.9

- Submitted 4 RTARS to RAC in Spring 2026 and 1 Work Statement
- Currently has 2 active Research Projects

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During the Research Committee Workshop we will:

1. Review the current status of all RTARS, Work Statements, and Active Research Projects.
2. Step through the process of taking a research idea from conception through published report.
3. Discuss new idea for research

Note – ASHRAE sponsors research they do not conduct research

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Track 4: Handbook

Bob McFarlane/Jonell Watson

Outstanding Handbook Items to Close in the Working Session

Name	Item
Uschas Chowdhury	Complete Liquid Cooling Section
Matt Koukl	Complete Figs. 2 & 3 (Racks, Cabinets & ITE Form Factors
???	Language Around New Fig. 3 (Typical ITE Form Factors)
???	Server Classifications (Need to Add GPU & AI Classes ???)
???	Select New Fig. 5 (Liquid Cooling Loop)
Dustin Demetriou	Datacom Encyclopedia & “Book” References Method
Dustin Demetriou	New Power Trends Section
Dustin Demetriou ?	Extract Liquid Cooling Table from Encyclopedia (Section 4.2?)
???	Confirm Temp. Change Gradient for Air Cooled Guidelines
???	Clarify Sentence in Environmental Guidelines for Liquid Cooled
???	IEEE Standards 3005 & 3003: Add Information??
???	Clarify CFD Modeling Outdoors vs. Data Center Modeling
???	Confirm: Is Liquid Immersion the Only 100% Liquid Cooling Solution?
???	Confirm Sources for ALL Illustrations
Dave Quirk	Clarify Statements in x-Factor Analysis
???	Commissioning: Has New GPC-1.6 Been Published?
Don Mitchel	Clarify Filtration Size Statements
???	Update All References to Most Current Publications

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Workgroups Now in Progress

Sunday Meeting Attendance

ASHRAE TC 9.9 Website

https://tc0909.ashraetcs.org

Datacom Encyclopedia

https://datacom.ashrae.org

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

2026 ASHRAE Annual Conference

Austin, Texas

Main TC 9.9 Committee Meeting

Monday June 29, 2026

Hybrid In-Person

Content Copyright ASHRAE TC 9.9. All Rights Reserved.

Welcome

ASHRAE TC 9.9

Status & Updates Session

High Level Agenda

- Welcome
- Hybrid Meeting Etiquette
- Introductions
- Title, Purpose, & Scope
- Membership
- Liaison Reports
- Subcommittee Updates

Meeting Organizers

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- Organize the meeting content
- Introduce topics
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Agenda – Main TC 9.9 Committee Meeting

Section	Topic	Time	Presenter
Welcome	Welcome, Agenda, & Meeting Etiquette	10	Mark Steinke
Introductions	TC 9.9 TPS, Structure, Subcommittee Chairs, Voting Members Introductions	15	Mark Steinke
TC 9.9 Activity	Recorded Votes Logistics Updates Website Updates	15	Mark Steinke Ecton English
TC 9.9 Membership	Membership Statistics	10	John Groenewold
Programs Subcommittee	2026 Summer & 2027 Winter Meeting Other Updates	15	Eric Yang
Handbook Subcommittee	Updates on Handbook Chapter Progress	5	Robert McFarlane Jonell Watson
Standards Subcommittee Liaison Reports	Standard 90.1 Standard 90.4 SSPC 127 OCP Decarb	20	Rick Pavlak Marcus Hassen David McGlocklin Matt Koukl Lixia Wu
BREAK		15	-
Attendance	Review Attendance Statistics	5	Mark Steinke
International Subcommittee	General Updates LinkedIn Statistics	10	Paul Finch
Research Subcommittee	Updates RTARs	35	Brad Cochran
Publications Subcommittee	Encyclopedia Updates Tech Briefs	20	Don Beaty Dustin Demetriou
IT Manufacturers Subcommittee	Updates	45	Dustin Demetriou
BREAK		10	-
IT Manufacturers Working Session	Closed Door Session (By Invitation Only)	45	Dustin Demetriou
	Total Time:	275	Minutes

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Meeting Attendance - Monday

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https://forms.gle/g7TnEXKKhatpkW4x5

Monday Meeting Attendance

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Antitrust Policy - https://youtu.be/ykisOzjHyZM

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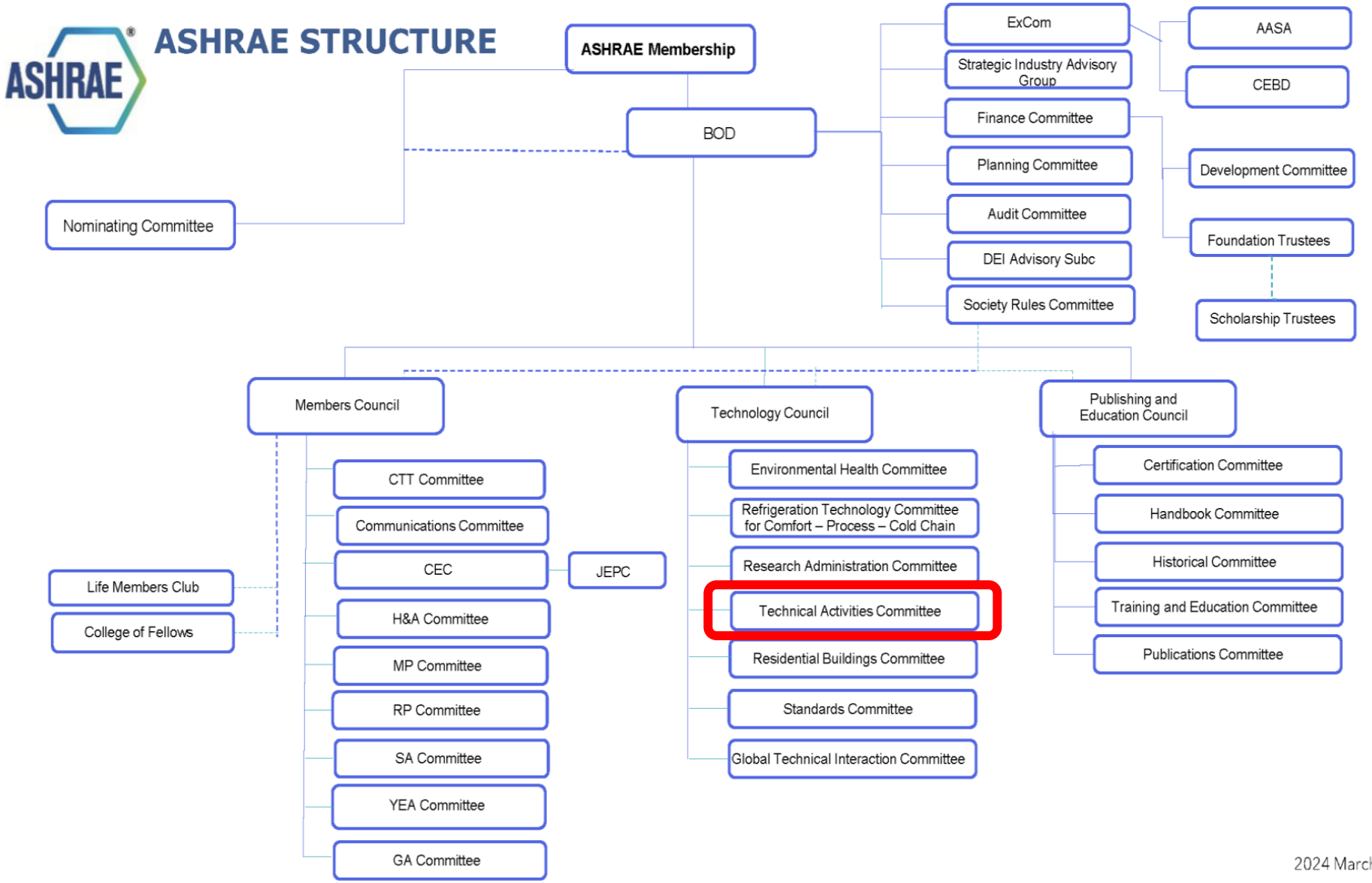
How is ASHRAE Structured?



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ASHRAE Technical Committee's Purpose

- ASHRAE Technical Committees consist of people who have a recognized proficiency in a specific field of interest
- The TCs are responsible for…
  - Preparing the text of ASHRAE Handbook chapters
  - Originating, coordinating, and supervising Society-sponsored research projects
  - Presenting programs at ASHRAE meetings
  - Reviewing technical papers
  - Evaluating the need for standards
  - Advising the Society on all aspects of the technology it embraces

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ASHRAE Technical Committee 9.9 (TC 9.9)

TITLE

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

PURPOSE

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 things 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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Who are TC 9.9 Members?

Participants

- TC 9.9 is the largest ASHRAE TC
- Most active TC with over 700+ members at our peak

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
- Many different segments
  - Government agencies, enterprise, telco, utilities, consultants, academia, testing laboratories…

Industry Volunteers Provide the Expertise

- Manufacturers, consultants, researchers, universities, utilities, regulators, contractors, and government

Areas of Influence

- Handbook, Standards, Research, Programs
- Technical Activities: Books, White Papers & Tech Briefs, Encyclopedia, Education…

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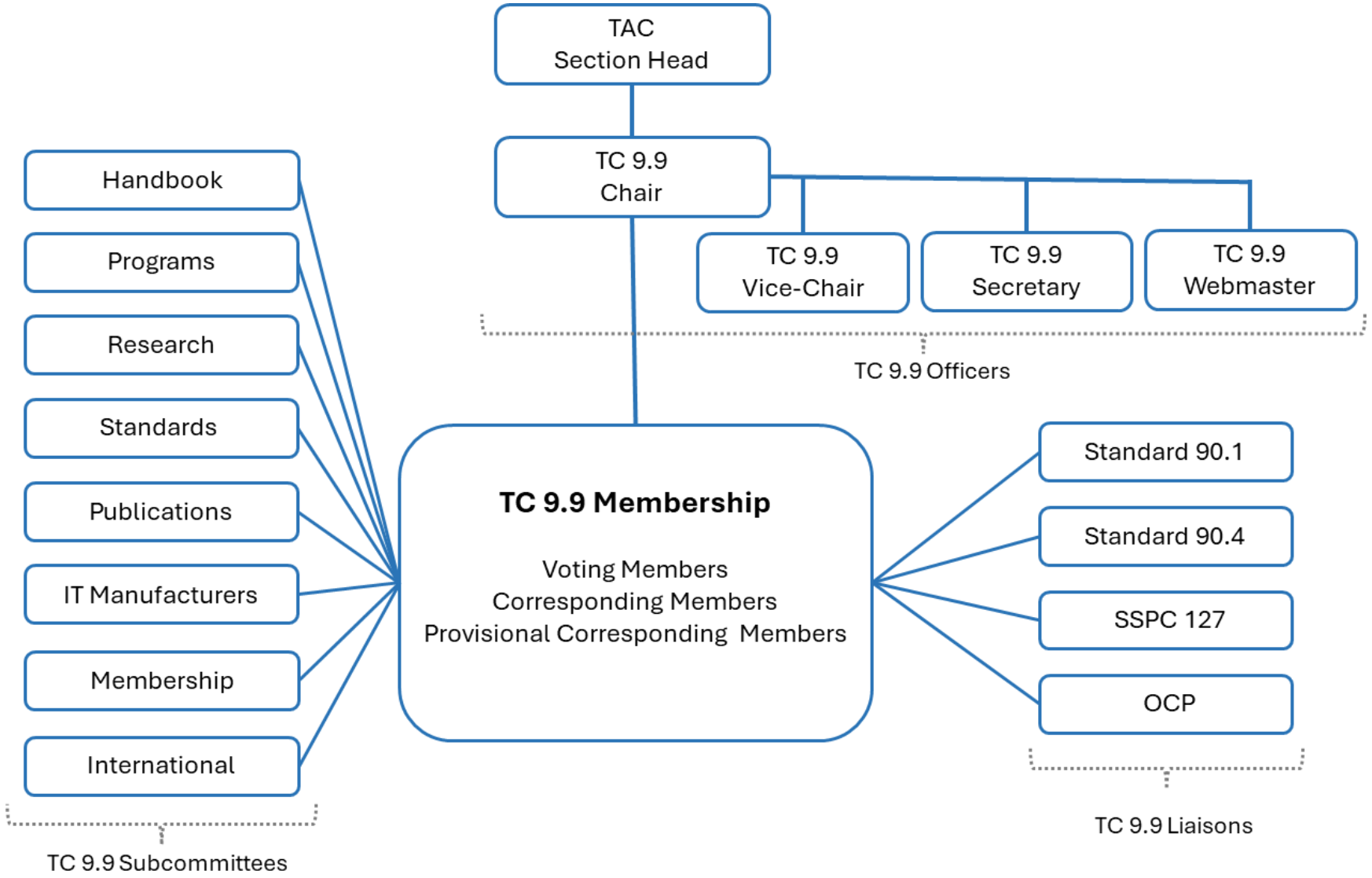
How is ASHRAE TC 9.9 Structured?



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ASHRAE TC 9.9 - Previous Chairs

Don Beaty
2005 - 2007
DLB Assoc.

Roger Schmidt
2007 - 2009
IBM

Fred Stack
2009 - 2011
Liebert

Jack Glass
2011 - 2013
Citigroup

Dave Quirk
2013 - 2015
DLB Assoc.

Robin Steinbrecher
2015 - 2017
Intel Corporation

Jason Matteson
2017 - 2019
Lenovo, Vertiv

Dustin Demetriou
2019 - 2021
IBM

John Groenewold
2021 - 2023
Vantage Data Centers

Matt Koukl
2023 - 2025
Affiliated Engineers, Inc.

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ASHRAE TC 9.9 - Officers & Subcommittee Chairs

TC 9.9 Officers

Chair
Mark Steinke
NVIDIA
TC0909@ashrae.net
TC99Chair@gmail.com

Vice-Chair
John Gross
IREN
TC0909.VCH@ashrae.net

Secretary
Chris Campbell
Vertiv
TC0909.SEC@ashrae.net

TC 9.9 Subcommittee Chairs

Handbook
Robert McFarlane
Shen Milson & Wilke, LLC
TC0909.HBK@ashrae.net

Programs
Eric Yang
My Energy LLC
TC0909.PRO@ashrae.net

Research
Brad Cochran
CPP, Inc.
TC0909.RES@ashrae.net

Standards
Rick Pavlak
Heapy Engineering, Retired
TC0909.STD@ashrae.net

Webmaster
Ecton English
Johns Hopkins University APL
TC0909.WEB@ashrae.net

Publications
Don Beaty
DLB Assoc., Retired
Don.Beaty@Outlook.com

Membership
John Groenewold
Cologix
john.groenewold@cologix.com

IT Manufacturers
Dustin Demetriou
IBM
dwdemetr@us.ibm.com

International
Paul Finch
Goldfinch Digital Infrastructure Partners
paul.finch@gdip.co.uk

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ASHRAE TC 9.9 - SY 25/26 Voting Members (13)

Dustin Demetriou
IBM

Jason Matteson
nVent

Tim Shedd
Independent Consultant

Ecton English
Johns Hopkins University APL

Robert McFarlane
Shen Milson & Wilke, LLC

Mark Steinke
NVIDIA

Paul Finch
Goldfinch Digital Infrastructure Partners

David McGlocklin
Schneider Electric

Lixia Wu
Cushman & Wakefield

Nick Gangemi
Weeks Group

Rick Pavlak
Heapy Engineering, Retired

John Gross
IREN

Dave Quirk
DLB Assoc.

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ASHRAE TC 9.9 - Voting Member Updates

- **Society Year 25/26**
  - Total voting members: 13
  - VM terms ending: 2

- **Society Year 26/27**
  - Total voting members: 14
  - VM terms ending: 5
  - Adding New VMs: 3

A big THANK YOU to…

Paul Finch
Goldfinch Digital
Infrastructure Partners

Rick Pavlak
Heapy Engineering, Retired

Paul Artman
AMD

Matt Koukl
Affiliated Engineers, Inc.

Vali Sorell
Oracle

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ASHRAE TC 9.9 - SY 26/27 Voting Members (14)

Paul Artman
AMD

Matt Koukl
Affiliated Engineers, Inc.

Tim Shedd
Independent Consultant

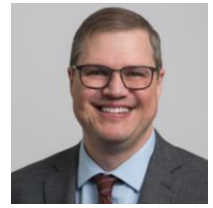
Dustin Demetriou
IBM

Jason Matteson
nVent

Vali Sorell
Oracle

Ecton English
Johns Hopkins University APL

Robert McFarlane
Shen Milson & Wilke, LLC



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NVIDIA

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Schneider Electric

Lixia Wu
Cushman & Wakefield

John Gross
IREN

Dave Quirk
DLB Assoc.

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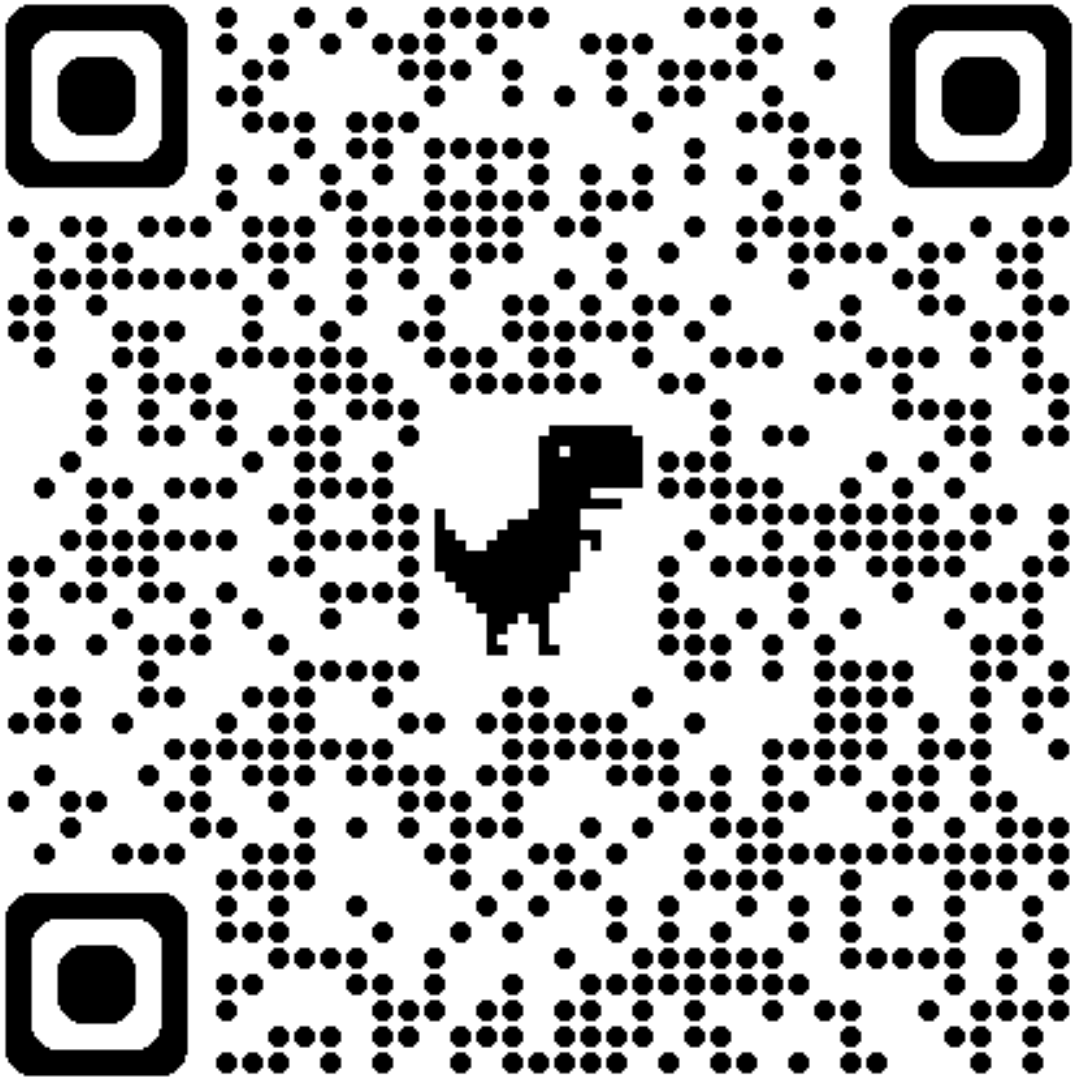
Meeting Attendee Introductions

- Trying something different…
- Utilize the attendance form input
- Display the results after the first break
- Still enter…
  - Name
  - ASHRAE Member Number
  - Organization
  - Membership Type
  - Industry Role Type (best fit)
  - Subcommittee Membership (multiples ok)
  - YEA Member
  - International Member
  - Attendance Type

Monday Meeting Attendance



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TC 9.9 Activities

Monday Meeting Attendance

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TC 9.9 Activity – Society Year 2025/2026

Activities for Society Year (SY) 2025/2026

July 1, 2025 - June 30, 2026

- Roster Updates for SY 26/27
  - SY 26/27 completed
  - Completed major overall of our roster
  - Originally had over 750+ listed
  - Removed
    - Inactive accounts
    - Email bounce backs
    - Zero attendance records
  - Roster count for SY 26/27 is now 483
- Roster Updates for SY 27/28
  - Working on a Proposal and will send to vote
    - A minimum activity requirement for CMs
    - Finalize the activity requirement for PCMs

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TC 9.9 Activity – Society Year 2025/2026

In Favor – Against – Abstaining – Not Present – Chair Voting/Chair Not Voting

Votes – SY 25/26

- **Vote 1:** Discontinuing Datacom Series printed books - **Passed** 12-0-0-1-CV
- **Vote 2:** Proposed TC 9.9 RTAR - Effective Refrigerant Dispersal Volume - **Passed** 11-0-0-2-CV
- **Vote 3:** Approval of 2024 Winter Minutes (Chicago), 2024 Annual Minutes (Indy), & 2025 Winter Minutes (Orlando) - **Passed** 10-0-0-3-CV
- **Vote 4:** Approval of the Draft 2025 Annual Meeting Minutes – Phoenix - **Passed** 12-0-0-1-CV
- **Vote 5:** Approval of 4Q2025 Quarterly Encyclopedia Updates - **Passed** 13-0-0-0-CV
- **Vote 6:** Approval of 1972-TRP PES Recommended Bidder - **Passed** 13-0-0-0-CV
- **Vote 7:** Approval of RTAR - External Flow Modeling of Data Centers – **Passed** 13-0-0-0-CV
- **Vote 8:** Approval of RTAR - Experimental evaluation of mixing different inhibitor-types in water-glycol mixtures – **Passed** 13-0-0-0-CV
- **Vote 9:** Approval of RTAR Submission - Flow Velocity Impact on Erosion – **Passed** 13-0-0-0-CV
- **Vote 10:** Approval of W.S. for RP-1956 Compact CFD Modeling of Thin Resistances – **Passed** 11-0-0-2-CV
- **Vote 11:** Approval of the "TC 9.9 2026 Winter Meeting Minutes - Las Vegas" Draft – **Passed** 12-0-0-1-CV
- **Vote 12:** Approval of Tech Alert - TCS Coolant Integrity and System Readiness Best Practices – **Failed** 6-1-0-6-CV
- **Vote 13:** Approval of Tech Alert - TCS Coolant Integrity and System Readiness Best Practices v2 – **Passed** 13-0-0-0-CV
- **Vote 14:** Approval of Tech Snapshot - AI Indirect / Direct Impact on Data Center Infrastructure Planning - **Passed** 12-1-0-0-CV

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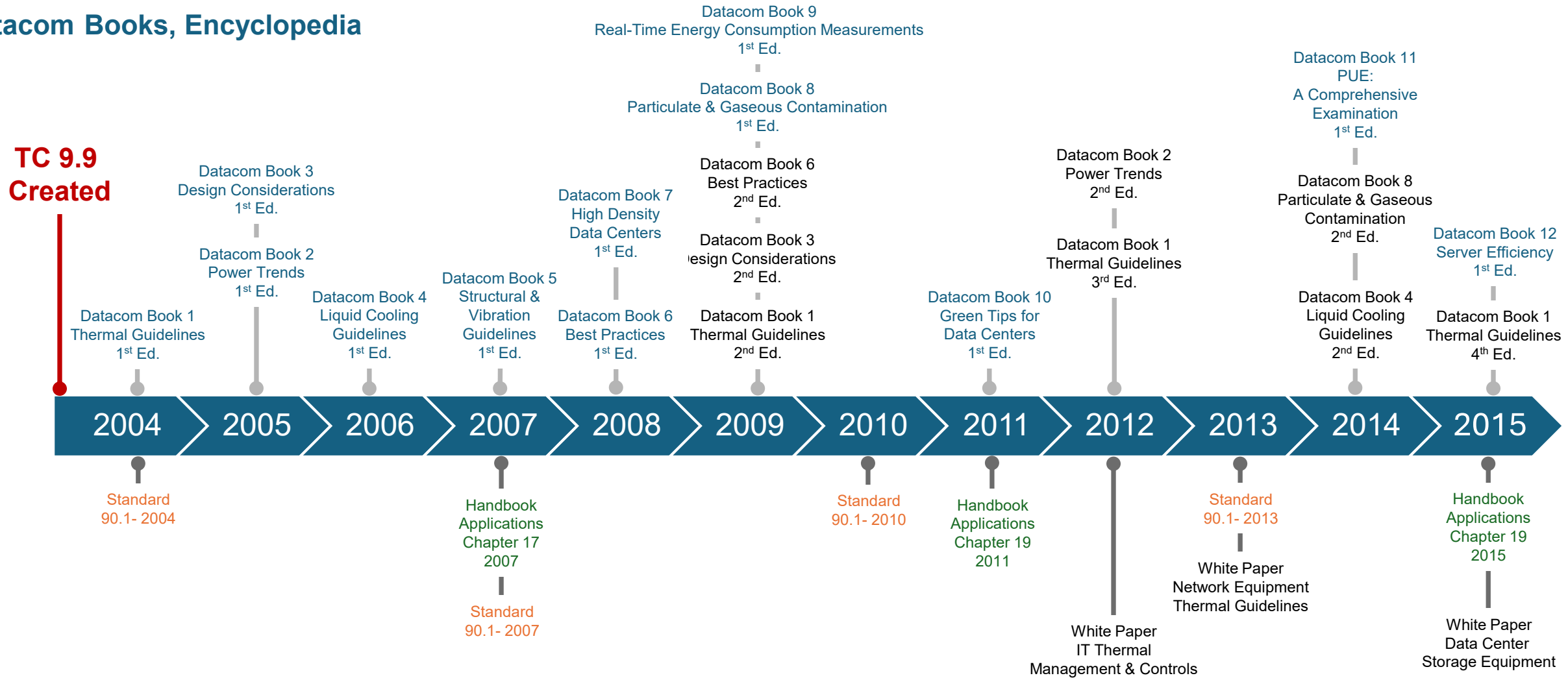
ASHRAE TC 9.9 - Publication Timeline (2004 – 2015)

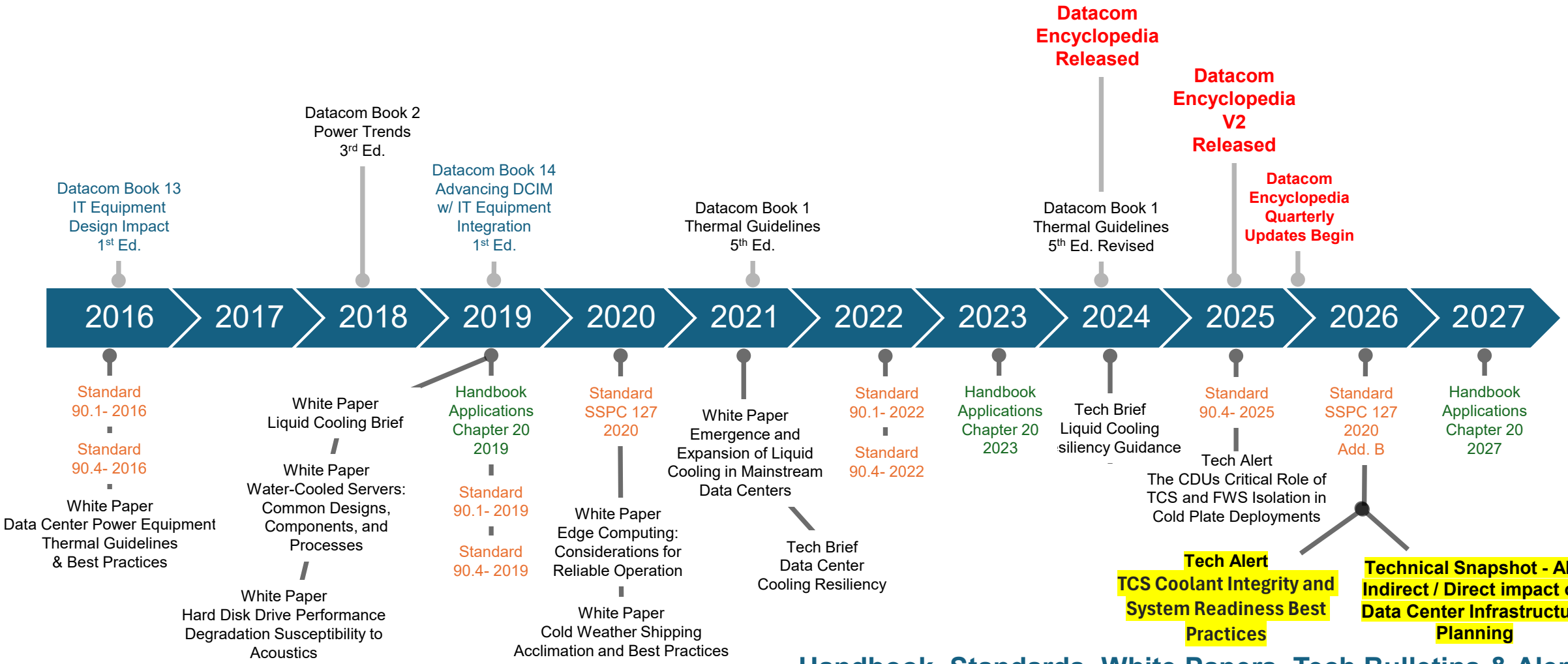
Datacom Books, Encyclopedia



Handbook, Standards, White Papers, Tech Bulletins & Alerts

ASHRAE TC 9.9 - Publication Timeline (2016 – Present)

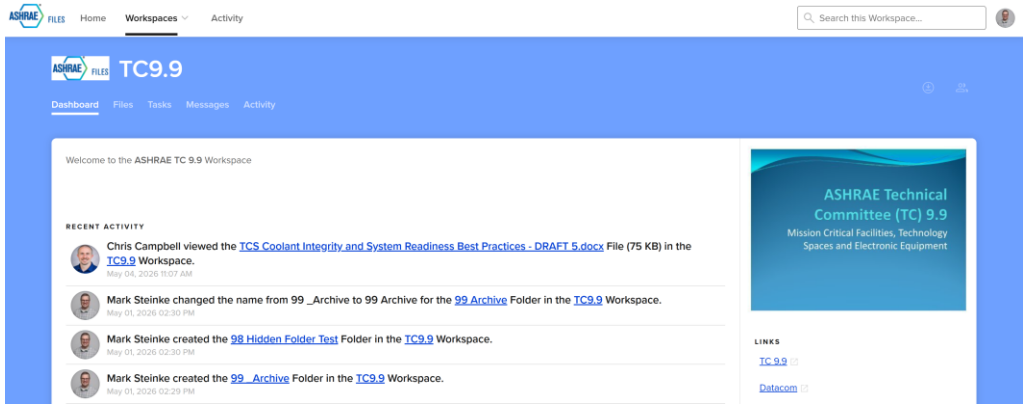
Datacom Books, Encyclopedia

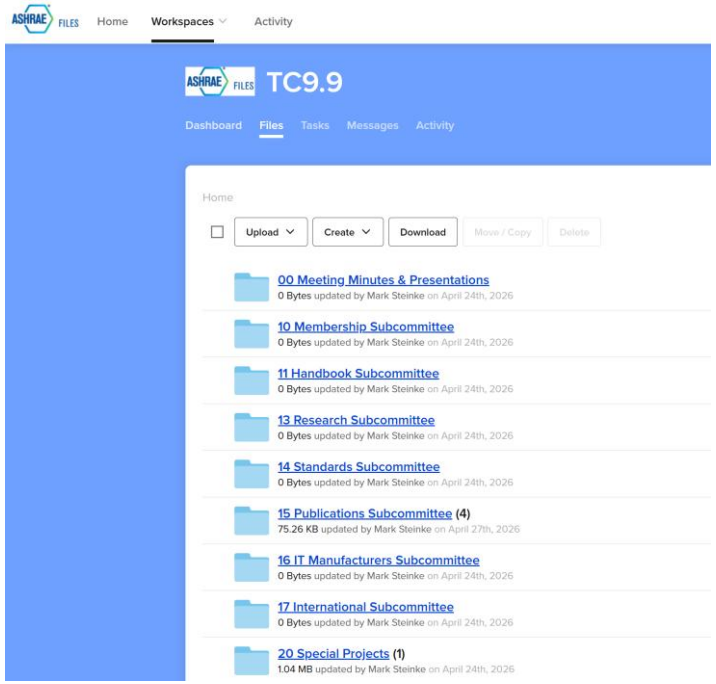


Handbook, Standards, White Papers, Tech Bulletins & Alerts

TC 9.9 Logistics Updates

- Need a better File Repository and File Sharing system for TC 9.9
- Worked with ASHRAE IT on the available tools
- Developing a new "TC 9.9" site on "ASHRAE Files" System
  - Allows for controlled access
  - Allows for concurrent editing of MS Office products
  - Persistent file storage for all functions
- Will begin adding TC members on an as needed basis
- Likely to start with the IT Manufactures Subcommittee and add over time





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Website Statistics

Ecton English

Analytics | ASHRAE TCs G4

ASHRAE TCs G4

Go to report

All Users | Add comparison

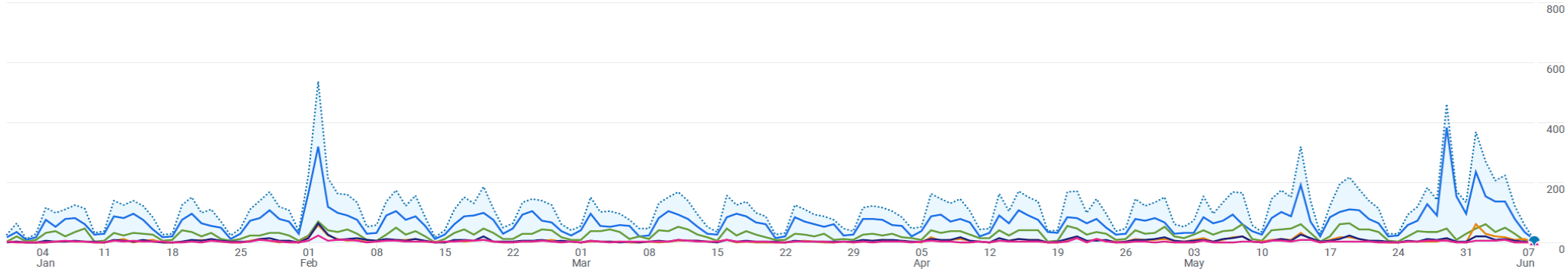
1 January 2026 - 7 June 2026

Pages and screens: Page title and screen name

Add filter

Views by Page title and screen name over time

Day



9.9

Rows per page: 10 Go to: 1 1-10 of 141

	Page title and screen name	Views	Active users	Views per active user	Average engagement time per active user	Event count All events	Key events All events	Total revenue
	Total	18,192 vs. 13,217 ↑ 37.64%	9,945 vs. 7,453 ↑ 33.44%	1.83 vs. 1.77 ↑ 3.15%	36s vs. 33s ↑ 9.38%	60,680 vs. 44,418 ↑ 36.61%	0.00 vs. 0.00	$0.00 vs. $0.00
1	Index | ASHRAE 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment							
	Jan 1 - Jun 7, 2026	11,149 (61.29%)	7,415 (74.56%)	1.50	28s	38,263 (63.06%)	0.00 (–)	$0.00 (–)
	Jan 2 - Jun 8, 2025	7,425 (56.18%)	4,973 (66.72%)	1.49	28s	25,838 (58.17%)	0.00 (–)	$0.00 (–)
	% change	50.15%	49.11%	0.7%	2.18%	48.09%	0%	0%

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Website Statistics

Ecton English

Analytics | ASHRAE TCs G4
ASHRAE TCs G4

Go to report

All Users | Add comparison

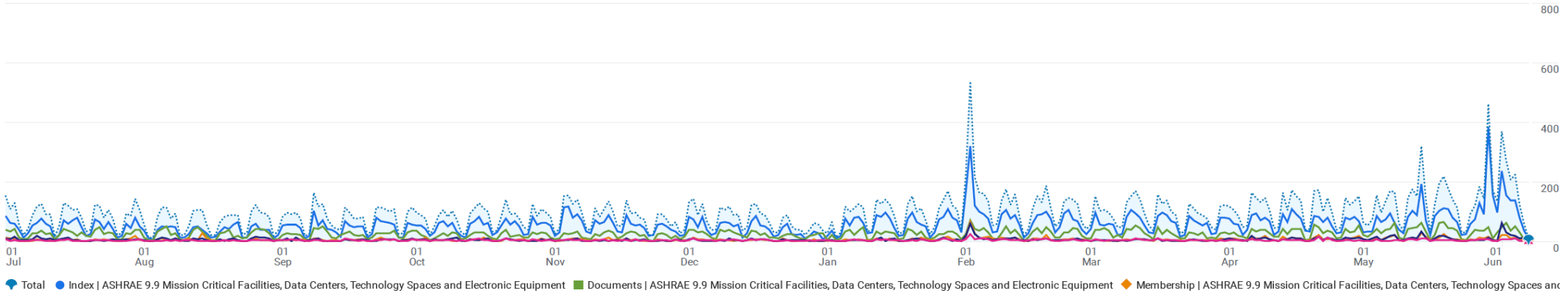
1 July 2026 - 7 June 2026

Pages and screens: Page title and screen name

Add filter

Views by Page title and screen name over time

Day



9.9

Rows per page: 10 Go to: 1 1-10 of 141

	Page title and screen name	Views	Active users	Views per active user	Average engagement time per active user	Event count All events	Key events All events	Total revenue
	SHOW ALL ROWS							
	Total	32,388 vs. 150 ↑ 21,492%	17,846 vs. 92 ↑ 19,297.83%	1.81 vs. 1.63 ↑ 11.31%	36s vs. 29s ↑ 21.78%	109,168 vs. 498 ↑ 21,821.29%	0.00 vs. 0.00	$0.00 vs. $0.00
1	Index | ASHRAE 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment							
	Jul 1, 2025 - Jun 7, 2026	19,437 (60.01%)	12,924 (72.42%)	1.50	28s	67,342 (61.69%)	0.00 (–)	$0.00 (–)
	Jul 1 - Jul 1, 2025	84 (56%)	66 (71.74%)	1.27	18s	285 (57.23%)	0.00 (–)	$0.00 (–)
	% change	23,039.29%	19,481.82%	18.17%	53.16%	23,528.77%	0%	0%

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Website Statistics

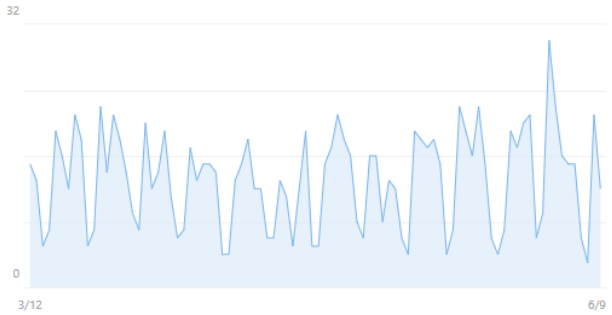
Ecton English

Overall traffic

Last 7 30 **90** days

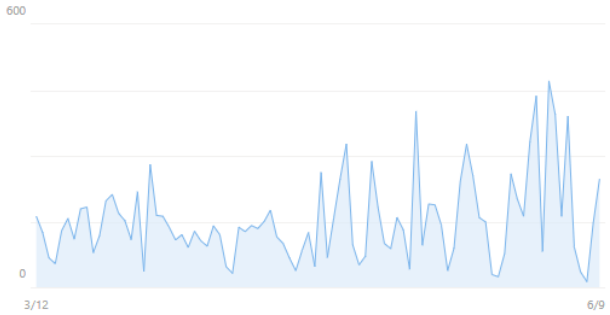
Unique viewers 890

The 90 day figure isn't available for this metric. Learn more.



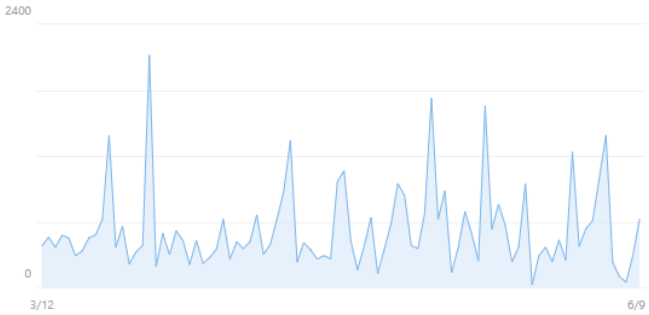
Site visits 73,329

13,725



Avg time spent per user

The 90 day figure isn't available for this metric. Learn more.



Popular content in the last 7 days

Site pages Sort by **Unique viewers**

Name	Unique viewers
DatacomHome.aspx	47
Cooling_Technologies_Search.aspx	15
Facility_Design_Considerations_Search.aspx	13
Liquid_Cooling.aspx	12
TCS_Coolant_Integrity_and_Readiness.aspx	11
Prior-Books.aspx	10
Thermal_Guidelines_Ch2.aspx	8
Thermal_Guidelines_Index.aspx	8
Liquid_Distribution.aspx	7
Environmental_Guidelines_Search.aspx	7

News posts Sort by **Unique viewers**

We do not have enough data to show here. Please try again later.

Documents Sort by **Unique viewers**

Name	Unique viewers
ASHRAE TC 9.9 Technical Alert The CDUs Critical Role of TCS an...	7
01-5a_ThermalGuidelines_5th Ed_RevExp_90581.pdf	6
whitepaper_tc099-watercooledservers.pdf	6
ASHRAE TC 9.9 Technical Bulletin Liquid Cooling Resiliency Guid...	4
04-2_LiquidCoolingGuidelines_2nd Ed_90564.pdf	4
emergence-and-expansion-of-liquid-cooling-in-mainstream-da...	4
hard-disk-drive-performance-degradation-susceptibility-to-aco...	4
01-1_ThermalGuidelines_1st Ed_90431.pdf	4
6 Liquid-cooling Infrastructure Considerations for Technology C...	3
01-5_ThermalGuidelines_5th Ed_90579.pdf	3

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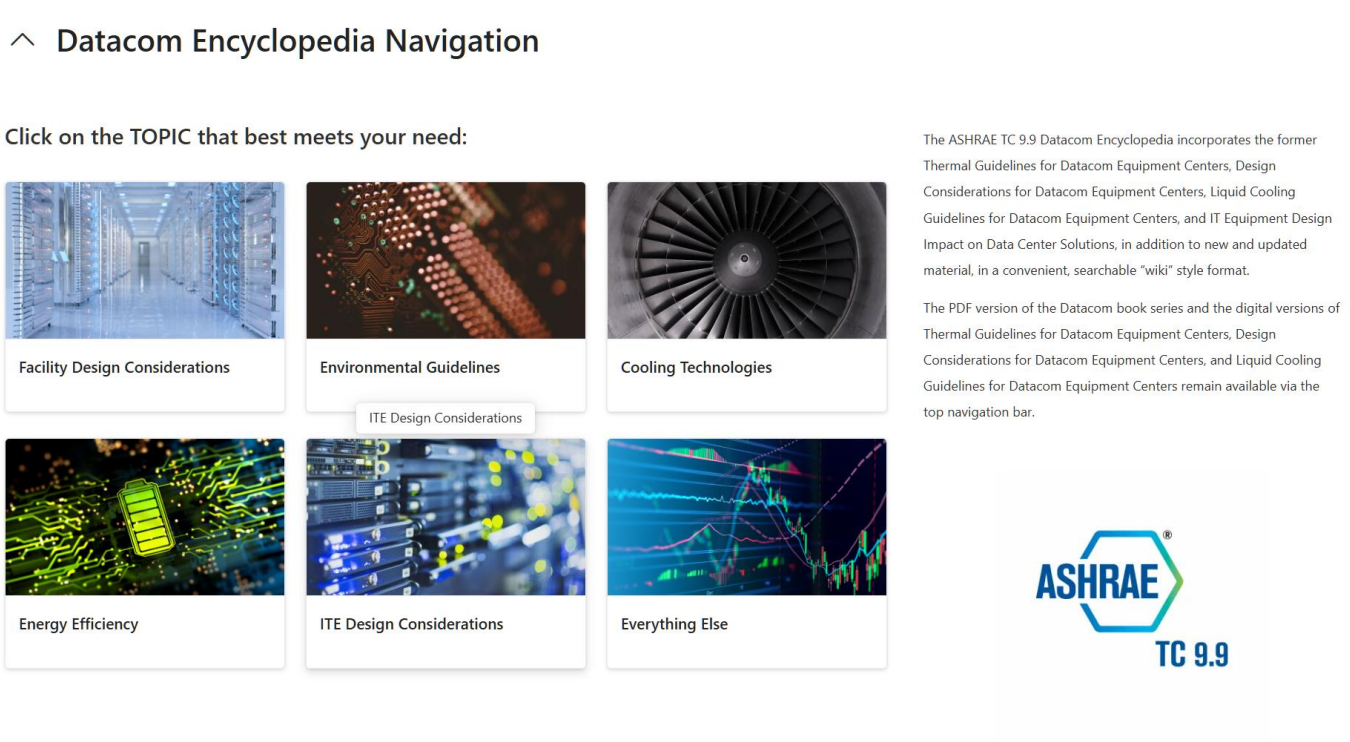
TC 9.9 Datacom Encyclopedia Subscriptions

Ecton English



2026 ASHRAE Summer Conference (Austin)

933 Subscribers!!

(As of 6/22/2026)

Up from 448 in June 2025

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TC 9.9 Activity – New Topical Conference

2027 Data Centers & AI Integration Conference

- *March 3-5, 2027 | Dallas, Texas*

- Joint effort between TC 9.9 & SSPC 90.4
  - Chair – Mark Steinke (TC 9.9 Chair)
  - Vice-Chair – Marcus Hassen (SSPC 90.4 Chair)

- Format: Keynotes, Seminars, Panels

- Tracks
  - Track 1: Roadmap + Research + Emerging Technology
  - Track 2: Codes + Standards + Guidelines
  - Track 3: Resources + Sustainability + Impact
  - Track 4: Applied Execution + Best Practices + Case Studies

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TC 9.9 Activity – New Topical Conference

2027 Data Centers & AI Integration Conference

- We'll need TC 9.9 & SSPC 90.4 support!!!
  - Content generation -> talks & presentations
  - Attendance
  - Raise awareness
- **Sponsorships Available**
- **Call for submissions for seminars is open**

SPONSORSHIP LEVELS AND BENEFITS	Diamond	Platinum	Sold Out Gold	Silver	Bronze	Lanyard
	$35,000	$25,000	$15,000	$10,000	$5,000	$5,000
Number of packages available	1	2	3	3	6	1
Conference App Sponsor – Logo on Conference App and Dedicated Sponsor Information Tab	Yes					
Keynote Sponsor Includes (5min.) Remarks and Intro of Keynote Speaker		Yes				
Logo/Signage at Conference Welcome Reception	Yes	Yes	Yes	Yes	Yes	
Breakfast Sponsor – Logo on Breakfast Signage Board and leave behinds on tables			Yes			
Lunch Sponsor - Logo on Signage Boards and leave behinds on tables				Yes		
Networking Reception Sponsor – Logo on Signage Boards and logo	Yes					
AM or PM Coffee Break Sponsor – Logo on Signage					Yes	
Recognition as Diamond and Platinum Sponsor in Conference Communications	Yes	Yes				
Complimentary Registration	5	4	3	2	1	1
30min Sponsor Tech Talk	Yes	Yes	Yes			
Information Table at in-person conference venue	Yes	Yes	Yes	Yes		
Recognition as the Conference Lanyard Sponsor						Yes
Logo on Conference program, website, and app	Yes	Yes	Yes	Yes	Yes	Yes
One Time use of Opt-in Conference Attendee Mailing List	Yes	Yes	Yes	Yes	Yes	Yes

* Conference registration includes conference light breakfasts, lunches and receptions.
**For additional sponsorship opportunities not listed above please contact sloeffler@ashrae.org

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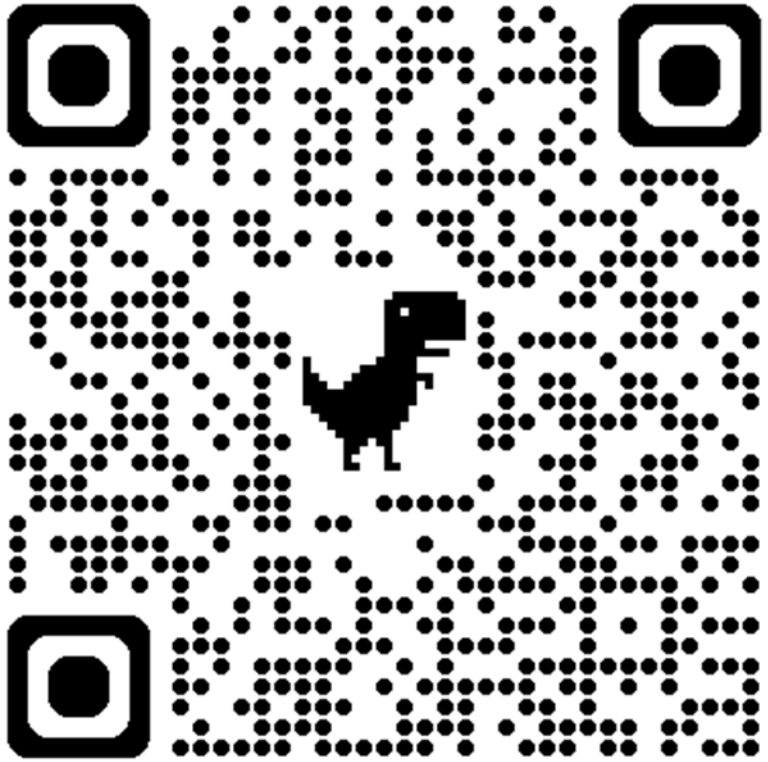
TC 9.9 Activity – How to Get Involved???

- Check out the TC 9.9 Website
  - Looking into creating an “Activity Section” or “Activity List” of some type
  - Active items such as Handbook work, Standards work, Research projects, Encyclopedia work, other items
- Reach out individually
  - Added email contact for all Officers & Subcommittee Chairs
  - They should be able to direct you to the right folks

ASHRAE TC 9.9 Website



https://tc0909.ashraetcs.org

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Conferences and Expositions Committee (CEC) Updates

- Provide your feedback to CEC on the ASHRAE Annual and Winter conferences to help continue to improve programming. (2-3 minutes, 10 questions)
- The Future of ASHRAE Conferences Ad Hoc Update
  - Possibly shifting of the AHR to March timeframe
  - Evaluating the Annual meetings
  - Recommendation to the Board of Directors is…
    - Eliminate the Annual in-person Technical Committee meetings
    - Connect & Convene
      - Connect: 4 Day Virtual conference for everyone
      - Convene: 4 day In-person conference for Councils & BoD

CEC Feedback Form

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Meeting Attendance - Monday

Meeting Attendance is tracked via a Google form. Please complete the attendance form for each meeting…

Monday Meeting Attendance

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TC 9.9
Subcommittee Updates

Monday Meeting Attendance

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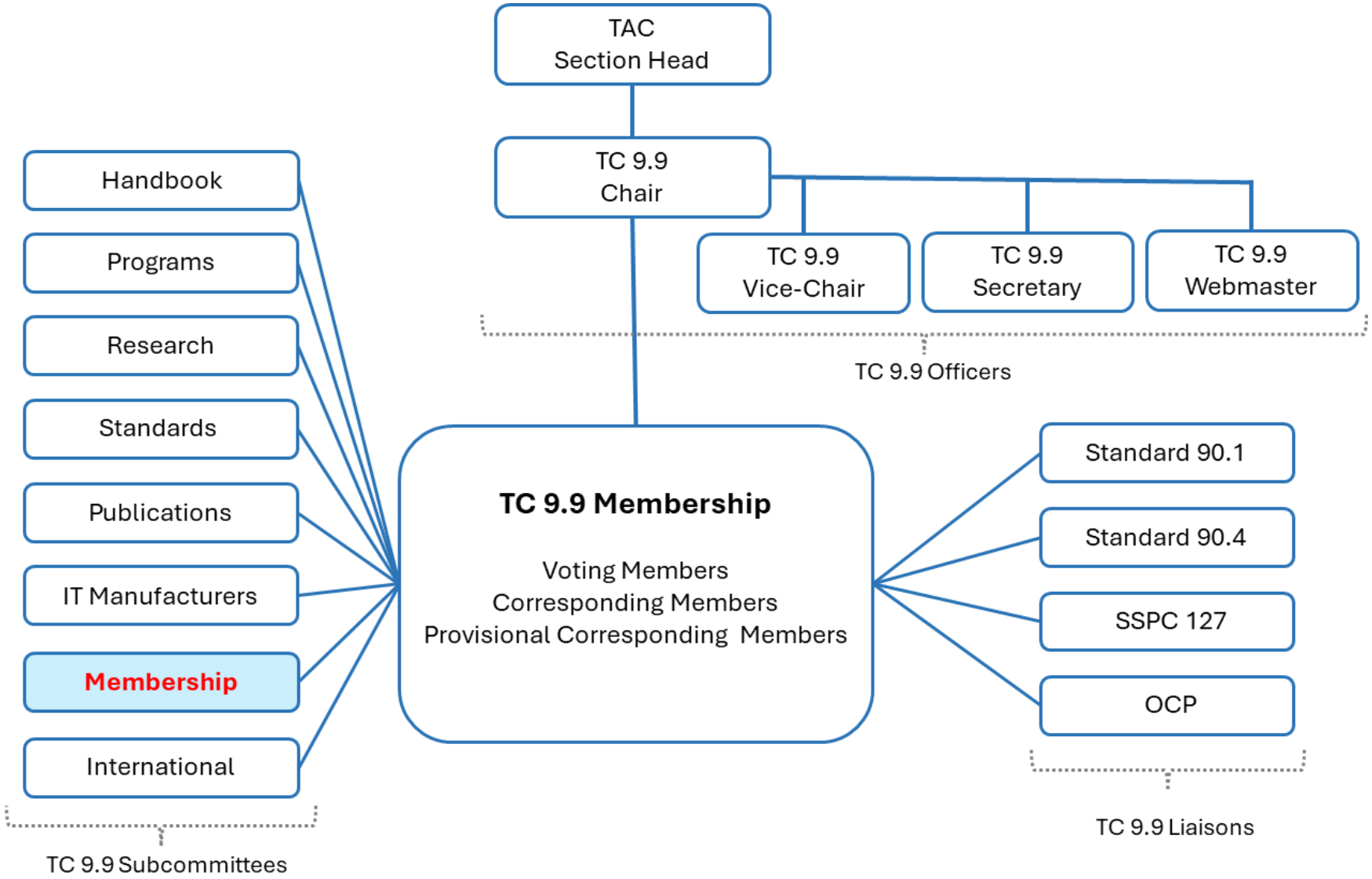
Membership Subcommittee



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TC 9.9 Membership Types

John Groenewold

- **Provisional Corresponding Member (PCM)**
  - PCMs are newly registered member to the TC & serve a two (2) year term as a PCM
  - Participation in committee activities & involvement needed to become corresponding member after the two years
  - PCMs are rolled off from the roster after two years if there was no participation
  - For purposes of committee assignments and other work, PCM status does not limit an individual's active involvement in the work of the committee
- **Corresponding Member (CM)**
  - Full member of the TC
  - Expected to participate in TC activities
  - May serve as Officers, Subcommittee Chairs, or Voting members
- **Voting Member (VM)**
  - Must be a Corresponding Member
  - Serve a four (4) year term
  - Only one VM per company

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TC 9.9 Membership – Roster Update

John Groenewold

Membership Type	2024 Annual Meeting	2025 Winter Meeting	2025 Annual Meeting	2026 Winter Meeting
Board, Chairs, & Liaisons	23	23 ⇨	23 ⇨	24 ↑
Corresponding Members	365	357 ↓	357 ⇨	142 ↓
Provisional Corresponding Members	139	185 ↑	259 ↑	337 ↑
YEA	67	69 ↑	100 ↑	129 ↑
TOTAL	**518**	**565** ↑	**639** ↑	**503** ↑

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TC 9.9 Membership – Meeting Attendance

John Groenewold

Membership Type	2025 Winter Meeting		2025 Annual Meeting		2026 Winter Meeting	
	Sunday	Monday	Sunday	Monday	Sunday	Monday
Board, Chairs, & Liaisons	7	9	11	14	13	14
Corresponding Members	18	44	26	38	35	48
Provisional Corresponding Members	28	45	17	28	24	43
YEA	1	3	4	10	7	15
TOTAL	**54**	**101**	**58**	**90**	**79** ↑	**120** ↑

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TC 9.9 Membership – Roster Updates

John Groenewold

- SY 25/26 Roster - 750+ members listed
- SY 26/27 Roster Updates – 450+
- Email list is built from the Roster Contact List
- Roster decisions based upon
  - Attendance
  - Participation
  - Contact emails
- Email delivery failures are used to update the roster
- Working on a new method to email the full TC 9.9
- **Keep your contact email updated!**

How to Join TCs

https://eweb.ashrae.org/eweb/TS_ProvisionalSignup.html

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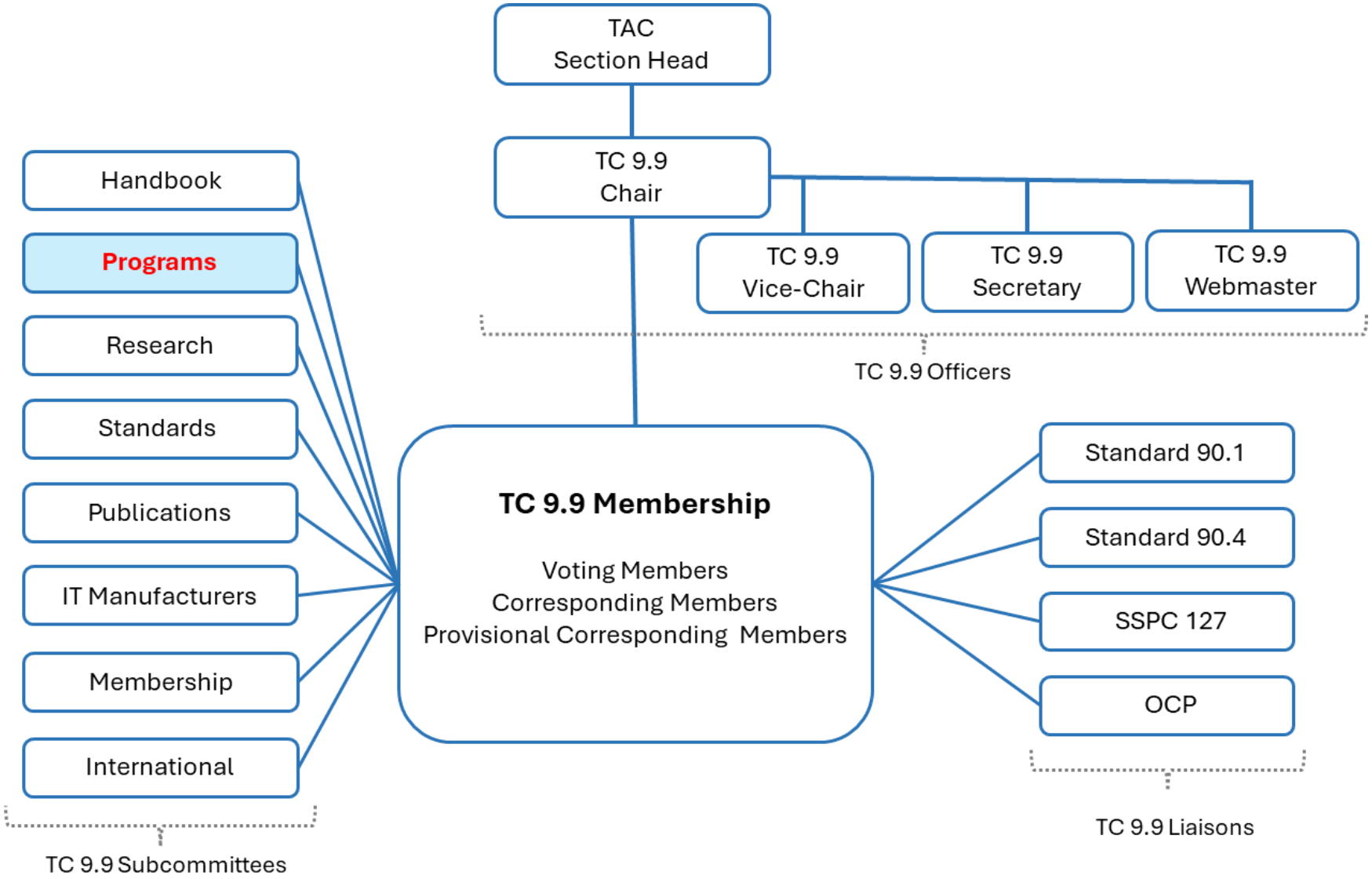
Programs Subcommittee



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2026 ASHRAE Annual Conference – Austin

Eric Yang

- Great turn-out, total 11 sessions in Austin sponsored and co-sponsored by TC9.9
- First time dedicated data center mini-track in the conference
- Plan on dedicated data center conference paper sessions (please let me know if you have an accepted abstract for Chicago conference)

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2026 ASHRAE Annual Conference – Austin

Eric Yang

Sunday

8:00 AM – 9:00 AM CDT

Seminar 2: Integrated Modeling and Optimization of Data Center Cooling and Waste Heat Reuse

Chair: Wangda Zuo

9:45 AM – 10:45 AM CDT

Seminar 8: Breaking Update: How the New ASHRAE 127 CDU Test Standard Shapes AI Data Centers
Chair: Mark Steinke

11:00 AM – 12:30 PM CDT

Panel 3: Fluid Quality Monitoring and Maintenance in Direct-to-Chip Liquid Cooling: Differentiating TCS and FWS Requirements Chair: Chris Campbell

1:30 PM – 3:00 PM CDT

Panel 4: Engineering the Backbone of AI Cooling: TCS Design and Commissioning
Chair: Matt Koukl

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2026 ASHRAE Annual Conference – Austin

Eric Yang

Monday

8:00 AM – 9:30 AM CDT

Panel 5: Powering the Cloud Requires People: Building the Workforce Behind Data Center Infrastructure

Chair: Eric Yang

9:45 AM – 10:45 AM CDT

Seminar 27: A Completely Waterless Two-Phase Cooling Architecture for Megawatt-Scale AI Data Centers Chair: Keith Dunnavant

11:00 AM – 12:00 PM CDT

Panel 7: A2L Refrigerants in Data Centers: Issues, Strategies, and Future Trends

Chair: Thomas Davidson

Tuesday

9:45 AM – 10:45 AM CDT

Panel 10: OCP & TC 9.9 Collaboration - Status, Workstreams, & Path Forward

Chair: Matt Koukl

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2026 ASHRAE Annual Conference – Austin

Eric Yang

Wednesday

8:00 am - 9:30 am CDT Seminar 48: Compact Modeling of HVAC&R Equipment for CFD Applications: High-Fidelity Digital Twin Models (co-sponsored by TC9.9)

Chair: Yang-Seon Kim

9:45am to 10:45am CST

Workshop 6: ASHRAE Standard 90.4 in Practice: A Data Center Energy Modeling Workshop

Chair: Ahmed Megahed

11:00 AM – 12:30 PM CDT

Seminar 62: How AI will Enhance CFD Airflow Modeling Techniques in Building Design (co-sponsored by TC9.9)

Chair: Mikhail Koupriyanov

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Mini Tracks for Future Conferences

Eric Yang

- Panel Track 1: Urgent TC 9.9 topics
  - Datacom Online Encyclopedia
  - Major Encyclopedia Updates
  - Technical Alerts
- Panel Track 2: FWS/TCS
  - CDU testing (SSPC 127)
  - Flow Velocity
  - Fluid quality
  - Filtration
  - Monitoring & Maintenance
- Panel Track 3: Commissioning
  - FWS/TCS
  - Best Practices
  - Pre-ITE
  - Post-ITE
- Panel Track 4: Energy Efficiency
  - Power Trends
  - Best Practices
  - Heat Recovery / Reuse
- Panel Track 5: Emerging Technologies
  - ARPA-E COOLERCHIPS as example
  - Quantum compute

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2027 ASHRAE Winter Conference – Chicago

Eric Yang

Tracks

- Fundamentals and Applications
- HVAC&R Systems and Equipment
- Research Summit
- Refrigeration & Refrigerants
- Residential HVAC Research and Demonstration
- Thermal Network Systems and Energy Storage
- Nexus of Real and Architectural Intelligence
- Decarbonization Retrofits

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Program Ideas for 2027 Winter Conference - Chicago

Eric Yang

- Fundamentals and Applications

Recent Updates of TC9.9 Publications

- Technical alert seminar (recent published)
- IT load Power trend and cooling requirement
- Datacom Online Encyclopedia update

Any useful guideline updates from OCP

- HVAC&R Systems and Equipment

Modular Data Center Design in Data Centers

Energy and water nexus of next-generation AI data centers

AI Data Centers: Where IT, Power, and Cooling Controls Must Meet

AI Data Centers and the Grid: Flexible Load or Uncontrollable Demand

Ai Factory topics: (mech/electrical, workforce training)

TCS Loops and ASHRAE 90.1: Regulated System or Special Exemption?–(John Gross)

Transient Analysis of liquid cooled system: case study & owner's perspective

TCS Cooling Chemistry 101

2-phase D2C Liquid Cooling

TCS Loop Design Lesson Learned

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Program Ideas for 2027 Winter Conference - Chicago

Eric Yang

- Research Summit

ARPA-E Cool Chip program update (2)

Digital Twin

- Thermal Network Systems and Energy Storage

Controls and Sequences for Thermal Ride-Through Systems

Commissioning Thermal Energy Storage for Mission-Critical Cooling

- Nexus of Real and Architectural Intelligence

Commissioning the Algorithm: How Do We Test AI-Enabled Data Center Controls

- Decarbonization Retrofit

Reliability First: Decarbonization Retrofits Without Compromising Uptime

Controls Before Capital: Finding Carbon Savings Through Optimization and Retrocommissioning

From Air Cooling to Hybrid and Liquid Cooling: A Retrofit Road Map

Heat Reuse/Carbon Capture That Actually Works: Lessons from Data Center Retrofit Projects

Operational Carbon Versus Embodied Carbon in Data Center Retrofits

Data Center Energy, Water, Carbon Analysis

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2026 Annual Conference - Austin

Eric Yang

Important Dates…

- **Monday, August 3, 2026**
  - Debate, Panel, Seminar, Forum, Workshop, and Debate Proposals Due
- **Monday, Sept 2, 2026**
  - Conference Papers and Extended Abstracts Due

Next Steps…

- Contact Eric Yang at ericyangcem@gmail.com
- If you need
  - Co-sponsorship from other TCs
  - ASHRAE speaker submission template
  - To understand the process of submitting a session

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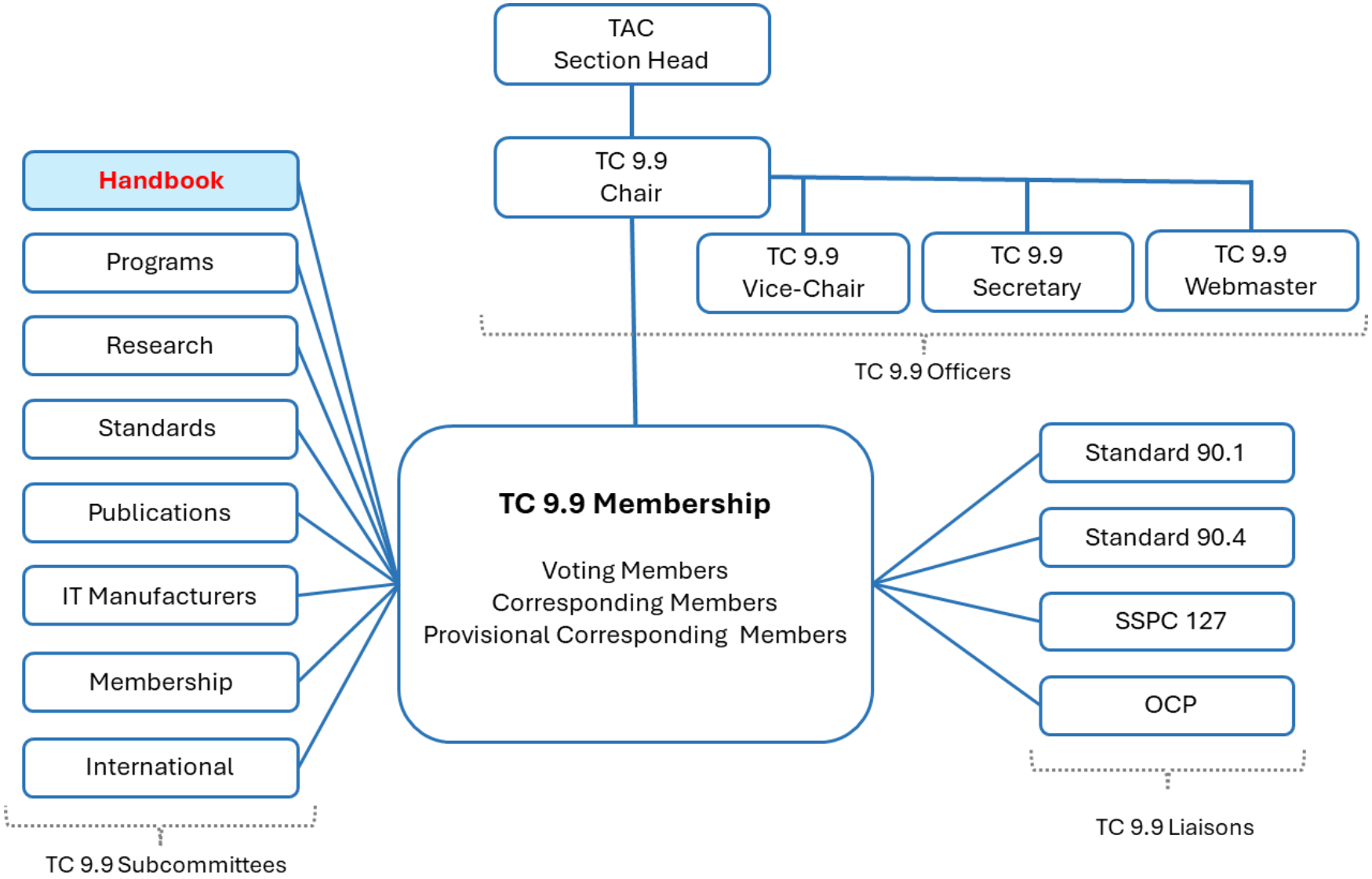
Handbook Subcommittee



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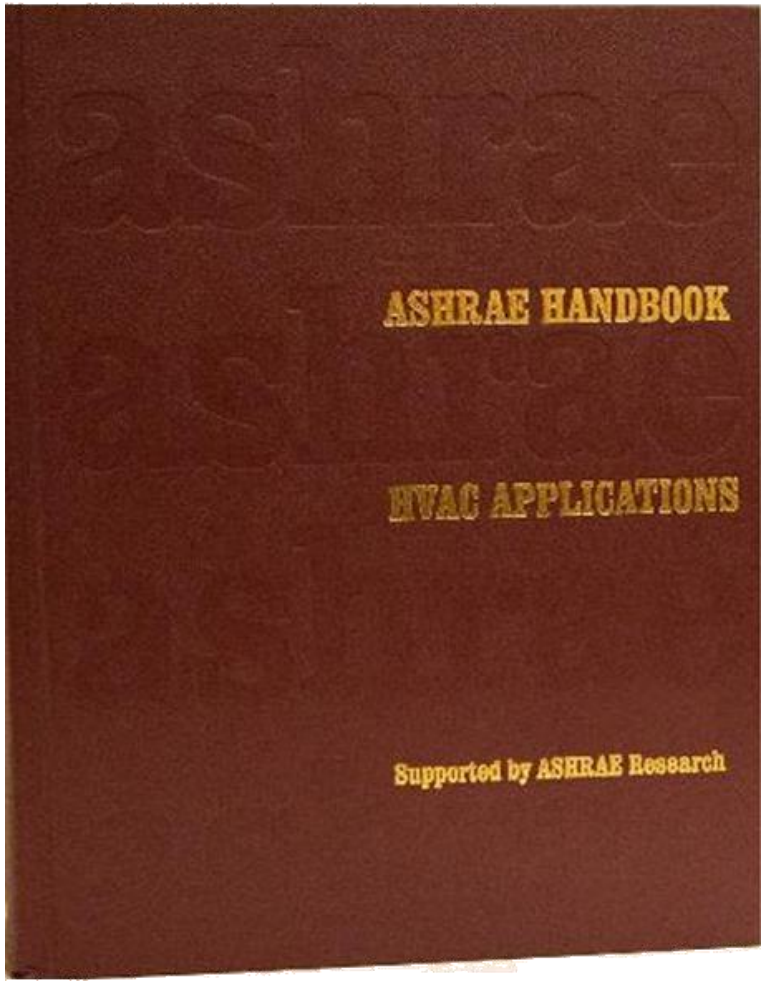
Handbook Subcommittee Updates

Bob McFarlane/Jonell Watson

ASHRAE HANDBOOK “Applications” - Chapter 20

- Background
- Purpose of "Applications", Chapter 20
- Current Status
- Next Steps & Today’s Priorities
- Questions



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Purpose of Chapter 20

Bob McFarlane/Jonell Watson

- “Handbook” is ASHRAE’s Most Important Publication
  - Tutorial for New Engineers
  - Reference for Experienced Engineers
  - An Alert to “What You Don’t Know”
    - Encourages Retaining Subject Matter Experts
  - “Best Practices” Information
  - Legal Reference *(Print Version)*

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Purpose of Chapter 20

Bob McFarlane/Jonell Watson

- "It's Also ASHRAE's Most Important Product
  - Worldwide Face of ASHRAE
  - A Unique Product
  - Prime ASHRAE Member Benefit
    - Handbook Online, PDF or Print
  - Basis for ASHRAE Codes and Standards
  - **The Public "Face" or Our TC !!**
    - **The Quality of our Chapter Reflects the Quality of Our TC**

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Background

Bob McFarlane/Jonell Watson

- ASHRAE's Handbooks - Four Publications
  - ✓*Fundamentals*
  - ✓*Refrigeration*
  - ✓***Applications***
  - ✓*HVAC Systems and Equipment*
- Published on Four-year Cycle
- TC9.9's Responsibility: Chapter 20 of "Applications"
  - "*Data Centers and Communications Facilities*"
- All Revisions by Volunteers through TC9.9

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Background

Bob McFarlane/Jonell Watson

Chapter 20 has 120 topics:

- 38 Initial Reviewers
  - 4 New Topics suggested for addition
- 30 Revisors
- 4 Secondary Reviewers
- 2 Very Tired Handbook Chairs!!!

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Volunteers

Bob McFarlane/Jonell Watson

- Greg Alexander
- Matt Archibald
- Jonathan Bastien
- Suren Babu
- Chris Campbell
- Brad Chen
- Rohit Dhumane
- Dan Donahoe
- Nicolas Estefanell
- Ed Gutowski
- John Groenewold
- Ali Heydari
- Alex Hubbard

38 Initial Reviewers

- Roger Huggins
- Mustafa Kadhim
- Matthew Kaufeler
- Alexander Kontoyanis
- Steve Kujak
- Carlos Lisboa
- Stephen Mathai
- Jason Matteson
- Dave McGlocklin
- Chris Muller
- Santosh Shekar Mudunur
- John Murgida
- Shlomo Novotny
- Baron Noviyanto
- Ben Petschke
- Joe Prisco
- David Quirk
- Terry Rodgers
- Pardeep Shahi
- Alkesh Solanki
- Andrew Terry
- Russ Tipton
- Eric Yang
- Philip Yu
- Nick Xu

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Volunteers

Bob McFarlane/Jonell Watson

30 Revisors

- Matt Archibald
- Suren Babu
- Jonathan Bastien
- Tom Bise
- Chris Campbell
- Brad Chen
- Uschas Chowdhury
- Carlos Lisboa
- Tom Davidson
- Dustin Demetriou
- Ben Dolcich
- Dan Donahoe
- Ed Gutowski
- John Groenewold
- Ali Heydari
- Alex Hubbard
- Roger Huggins
- Matthew Kaufeler
- Steve Kujak
- Dave McGlocklin
- Chris Muller
- John Murgida
- Ben Petschke
- Joe Prisco
- David Quirk
- Terry Rodgers
- Mark Steinke
- Mark Stevens
- Andrew Terry
- Russ Tipton
- Eric Yang

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Volunteers

4 Secondary Reviewers

- Rohit Dhumane
- Srushti Dupare
- Dalia Ghaddar
- Jeshwanth Kundem
- Santosh Shekar Mudunur

THANK YOU ALL !!!

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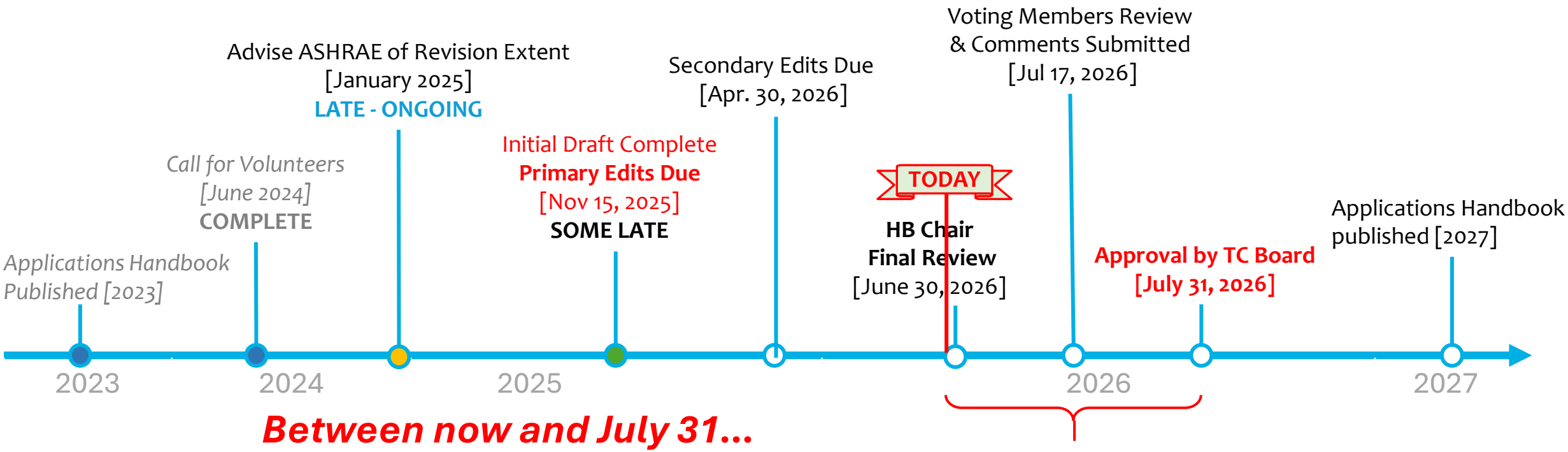
Current Status

Bob McFarlane/Jonell Watson

We are now at the END of our revision cycle for the Applications Handbook!



Between now and July 31…

1. **<TODAY> Complete Missing Details in Work Session.**
2. **Voting Members Review & Comment (By July 17 !!)**
3. **Final Revisions & Voting Member Ballot Approval (By July 31 !!)**

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Background

ANOTHER IMPORTANT CONCERN

Are We In Conflict With Any Other Handbook Chapter or Standard?

TC 9.9 Must Consider & Research

ASHRAE Now Allows Us to Use AI to Assist in This

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Additional Questions

Bob McFarlane/Jonell Watson

QUESTIONS?

Please advise Bob McFarlane or Jonell Watson

rmcfarlane@smwllc.com | jonell@hudson-trading.com

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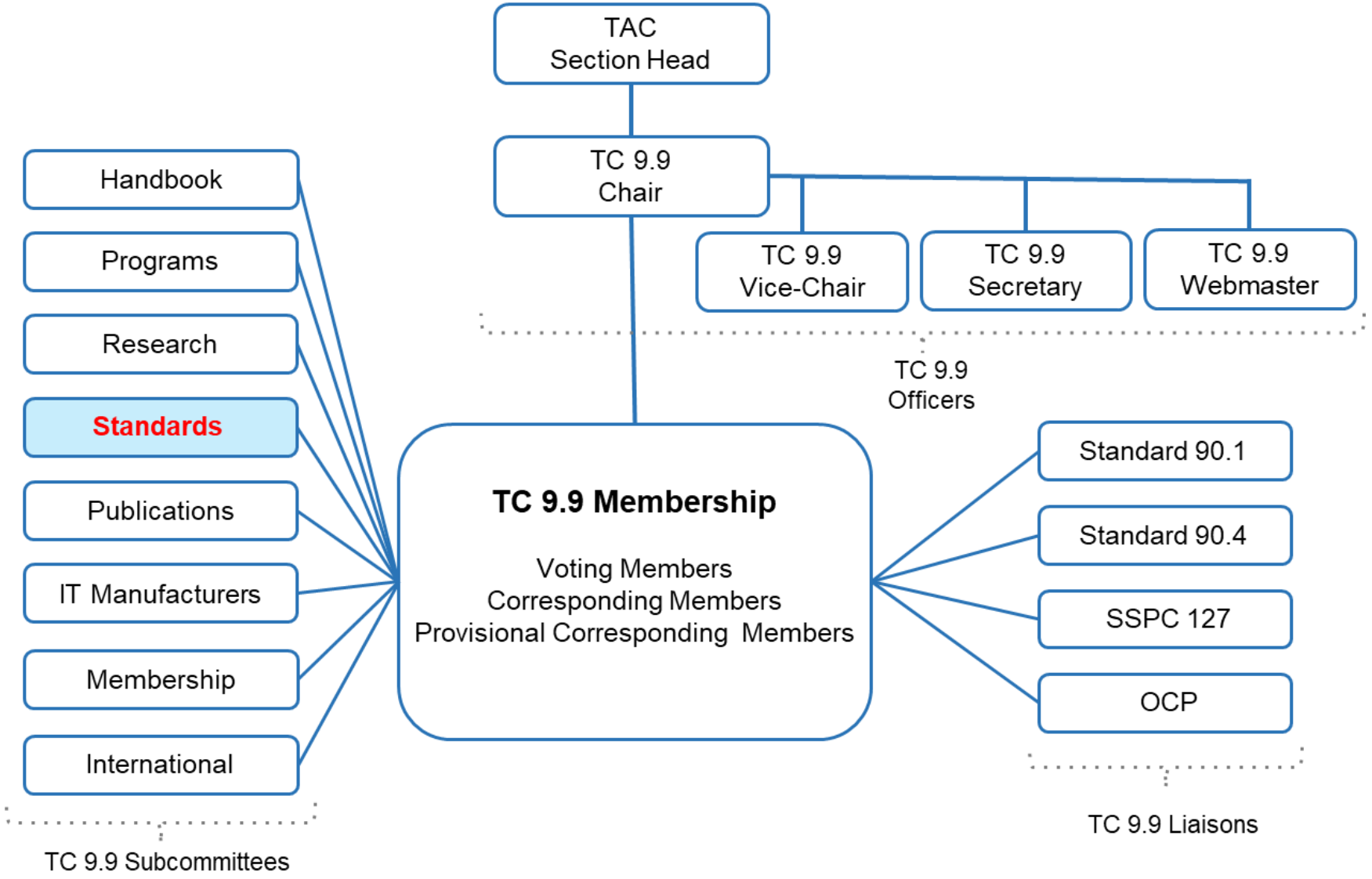
Standards Subcommittee



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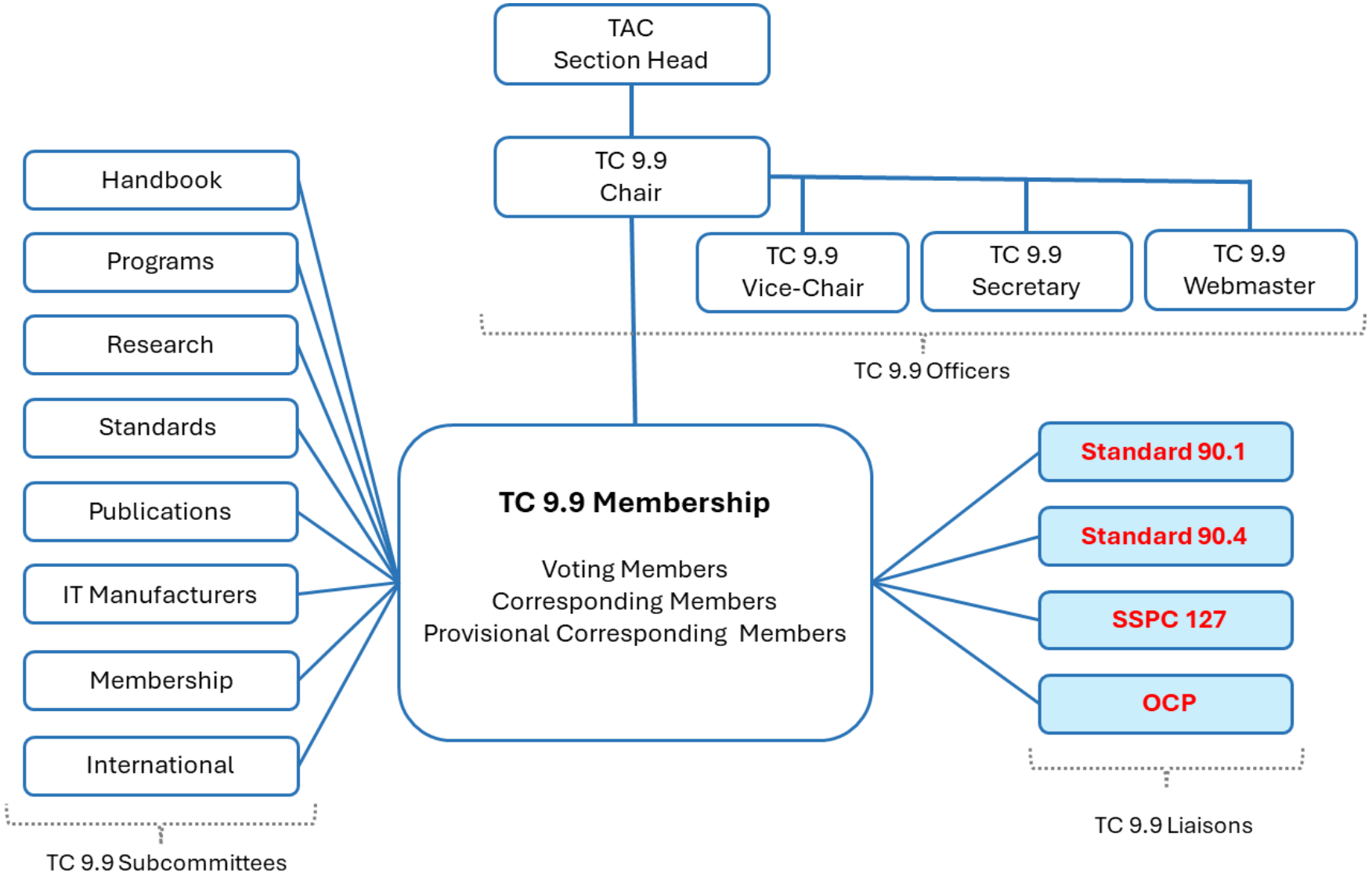
Liaison Reports



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Liaison Reports – 90.1

Rick Pavlak

- 90.1-2025 Published this spring and is available to use.
- SSPC 90-1 held a Spring meeting at ASHRAE Headquarters in Atlanta
- 90.1-2028-2031 Workplan has 2 major components-energy efficiency and net zero operational carbon. Looking like this will result in two 90.1 Standards.
- 90.1 will continue as a minimum standard focused on energy efficiency.
- 90.1E will be created to focus on ASHRAE Leadership goal of a net zero operational carbon by 2031.
  As of the spring meeting there are 22 active addenda 17 carryover and 5 new.

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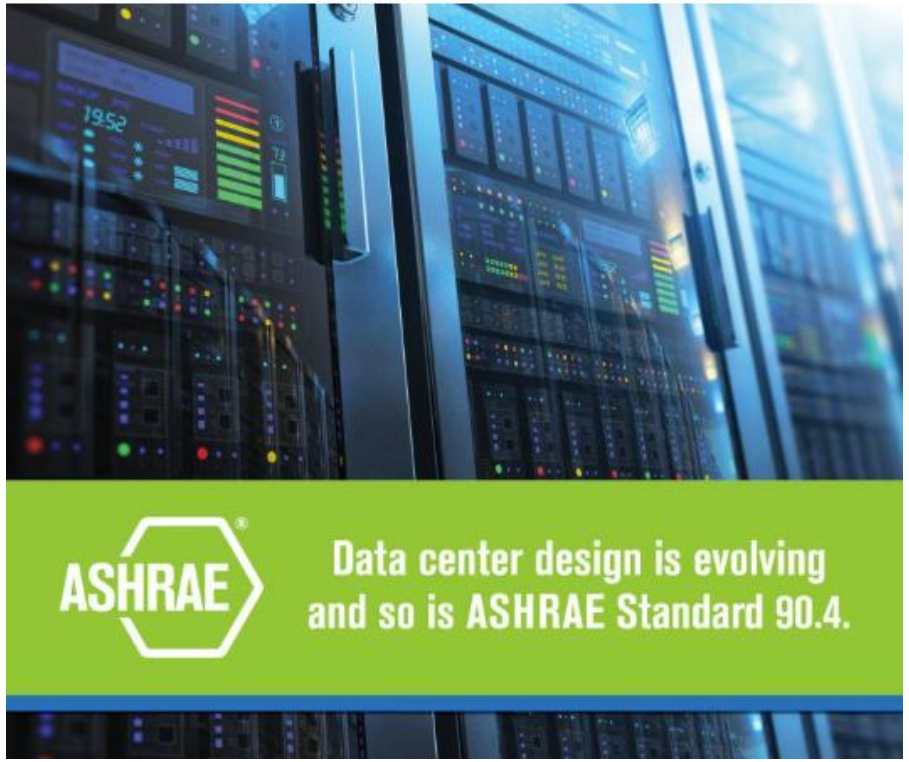
Liaison Reports – 90.4

Marcus Hassen

ASHRAE
178,894 followers
2d •

The 2025 edition of ASHRAE Standard 90.4 is a continuation of its mission to establish and refine criteria to enable the effective and optimal use of energy resources in the programming and design of data centers. The new edition strengthens data center sustainability by expanding the scope beyond energy efficiency to include greenhouse gas emissions, water use, and broader resource impacts. 90.4-2025 marks the publication of the fourth edition of the standard, affirming its position as an essential reference for the data center industry and broader Built Environment discipline. Learn more: https://bit.ly/4rG5roN



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Liaison Reports – 90.4

Marcus Hassen

Code and Industry Alignment

- Adoption into IECC and local/state energy codes
- ASHRAE 90.1 – Alternate Compliance Path
- Alignment with ASHRAE TC 9.9 guidance (thermal and operational best practices)
  - Referenced in **2024 IECC** as a compliance pathway

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Liaison Reports – 90.4

Marcus Hassen

Committee Working Group Operations

Active Standing Standard Project Committee (SSPC 90.4) with structured Working Groups

- **Mechanical (MLC)**
- **Electrical (ELC)**
- **ESG**
- **Marketing**

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Technical Workstreams

- **Mechanical Load Component (MLC) metrics**
- **Electrical Loss Component (ELC) metrics**
- **ASHRAE Harmonization (Decarbonization Standards)**
  - Water usage effectiveness (WUE)
  - Carbon / emissions accounting
  - Renewable energy integration guidance

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Liaison Reports – 90.4

Marcus Hassen

Addendum D

- New Baseline Models
  - Air Cooled ITE at TC 9.9 H1 temperature
  - Liquid Cooled ITE at TC 9.9 S20 temperature
  - Air cooled Mag-lev Chillers without economizers or water consumption
  - AHRI minimum efficiency chillers with free cooling.

- Adds a formal definition for Liquid Cooling
- Provides credit for project's design temperature setpoints
- MLC Adjustments for Large (> 2.5 MW) new construction
- Water regulation removed (separate addendum)

2nd Public Review (ISC) Pending

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Liaison Reports – 90.4

Marcus Hassen

New! Guiding Principles for Building & Operating Energy-efficient AI Data Centers

With sections covering all stages of planning, design, construction, operation, and retrofit, the ASHRAE/NEMA/PNNL AI Data Center Energy Performance Framework guides AI data center development toward optimized and energy-efficient performance.

EXPLORE THE FRAMEWORK

PNNL/ASHRAE/NEMA AI Data Center Energy Performance Framework

Center of Excellence for Building Decarbonization (CEBD) Project

Formal Launch: June 10th

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Liaison Reports – 90.4

Marcus Hassen

2027 ASHRAE Data Center and AI Integration Conference

March 3-5, 2027 | Dallas, TX

SUBMIT A PRESENTATION PROPOSAL

Presentation proposals are due August 7th, 2026

STEERING COMMITTEE ➡

TC9.9 [Chair]
ASHRAE 90.4 [Vice-Chair]
ASHRAE 127

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Liaison Reports – 90.4

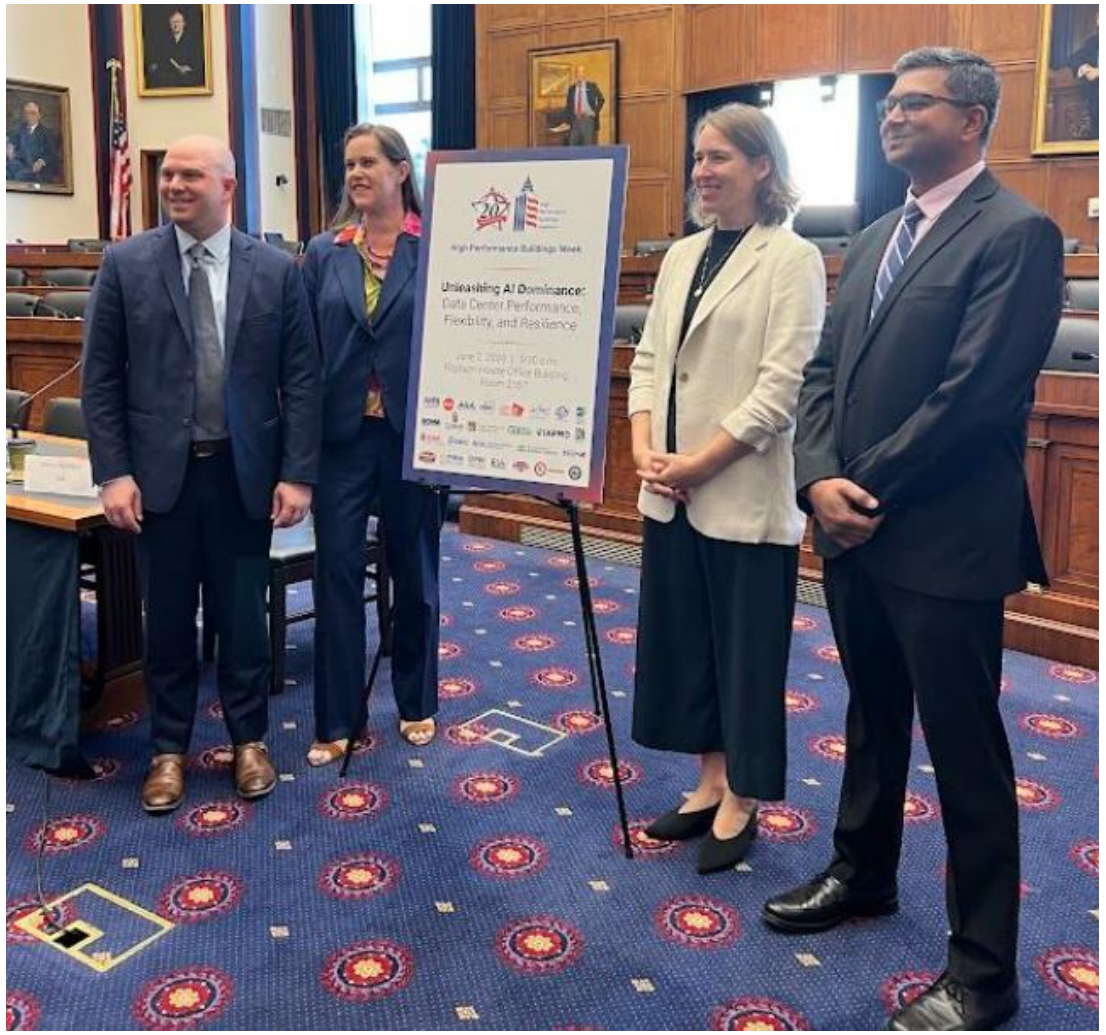
Marcus Hassen

ASHRAE Governmental Affairs

HPBC Congressional Briefing

June 2026

90.4-2025 Fact Sheet



Unleashing AI Dominance: Data Center Performance, Flexibility and Resiliency

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ASHRAE Standard 90.4 SSPC

Marcus Hassen

- Increased Code adoption and regulatory influence
- Rapid response to AI-driven load density and cooling technologies evolution
- Continuous refinement - active working groups + quarterly cycles
- **Strong alignment with TC 9.9 and data center ecosystem**
- Transition from energy-only → broader sustainability metrics

Pending Deliverable

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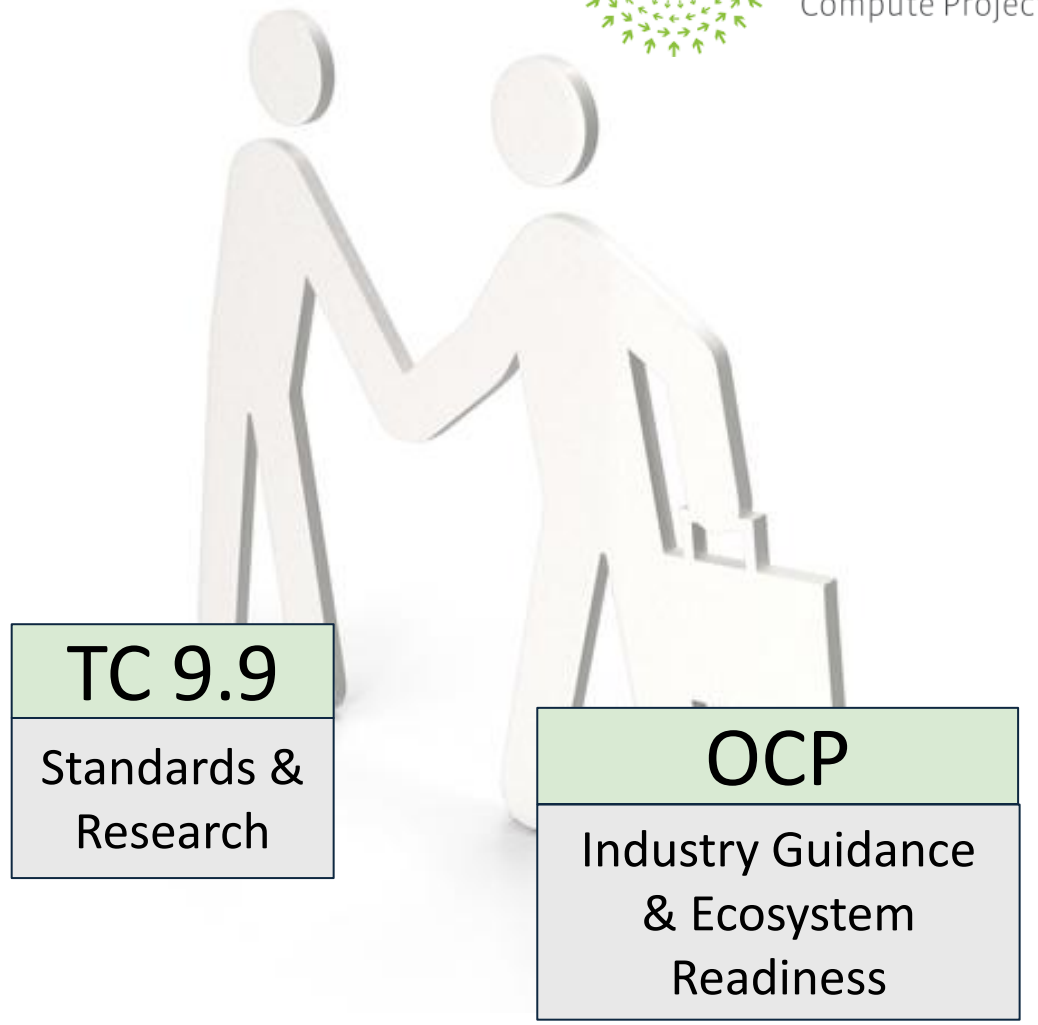
OCP Liaison Report

Matt Koukl

Why Collaborate?

- Generate wider knowledge base
  - Leverage unique strengths
  - Coordination of different voices in the value chain
  - Engagement from silicon to ambient
- Educate
  - Avoid duplication of work
- Collaborate
  - Shared/aligned roadmap
- Communicate
  - Published work; publicizing



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OCP Liaison Report

Matt Koukl

What's Happened Since...

- Aligned activities
  - Flow velocity & erosion workstream (OCP Cold plate SPJ)
  - Guidelines for pre-commission preparation of TCS row manifolds
  - Fluids workstream (OCP Cold plate SPJ)
  - Initiation of Cooling Environments CDU SPJ
- Underway
  - PG25 mixing studies

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Liaison Reports – SSPC 127

David McGlocklin

Title: Method of Testing for Rating Cooling Equipment Serving Data Center and Other Information Technology Equipment Spaces

Purpose: The purpose of the standard is to establish a uniform method of test requirements for rating cooling equipment that is applied in data center (DC) and other information technology facilities, spaces, and equipment..

Scope: This standard applies to classes of cooling equipment that are used to remove thermal loads in data center (DC) and other information technology facilities, spaces, and equipment.

SSPC Leadership:

SSPC 127 – Chair Dave McGlocklin, Vice Chair John Gross, Secretary Dave Meadows,

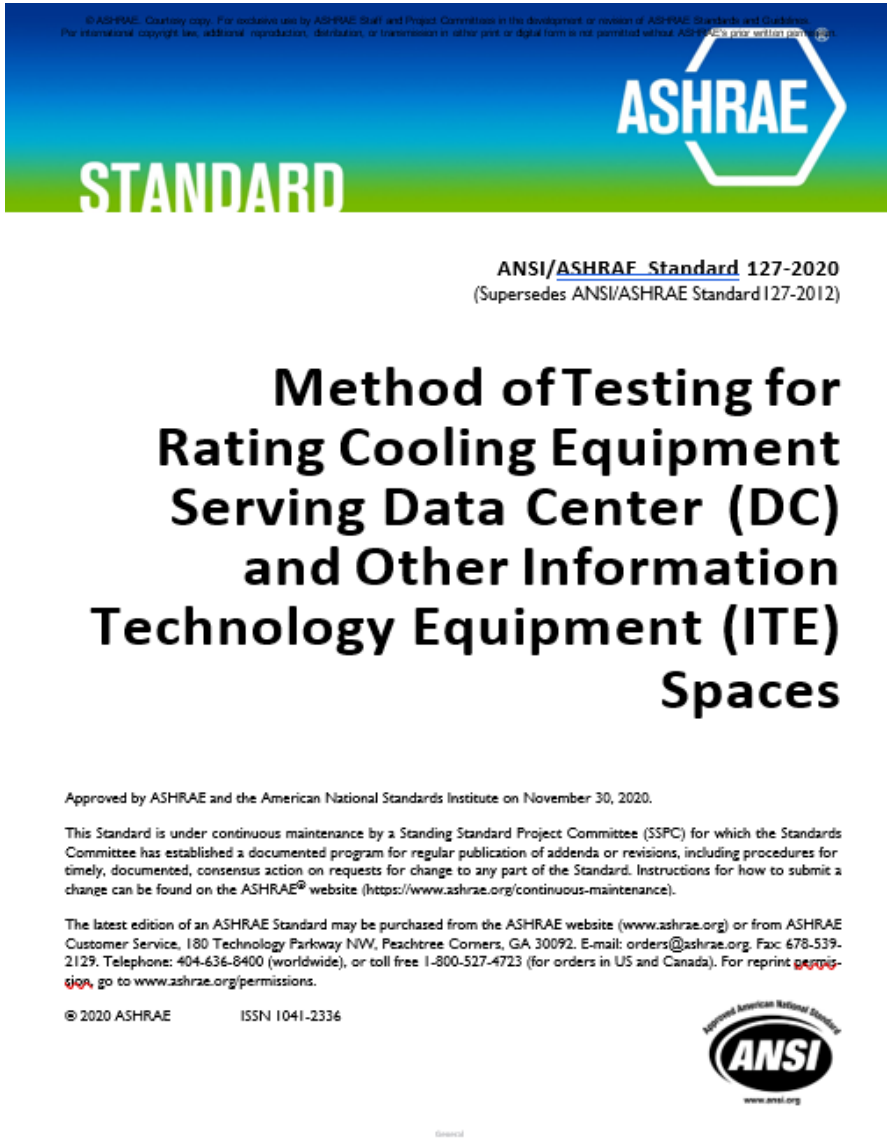
- Air Subcommittee – Chair Dave McGlocklin, Secretary Dave Meadows
- Liquid Subcommittee - Chair John Gross, Vice Chair Dr. Tim Shedd, Secretary Dustin Demetriou
- ASHRAE Staff - SPLS Liaison - William Healy, Staff Liaison – Thomas Loxley

2026 June Update & Plans:

Liquid Sub has released **Addendum b** covering the **L2L CDU MoT** in Feb 2026 . In parallel, we have 4 other addendums being worked on. **L2A Addendum c** is in process and will be voted out soon for a PPR. **2 Phase DLC and Immersion Workgroups** have been working hard on what will become **Addendum e & f** and progress will be reviewed during this conference.

Air Sub has been holding joint meetings with the AHRI 1360 committee on a monthly basis as we work on what will become **Addendum d,** which is a harmonized version of the standard. This effort removes redundant information from 127 that already exists in ASHRAE 37, as well as additions/removals of MoT/Rating content to the appropriate place in AHRI 1360. We have now completed the main harmonization work. AHRI Datacom Committee update soon.

Meeting Tuesday June 30th 8am-12pm (JW Marriott Austin JW – Lonestar Ballroom D - L3)



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BREAK – 15 Minutes

ASHRAE TC 9.9 Attendance Record

ASHRAE Technical Committee 9.9 - Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

Meeting Attendance is tracked via a Google form. Please complete the attendance form for each meeting…

Monday Meeting Attendance

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Attendance Statistics

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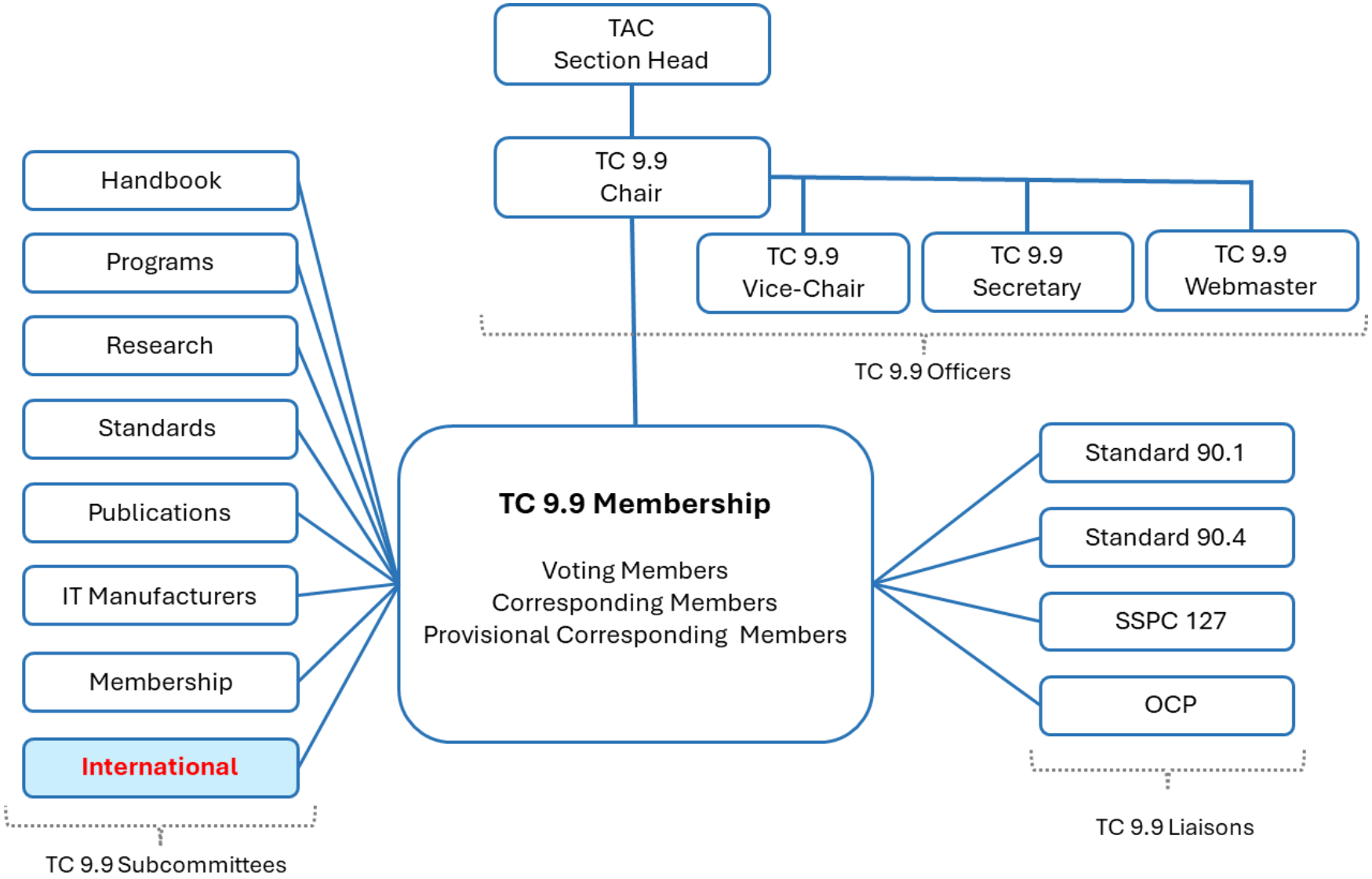
International Subcommittee



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International: Communications Background

Paul Finch

- ASHRAE Technical Committee 9.9: LinkedIn overview
  - **Background**: TC9.9 LinkedIn site launched back in June 2018
  - **Purpose:** raise global awareness, providing updates and a conduit to the web-site and bookstore
  - **Scope:** updates spanning meetings, publications, standards and research.
  - **Relevance:** time-to-market significance relating to guidance and standards
  - **Next steps**: content drives engagement evidenced by the increase traction evidenced
  - **Statistics:** update, see over.

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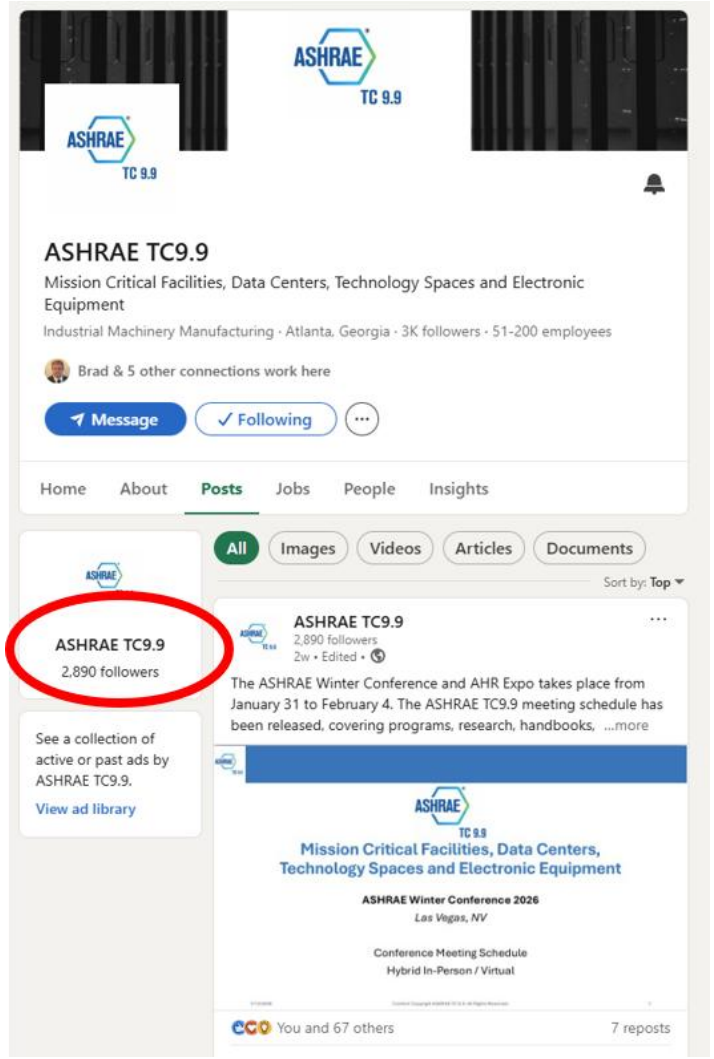
International: Communications

Paul Finch

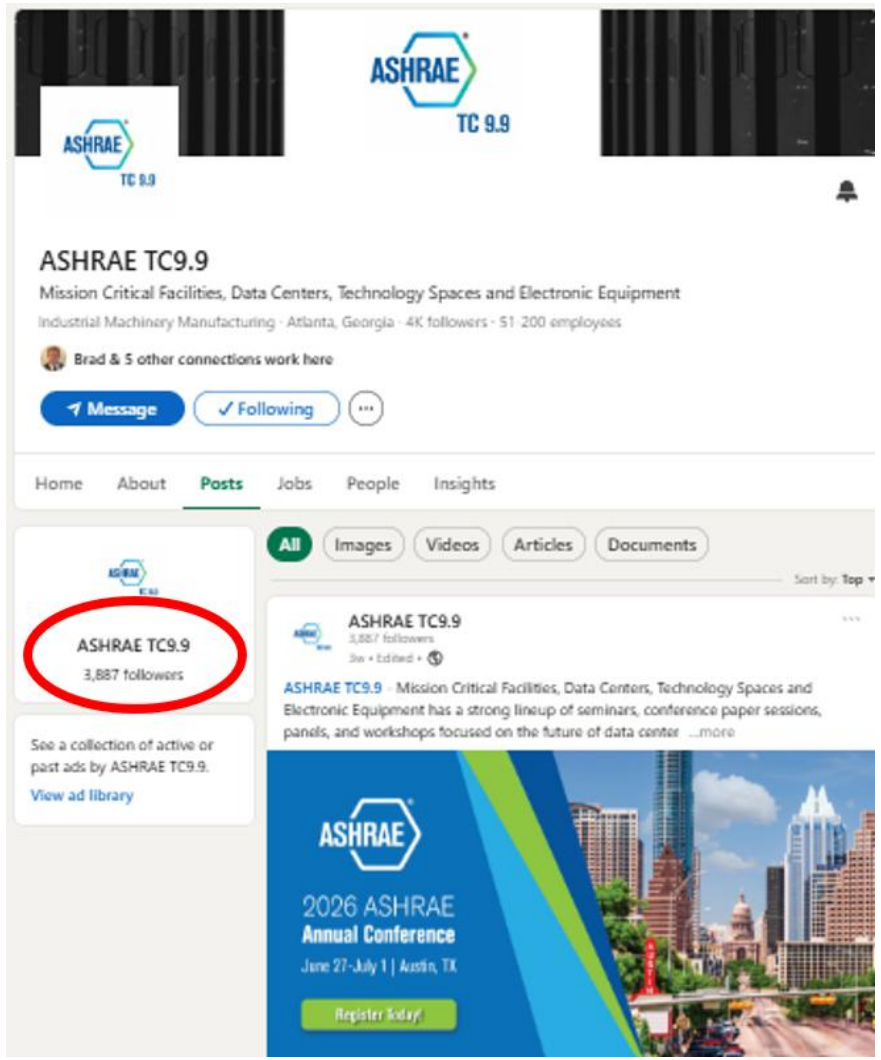
Las Vegas: January 2026



3887
'followers'
up from
2890 (+34%)

Step-change in engagement driven by material recent updates

Austin: June 2026



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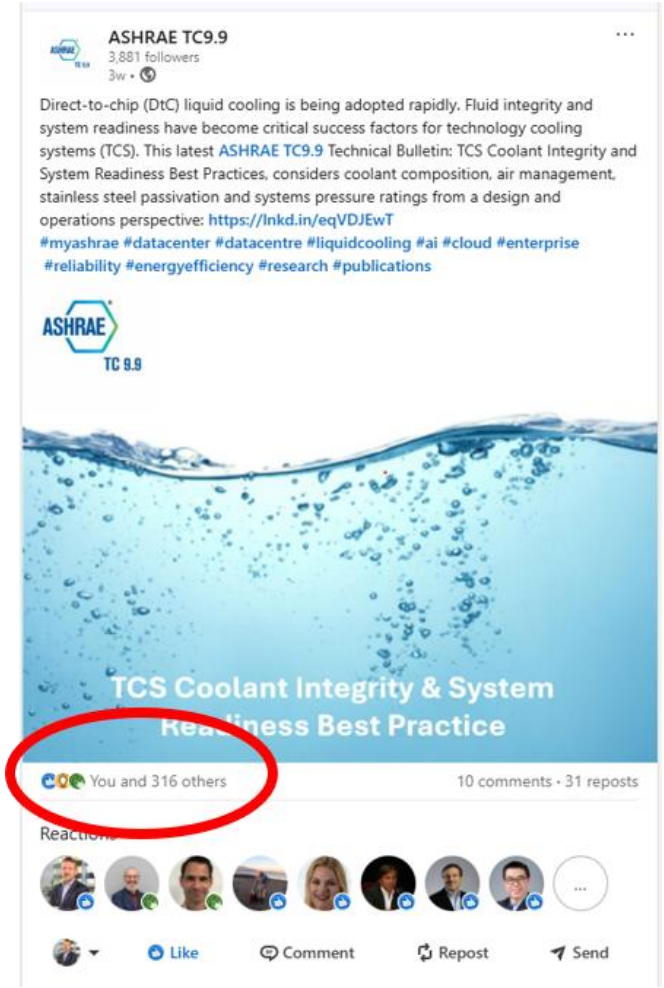
International: Communications

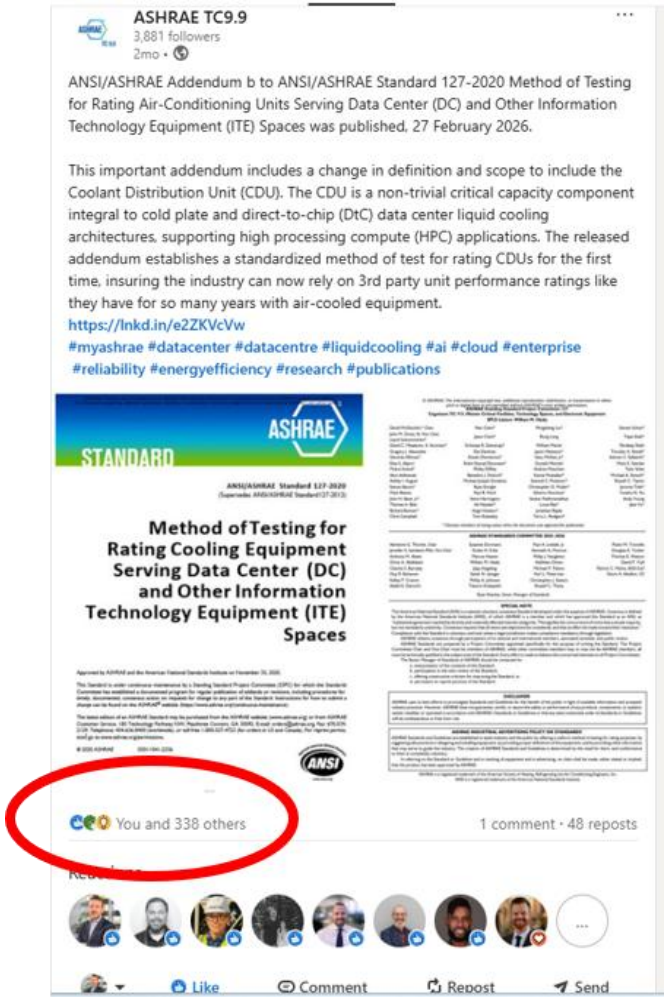
Paul Finch

Recent posts driving engagement during period:

Technical Bulletin: 316 "Likes"



Addendum to Standard 127: 338 "Likes"



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International: Awareness (no updates since Las Vegas

Paul Finch

- Standards & Guidelines:
  - European Commission: Review of the Ecodesign Regulation on servers and data storage products 2019/424 (and potential energy label for servers)
  - European Commission have published the 2025 Best Practice Guidelines for the EU Code of Conduct on Data Centre Energy Efficiency (2025)
- Groups:
  - ASHRAE UK Chapter: Data Centre Special Interest Group: https://www.ashrae.uk/about/ (2025)
  - CIBSE Data Centre Interest Group: https://www.cibse.org/get-involved/special-interest-groups/data-centres-group/ (2025)
- Next steps:
  - Expand international updates to include:
    - MENA
    - APAC

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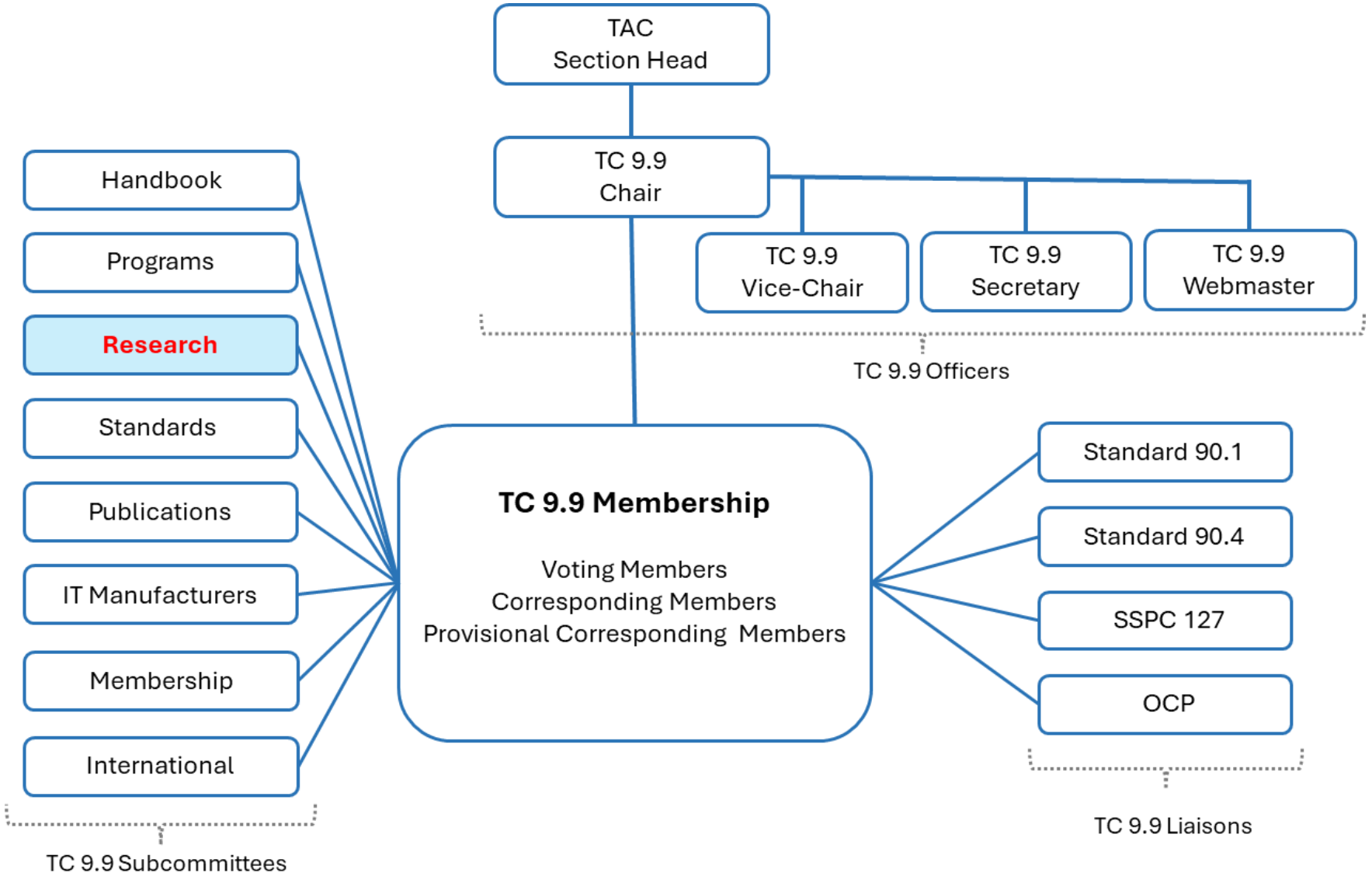
Research Subcommittee



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Research Subcommittee Updates

Brad Cochran

TRP-1913 - *Study of the Corrosion Impact on Information Technology Equipment in Data Centers Located in Coastal Regions with High Sea Salt Concentration* (Chris Muller)

Research was awarded in Summer 2025
Project underway.

TRP-1972 - *Data Center Direct-to-Chip Liquid Cooling Resiliency – Failure Modes and IT Throttling Impacts* (Tom Davidson)

Bids have been received and being reviewed by the PES. Expect vote on the selected bidder during executive session on Monday.

WS-1956 - *Compact CFD Modeling Guidance for Thin Flow Resistances*

(Jim Van Gilder, et al.)

TC4.10 is the cognizant TC, TC9.9 is a Co-Sponsor

Difficulty getting buy-off from RAC. May drop.

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Research Subcommittee Updates

Brad Cochran

- TC 9.9 submitted four (4) RTARs to RAC in Spring 2026
  - RTAR-2007 *Height Limitations in U1010.DVN.8.1 – Returned w/out Vote*
  - RTAR-2108 *Determining Flow Velocity Impact on Erosion – Accepted w/ Comments*
  - RTAR-2109 *Experimental Evaluation of Mixing Different Inhibitor Types in Water Glycol Mixtures - Rejected*
  - RTAR-210 *External Modeling of Data Centers – Returned w/ Comments*
- 1 Work Statement was reviewed
  - WS-1956 *Compact CFD Modeling Guidance for Thin Flow Resistance – Returned w/Comments*
- 2 Active Research Projects
  - RP-1913 *Study of the Corrosion Impact on IT Equipment*
  - RP-1972 *Data Center Direct-to-Chip Liquid Cooling*

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Research Status Summary - RP-1913

Brad Cochran

RP-1913 - *Study of the Corrosion Impact on Information Technology Equipment in Data Centers Located in Coastal Regions with High Sea Salt Concentration*

PMS Chair – Chris Muller

Researcher – Lihong Lao, Syracuse University

Executive Summary –

ASHRAE's data center environmental guidelines extend the acceptable range up to 90% relative humidity (RH) and 24°C dew point. However, operating data centers at these high and/or variable levels, for example those that can be experienced when using free-cooling, can have detrimental effects on electronic equipment reliability if the environment has high levels of sea salt concentrations. This research project seeks to characterize the impact that high humidity combined with high sea salt concentrations representative of marine environments have on information technology equipment.

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Syracuse University
College of Engineering
& Computer Science

ASHRAE 1913-RP:

Study of the Corrosion Impact on Information Technology Equipment in Data Centers Located in Coastal Regions with High Sea Salt Concentration

PI: Dr. Lihong Lao, CO-PI: Dr. Jianshun "Jensen" Zhang

Mechanical & Aerospace Engineering

Center of Excellence for Environmental and Energy Systems

Syracuse University

LLao02@syr.edu

6/28/2026

Background (ASHRAE 1913-TRP)

Atmospheric corrosion in coastal regions:

- SO_2 pollutant
- Airborne salinity
- Time of wetness (humidity)

- A large part of the world's coastal regions and almost all of Europe are shown to have corrosivity indexes in the highest categories (C5 to C8).

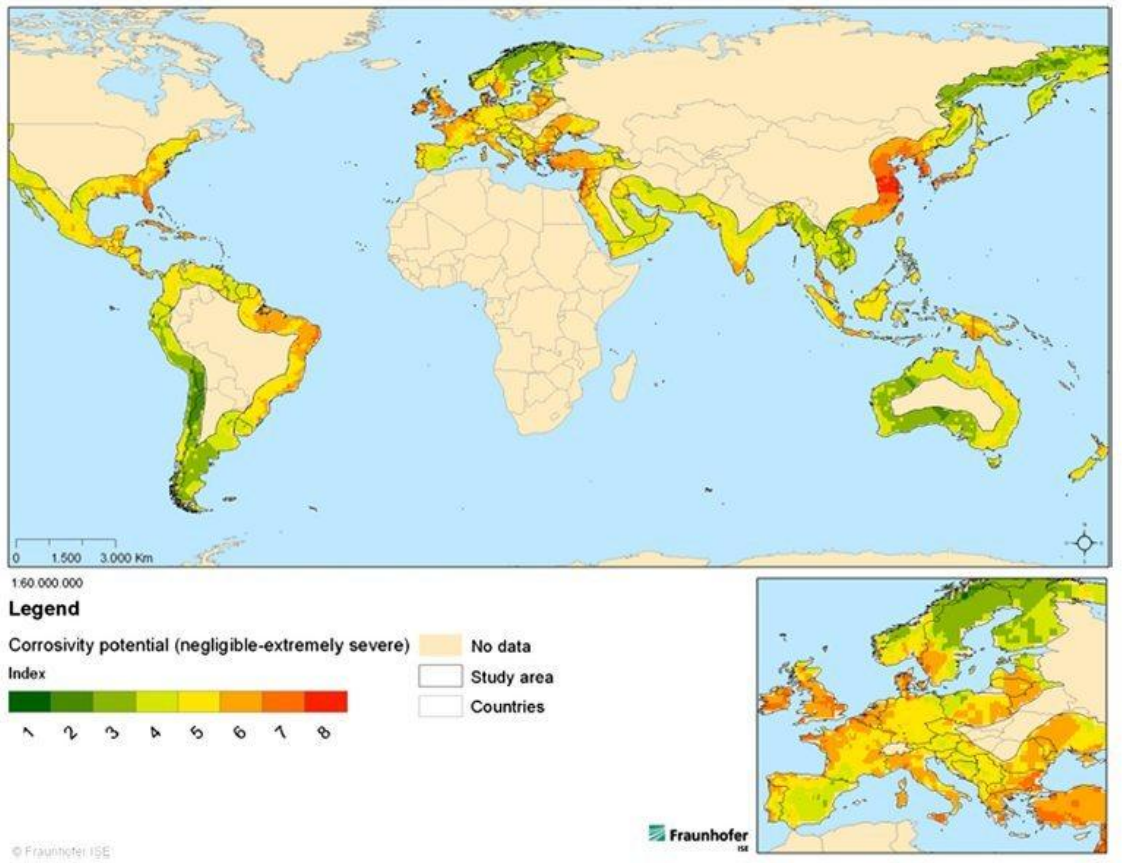


Figure. A map estimating worldwide atmospheric corrosion

Project Scope/Tasks

Understand the combined effects of gas, salt pollution and moisture in the air on IT equipment reliability in coastal regions and provide thermal guidelines for coastal data centers.

Task 1: Performing literature review (Sept-Dec 2025)

- Marine environment: Chemical composition of sea salt, relation between humidity, salt form/concentration vs distance
- Variables: **temperature, humidity, salinity levels, SO_2 levels, wet/dry cycle**

Task 2: Develop a test facility (Jan-Aug 2026)

- To monitor and control temperature (dry bulb, wet bulb, dew point), humidity, air flow velocity, so2, sea salt concentration, time of exposure

Task 3 & 4: Running the experiments (Apr 2026 – Jun 2027) (Apr-Aug 2027)

- Test Ag, Cu, (PCBs) coupon samples
- At a minimum, conditions would be **20–35 °C, 40–85% relative humidity, range of salinity levels, range of SO_2 levels and wet/dry cycles** experienced by coastal data centers in a 24 hr period.

Task 5: Provide guidelines based on the findings from the tests (Jul-Aug 2027)

- Provide a matrix of acceptable/unacceptable regions of variables in which to operate ITE in data centers in marine area

Task 6: Write reports and papers (Apr-Aug2027)

Project Tasks and Schedule

Project Schedule (9/2025-8/2027)	25'		26'				27'		DL
Tasks	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	
1. Deliver detailed literature review	xxx								M1
2. Develop a MFG test facility		xxx	xxx	xx					M2
3. Determine and document relationship between environmental conditions and corrosion rates (e.g., Cu, Ag, and PCBs)			xxx	xxx	xxx	xxx	xxx		M3
4. Investigate the effects of the rate of change of humidity on corrosion rates							xxx	xx	M4
5. Develop an updated thermal guidelines								xx	M5
6. Write reports and papers (Rs/Ps)	x	x	x	x	x	x	xxx	x	M6
DL=deliverables, M=Milestone, R=Report, P=Paper. Q=Quarter									

Project Status

Last Update

- **Task 1: Literature Review- Sea Salt**
  - Sea Salt Composition
  - Sea Salt Aerosol Particle Size
  - Sea Salt Concentration (Ocean, Distance, Outside Data Center, Inside Data Center)
    - Sea Salt Concentration Estimation
- **Possible test condition**
  - Sea Salt
  - Sulfur Dioxide (SO2)
  - Temperature and Humidity
  - Wet/Dry Cycles (Humidity Fluctuation)

Current Update

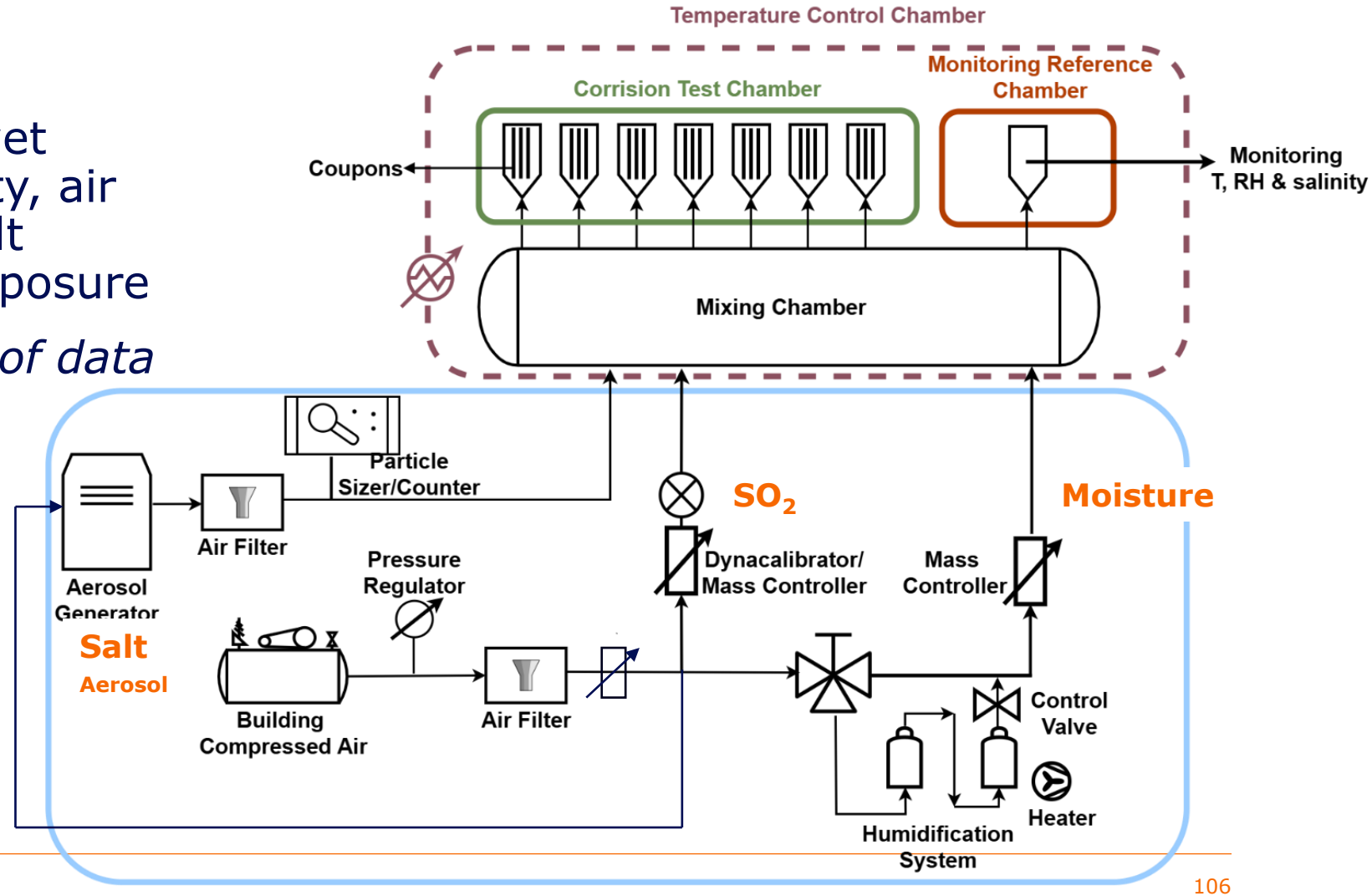
- Task 2. Develop a MFG test facility
- Task 3. Determine relationship between environmental conditions and corrosion rates *(Simulation)*

Future Plans

- Task 3. Determine relationship between environmental conditions and corrosion rates *(Experimental)*
- Task 4. Investigate the effects of the rate of change of humidity on corrosion rates
- Task 5. Develop an updated thermal guidelines
- Task 6. Write reports and papers

Task 2: Develop a test facility (1-8/2026)

- To monitor and control temperature (dry bulb, wet bulb, dew point), humidity, air flow velocity, so2, sea salt concentration, time of exposure
- *Similar to the conditions of data center in marine area*

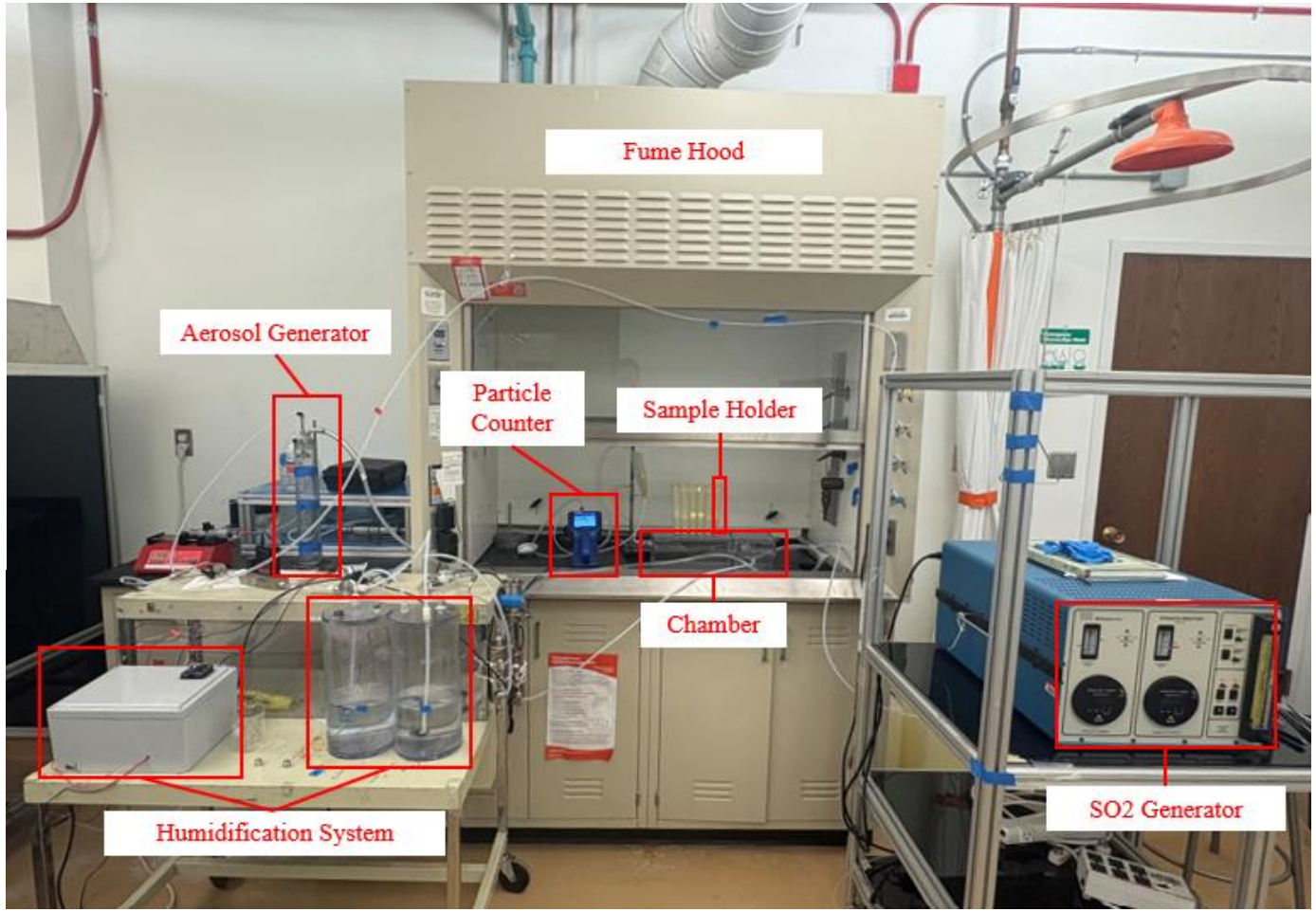


Chamber Test Setup

- The chamber has been set up for testing
- There will need to be iteration tests to determine the correct pressure/airflow, and liquid feed rate for the intended particle amounts.
- The components and concentrations of the salt solution that will simulate ocean spray needs to be will also need to be determined (or referred to the literature).

Table 1 Exposure tests schedule

Phase 1	Constant T and RH (21°C, 50%) - Varying salt particle count - Varying SO_2 ppb
Phase 2	Constant particle count and SO_2 - Varying T and RH
Phase 3	Testing the effects of Wetting/drying cycles



Current exposure chamber test set up

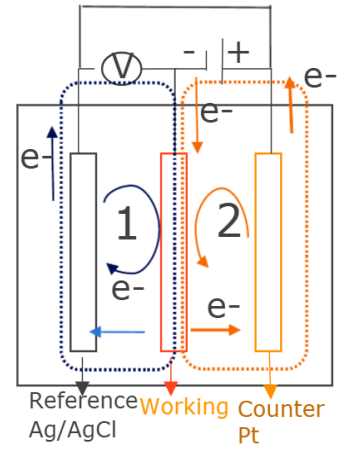
- Corrosion chamber has been set up for testing.
- Currently, we are verifying salt particle generations.

Experimental Plan: Characterization Methods

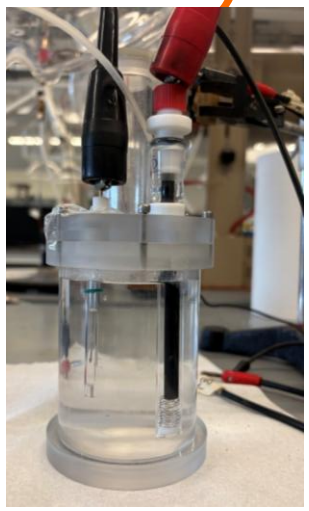
- **Coulometric reduction** (ASTM B825/ISA Standard 71.04-2013):
  - Measure thickness based on electricity resulted from the reaction of electrolyte and corrosion products.
  - Cu, Ag, (PCBs) coupons and PCBs, on Day 3, 6, 12, 20, 25 and 30
    - *Pure Air will assist.*
    - *Set up in lab (graduate student: Kessidy)*
- **Visual Inspection, Color Indexing (RGB Values)**
  - *SU*
- **Corrosion tests**:
  - SEM/EDS, AFM, Raman, FTIR -- *SU*
  - XPS -- *Cornell CCMR*
- **Salt deposition**: leaching and HPIC
  - *Dionex ICS-6000 HPIC System at SUNY ESF (to verify)*
- **Impact of bias (optional):** Teston voltage biased and unbiased coupons
  - *e.g., Quad 4 (PERM 19) from Foresite has surface mount components that can be biased and provides a good representation of a server PCB.*

Experimental Plan: Characterization Methods (Cont.)

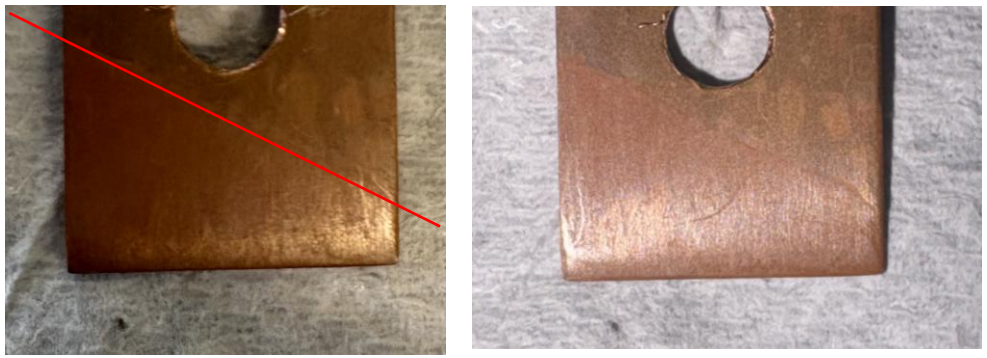
- **Coulometric Reduction Test** (ASTM B825/ISA Standard 71.04-2013):
  - Used to determine the thickness of known corrosion films
  - Coupon as working electrode, Pt counter electrode, and Ag/AgCl2 refe electrode, 0.1 M KCl electrolyte



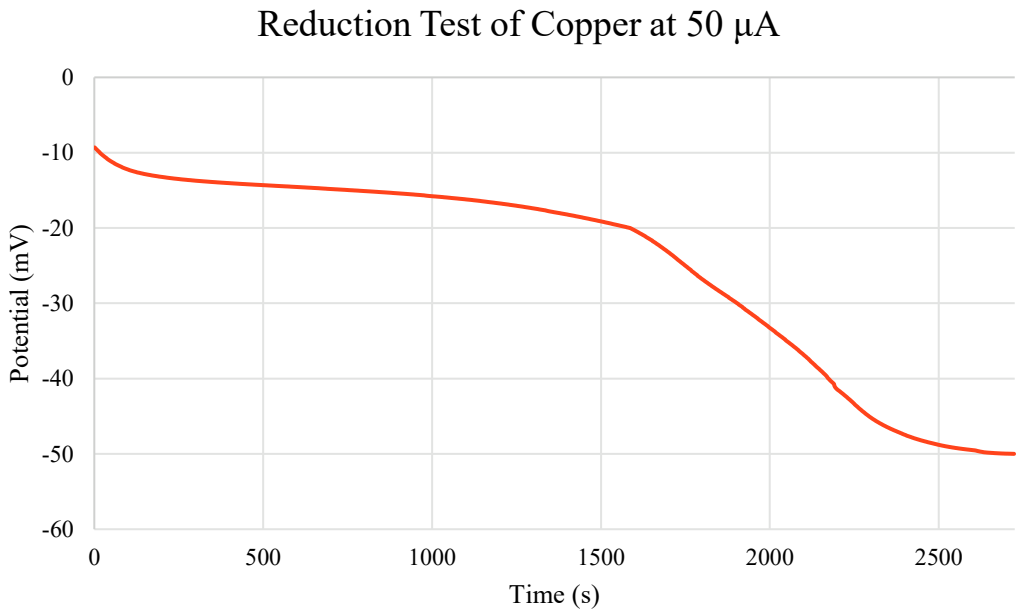
Coulometric reduction reaction



Current test set up



Sample coupon after coulometric reduction



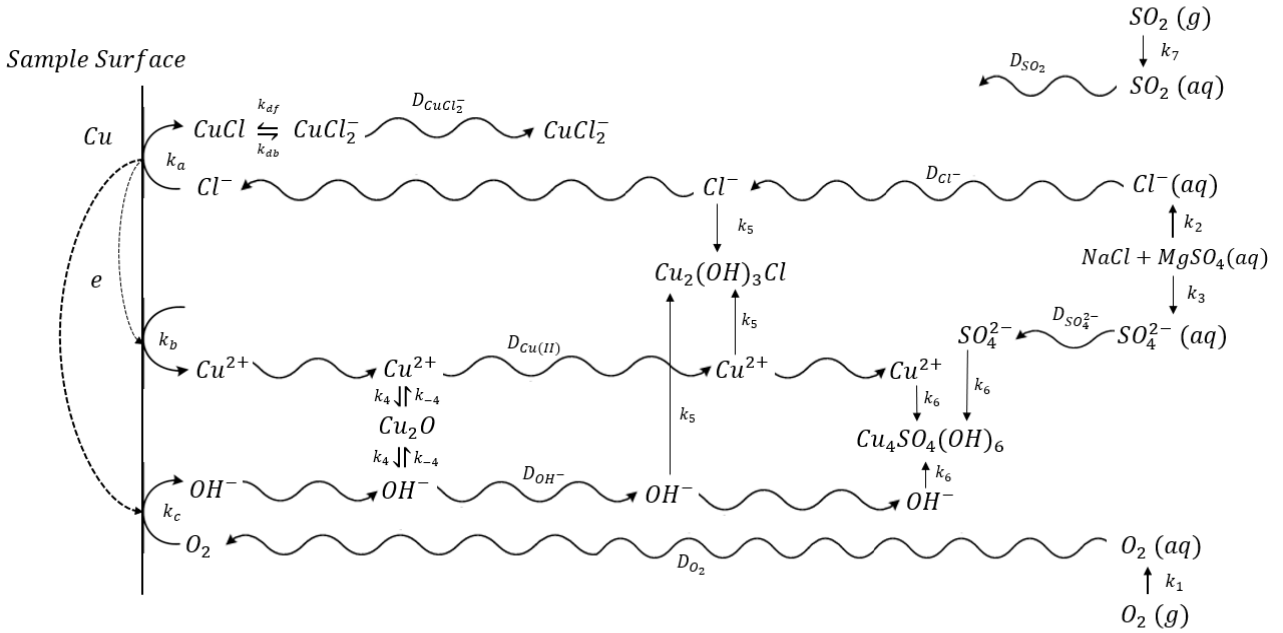
Coulometric reduction test results

- Initial results show reduction of the samples as shown by the line in which the copper was submersed.
- More tests are undergoing.

Corrosion Simulation

- The simulation will be used to understand the mechanisms driving corrosion and to predict corrosion patterns.
- This is a designed model for the current experiments with NaCl and $MgSO_4$
- COMSOL will be used as the simulation software

Step	Dimensionality	Solution Type	Incremental Species	Temperature
1	1-D	Steady State	$O_2, Cl^-, CuCl_2^-$	Isothermal
2	1-D, 2-D	Transient	$O_2, Cl^-, CuCl_2^-$	Isothermal
3	1-D	Transient	Cu^{2+}	Isothermal
4	1-D, 2-D	Transient	Cu_2O	Isothermal
5	1-D	Transient	$Cu_2(OH)_3Cl$	Isothermal
6*	1-D	Transient	$SO_4^{2-}, Cu_4SO_4(OH)_6$	Isothermal
7*	2-D	Transient	With Deposits	Isothermal
8*	1-D, 2-D	Transient	SO_2	Isothermal
9*	2-D	Transient	With Deposits	Isothermal
10(a/b)	1-D, 2-D	Transient	All of the above, + ΔRH (b)	Variation(a)



Reaction scheme with NaCl and $MgSO_4$

- Have setup the environmental parameters for COMSOL simulation, and results are pending.

Summary and Next Steps (1-6/2026)

Task 1: Performing literature review (9-12/2025)

- **Chemical composition of sea salt** – *Completed*
- **Marine environment: relation between humidity, salt form/concentration vs distance** – *Completed*
- **Variables: temperature, humidity, salinity levels, SO2 levels, wet/dry cycle -** *Completed;* may survey on available data centers located in coastal areas – *in progress*

Task 2: Develop a test facility (1-8/2026)

- **Develop a test facility, e.g., T, RH, air, RH rate, SO2 and Salt generator, etc –** *Completed*
- **Simulation: COMSOL** (simulate corrosion with varying parameters) – *in progress*

Task 3/4: Running the experiments (4/2026-8/2027)

- **Start to prepare Cu, Ag, (PCBs) coupons: quantities, purchasing, etc** – *in progress*
- **Characterizations: Coulometric reduction setup** – *in progress*
- **Run experiments**

Additional Support Anticipated – Request to TC9.9

Can members of TC 9.9 provide access to coastal DC for monitoring?

e.g., temperature, humidity (and wet/dry cycles), salinity, VOC levels, etc

- **National Energy Research Scientific Computing Center (NERSC)** (in communication)
- **Mississippi Power Chevron Cogen** (can send coupons, but which locations to test?)
- Sunnyvale Data Center? (can compare with literature)
- Or other data center access?

Communicate with Pure Air Filtration:

- Confirm with the purchase discount (last time confirmed with $125-150/set, including analysis, report and shipping).
- Request loan of **Environment Corrosivity Monitor (ECMv2)** to detect and measure corrosion in real time using copper and silver sensors?.

Thank You!

PI: Dr. Lihong Lao, CO-PI: Dr. Jianshun "Jensen" Zhang

Mechanical & Aerospace Engineering

Center of Excellence for Environmental and Energy Systems

Syracuse University

LLao02@syr.edu

Research Status Summary - RP-1972

Brad Cochran

RP-1972 - *Data Center Direct-to-Chip Liquid Cooling Resiliency – Failure Modes and IT Throttling Impacts*

PMS Chair – Tom Davidson

Researcher – Jaco Dirker, University of Pretoria, South Africa

Executive Summary –

There are currently no published data on acceptable rate-of-rise of liquid temperatures from various failure scenarios associated with liquid-cooling systems supporting high-density processors. This research will provide detailed engineering information necessary for facility designers to enhance server resiliency and promote liquid cooling adoption. It will also model the energy consumption of several liquid cooling topologies so that designers and users understand the energy impact of various liquid-cooled systems, including a comparison to more traditional air-cooled systems.

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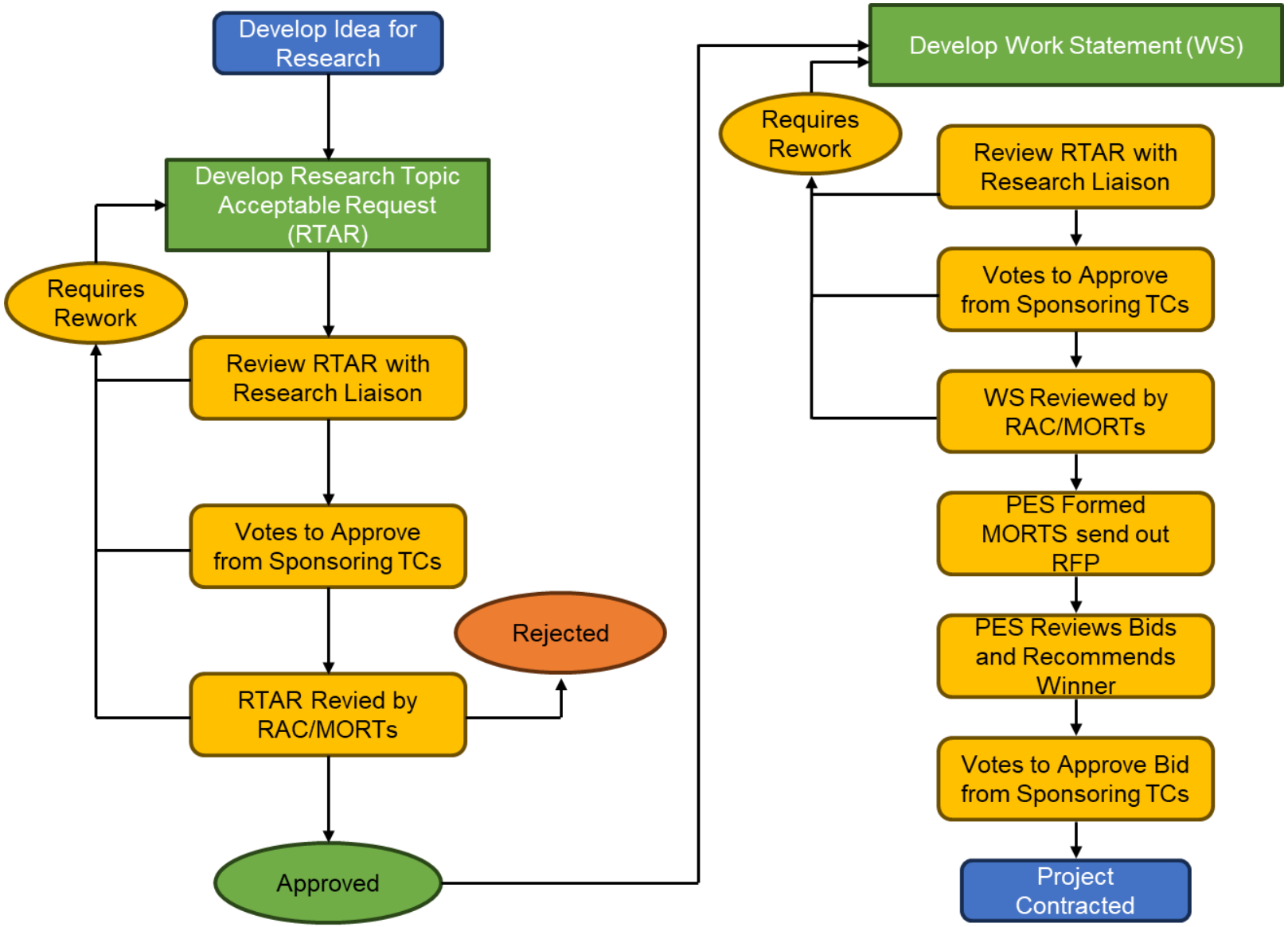
Research Project Development Flow Chart

Brad Cochran



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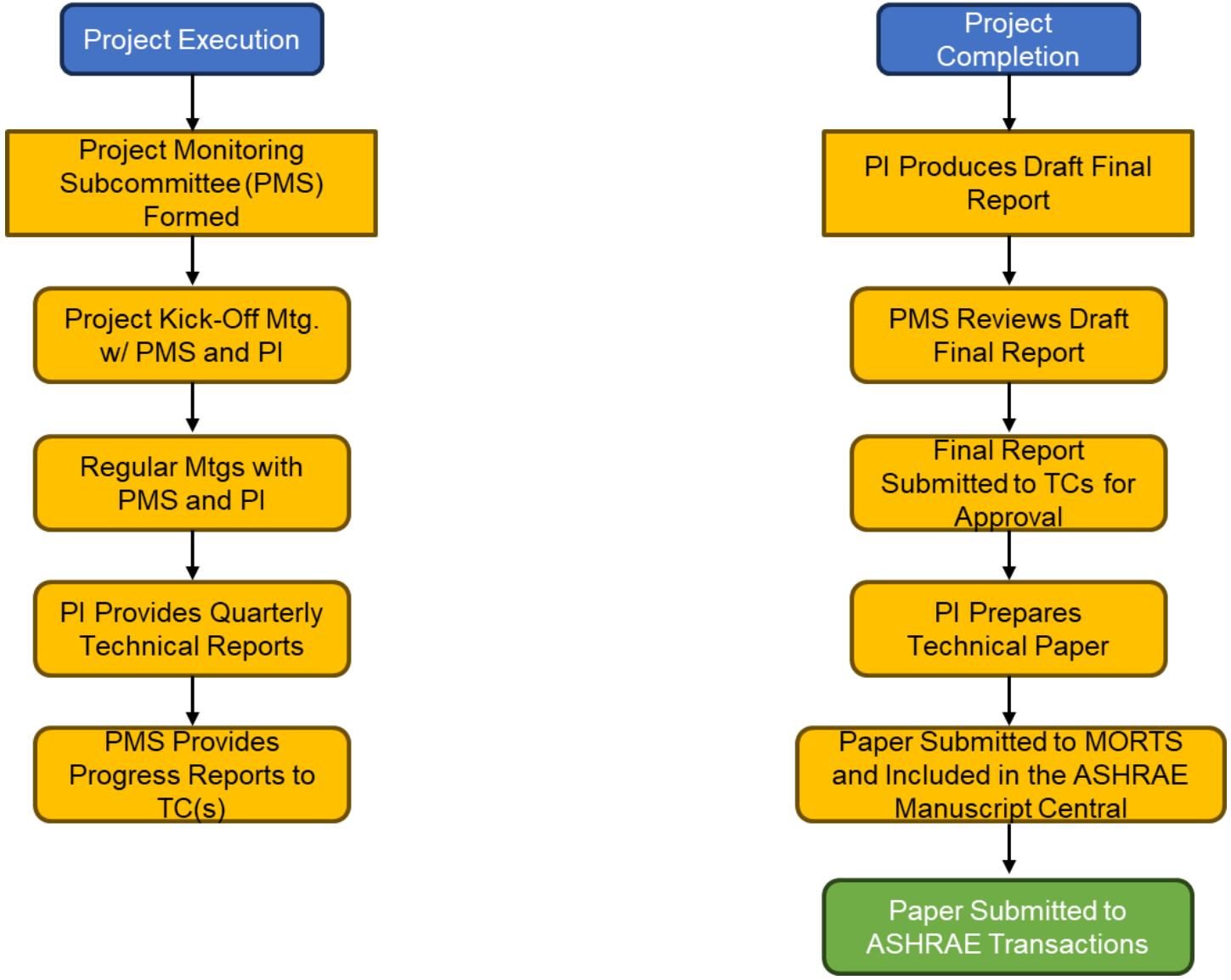
Research Project Development Flow Chart

Brad Cochran



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Research Subcommittee Updates

Brad Cochran

New Research Ideas

- Digital twin for data center environments for liquid cooling and how that might be able to be developed
- Commissioning/Flushing requirements for fluid mixing in direct to chip cooling applications
- Evaluating the potential to implement 2-phase dielectric refrigerant for immersive cooling.
- Surface Treatments to enhance nucleation for 2P-DLC and potential for localized critical heat flux phenomena..
- Based on Nexus (PUE/WUE/CUE), figure out what cooling facility structure (outside data center), is required based on the weather climate across the world (no politics/ regulatory considerations – only thermal energy scientific based)
- Impact of particle size distribution on cold plate performance/PUE

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Research Subcommittee Updates

Brad Cochran

New Research Ideas

RAC has a new on-line RTAR process.

https://app.ashrae-research.com/

Or:

RTAR form online at:

https://www.ashrae.org//File%20Library/Technical%20Resources/Research/RTAR-Form-Template_2019--2-.DOCX

Any questions you can reach me at:

BCochran@cppwind.com or

TC09.09.RES@ashrae.net

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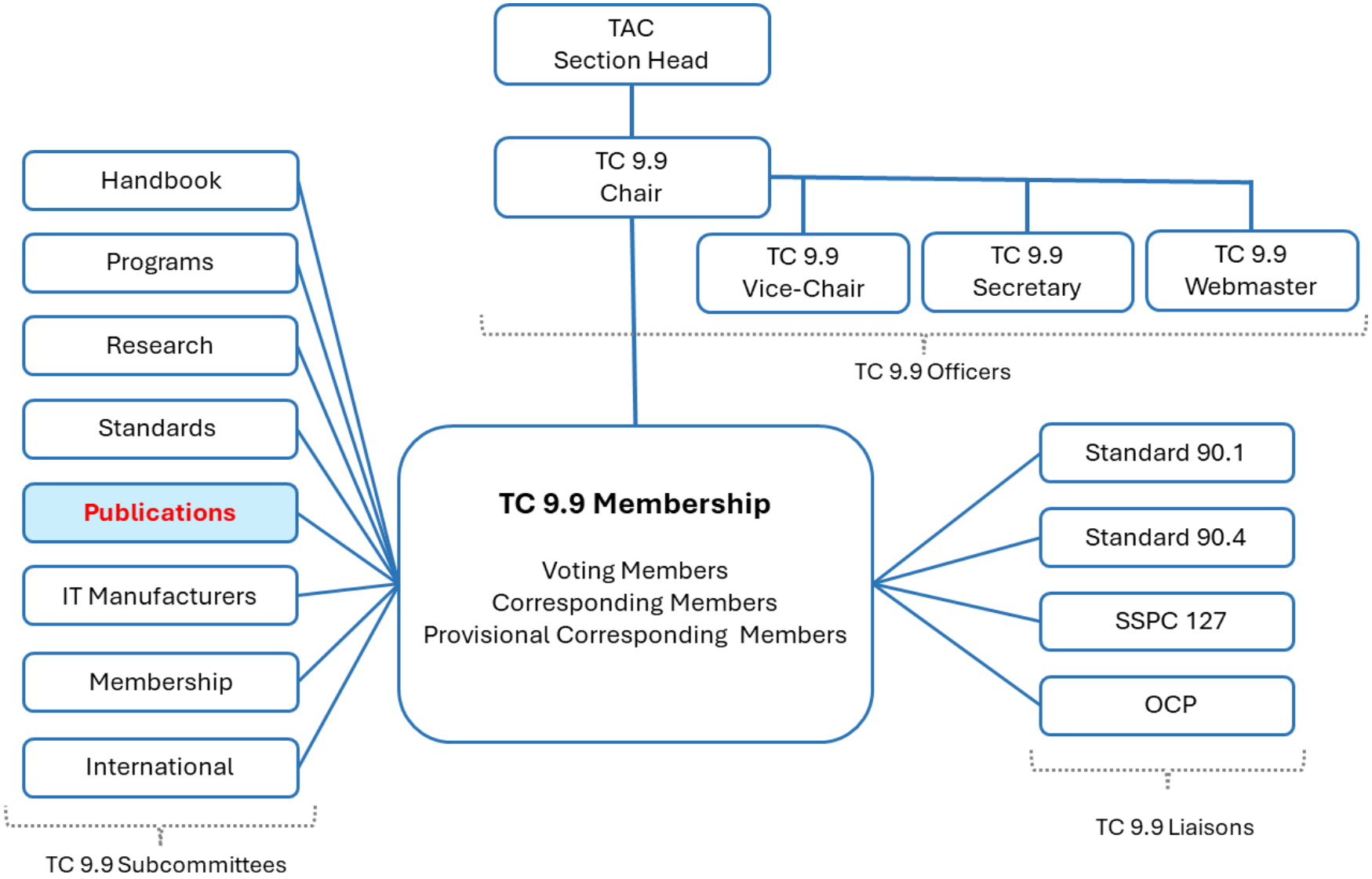
Publications Subcommittee



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Publications Subcommittee Encyclopedia Updates

Dustin Demetriou

The **ASHRAE TC 9.9 Datacom Encyclopedia** evolved in 2024 from the longstanding ASHRAE Datacom Series, a series of print books that provides information on data center-related subjects.

The Datacom Encyclopedia offers **updated, previously unpublished content** formerly covered by the Datacom Series books *Thermal Guidelines for Data Processing Environments*, ***Design Considerations for Datacom Equipment Centers***, and ***Liquid Cooling Guidelines for Datacom Equipment Centers***, as well as **PDFs of every edition of the 14 books in the ASHRAE Datacom Series** for historical reference. Over time, the pertinent information from all the books will transition to be housed in this online encyclopedia.

Subscribe today to access the ASHRAE TC 9.9 Datacom Encyclopedia. Access is granted via payment of an annual fee ($33 list price per year / $24 Member price per year).

To enable and disable access to the encyclopedia, visit **https://datacom.ashrae.org/** and click Manage Subscription in the top blue bar. Users can review ASHRAE's privacy policy at **www.ashrae.org/privacy-policy**.

Datacom Encyclopedia

https://datacom.ashrae.org

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Encyclopedia Update Summary

Dustin Demetriou

- Review of all entries in *ITE Design Considerations, Facility Design Considerations, Environmental Guidelines, and Cooling Technologies* complete and database of action items created.
- Categorization of chapters from *PUE, Real Time Energy Measurements, Best Practices,* and *DCIM* datacom books complete.
- Acknowledgements
  - Topic Editors
    - Donovan Aguirre, Mohammad Alkiswant, Sankar Padhmanabhan, Ed Gutowski
  - Datacom Book Organizers
    - Rajat Bhagat, Lauren Huffman, Raha Kalantarpour
- Continued feedback requested. Please email datacom@ashrae.net.
  - If there is a topic you want to expand, please send an email.
    - Reminder – ASHRAE material must remain **vendor neutral, unbiased**

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What's New

Dustin Demetriou

June 29, 2026	• Updated information on ◦ AI's Indirect / Direct Impact on Data Center Infrastructure Planning published ◦ Updated the Data Center Standards page to reflect the latest edition of each standard
May 20, 2026	• TCS Coolant Integrity and System Readiness published.
January 22, 2026	• Updated information on ◦ Wetted Materials (Version 2.1) including revised tables of common metal and metal alloys and elastomers, plastics, and other materials ◦ Liquid Filtration (Version 2.1) including revised guidance for TCS filtration to 25 micron and 5000 beta ratio ◦ Fluid Quality Considerations (Version 2.1) including expanded coverage of propylene glycol fluids
October 13, 2025	• Datacom Encyclopedia V2 launched. The ASHRAE TC 9.9 Datacom Encyclopedia incorporates the former Thermal Guidelines for Datacom Equipment Centers, Design Considerations for Datacom Equipment Centers, Liquid Cooling Guidelines for Datacom Equipment Centers, and IT Equipment Design Impact on Data Center Solutions
June 24, 2025	• Datacom Encyclopedia V2 (beta) launched
May 10, 2025	• Liquid-cooling Infrastructure Considerations for Technology Cooling Systems updated to introduce S20 and S25 classes • Clarification provided around S- vs. W-classes and CDU approach temperature

Note: A complete listing of all historical changes is available here.

- Five most recent updates

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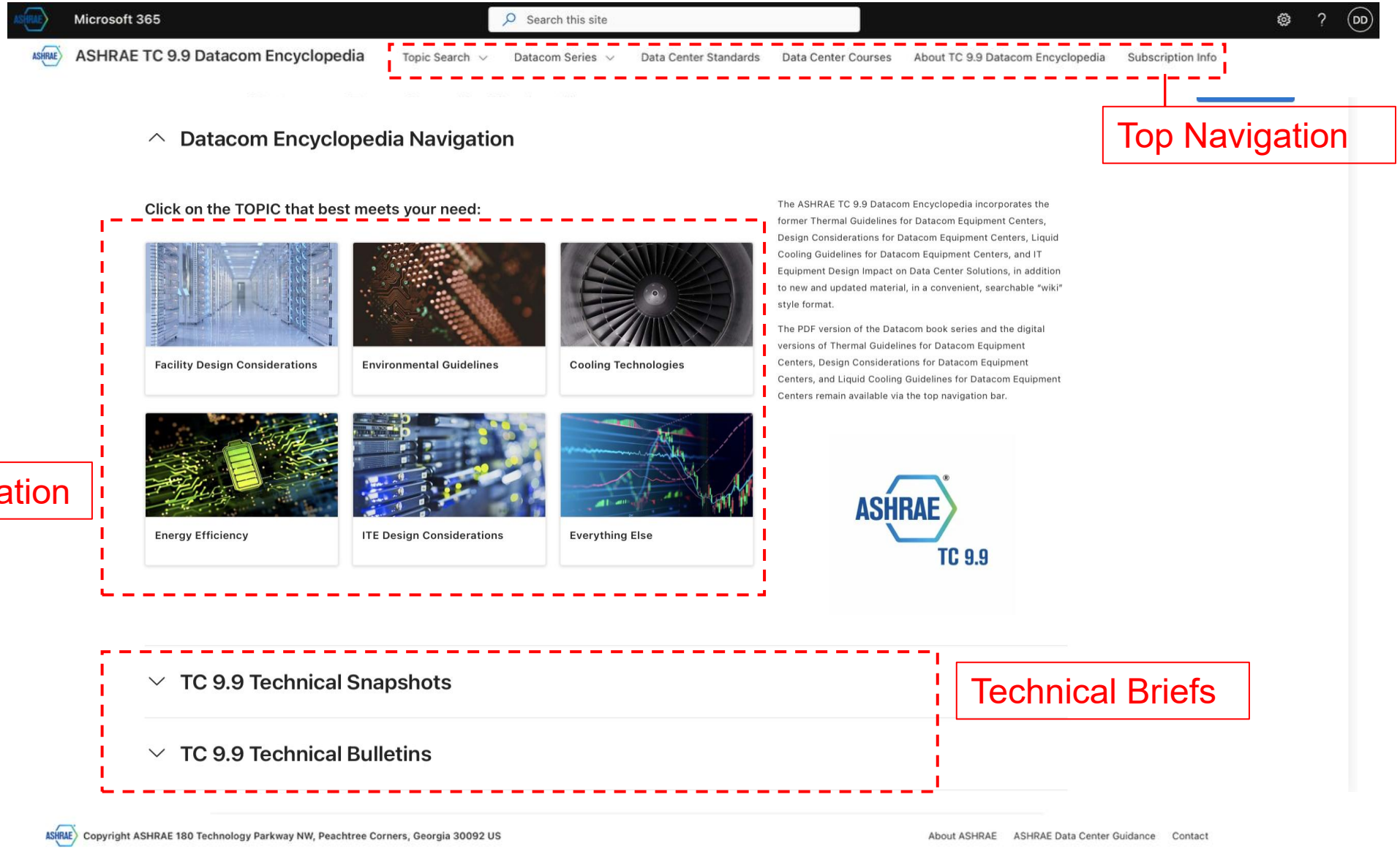
Homepage

Dustin Demetriou



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Datacom Encyclopedia Work Structure

Dustin Demetriou

- Site Management:
  - Coordination with TC on encyclopedia direction and approval
  - Responsible for updates to the encyclopedia
- Content Supervision (IT Subcommittee and Publications Chair):
  - Responsible for topic change control and documentation
  - Interface with site management
- Topic Editor:
  - Responsible for ensuring topic content is up to date
  - Provide overall project management for topic edits
  - Select content editors & developers to assist
  - Determine proper structure for topic and integration of each subtopic
- Content Developer:
  - Provide overall editing of one or more articles within the topic to ensure consistency and accuracy
  - Integration of datacom books into existing articles

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Content Developers

Dustin Demetriou

- If you would like to volunteer as a ***content developer***
  - A pre-defined listing of topics that need to be created and/or edited based on the Encyclopedia is available at the QR code
  - To sign up for a topic add your name in the **Volunteer** column and mark **Status** as **In Progress**
  - Send an email to tc99publications@gmail.com if you want to connect on the need

Table1

Topic	What's Needed	Volunteer	Status	Notes
Energy Star for Servers	Update			Need to reflect current version and st
ASHRAE Standard 90.1	Update			Need to reflect current version. In **Sta**
ASHRAE Standard 90.4	Update			Need to reflect current version. In **Sta**

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Next Steps

Dustin Demetriou

- Topic Editor
  - Requesting applicants to serve as topic editors for a 1-year term
  - Focus is on addressing already identified gaps.
    - For Energy Efficiency topic a thorough review is still needed
  - Coordinating with volunteers of new or updated topics
  - Send an email to tc99publications@gmail.com
- Datacom Book Integration
  - Four datacom books have been categorized
  - Work with topic editors to integrate the content into their topics
  - Focused effort to leverage AI to do this
  - Need reviewers to categorize Contamination, Structural, Server Efficiency and Green Tips

March 2024	TC 9.9 Datacom Encyclopedia is launched with updates to Design Considerations for Datacom Equipment Centers & Liquid Cooling Guidelines for Datacom Equipment Centers.
August 2024	Process is introduced and approved by TC 9.9 for providing content updates and version tracking.
October 2025	TC 9.9 Datacom Encyclopedia is transitioned to an encyclopedia format that incorporates Thermal Guidelines for Datacom Equipment Centers, Design Considerations for Datacom Equipment Centers
1H2026	Formalize Encyclopedia Leadership and work to incorporate existing material from other Datacom Series book, white papers, and technology briefs.
End 2026	Transition of all Datacom Series books into Encyclopedia
On-going	Quarterly updates, approved by TC 9.9, begin.

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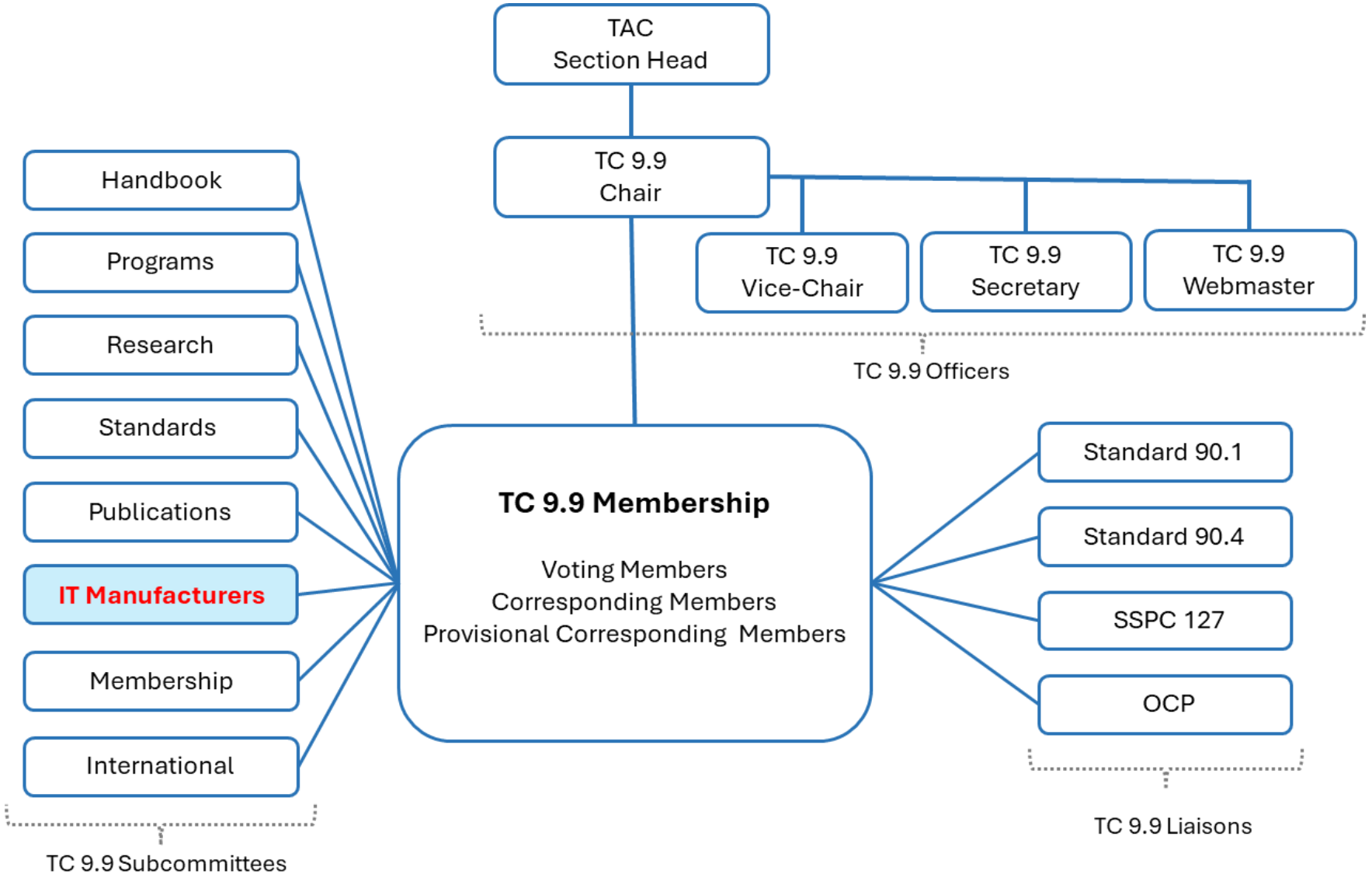
IT Manufacturers Subcommittee



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IT Manufacturers Subcommittee Updates

Dustin Demetriou

AGENDA

Topic	Presenter	Duration
CDU Safety Testing (IEC 62368-1)	Dustin Demetriou	5
AHRI Product Safety Standards 60335 Advisory Group - Position on Safety Testing of Standalone CDU	Justin Prosser	15
IT Subcommittee Publishing	Dustin Demetriou	5
Technical Snapshot - AI Impact on Data Center Planning	Mark Steinke	10
Technical Bulletin - TCS Coolant Integrity	Justin Seter	10

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IEC/UL 62368-1 Testing on Cooling Components

Dustin Demetriou

- Concerns regarding the Tubing and Fitting Compatibility Test required in IEC/UL 62368-1 in regard to complex liquid cooling systems were brought to the IT Subcommittee
  - 3rd edition Sec. G.15.2.3
  - 4th edition G.15.2.3 for self-contained equipment and G.15.3.4 for modular equipment
- IT Subcommittee approached TC108 USTAG to seek formal guidance to determine if certification of stand-alone CDUs to IEC 60335-2-40 is acceptable and the CDU is not classified as ITE equipment and is not within the scope of IEC/UL 62368-1 unless the communication interface is used for functional control by information-processing equipment.
- Interpretation submitted to IEC Chairman's Advisory Group for review in 4Q2025.

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Key Concerns

Dustin Demetriou

- 62368 requires testing every potential combination of non-metallic material and cooling fluid
  - This results in thousands of test samples for a complex, commercially available system (ref example below)
  - This in turn directly impedes the system manufacturer's speed to market and increases development costs
  - The high number of samples required and long test duration can also potentially overwhelm the various NRTL's
- 62368 requires a very specific "dog-bone" form factor for tensile testing pre/post conditioning
  - System manufacturer is not necessarily procuring the non-metallic sub-component directly.
  - Drilling down to 3rd or 4th tier vendors to get the material samples made in custom form factors can be very challenging
    - For example, say vendor A buys a ball valve from vendor B to use in their unit. Vendor B uses an O-ring in their valve which they get from vendor C. Vendor A now has to navigate through multiple communication layers and convince vendor C to provide the custom samples
  - Testing specific coolant blends and vendor specific polymers/rubbers implies these are now controlled components
    - This would limit the customer base from taking full advantage of the plethora of fluid vendors out there and potentially limit them to a select few.
    - Manufacturers would be hampered in their ability to second source components, as introducing an alternate would trigger another round of sample gathering and compatibility testing
    - Many hydraulic components are COTS parts sold in very high volume, the makers of these parts are very unlikely to notify their customers if they switch from one gasket vendor to another for example. The cooling system manufacturer won't have visibility to if their vendor's, vendor's, vendor makes a change

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IEC Resolution 108/862/INF

International Electrotechnical Commission

Standards development | Conformity assessment | Where we make a difference | Who benefits | News & resources | Programmes & initiatives | Who we are

Home / Standards development / Technical committees and subcommittees / TC 108 Dashboard

TC 108 Safety of electronic equipment within the field of audio/video, information technology and communication technology

Scope | Structure | Projects / Publications | Documents | Votes | Meetings | Collaboration Platform

Working Documents | Other Documents TC 108 | Supporting Documents

en | fr

TC 108 Working Documents since 2025-06-17

Reference, Title	Is Online(Y/N)	Downloads	Circulation Date	Closing Date	CENELEC	Voting / Comment	Aux comites Authorises
108/865/RVC Result of Voting on 108/851/CDV - IEC 63315 ED1: Audio/video, information and communication technology equipment – Safety – DC power transfer between ICT equipment ports using ICT wiring and cables at voltages not exceeding 60 V DC	Y	998 kB 141 kB	2026-05-29		Y		TC 23 TC 34 TC 61 TC 62 TC 72 TC 100
108/864/AC Call for nominations for the chair of TC 108	N/A	170 kB	2026-05-15	2026-08-07	N/A		
108/860/INF Interpretation Panel Question 34	N/A	153 kB	2026-04-10		N/A		
108/861/INF Interpretation Panel Question 35	N/A	175 kB	2026-04-10		N/A		
108/862/INF Interpretation Panel Question 36	N/A	248 kB	2026-04-10		N/A		
108/863/INF	N/A	188 kB	2026-04-10		N/A		

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IEC Resolution 108/862/INF

- Question to the Panel:
  - Is IEC 60335-2-40 an acceptable standard for the evaluation of stand-alone Cooling Distribution Units (CDUs) used in data centers?
- Opinion of the Panel:
  - Yes, compliance with IEC 60335-2-40 is deemed acceptable for stand-alone CDUs that are installed in data centers
- Action:
  - The panel suggests:
    - To publish the interpretation as an INF document
    - To inform CTL about this interpretation
    - To propose modifications to IEC 62368-1, and IEC TR 62368-2 to reflect the decision made by TC108 experts

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Next Steps

- Continue to engage TC108 as work begins on the next version of the standard
  - Opportunity to propose addition of 60335 as an acceptable standard within 62368
  - Work with TC108 by bringing industry expertise to resolve current objections to fluid / material safety concerns

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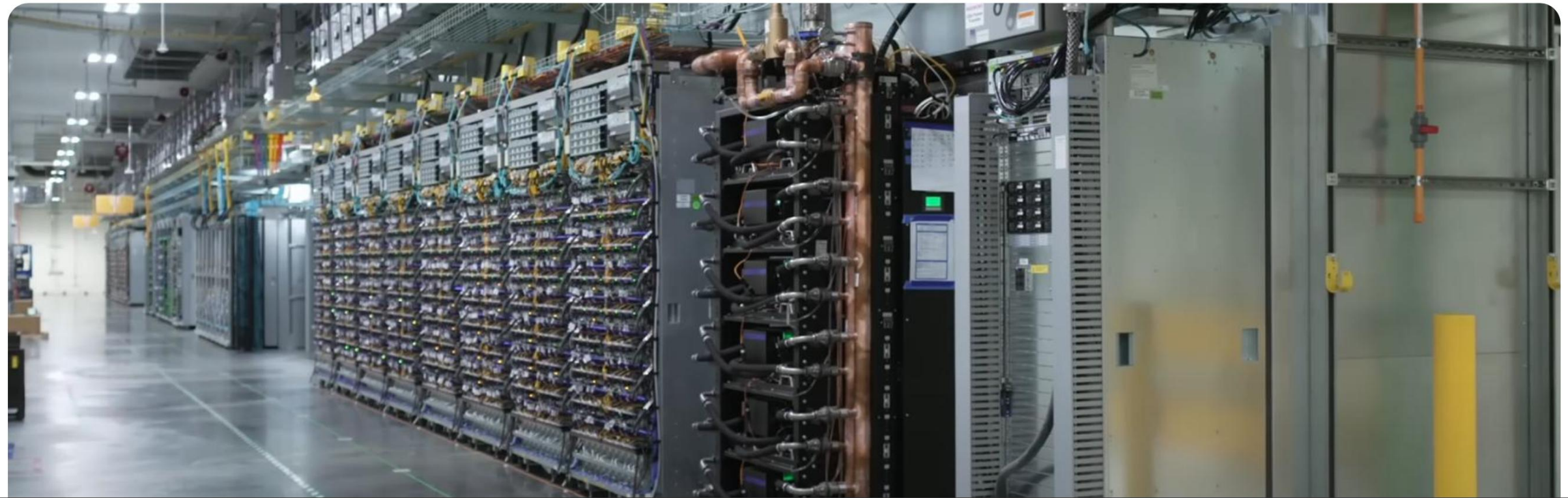
UL62368-1 vs UL60335-2-40

June 29, 2026



Background

July 2025

UL 62368-1 (info from UL Coolant Distribution Unit Infosheet)

- Ed.4 published
- Scope includes CDUs if it contains coolant only (non-refrigerant)

Jan 2026

UL 60335-2-40 / UL 1995

- Liquid chillers included in UL 1995 since 1990s
- Scope includes CDUs (refrigerants and non-refrigerants)
- UL 60335-2-40 Ed.5 proposals related to CDUs: PR43902 and PR43903

Apr 2026

ASHRAE TC9.9

- Requested clarification from IEC TC108: Is IEC 60335-2-40 an acceptable standard for the evaluation of stand-alone Cooling Distribution Units (CDUs) used in data centers?
- TC108 response: Yes, compliance with IEC 60335-2-40 is deemed acceptable for stand-alone CDUs that are installed in data centers.

May 2026

AHRI Product Safety Standards 60335 Advisory Group

- Position: UL 60335-2-40 is the appropriate standard for stand-alone CDUs that are installed in data centers.

Jun 2026

TC9.9 comments?

Standards that apply and history

CSA C22.2 No.62368-1/UL 62368-1, the Standard for Audio/Video, Information and Communication Technology Equipment, and IEC 62368-1, the product safety standard for Audio/Video, Information and Communication Technology Equipment. Currently, it's at its fourth edition (IEC 62368-1:2023).

The Canada and U.S. (CSA/UL) versions of the IEC standard contain the base IEC content, with additional national differences, typically driven by Canada and U.S. regulatory codes and standards, in addition to Canada and U.S. component requirements.

Related to liquid cooling in IEC 62368-1, components of a liquid cooling system are designated liquid filled components (LFC) or LFC assemblies. IEC 62368-1 has had requirements for such liquid cooling systems ever since being used in data centers, including CDUs. Reference is made to IEC 60335-2-40 (and IEC 61010-2-011) for systems incorporating refrigerants.

Liquid cooling systems were first used in data centers requiring heat exchange through refrigerant loops referenced to IEC 60335-2-40 (and IEC 61010-2-011).

IEC 62368-1 also has included requirements for insulating liquids (immersion fluids) that permit a complete ICT immersion cooling system (e.g., enclosures/ insulating liquids/servers) to be investigated to IEC 62368-1.

In 2025, UL Solutions published UL 2417, The outline of Investigation for Immersion Cooling Fluids for Use with Information and Communication Technology Equipment.

CSA C22.2 No.60335-2-40/UL 60335-2-40, the Standard for Household and Similar Electrical Appliances Particular Requirements for Electrical Heat Pumps, Air Conditioners and Dehumidifiers.

Chiller and cooling tower manufacturers that were Listed (i.e., Certified) to UL 1995/CSA 22.2 No. 236 under the category LZFE/LZEF began to manufacture CDUs and desired one certification path for their cooling equipment.

Harmonization of UL 1995 and IEC 60335-2-40 began in 2011, and for approximately 14 years, both UL 1995 and UL 60335-2-40 were published as national standards, with a harmonized binational standard being published in May of 2023. The scope of CSA C22.2 No. 236 was limited to comfort cooling equipment with some industrial process applications allowed within that scope. Work is ongoing which would provide a new certification path under CSA/UL 60335-2-40, which would allow chiller/CDUs used in data centers.

It was intended these requirements would apply to CDUs for water and refrigerant loops for in-rack cooling and can be applied to other types of liquid loops as well as other coolants.

The scope of UL/CSA 60335-2-40 covers liquid chillers. These products incorporate a heat exchanger for the purpose of removing (or adding) heat to a space. UL/CSA 60335-2-40 specifically identifies that indoor heat exchangers are “designed to transfer heat to the … indoor hot water supplies (e.g., sanitary water) or to remove heat therefrom.”

Source: Safety Certification of IT Equipment Cooling in Data Centers

Classified as Business

Differences between ICE 62368-1 and 60335-2-40

Standards	IEC 62368-1	IEC 60335-2-40
For equipment designed for	Equipment cooling (direct-to-chip cooling; immersion cooling)	Spatial cooling (psychrometry and human comfort)
Standards required for GMA	UL/IEC 62368-1	IEC/EN 60335-2-40; ISO 5149; EN 378
Modularity/interoperability	Y	N/A – These are engineered systems
Electrical insulation	Y	Y
Mechanical strength	Y	Y
Touch temperature	Y	Y
Creep resistance non-metallic (non-metallic liquid containing parts)	Y	N
Hydrostatic pressure test	Y	Y
Material compatibility	Y	N/A
Vibration test	Y	N
Thermal cycling	Y	N
Technologies	Direct-to-chip; immersion	Refrigeration cycle
Operating principles	Convection	Refrigeration cycle
Fluid	Coolant (PG/EG)	Refrigerant (A1, A2, A2L, A3) and water
Operating pressure	~2 bar (200 kPa/29 psi)	Atmospheric to hundreds bar
Piping materials	Metallic and non-metallic	Metallic
Toxicity and flammability	N	Y

Source: Safety Certification of IT Equipment Cooling in Data Centers

Classified as Business

Draft Proposal

UL 60335-2-40

1 Scope

This part of CSA C22.2 No. 60335-2-40/UL 60335-2-40 deals with the safety of:

- electric HEAT PUMPS, including HOT WATER HEAT PUMPS,
- AIR CONDITIONERS,
- DEHUMIDIFIERS incorporating motor-compressors as well as without motor compressors,
- HYDRONIC FAN COILS UNITS~~, and~~
- CENTRAL WARM AIR FURNACES and ADD-ON ELECTRIC HEAT KITS, and
- COOLANT DISTRIBUTION UNITS.

3 Terms and definitions

3.221DV

COOLANT DISTRIBUTION UNIT Note: definition based on the REFRIGERATING SYSTEM definition

combination of interconnected fluid containing parts constituting one closed circuit in which fluid is circulated for the purpose of extracting heat and not including components integrated into INFORMATION TECHNOLOGY EQUIPMENT (ITE).

UL 62368-1

Revise scope to specifically exclude coolant distribution units as defined in UL 60335-2-40.


Danfoss

TC 9.9 IT Manufacturers Subcommittee

TC 9.9 members that work for chip & HW manufacturers have insight into products being developed.

TC 9.9 has been most successful when they are able to tap into that insight to translate current & future HW needs into infrastructure requirements.

- **Translate Requirements** - Since its inception, TC9.9 focuses on translating hardware / software requirements into data center infrastructure requirements.
- **Future HW Needs** - Rapid change increases the difficulty in planning for future hardware needs without over investment or premature obsolescence.
- **Best Visibility** – TC 9.9 IT Subcommittee has the best visibility into hardware products being developed.
- **High Level Data Center Infrastructure Trends** - The intent should be to share insight and translate it into high level data center infrastructure trends in an ***unbiased, vendor-neutral*** format.

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IT Subcommittee Publishing – Technical Briefs

Dustin Demetriou

- **Technical Alert** (1 page) - Time-sensitive information on a single, focused topic
  - Audience awareness is the primary goal
  - Minimal formatting, fast turnaround (hours to ~2 days)
  - Informational; may precede full analysis
- **Technical Snapshot** (2-4 pages) - Concise but substantive treatment of a topic
  - Self-contained; stands alone without prior context
  - Light visual support (table, diagram, callout)
  - Moderate turnaround (weeks)
- **Technical Bulletin** (4-8 pages) - Comprehensive coverage
  - Multi-section with full context, background, and supporting data
  - Longer production cycle (weeks-months)
  - Archival quality; suitable for datacom encyclopedia inclusion

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IT Subcommittee Publishing - Approach

Dustin Demetriou

- Small team(s), put together document, following template
- 1-week review and comment by IT Subcommittee
- 1-week review and vote by TC 9.9
- Publish in datacom encyclopedia, with extract published publicly for first release
- Updates made to datacom encyclopedia version only
- Technical Briefs mapped to datacom topics

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Tech Brief Overview

Dustin Demetriou

- Tech Brief has been valuable and well received but we need to accelerate their publication to have a real impact
- Goal is to publish 2 tech briefs every 6 months
- IT Subcommittee monthly meetings will focus on 1x Tech Brief a month to draft content based on a pre-defined outline for prioritized topics
  - Ranking to determine top needs for the next 6 months
  - Lead needs to be identified for the topic
- Outlines can be worked on offline when people have time

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Tech Brief Index

Dustin Demetriou

- Enabling asynchronous collaboration (Google Drive)
  - Request access by emailing tc99publications@gmail.com
  - Must have a gmail address

Tech Brief Roadmap

Subject	Status	Related files	Lead
1. Fluid Testing and Maintenance	Ready for Re…	Fluid Testing an…	John Groenwald,Keegan Yaroch, Tanya Hutter, Lauren Huffman
2. Fluid Quality	Ready for Re…	Fluid Quality	Keegan Yaroch, Tanya Hutter, Lauren Huffman
3. TCS Commissioning	In progress	TCS Commissio…	John Gross
4. Biostatic vs. biocide vs. biofilm	In progress	Biostatic vs. bio…	Tanya Hutter, Matt Hatley
5. L2A CDU Trends	In progress	L2A CDU Trends	Jason Matteson
6. Liquid Cooling Deployment Questions	In progress	Liquid Cooling …	John Gross
7. Bleeding Fluid Networks	Not started	Bleeding Fluid …	Tim Shedd
8. Liquid Cooling TCO	Not started	Liquid Cooling T…	Peter DeBock
9. Multi-Loop FWS Design	Not started	Multi Loop FWS	John Gross
10. S20/S25 Justification	Not started	S20/S25 Trends	Paul Artman
11. TCS Piping Arrangement	Not started	Piping Arrange…	
12. TCS Coolant Integrity and System Readiness Best Practices	Launched	TCS Design Be…	Justin Seter
13. ITE Power Trends	Launched	ITE Power Trends	Dustin Demetriou

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Technical Snapshot

AI's Indirect / Direct impact on Data Center Infrastructure Planning & its Predecessors

Don Beaty

- **Latest & Future Products**
  - **PC -** Since the PC invention, HW engineers recognized the critical need to give the data center industry a heads up about the infrastructure needs of the latest & future products
  - **HW Rapid Change -** If data centers cannot accommodate latest & future products; it is a major problem for everyone. Today's rapid changes are really challenging
- **History of Hardware Engineers informing Data Center Industry**
  - **Originally** - Each hardware manufacturer communicated independently to their customers
- **Thermal Management Consortium**
  - Major hardware manufacturers such as IBM, Dell, HP, Sun, Fujitsu, Cray, Nortel, Intel formed a consortium to inform the industry
- **TC9.9 -** Thermal Management Consortium became TC9.9

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Technical Snapshot

AI's Indirect / Direct impact on Data Center Infrastructure Planning & its Predecessors

Don Beaty

Thermal Mgmt Consortium	TC9.9			
	2005 1st Ed	2012 2nd Ed	2018 3rd Ed	2026 Technical Snapshot
HW Categories	HW Categories	Vol Server Config	Compute Apps	Compute Performance
Servers & Disk Storage Sys	VOLUME Servers (1U, Blades, Custom)	1U, 1 Socket	Scientific	GPC - Gen Perf Computing
		1U, 2 Socket	Analytics	HPC - High Perf Computing
Tape Storage Sys	(2U & Greater)	1U, 3 Socket	Business	Mixed-use
Comm Equip	Storage Servers	1U, 4 Socket	Cloud/IPDC	(combo GPC & HPC)
Workstations	Tape Storage	7U Blade	Visualization	
	Extreme Density	9U Blade	Comm/Telco	
	High Density	10U Blade	Storage	
	Workstations	2U, 2 Socket		
		2U, 4 Socket		
		4U, 4 Socket		

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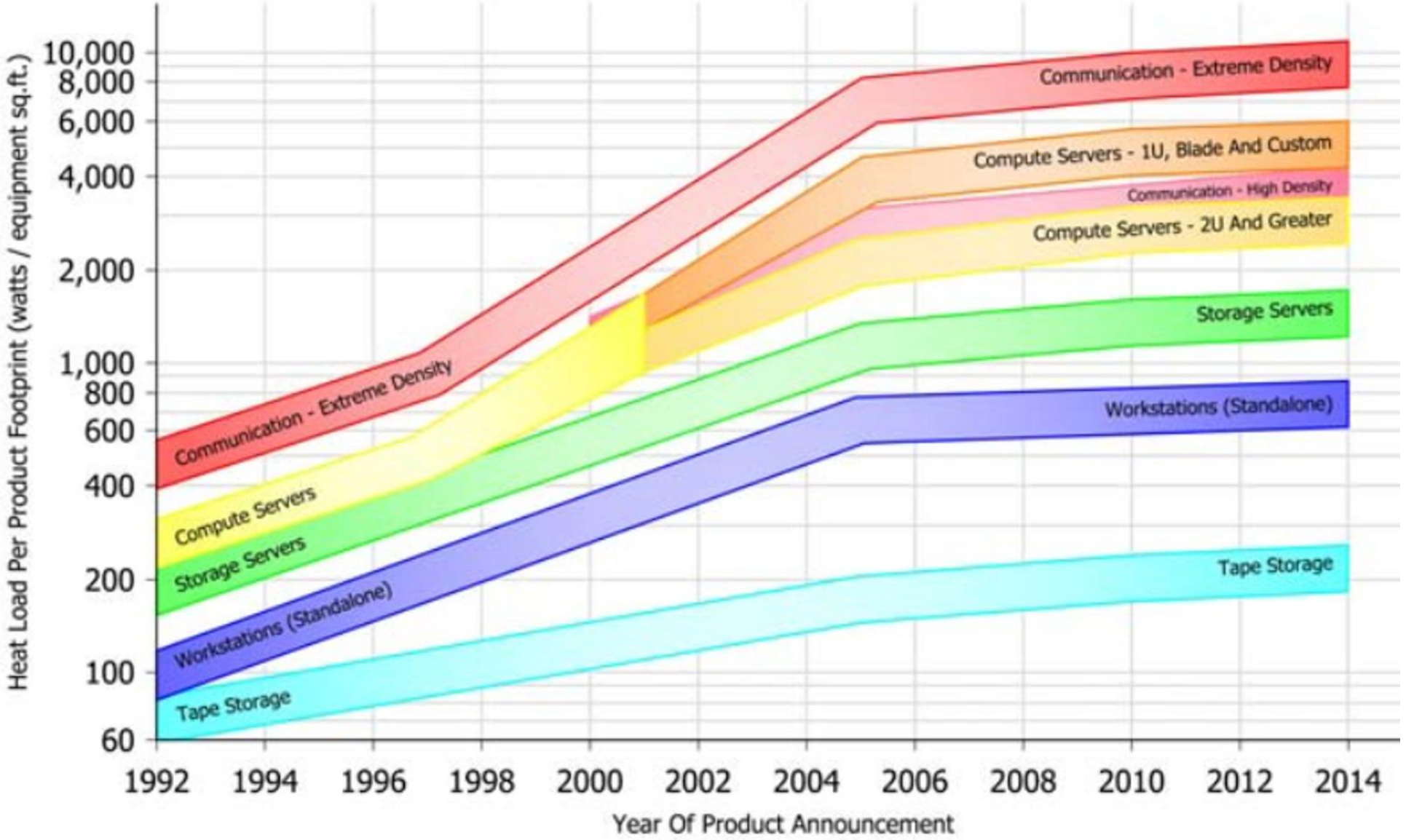
Technical Snapshot

TC 9.9 Trend Chart – 1st Edition

Don Beaty



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Technical Snapshot

TC 9.9 Trend Chart – 3rd Edition

Don Beaty

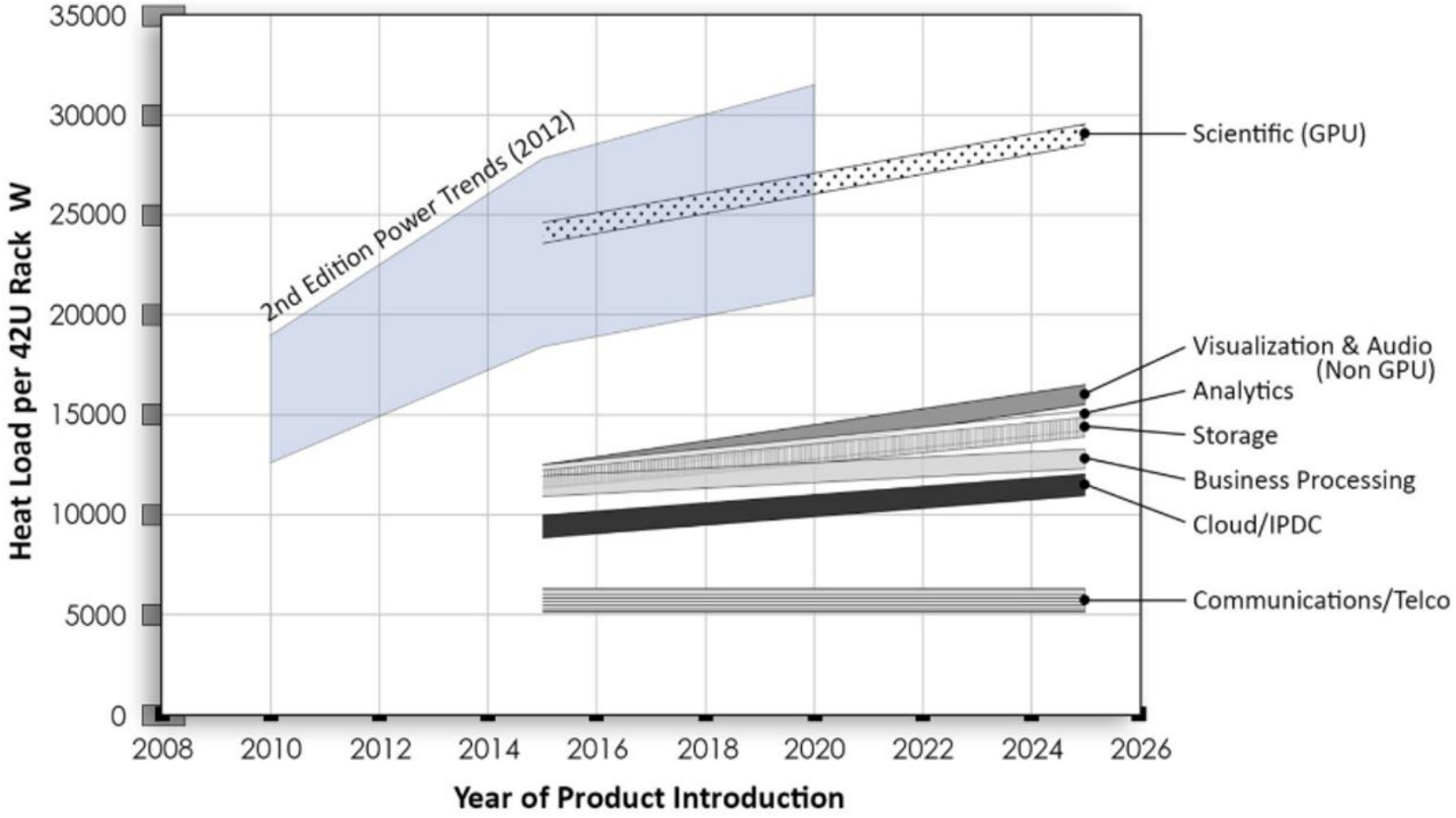

Figure 5.1 Evolution of the ASHRAE power trends from the second edition to the third edition for 2U 2S servers.

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AI Indirect - Direct impact on Data Center Infrastructure Planning

AI's Indirect / Direct Impact on Data Center Infrastructure Planning

6/25/2026 · 3 min read

Artificial Intelligence (AI) is impacting how we live, work, and play including BOTH mixed / dedicated use data centers.

- **Rapid Change –** Hardware (HW) / software (SW) changes are rapid, risking data centers rapidly becoming inadequate to handle the new requirements.
- **Mixed Use Data Centers –** Increasing use cases for one or more high-performance computing (HPC) racks along-side general performance computing (GPC) racks creates the need for more mixed-use data centers.
- **Different Infrastructure Requirements -** HPC racks have more demanding power & cooling infrastructure requirements that are often difficult to meet in a mixed-use data center.

The intent of this Technical Snapshot is to share high level data center infrastructure trends based on insights from the TC 9.9 IT Manufacturer Subcommittee members that work for silicon & HW manufacturers.

- **Scope -** This snapshot includes both commercially available GPC (general performance computing) and HPC (high-performance computing). Hyperscaler-specific hardware based on custom processors / architectures is not within the scope.
- **Future HW Needs -** Rapid change increases the difficulty in planning for future hardware needs without over investment or premature obsolescence.

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AI Indirect - Direct impact on Data Center Infrastructure Planning

General Performance Computing (GPC)

- **Standard HW/SW -** The use of traditional hardware and software architectures designed to handle a wide variety of tasks with moderate resource requirements.
- **Priority -** It prioritizes versatility and cost-efficiency over specialized processing power.
- **Infrastructure** – other than extreme use cases, infrastructure is traditional.

High-Performance Computing (HPC)

- **Super Computers / AI Clusters -** The use of "supercomputers" or computer clusters to solve complex computational problems that are either too large for standard computers or would take too long to process.
- **Priority -** It prioritizes parallelism and throughput.
- **Infrastructure –** extreme density, often different requirements for form-factor, space, power & cooling.

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AI Indirect - Direct impact on Data Center Infrastructure Planning

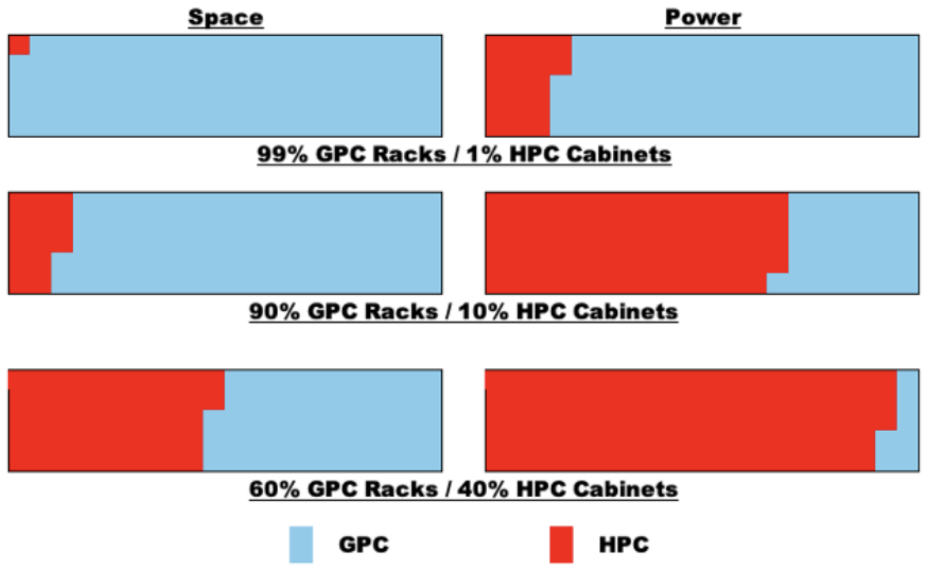
High-Level Infrastructure Trends

HPC power, cooling, & structural support differences vs. GPC

- **HPC Cooling Infrastructure –** often has both air & liquid cooled components, the latter requiring coolant distribution units.
- **HPC Power Infrastructure –** often high-voltage 3 phase AC or direct current (DC) vs. GPC 3 phase (208/415V) or single phase.
- **HPC Structural Infrastructure –** often higher floor and ceiling loading required for heavier cabinets, fluid distribution systems, power delivery, and dense networking.

Impact of HPC on mixed-use data centers

- A small number of HPC cabinets has an outsized impact on the data center power, cooling & structural requirements.
- **High density zones –** Dedicated zones are required to support HPC in a mixed-use data center.



Comparing Space & Power Needs of Mixed-Use Data Halls with varying % HPC Cabinets

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AI Indirect - Direct impact on Data Center Infrastructure Planning

Installed Server Volume Trends

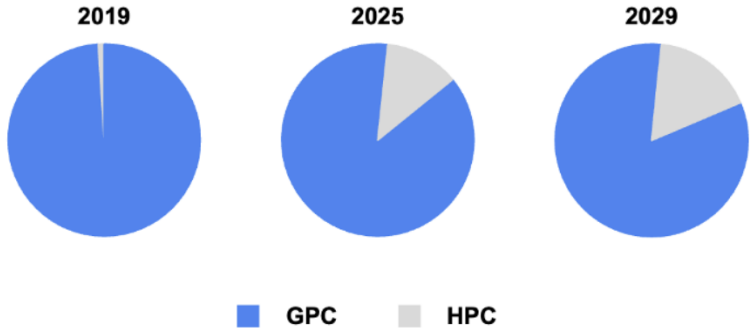
Although AI dominates the news, the MAJORITY of servers continue to be GPC.

- **Growth vs Majority –** Although HPC growth from 2023 to 2026 has been significant, it's still a small percentage of total servers
- **Future Growth vs Majority –** All indications are continued significant future HPC growth

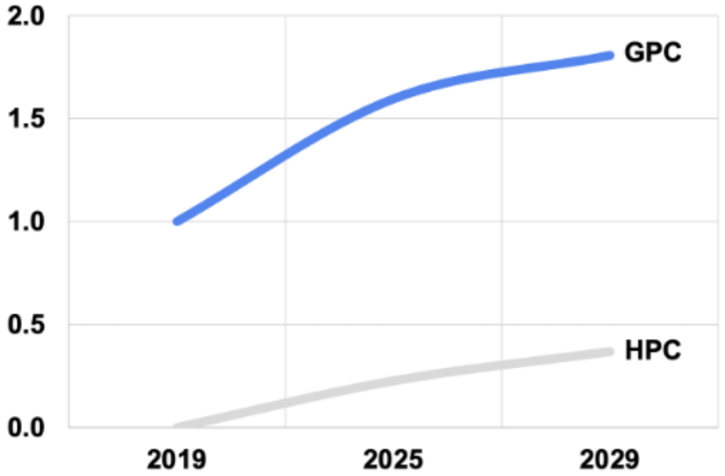
The many use cases for general performance computing are not declining, resulting in general performance servers being the majority for the foreseeable future.

- **AI Agent Orchestration & Small Language Models -** Are heavy users of GPC (CPU, memory, and GPU)
- **Hybrid / Private Cloud –** Is growing in popularity due to security, data sovereignty, economics, etc.
- **LLMs / Inference –** Large Language Models and inference are rapidly growing and requiring higher compute density per rack

[1] HPC volume before 2019 was not zero but very small compared to total server volume



Share of Rack Shipped Volume



Growth in Installed Servers [1]
(relative to 2019 total volume)

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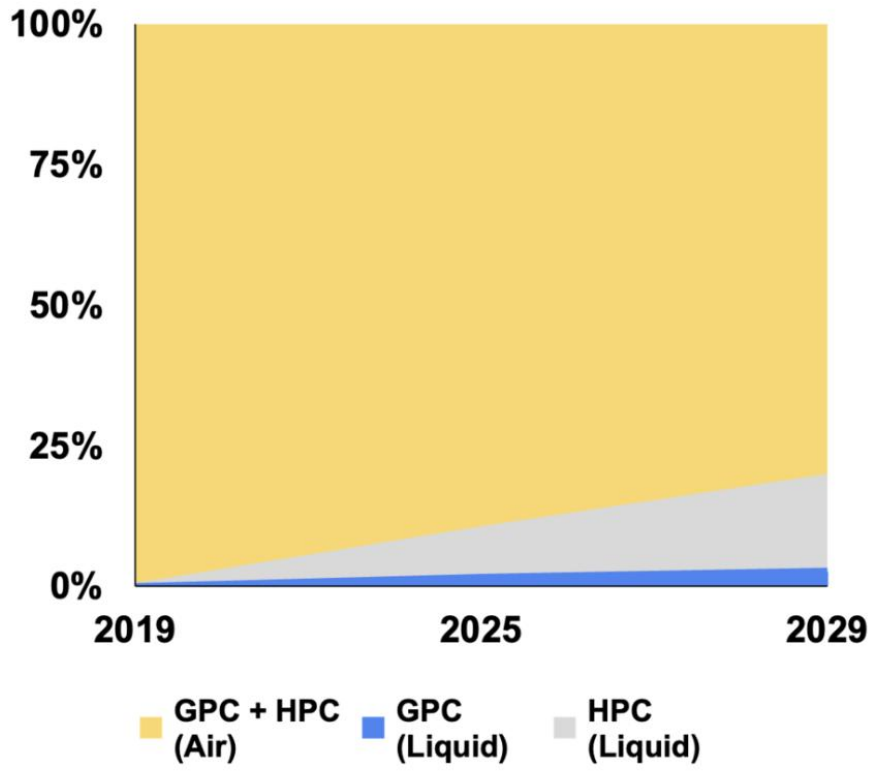
AI Indirect - Direct impact on Data Center Infrastructure Planning

GPC Liquid Cooling Trends

HPC undoubtedly will demand liquid cooling, but a portion of GPC will grow to also require and/or prefer support for liquid.

- **GPC High Density –** kW/Rack exceeding the cooling capability of air toward the end of the decade
- **Supply Chain –** Robust liquid cooling supply chain setup by HPC enables new use cases in GPC
- **Efficiency –** Regulation and sustainability drive the need for liquid cooling in on-premises data centers



Share of Total Installed Servers by Cooling Type

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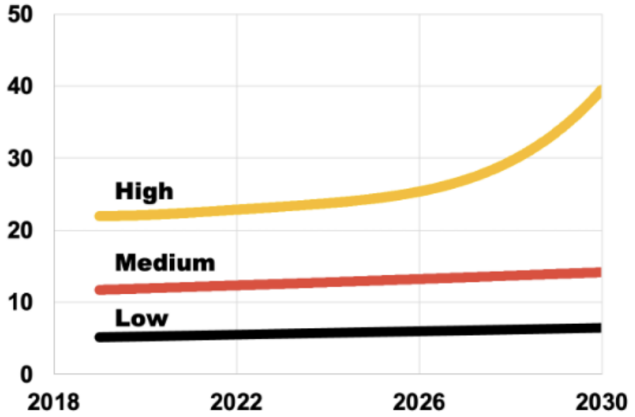
GPC and HPC Infrastructure Trends

GPC kW/Rack. The trend is on premises to be replaced with hybrid cloud which tends to have a higher utilization rate.

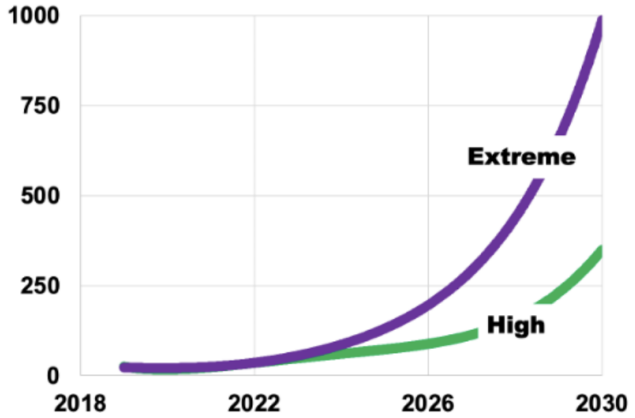
- **GPC Low Density –** Typically no justification to increase kW/Rack
- **GPC Medium Density –** Typically some performance improvement through increased kW/Rack
- **GPC High Density –** Typically good performance improvement through increased kW/Rack and the hardest to predict future requirements. Trending towards HPC-like infrastructure (rack, cooling & power)



GPC Power Trends
kW / Rack

HPC kW/Cabinet. The trend is mixed-use high-density zone or specialized data centers with unique installation requirements (e.g. larger cabinets [800 mm or 1200 mm] vs. standard rack).

- **HPC High Density –** Typically good performance improvement through increased kW/Cabinet
- **HPC Extreme Density –** Significant latency and training performance improvement through increased kW/Cabinet due to shorter interconnects and reduced networking overhead



HPC Power Trends
kW / Cabinet

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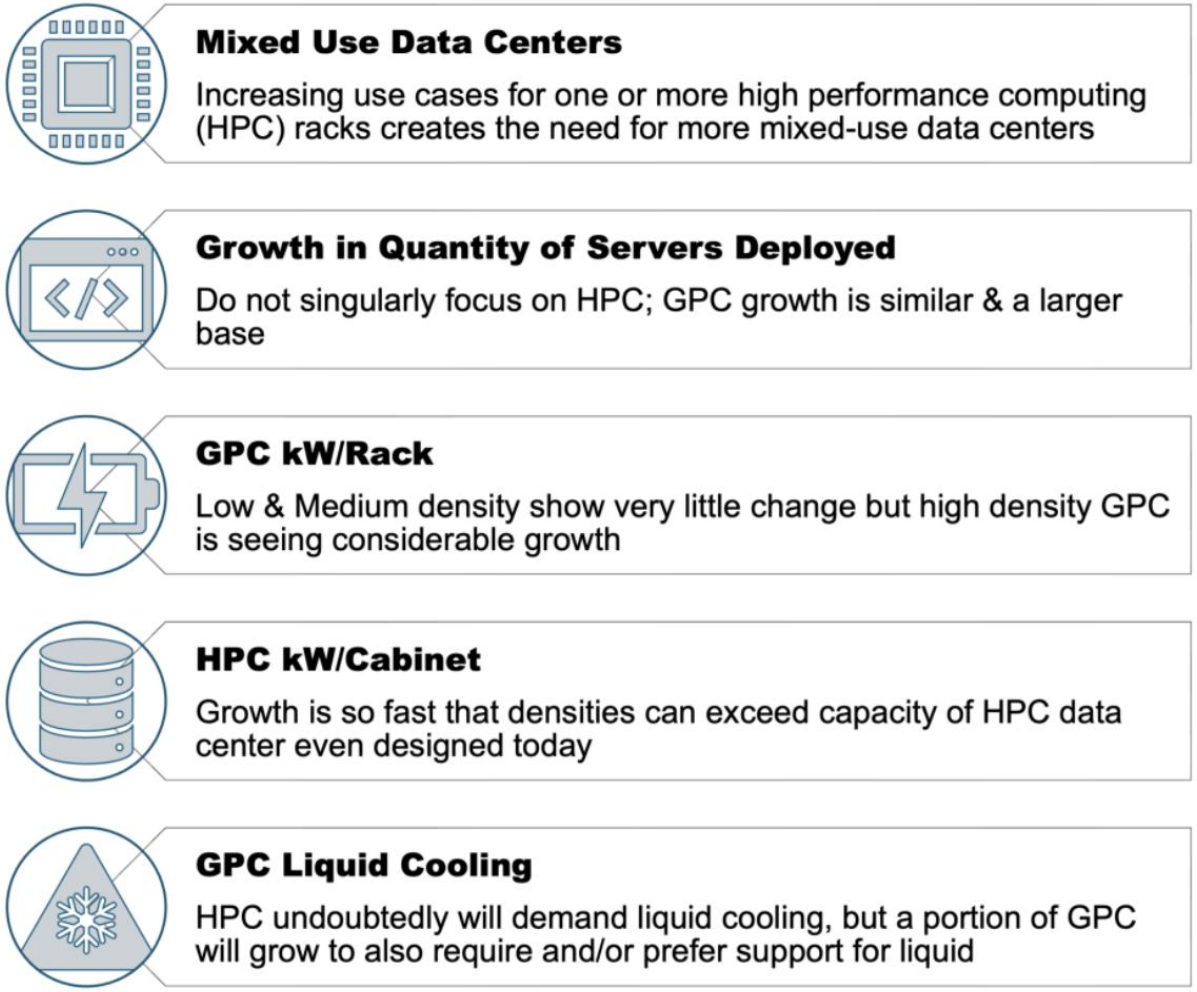

AI's Indirect / Direct Impact on Data Center Infrastructure Planning

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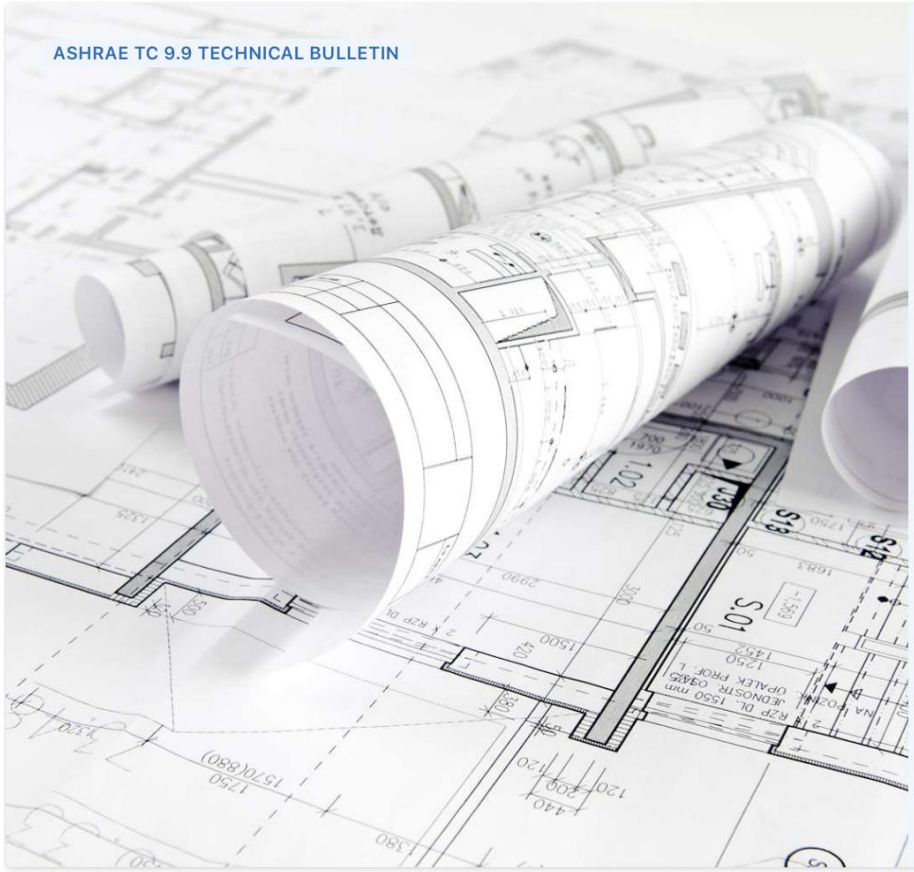
TCS Coolant Integrity and System Readiness Best Practices

ASHRAE TC 9.9 DATACOM ENCYCLOPEDIA

TCS Coolant Integrity and System Readiness Best Practices

Published 5/20/2026



TL; DR

It is too easy to **violate** direct to chip cooling system operational and warranty requirements. This Technical Bulletin flags four areas where deviations from design intent can create problems that aren't immediately obvious but can cause real damage down the line:

Coolant composition: Systems are designed around a specific coolant (e.g., propylene glycol mix). Drifting from that changes corrosion protection, pressure drop, pump behavior, and heat exchanger performance in ways that cascade through the whole system.

Air management: Entrained air reduces cooling effectiveness, causes pump cavitation, accelerates corrosion, and can drag out commissioning. Proper vent placement and purge procedures are critical, especially at startup.

Stainless steel passivation: Welding and fabrication damage the passive corrosion-resistant film on stainless piping. Without proper cleaning, passivation, and flushing afterward, there is risk of metal release into the coolant and fouling of sensitive microchannel surfaces.

System pressure ratings: Designers need to model the full pressure cascade to ensure no component ever sees pressure beyond its rating.

Read the Bulletin

PDF

Encyclopedia

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TCS Coolant Integrity and System Readiness Best Practices

This Technical Bulletin highlights **design and operational-basis assumptions** that are commonly embedded in equipment selection, modeling, factory testing, and commissioning. It identifies **conditions where additional review** may be warranted to maintain alignment with original system intent and to reduce avoidable schedule and reliability risks. A structured technical review is recommended when one or more of the following conditions has occurred:

- Deviation from the design-basis coolant formulation or concentration (e.g., coolant chemistry changed without confirming impacts or coolants mixed).
- Persistent entrained air, recurring air binding, or prolonged difficulty fully venting the system.
- Field welding or fabrication of stainless-steel piping/components after cleaning/passivation.
- Extended construction delays with stagnant or partially filled systems (which increases risk of contamination, oxidation, or inhibitor depletion).
- Change to fill/makeup water source or chemistry management approach.

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TCS Coolant Integrity and System Readiness Best Practices

DESIGN CONSIDERATIONS

Coolant Composition

Coolant composition and quality are typically established during design and used as the basis for sizing and validating cold plates, CDUs, pumps, heat exchangers, and control sequences.

A nominal 25% (by volume) propylene glycol–water mixture (PG25) is commonly used as a single-phase TCS design condition in many deployments.

Why composition matters

- Thermophysical properties change with concentration (viscosity, density, specific heat, thermal conductivity).
- Hydraulic effects include altered pressure drop, flow distribution, and pump operating point (including NPSH margin considerations on the suction side).
- Thermal impacts include changes in heat exchanger effectiveness and approach, and potential impacts to CDU control stability (valve authority, bypass fraction, pump speed control).
- Chemical/biological considerations vary with concentration; glycol–water mixtures can inhibit microbial growth at commonly used concentrations but do not eliminate the need for contamination control and monitoring. Several bacteria-ingress mechanisms are possible during both construction and operation.
- Glycol should meet the minimum recommended quality defined by TC 9.9* or specified by the ITE manufacturer.

Air Management

Air in a liquid cooling loop can reduce heat-transfer effectiveness and disrupt hydraulic performance.

In practice, air management issues can prolong commissioning, contribute to pump noise/cavitation, accelerate corrosion, and create intermittent performance faults (e.g., air binding in high points, reduced flow through heat transfer surfaces).

Air can enter or remain in the system in many ways, including (but not limited to):

- During filling, equipment connection/disconnection, and maintenance activities.
- In-leakage via seals, fittings, vents, and negative-pressure conditions.
- Release of dissolved gases as pressure decreases and/or temperature increases along the circuit.
- High points created by unvented and poorly routed flexible hoses.

Design Practices to Support Effective Removal

- Locate air separation where fluid temperature is relatively high and pressure is relatively low (often on the return line near the CDU inlet and pump suction).
- Provide manual/automatic vents at separators and at known high points; avoid vent locations that can leak or draw in air; capture any vented water/glycol fluid and avoid discharging to sanitary systems.
- Avoid geometries that trap air (vertical dead legs, inverted “U” bends, localized high points without venting).

* Accessed via subscription to the TC 9.9 Datacom Encyclopedia

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DESIGN CONSIDERATIONS

Stainless-Steel Passivation

Stainless steel relies on a chromium-oxide passive film for corrosion resistance.

Fabrication, grinding, handling, and welding can introduce free iron and heat tint that compromise this film and can drive localized corrosion or metal release into the coolant. Proper cleaning of weld beads plays an important role in improving surface finish and preventing contamination (e.g., ASME B31.3 and AWS D18.1).

Maintaining surface condition is therefore a key element of TCS cleanliness and chemistry stability. Passivation is the process that is used to:

- Reduce early-life metal release that increases inhibitor demand and complicates initial fluid stabilization.
- Limit particulate formation and downstream fouling risk in strainers, filters, valves, and microchannel heat transfer surfaces.
- Support long-term reliability and repeatable commissioning results across phased expansions.

Typical passivation approaches

- Factory / Shop: controlled cleaning, chemical passivation (e.g., nitric or citric formulations) by submersion, thorough rinsing, drying, and packaging to prevent recontamination.
- Field: Piping system interior is subjected to controlled cleaning, chemical passivation (e.g., nitric or citric formulations), neutralization, thorough rinsing, and control of runoff per site constraints.
- **Note**: It is important to remember that what applies to part of this system MUST apply to all. An individual installed component that is NOT passivated can jeopardize the operation of the system.

System Pressure Rating

Pressure ratings of all components of a TCS system must be understood as part of the design process.

Besides confirming that secondary pumps have sufficient total dynamic head (TDH) to pump through the system, designers must also make certain that possible pump operating conditions will not exceed rated pressure of any component.

If the pressure in any part of the system exceeds the ratings of that component, it may result in a failure condition. This is especially true of IT equipment, where the risk is costly failure.

Pressure analysis

- A hydraulic model is recommended to ensure the pressure cascade is understood at all points in the system.
- Pressure analysis must include conditions outside of normal, steady state operation. Sources include the project specific flush, clean and fill pressures, static height of the system, maximum pressure set by the system pressure relief valve(s), expansion tank pre-charge pressure (both the low- and high-pressure values), and pressure excursions that occur during the connection or disconnection of equipment.
- IEC 62368-1 (4th Edition)* requires a hydrostatic pressure ***safety test*** of 1.5x the *rated maximum working pressure*. The systems pressure relief value must be set to lower than the *rated maximum pressure* – which ITE manufacturers should specify in their product’s thermal template*.
- Many CDU manufacturers provide customization for pressure relief valves which must be selected and aligned to the requirements of the system.

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TCS Coolant Integrity and System Readiness Best Practices

OPERATION CONSIDERATIONS

Coolant Verification

Coolant verification and lifecycle considerations

- Verify using a lab test and document the concentration and fluid quality at initial fill, after any significant addition of makeup fluid, and on a periodic schedule as specified by the manufacturer.
- Control the quality of mix water used for dilution and makeup* to avoid introducing ionic contaminants or particulates.
- Document the design-basis fluid specification (manufacturer, inhibitor package, concentration, target pH, conductivity limits, filtration strategy) and wetted material compatibility* and include it in turnover deliverables. Include guidance indicating ITE manufacturer-approved fluids and limitations of product mixing or replacement
- Recognize that lifecycle changes (adding new racks, activating previously stagnant branches, replacing components) can introduce contaminants or alter fluid conditions; maintain monitoring and corrective-action protocols.

Passivation

Passivation verification and documentation

- Confirm removal of free iron and acceptable surface condition using accepted methods (e.g., ASTM A380/A967 guidance, fluid analysis and associated ferrous contamination tests).
- Retain passivation records and test results as part of turnover documentation; where 100% testing is impractical, apply a documented QA sampling plan.

Commissioning

Commissioning practices that support air removal

- Automatic air vents are an important part of system startup, ensuring air is effectively removed during the initial filling and commissioning process. Everyday service activities (e.g., filter maintenance or IT equipment additions) can introduce air into the system that needs to be removed. Automatic air vents provide ongoing protection against this. While some end users may desire to replace these with manual air vents once the system has been confirmed air-free via real time monitoring of performance, this decision deserves careful consideration. Many automatic vents contain a cap that can be closed; effectively making them manual vents, or if allowed by local code, a more practical approach is to install a manual isolation valve at the vent that can be closed when the system is confirmed air-free.
- Degassing is most effective at elevated temperatures, which are often only reached during normal operating conditions or commissioning with load banks. Issues can appear weeks after start-up once the system is at steady state temperatures.
- Provide purge connections and commissioning procedures that enable high-velocity flushing of branches to mobilize trapped air (do not exceed equipment manufacturer limits).
- Confirm operation of vents and separators during functional testing and after thermal transients (startup, step-load changes).
- Vacuum or semi-vacuum filling is a technique that some in the industry have found effective for reducing trapped air in the TCS. Because a mixture like TCS coolant may undergo a separation of components when exposed to a vacuum, it is recommended that coolant sampling and laboratory testing be performed after the filling process to ensure that acceptable concentrations of all coolant components are present throughout the TCS.

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OPERATION CONSIDERATIONS

Foreign Material Exclusion

Foreign material exclusion (FME) and post-treatment practices

- Protect cleaned/passivated surfaces during transport and installation using clean, non-contaminating materials.
- Perform controlled flushing and filtration prior to final fill; flush water should meet or exceed Water Quality Guidelines for TCS loops* or ASTM D1193 Type II (C).
- Verify cleanliness (via fluid testing and analysis) before connecting sensitive equipment.
- Reassess surface condition and fluid quality after late work or extended stagnation periods via fluid testing and analysis.

Pressure Management

System pressure safeties

- A combination of controls-based pressure management and mechanical pressure management should be considered, as required by local code and/or authority having jurisdiction (AHJ).
- Controls-based alarms and bypass valves can be included to ensure pressure remains within expected ranges during normal operation.
- Mechanical safeties, such as pressure reducing valves and/or pressure relief valves, should be considered as ultimate safeties, since fill pressure settings and controls sequences could be subject to operator overrides. These should be visually verified to be operable and not left in an override position after commissioning.

Field Verification Checklist

Topic	What to verify	Examples of methods / evidence	Why it matters
Coolant formulation	Manufacturer, concentration, quality and inhibitor package match design basis	Refractometer/density check; chemical vendor documentation; mixing procedure	Hydraulic/thermal performance and chemistry stability are concentration-dependent
Particulate / cleanliness	Filtration strategy implemented and effective	Filter ratings; differential pressure trends; flushing records; cleanliness sampling plan	Protects sensitive heat transfer surfaces and valves; reduces commissioning churn
Air management	Air separators, vents, and purge points function; high points are able to be vented	Functional test results; vent locations; purge procedure; observed stable DP/flow after transients	Avoids air binding, cavitation, corrosion, and performance instability
Stainless surface condition	Post-fabrication cleaning/passivation completed and documented	ASTM A380/A967-based procedure; ferrous contamination tests; records	Reduces localized corrosion and metal release into coolant
Lifecycle changes	Expansion/maintenance plan includes fluid QA before reconnecting	MOP/SOP; sampling schedule; acceptance criteria; corrective actions	Phased deployments can re-introduce contamination or alter chemistry

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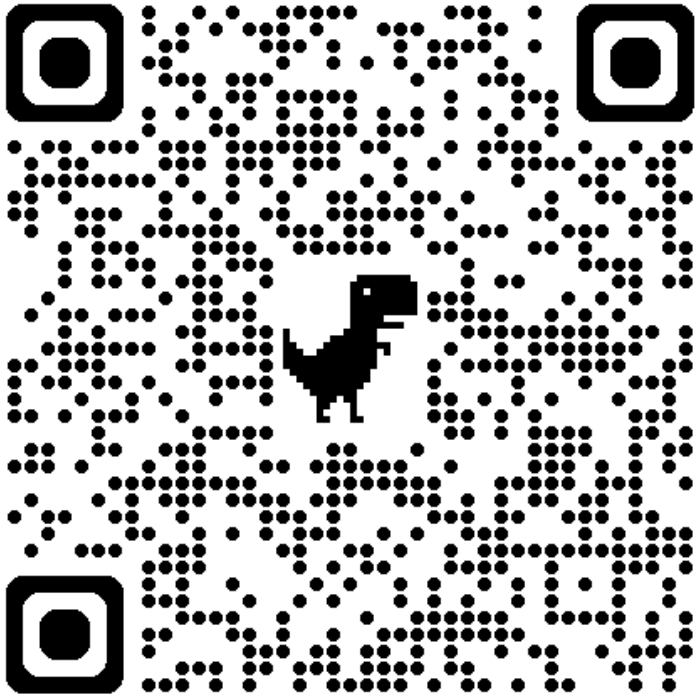
Main TC 9.9 Meeting Closed

Monday Meeting Attendance



ASHRAE TC 9.9 Website

https://tc0909.ashraetcs.org

Datacom Encyclopedia

https://datacom.ashrae.org

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BREAK – 10 Minutes

ASHRAE TC 9.9 Attendance Record

ASHRAE Technical Committee 9.9 - Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

Meeting Attendance is tracked via a Google form. Please complete the attendance form for each meeting…

Monday Meeting Attendance

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IT Mfg Subcommittee Closed Door Session

TC 9.9 members that work for chip & HW manufacturers have insight into products being developed.

TC 9.9 has been most successful when they are able to tap into that insight to translate current & future HW needs into infrastructure requirements.

- **Translate Requirements** - Since its inception, TC9.9 focuses on translating hardware / software requirements into data center infrastructure requirements.
- **Future HW Needs** - Rapid change increases the difficulty in planning for future hardware needs without over investment or premature obsolescence.
- **Best Visibility** – TC 9.9 IT Subcommittee has the best visibility into hardware products being developed.
- **High Level Data Center Infrastructure Trends** - The intent should be to share insight and translate it into high level data center infrastructure trends in an ***unbiased, vendor-neutral*** format.

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Discussion Topics

- IT Power Trends Tech Snapshot
  - Do we need it to be more comprehensive?
  - How can we collect data on products that can be mapped to the trends
- Difficulty to cool chart update
  - Who has the source chart?
  - What was the methodology for thermal resistance?
  - How do we get additional data?
- Air cooled server trends
  - Pressure impact of high airflow servers
  - Airflow and power vs. temperature
- Liquid cooled server trends
  - Acoustics
  - Airflow and power vs. temperature

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